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# Improving Productivity and Fruit Quality in Murcott Mandarin Trees by Foliar Application of Chelate Zinc and Algae Amphora Coffeaeformis under New Valley Conditions

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**Abstract**

A FIELD experiment was carried out during 2020 and 2021 seasons on 7 years old Murcott mandarin trees grown in sandy soil under drip irrigation system from well at private orchard at El farafra road , Alwadi aljadid Governorate Egypt. The aim of this study is to investigate the effect of four levels of algae foliar spray Algae 90% *Amphora Coffeaeformis* (0.0, 0.5, 1 and 1.5 g/litter) and three levels of chelate Zinc foliar spray at (0.0,0.4g and 0.8g/litter) on vegetative growth parameters, yield and fruit quality of Murcott mandarin trees. Obtained results showed that the combination of chelate zinc and Algae 90% Amphora Coffeaeformis enhanced vegetative growth parameters, yield, and fruit quality traits when compared with untreated trees (water spray). As a conclusion, the combination between algae *Amphora Coffeaeformis* (AC) at 1g spray and chelate zinc(CZ) at 0.8g recorded the best results of vegetative growth ,fruit set percentage , number of fruits /tree , yield / tree , yield / feddan , fruit physical properties , fruit chemical properties and leaf N%,P%,K% content.

**Keywords:** Mandarin, Murcott, Algae, Chelate zinc, Fruit set, Yield.

## Introduction

Alwadi aljadid (The New valley), is situated in Egypt›s western desert›s southwest corner. The area covers around 376505 square kilometers, or roughly 56% of Egypt›s western desert and 37.6% of Egypt›s overall land area. The New Valley Governorate›s five districts—El-Kharga, Paris, Balat, Mut, and Farafra—as well as the East Ewinate area are the only areas where agricultural expansion is permitted (Salah et al., 2017). Numerous powerful and promising agricultural projects have recently been initiated in this region (Sara et al., 2018)

Tucker et al, (1998). Mentioned that in 1916, tangerine and sweet orange hybridization carried out by the USDA citrus breeding program in Florida resulted in the creation of the «Murcott» mandarin. In addition, when the fruit load on the tree is moderate, the fruit size is medium. When fully grown, the flesh is a rich orange color, with a yellowish-orange peel. Peeling is not too difficult, and the rind is smooth and thin. The commercial harvest season for the «Murcott» mandarin is from January to March. The citrus reticulata blanco, or «Murcott» mandarin, is one of Egypt›s most important new export crops.

Zinc is a necessary metal for healthy plant development and growth. (Cakmak, 2000) It is crucial to numerous vital physiological processes, including IAA and protein metabolism (Marschner, 1995). It is commonly recognized that zinc plays a crucial role in the manufacture of numerous essential enzymes, which are involved in photosynthesis (Brown et al., 1993). It maintains membrane and DNA-binding protein structures stable (Aravind and Prasad, 2004). Plants› nitrogen metabolism depends heavily on zinc, and plants with low zinc levels have lower

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protein contents (Mengel et al., 2001 and Hassan et al., 2010). Also, EL-Baz (2003) mentioned that zinc sulfate treatment increased yield and enhanced the physical and chemical characteristics of the fruit on Balady mandarin trees. Masoud et al (2019) mentioned that foliar application of Zinc on growth and fruiting of Balady Mandarin trees enhanced the fruit set percentage and yield/ tree. Also, it improves the growth traits and total chlorophyll as well as the total carbohydrates, nitrogen content, and C/N ratio of the shoots, as well as the fruit weight, pulp percentage, total soluble solids, sugar, and vitamin C contents, and decreased the overall acidity.

Algae have long been used as food and medicine and are both commercially and environmentally beneficial. Extracts from several algae species have been employed recently in a wide range of foods, dairy products, medications, and cosmetics. (Raja et al., 2013). *Amphora coffeaeformis* (AC), a member of the Catenulaceae family, is important for the manufacture of biodiesel because of its quick growth (Chtourou et al., 2015). It is one of the diatoms that is recognized as a source of biochemical products, including lipids, proteins, and carbohydrates (Rajaram et al., 2018). Additionally, the extract from Amphora coffeaeformis is rich in bioactive components that can increase the productivity of agricultural crops, such as fatty acids, vitamins C and E, hormones, amino acids, and certain macro and microelements, particularly P, Fe, and Zn. These include plant pigments like chlorophyll and carotenoids as well as natural antioxidants (El-Sayed et al., 2018). Applying algae contributes to a reduction in the quantity of chemical pesticides and fertilizers needed in agriculture (Radkowski and Radkowska, 2013). The effect of algae on reducing tress may be due to releasing certain chemical compounds that differ in their metabolic process. (Fabio et al., 2014). Meanwhile, Noha and Shaimaa (2021) demonstrated spraying Amphora coffeaeformis algae extract to “Le-Conte” pear trees at a 500 ppm level progressively enhanced the fruit’s yield, chemical characteristics, macro-nutrient content.

The aim of this trial is to detect the novel approach to enhance growth and yield (quantity& quality) of “Murcott “mandarin trees grown in new reclaimed soils under new valley conditions by determine the application level of chelate zinc (CZ) . As well as the suitable dose of the algae extract *Amphora coffeaeformis* (AC) with possibility to select the best combination between them.

## Materials and Methods

The present study was carried out during two successive seasons 2020 and 2021 at private orchard at El farafra road, El wadi el gadid Governorate 27o52’43.8’’N28o36’01.3’’E Egypt. Seven years old Murcott mandarin trees *(Citrus sinensis* L. Osbeck × *Citrus reticulate* Blanco) -old budded on Volkamer Lemon rootstock (*Citrus volkmeriana* Tan & Pasq.), grown in sandy soil and spaced 5 x 5 m apart subjected to drip irrigation system. Soil samples were collected from 2 depths (0-30cm and 30-60 cm) and physical and chemical analyses were determined as shown in Table (1). Also, chemical analysis of irrigation water as shown in Table (2)

Thirty-six healthy trees, nearly uniform in shape, size and productivity were arranged in randomized complete block design with three replicates for each treatment and each replicate was represented by one tree. The foliar treatments consisted of four levels of algae 90% *Amphora Coffeaeformis* (AC) (0, 0.5, 1.0 and 1.5 g/litter) and three levels of chelate Zinc (CZ) (0.0, 0.4 and 0.8g/litter. Treatments are described as follows:

| | | | |
|---|---|---|---|
| 1 | Control water spray | 7 | Algae 90% at 1g/L |
| 2 | Chelate zinc at 0.4g/L | 8 | Algae 90% at1g+Chelate zinc at 0.4g/ L |
| 3 | Chelate zinc at 0.8g /L | 9 | Algae 90% at 1g+Chelate zinc at0.8g. / L |
| 4 | Algae 90% at 0.5g/L | 10 | Algae 90% at 1.5g. /L |
| 5 | Algae 90% at 0.5g+Chelate zinc at 0.4g/L | 11 | Algae 90% at 1.5g+Chelate zinc at 0.4g. /L |
| 6 | Algae 90% at 0.5g+Chelate zinc at 0.8 g/L | 12 | Algae 90% at 1.5g+Chelate zinc at 0.8g. /L |

All trees under study received the same horticulture practices including fertilization and drip irrigation. However, foliar sprays of algae Algae 90% *Amphora Coffeaeformis* (AC) or chelate zinc (CZ) as well as their combinations were carried out at three times during each season at full bloom, after fruit set and one month later. Meanwhile, the control trees were sprayed with tap water. Tween-20 was added at 0.1% as a surfactant to spray solution for each treatment including the control "tap water". Spraying was carried out using compression sprayers (5L solution/tree) at the previously mentioned times. Responses of Murcott mandarin trees to the tested treatments were determined through the following parameters:

*Vegetative growth:*

- Leaf area ($cm^2$) using a leaf area meter (model cl -203, USA)
- Total chlorophyll as described by Moran and Porath (1985)
- Number and length of branches (cm) resulting from the current growing season were taken.

*Yield properties:*

- *Initial fruit set:* Flowers were counted the last week of April to calculate the fruitlets (the second half of May ) as follows: Number of fruitlets /total number of flowers x 100
- *Yield kg/tree*: The yield per tree was weighed and recorded
- *Total yield (ton) / feddan*: It is calculated by weighing the tree yield to the total number of trees per feddan
- *No. of fruits/tree*: At harvest time, the number of fruit per tree was counted.

*Fruit quality*:

- *Fruit physical and chemical properties*: Twenty-five fruits were taken at harvest (at 2nd week of February) from each treated tree for determination of the following physical and chemical properties.
- *Fruit physical properties* including fruit volume (ml), submerging it in a container with water and measuring the volume of the displaced water. Fruit weight, fruit juice percentage, peel weight (g), peel percentage, pulp weight (g) and pulp percentage were measured.
- *Fruit chemical properties*: Total sugar percentage, total soluble solids % (T.S.S.%) was measured by digital refractometer. Percentage of titratable acidity as g citric acid / 100 g Fresh weight and L. ascorbic acid (mg /100 ml juice) were determined according to A.O.A.C. (1995).

*Leaf mineral content:*

- Thirty leaves (third or fourth leaf from top) of 6-month-old developing non-fruiting shoots from the spring cycle were collected to determine macronutrient (N, P, K) content. These leaf samples were taken at the end of September of each season. Leaf samples were washed with tap water then with distilled water to remove the dust. After washing, they were dried in an electric oven at 70ºc for 72 hours. The dried leaves were ground, digested and prepared for analysis using the method described by Parkinson and Allen (1975).
- Total nitrogen was determined by the semi-micro Kjeldahl method (Bremner, 1965).
- Phosphorus was estimated by the method of Chapman and Pratt (1961).
- Potassium was determined by the flame-photometer according to Jackson (1958).

At harvest time, Number of fruits per tree was counted at 2nd week of February. Yield was evaluated at harvest stage by Kg/tree and then Ton/feddan per feddan

*Statistical analysis*:

The layout of experiment was a completely randomized block design (RCBD). The experiment included 12 treatments each treatment included three replicates; each replicate one tree. The data were statistically analyzed as analysis of variance according to Snedecor and Cochran (1990). Duncan's multiple range test (Duncan, 1955) at 5% level was used to compare treatments mean values.

**TABLE 1. Chemical analysis of experimental soil .**

| Soil depth | Texture class | pH Soil past | EC ppm | $CaCo_3$ % | Soluble cations (meq/l) | | | | Soluble anions (meq/l) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $Ca^{++}$ | $K^+$ | $Na^+$ | $Mg^{++}$ | $Cl^-$ | $SO_4$= | $CO_3+HCO_3$ |
| 0-30 | sand | 7.99 | 1910 | 8.05 | 7.6 | 1.3 | 14.0 | 3.6 | 16.8 | 9.5 | 0.2 |
| 30-60 | Sand | 7.85 | 1960 | 7.15 | 8.1 | 1.6 | 12.5 | 3.1 | 15.3 | 9.7 | 0.3 |

**TABLE 2. Chemical analysis of irrigation water .**

| P H | E.C. $dSm^{-1}$ | Soluble cations (meq/l) | | | | Soluble anions (meq/l) | | |
|---|---|---|---|---|---|---|---|---|
| | | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | $Cl^{-}$ | $CO_3^{-}$ | $HCO_3$ |
| 6.56 | 0.33 | 1.47 | 2.18 | 3.16 | 0.61 | 6.24 | - | 1.18 |

**Results and discussion**

*Vegetative growth*

*Leaf area ($cm^2$)*

Table (3) illustrates that the data of Murcott mandarin trees of leaf area (cm2) have been positive affected by the foliar application of chelate zinc (CZ) and algae *Amphora Coffeaeformis* (AC) either alone or in combination during two growing seasons. The combination between algae *Amphora Coffeaeformis* (AC) at 1g /l spray and chelate zinc (CZ) at 0.8g/l led to a decrease in leaf area ($cm^2$) . The positive increase in the number of branches caused by this treatment led to a decrease in leaf area On the other hand, untreated trees gave the highest leaf area and had the lowest number of branches

*Leaf total chlorophyll content:*

The presented results in Table, (3) showed that trees sprayed by the combination between algae *Amphora Coffeaeformis* at 0.5 ,1 and 1.5 g/l and chelate zinc at 0.4g and 0.8g /l significantly increased total chlorophyll leaf content as compared with trees sprayed with tap water in both studied seasons. Foliar spraying the combination of algae Amphora Coffeaeformis at 1g/l and chelate zinc at 0.8g/l recorded total chlorophyll content in leaf of 1.079 and 1.005 mg/100g fresh weight but the control trees ( spray with tap water ) recorded the lowest values ( 0.724 and 0.756 mg/100g fresh weight ) in both studied seasons respectively . In addition, other treatments showed average values in this regard.

*Number of branch:*

As shown in Table (3) the obtained results indicated that control trees exhibited the lowest branch number (7.4 and 8.1), respectively in the two studied seasons. On the contrary, trees treated with algae Amphora Coffeaeformis at 1g/l +chelate zinc at 0.8g/l gave the higher number of branches in both seasons (14.5 and 14.0), respectively followed by other combined treatments at all concentrations compared with control and other treatments. In addition, foliar application of algae extract in the two seasons had also a beneficial effect in this concern as compared with the control. Finally, from data recorded in Table (3) all combination treatments surpassed all chelated zinc and algae extract treatments and gave a positive effect on increasing branch number in both studied seasons.

*Branch length:*

The results presented in Table (3) recorded the effect of spraying mandarin tree with various treatments on branch length. It is clear that branch length was significantly increased by all foliar application treatments at all concentrations compared with the control. The untreated trees had recorded (6.9 and 7.4 cm) branch length in the first and second seasons, respectively. In contrast, the treatment of Amphora Coffeaeformis 1 g+ zinc chelate 0.8 g /l showed the highest significant values for branch length (9.2 and 10.1 cm) in both seasons respectively.

Meanwhile, all chelated zinc and algae *Amphora Coffeaeformis* treatments gave the intermediate values of mandarin branch length at all concentrations in two seasons 2020 and 2021.

The leaf chlorophyll content results of the algal extract treatments are consistent with the results of Ismail et al., (2011) who demonstrated that the application of algae increased the bitter orange leaf chlorophyll content.

Algae extract's apparent effects can be attributed to its ability to increase cell membrane permeability and improve plant efficacy in absorbing different nutrients, such as nitrogen, which is directly correlated with the amount of chlorophyll in leaves. Additionally, the algae extract had a high concentration of cytokines, which prevent chlorophyll breakdown and postpone the senescence of leaves (Raupp and Oltmanns, 2006 and Yassen et al., 2007). In addition (El-Sayed et al., 2018) highlighted how the algae extract from Amphora coffeaeformis is rich in pigments like fucoxanthin and β-carotene, two carotenoids that enhance a variety of cellular functions. Moreover, (Mogazy et al. 2020) found that applying Amphora coffeaeformis algae extract (1 and 2 g $L^{-1}$) topically to White Lupine (*Lupinus albus L.*) plants increased their height, number of leaves, leaf area, , and chlorophyll a and b levels.

**TABLE 3. Effect of chelate zinc (CZ), algae *Amphora Coffeaeformis* (Ac) spray and their combination on leaf area, chlorophyll content , branch number and branch length of "Murcott" mandarin trees during 2021 and 2022 seasons.**

| Treatments | Leaf area (cm²) | | Total chlorophyll (mg/100g F. W) | | Branch number | | Branch length (cm) | |
|---|---|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| **Control** | 24.7a | 25.3a | 0.724f | 0.76d | 7.4 i | 8.1 f | 6.9fg | 7.4de |
| **CZ 0.4g** | 19.5bc | 20.1c | 0.772ef | 0.81cd | 9.2 fg | 10.1cd | 7.8de | 7.9cd |
| **CZ 0.8g** | 18.8 cd | 19.0cd | 0.814de | 0.86c | 9.6efg | 9.8 cd | 8.1bcd | 8.3bc |
| **AC 0.5g** | 18.3cd | 18.1 cd | 0.832de | 0.92b | 10.4 de | 10.7bc | 6.8g | 7.3e |
| **AC0.5g+CZ0.4g** | 17.6d | 17.0cd | 0.834de | 0.928b | 10.0def | 10.5bc | 7.9cd | 8.2bc |
| **AC0.5g+CZ0.8 g** | 15.3ed | 16.1 ef | 0.911bc | 0.95ab | 13.7ab | 14.3a | 8.2bcd | 8.4bc |
| **AC 1g** | 20.7b | 22.4b | 0.792de | 0.851c | 8.2hi | 8.8ef | 7.3efg | 7.5de |
| **AC1g+CZ0.4g** | 15.1ed | 15.2ef | 0.938bc | 0.97ab | 13.0 b | 13.8a | 8.7ab | 8.6b |
| **AC1g+CZ0.8g** | 13.9d | 14.3f | 1.079a | 1.005a | 14.5 a | 14.0a | 9.2a | 10.1a |
| **AC1.5g** | 19.4bc | 19.8c | 0.779ef | 0.825c | 8.7 gh | 9.3de | 7.0fg | 7.5de |
| **AC1.5g+CZ0.4g** | 15.7e | 16.1 de | 0.862cd | 0.93b | 11.0 cd | 10.6bc | 7.8de | 8.0bc |
| **AC1.5g+CZ0.8g** | 15.2ed | 15.7ef | 1.01ab | 0.98ab | 11.6 c | 11.4b | 8.5bc | 8.5b |

- **Values followed by the same letter (s) are not significantly different at 5% level each column**
- **CZ =chelate zinc -AC = algae *Amphora Coffeaeformis***

Regarding the chlorophyll content in the leaves, the zinc treatments' outcomes concur with those of (Desai et al. 1991) on sweet oranges and (Supriya and Bhattacharyya, (1993) on citrus lemon. They discovered that sweet orange and lemon plants' total chlorophyll content was increased by zinc foliar sprays. Additionally, (Salama, 2015 ) found that Zinc sulfate in combination with algal extract applied topically increased the total chlorophyll content of the leaf. Generally, the most effective treatment for improving all examined leaf metrics was 2.0% algae extract combined with 0.4% zinc sulfate. Also, Razzaq et al., (2013) In «Kinnow» mandarin, foliar treatment of zinc sulfate up to 0.6% enhanced tree development.

*Yield properties:*

*Initial fruit set%:*

Data in Table, (4) showed that all spraying treatments i.e chelate zinc at (0.4g and 0.8g/l), and Algae *Amphora Coffeaeformis* at (0.5g ,1g and 1.5 g/l) either alone or in combination significantly increased initial fruit set compared to untreated trees(control) which gave the lowest initial fruit set in the two studied seasons(25.21and 11%), respectively. Data also showed that all combination of algae Amphora Coffeaeformis spray and chelate zinc concentration recorded the best results of initial fruit set followed by other treatments in both seasons. In this respect, the higher value of mandarin trees cv. "Murcott" fruit set (51.75 and 24.3%) was proved with combination of algae Amphora Coffeaeformis at 1g/l and chelate zinc 0.8 g/l spray, compared with control and other treatments in the two seasons respectively.

*Yield (Kg)/ tree :*

It could be noticed from Table (4) that all treatments significantly increased yield (kg)per tree than the control in both seasons. Also, spraying trees with algae Amphora Coffeaeformis spray at 1g/l and zinc chelate zinc at 0.8 g/l produced the highest yield (kg) per tree (21.7 and 9.52 kg/tree) in the first and second seasons, respectively. On the other hand, the control trees exhibited the lowest yield weight (8.0 and 3.28 kg/tree) in the first and second seasons, respectively. Finally, all combinations of the foliar application of chelate zinc and algae Amphora Coffeaeformis gave better values of mandarin yield weight (kg) per tree compared with chelate zinc and algae Amphora Coffeaeformis each alone at all concentrations in the two seasons 2020 and 2021 .

*Yield as (ton)/feddan:*

It could be noticed from Table (4 ) that all treatments significantly increased yield (kg)per tree than the control treatment and chelate zinc at 0.4g/l in both seasons. Also, spraying trees with algae Amphora Coffeaeformis spray at 1g/l combined with chelate zinc at 0.8g/l concentration produced the highest yield as (ton)/feddan (3.74 and 1.52 (ton) /feddan) in the first and second seasons, respectively. On the other hand, the lowest yield as (ton) / feddan was observed with the chelate zinc at 0.4g/l and the control trees (1.38 and 1.28 (ton)/feddan ) in the first season and the control trees and the chelate zinc at 0.4g/l ( 0.64 and 0.525 (ton)/feddan ) in the second seasons, respectively. Finally, all treatments either alone or in combination at all concentrations gave intermediate values of mandarin yield as (ton)/feddan in two seasons 20 20 and 20 21 .

*Number of fruits/ tree:*

Data in table (4) showed that number of fruits per tree was significantly increased by all treatments of chelate zin and algae Amphora Coffeaeformis at all concentrations compared to the control. The control trees had recorded (67.7 and 29.4 ) number of fruits per tree in both studied seasons, respectively. Furthermore, spraying trees with algae Amphora Coffeaeformis spray at 1g/l combined with chelate zinc at 0.8 g/l recorded the maximum number of mandarin fruit per tree in both seasons (138.5 and 65.1 ) number of fruits/ tree, respectively in the two seasons 2020 and 2021. Meanwhile, other treatments either alone or in combination recorded an intermediate values of number of fruits per tree in both studied seasons.

Salama, (2015) found that number of fruits produced per tree and, yield, improved by application of algae extract and/or foliar spray of zinc sulfate on Orange Tree cv. Valencia Razzaq et al., (2013) said that the greatest amount of fruit on each tree was harvested when 0.4% zinc sulfate was applied. Finally, zinc sulfate applied topically up to 0.6% increased productivity and enhanced fruit quality in «Kinnow» mandarin..

Algae extract treatment may have a greater impact on tree yield since it contains minerals, vitamins, and growth regulators, including IAA and cytokinins, which have been shown to reduce fruit drop, increase the quantity of fruits per tree, and boost yield (kg/tree) (Stirck et al., 2003; Abd El-Motty et al., 2010 and Abd El-Wahab, 2007). Moreover, greater yield and fruit production are a result of increased photosynthesis and chlorophyll production.

The results of the algae extract obtained are consistent with the findings of Hegab et al., (2005) who claimed that algae extract increased the yield of Balady orange trees. Also, Abd El-Moniem and Abd-Allah (2008) Spraying algae extract at 50% concentration, increased yield of Williams banana trees. Hassan, (2008) demonstrated that applying algae extract to Balady orange trees was a very successful way to encourage fruiting. Abd El-Motty et al., (2010) found that the quantity of fruits per tree and yield were increased by spraying «Keitte» mango plants once during full bloom with either 2% algae alone or 0.2% yeast in combination. .Also, Noha and Shimaa ,(2020) determined that the highest yield and its constituents on «Le-Conte» pear trees were obtained by mixing the third level of Amphora coffeaeformis extract at 500 ppm with the medium level of NEM. On the other hand, zinc may boost photosynthetic activity and protein synthesis in leaves, which could explain the rise in fruits per tree and yield (kg) per tree of Valencia orange trees. Zinc is also necessary for the production of IAA and plays a significant role in inhibiting the formation of the abscission layer, which reduces fruit loss and increases fruit retention, increasing the quantity of fruits on a tree and improving yield per tree (Marchner, 1995; El-Baz, 2003 and Aravind and Prasad, 2004).

The zinc data that were obtained concur with the conclusions of Dawood et al., (2000) on Washington navel orange trees and EL-Baz, (2003) on Balady mandarin trees. They claimed that using zinc sulfate enhanced yield. Hanafy Ahmed et al., (2012) showed that applying zinc foliar spray increased Valencia orange trees› production. Abd El-Motty and Orabi, (2014) showed that applying a foliar spray containing 1000 mg/l of zinc sulfate increased the production of Navel orange trees.

*Fruit physical properties*

*Fruit volume (ml):*

The results presented in Table (5) recorded the effect of spraying mandarin tree with various treatments on fruit volume. It is clear that fruit volume was significantly increased by all foliar application treatments at all concentrations compared with algae Amphora Coffeaeformis at 1g/l spray and chelate zinc at 0.4g /l concentration . The untreated trees had recorded (127.3 and 130.5 ml) fruit volume in the first and second seasons, respectively due to the low number of fruits/tree. On the other hand, spraying trees with algae Amphora coffeaeformis coffeaeformis at 1g/l spray combined with chelate zinc at 0.8g /l reached the maximum number of mandarin fruit volume in both seasons (153.6 and 141.7 ml), respectively. Meanwhile, all combined treatments of chelate zinc and algae Amphora coffeaeformis gave the best and intermediate values of mandarin fruit volume compared with solo treatments of algae Amphora Coffeaeformis and chelate zinc at all concentrations in the two seasons 2020 and 2021.

*Fruit weight (g):*

The results presented in Table (5) recorded the effect of spraying mandarin tree with various treatments on fruit weight (g) . It is clear that fruit weight (gm) was significantly increased by all foliar application treatments at all concentrations compared with chelate zinc at 0.4g/l concentration and algae *Amphora Coffeaeformis* at 1g/l spray . Meanwhile, all combined treatments of chelate zinc and algae *Amphora Coffeaeformis* recorded the intermediate values of mandarin fruit weight compared with solo treatments of algae *Amphora Coffeaeformis* and chelate zinc at all concentration in the two studied seasons . On the other hand, spraying trees with algae *Amphora Coffeaeformis* at 1g/l spray combined with chelate zinc at 0.8g/l reached the maximum number of mandarin fruit weight in both seasons ( 156.7 and 146.2 g ), respectively. Obviously, The untreated trees had recorded (129.9 and 133.7 g) fruit weight in the first and second seasons, respectively due to the low number of fruits /tree

*Fruit juice %:*

Results in Table (5) cleared that chelate zinc and algae *Amphora Coffeaeformis* treatments significantly increased juice % than the control in both studied seasons. In this respect, the highest value for fruit juice % properties parameter was recorded from trees sprayed with algae *Amphora Coffeaeformis* at 1g/l spray combined with chelate zinc at 0.8g/l in both studied seasons compared with control and other treatments. However, the control trees exhibited the lowest fruit juice % (44.7 and45.4%), compared with chelate zinc and algae *Amphora Coffeaeformis* at all concentrations either alone or in combination with each other in the first and second seasons, respectively. Furthermore, from the previous results in Table (5), it is clear that fruit juice % was increased and reached the maximum by spraying trees with all combination of chelate zinc and algae *Amphora coffeaeformis* treatments followed by other treatments in descending order.

*Peel weight (g):*

Results in Table (5) cleared fruit peel weight (gm) was significantly decreased with all treatments of chelate zinc concentration and algae *Amphora coffeaeformis* sprays either alone or in combination when compared with the untreated trees (control) in both studied seasons. In this respect, the highest value for fruit peel weight (g) parameter was recorded from trees sprayed with tap water (control) in both studied seasons when compared with other treatments. However, the control trees exhibited the lowest fruit peel weight, (36.7 and 34.6 g) compared with chelate zinc and algae *Amphora coffeaeformis* at all Concentration either alone or in combination in descending order in the first and second seasons, respectively.

**TABLE 4. Effect of chelate zinc, algae *Amphora Coffeaeformis* spray and their combination on initial fruit set %, fruit yield (kg/tree(, fruit yield (Ton /feddan( and number of fruits /tree of "Murcott" mandarin trees during 2021 and 2022 seasons.**

| Treatments | Initial fruit set (%) | | Fruit yield (kg /tree) | | Fruit Yield (Ton/ feddan) | | Number of fruits /tree | |
|---|---|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st Season | 2nd season |
| **Control** | 25.21g | 11.0g | 8.0 f | 3.28 f | 1.28 f | 0.64 de | 67.7g | 29.4 f |
| **CZ 0.4g** | 29.28f | 13.0f | 8.6 f | 4.00 ef | 1.38 ef | 0.525 e | 76.7f | 34.8 ef |
| **CZ 0.8g** | 35.78cd | 15.0e | 8.8ef | 5.20 cd | 1.41 ef | 1.04 bc | 98.6d | 40.0 cd |
| **AC 0.5g** | 33.96cde | 16.3d | 11.6 cd | 5.48 c | 1.86 de | 0.877 c | 94.5de | 43.5 c |
| **AC0.5g+CZ0.4g** | 36.85c | 15.8de | 13.7 c | 5.47 c | 2.19 cd | 0.875 c | 103.0d | 42.1 cd |
| **AC0.5g+CZ0.8g** | 41.20b | 19.0bc | 15.7 b | 6.75 b | 2.51 bc | 1.08bc | 119.3bc | 50.5 b |
| **AC 1g** | 33.39de | 15.6e | 10.8 de | 5.23 cd | 1.73 de | 0.837 d | 88.3e | 41.8 cd |
| **AC1g+CZ0.4g** | 41.60b | 20.0b | 16.8 b | 7.3 b | 2.69 b | 1.2 b | 124.7b | 53.2 b |
| **AC1g+CZ0.8g** | 51.75a | 24.3a | 21.7 a | 9.52 a | 3.47 a | 1.52 a | 138.5a | 65.1 a |
| **AC1.5g** | 31.1ef | 14.0f | 9.6 ef | 4.32 de | 1.57 ef | 0.691 de | 84.0ef | 37.5 de |
| **AC1.5g+CZ0.4g** | 40.78b | 18.4c | 12.4 cd | 6.5 b | 1.98 d | 0.832 d | 111.0cd | 48.9 b |
| **AC1.5g+CZ0.8g** | 41.42b | 20.0b | 17.1 b | 7.47 b | 2.74 b | 1.17 b | 120.7bc | 53.5 b |

- **Values followed by the same letter (s) are not significantly different at 5% level each column**
- **CZ =chelate zinc -AC = algae *Amphora Coffeaeformis***

**TABLE 5. Effect of chelate zinc, algae *Amphora Coffeaeformis* spray and their combination on fruit volume (ml), fruit weight (g), juice (%) and peel weight (g) of "Murcott" mandarin trees during 2021 and 2022 seasons.**

| Treatments | Fruit volume (ml) | | Fruit weight (g) | | Fruit juice (%) | | Peel weight (g) | |
|---|---|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| **Control** | 127.3cd | 130.5bc | 129.9 cd | 133.7 bcd | 44.7 f | 45.4 g | 36.7 a | 34.6 a |
| **CZ 0.4g** | 98.5 g | 107.4 f | 103.7 g | 111.4 f | 46.1ef | 48.9ef | 34.4 ab | 32.5 ab |
| **CZ 0.8g** | 115.3 ef | 116.2ef | 118.9 ef | 125.9 d | 51.1 d | 50.7de | 30.7 b | 31.12 b |
| **AC 0.5g** | 109.9fg | 119.4de | 114.5 ef | 125.1 de | 48.6de | 47.9 f | 33.2 b | 32.6 ab |
| **AC0.5g+CZ0.4g** | 116.9ef | 126.5cd | 120.5 de | 129.8 cd | 50.9d | 52.1d | 25.2 de | 26.4 de |
| **AC0.5g+CZ0.8 g** | 127.8cd | 130.4 bc | 130.4 bcd | 133.1 bcd | 56.1 bc | 55.4c | 23.4 ef | 23.1 fg |
| **AC 1g** | 97.7 g | 109.7 f | 101.8 g | 114.2 f | 50.0 d | 51.2de | 27.2 d | 28.5 cd |
| **AC1g+CZ0.4g** | 134.9bc | 136.2 ab | 137.9 bc | 140.4 ab | 59.2 a | 62.4a | 20.7 f | 21.7 fg |
| **AC1g+CZ0.8g** | 153.6 a | 141.7 a | 156.7 a | 146.2 a | 61.2 a | 64.3a | 21.2 f | 20.9 g |
| **AC1.5g** | 104 g | 108.6 f | 108.3 fg | 115.3 ef | 45.2 f | 46.7 fg | 29.7 c | 30.4 bc |
| **AC1.5g+CZ0.4g** | 120.2de | 124.4cd | 122.7 de | 130.0 bcd | 54.0 c | 55.1c | 23.4 ef | 24.3 ef |
| **AC1.5g+CZ0.8g** | 139.5 b | 132.1bc | 140.9 b | 136.7 abc | 56.8 b | 58.3b | 21.9 f | 23.2 fg |

- **Values followed by the same letter (s) are not significantly different at 5% level each column**
- **CZ =chelate zinc -AC = algae *Amphora Coffeaeformis***

*Fruit peel % :*

Results in Table (6) cleared that solo treatments of chelate zinc, algae *Amphora coffeaeformis*, and the untreated trees as control (water spray) significantly increased peel % than the combined treatments of chelate zinc and algae *Amphora Coffeaeformis* in both studied seasons. In this respect, the highest value for fruit peel % parameter was observed from trees sprayed with chelate zinc at 0.4g/l concentration in both studied seasons compared with control and other treatments . However the lowest values of fruit peel % was recorded with trees treated with algae *Amphora coffeaeformis* at 1g/l spray combined with chelate zinc at 0.8g/l concentration in the two seasons 2020 and 2021, respectively.

*Fruit Pulp weight (g) and pulp %:*

The results presented in Table (6) recorded the effect of spraying mandarin tree with various treatments on fruit pulp weight. (g) and pulp %. It is clear that fruit pulp weight (g) , and pulp % was significantly increased by all foliar application of combined treatments of chelate zinc and algae *Amphora Coffeaeformis* at all concentrations compared with chelate zinc at 0.4g/l concentration and other spray treatments each alone . Meanwhile, treatment of algae *Amphora coffeaeformis* at 1 g/l spray combined with chelate zinc at 0.8g /l concentration recorded the best values of mandarin fruit pulp weight (135.5 and 132.1 g) in the two studied seasons when compared with control and other treatments . On the other hand, it was observed that spraying trees with tap water (control) recorded (93 and 90.5 g) fruit pulp weight due to the low number of fruits / tree, and the shallow increase in fruit weight (g) in the two seasons 2020 and 2021. . Obviously, treated trees with chelate zinc at 0.4g/l concentration had recorded (69.3 and 70.3 gm) fruit pulp weight in the first and second seasons, respectively due to the low fruit weight (g). Regarding fruit pulp % parameter in the same table, the presented data gave the same trend of results in the first studied season. Meanwhile, it is clear that the combined treatments of algae *Amphora coffeaeformis* at 1 g/l spray and chelate zinc at 0.4 g/l concentration gave the best record of fruit peel % in both studied seasons. Other treatments included control tree gave an intermediate value in this concern.

Salama, (2015) showed that fruit quality was improved by using an algae extract foliar spray or zinc sulfate in combination. Razzaq et al., (2013). Stated that ,»Kinnow» mandarin fruit weight per tree peaked when 0.4% zinc sulfate was applied and fruit quality increased after foliar application of zinc sulfate up to 0.6%. Also, Noha and Shimaa, (2020) concluded that the fruit quality of «Le- Conte» pear trees was enhanced by the combination of NEM and *Amphora coffeaeformis*.

**TABLE 6. Effect of chelate zinc , algae *Amphora Coffeaeformis* spray and their combination on peel (%), pulp weight (g), juice (%) , and pulp (%) of "Murcott" mandarin trees during 2021 and 2022 seasons.**

| Treatments | Peel (%) | | Pulp weight (g) | | Pulp (%) | |
|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| **Control** | 28.4bc | 25.87b | 93 d | 90.5 d | 71.5 f | 77.6 d |
| **CZ 0.4g** | 33.1a | 29.17 a | 69.3 h | 70.3 e | 66.8 h | 70.4 fg |
| **CZ 0.8g** | 25.8d | 24.7 b | 88.2 de | 90.2 d | 74.1 e | 75.6 de |
| **AC 0.5g** | 28.9b | 26.05 b | 81.3 ef | 79.4 e | 71.0 f | 69.4 g |
| **AC0.5g+CZ0.4g** | 20.9 e | 20.33 c | 95.3 d | 93.5 cd | 79.0 d | 83.4 b |
| **AC0.5g+CZ0.8 g** | 17.9 f | 17.35de | 107.0 c | 103.1 c | 82.0 c | 85.7 a |
| **AC 1g** | 26.7 cd | 24.95b | 70.7(3 gh | 72.9 e | 69.4 fg | 72.4 f |
| **AC1g+CZ0.4g** | 15.0 g | 15.45ef | 117.2 b | 120.3 b | 84.9 ab | 86.1 a |
| **AC1g+CZ0.8g** | 13.5 g | 14.29f | 135.5 a | 132.1 a | 86.4 a | 80.3 c |
| **AC1.5g** | 27.4 d | 26.36b | 74.3 fgh | 77.9 e | 68.6 gh | 70.1 g |
| **AC1.5g+CZ0.4g** | 19.0 ef | 18.69cd | 96.8 d | 100.8 c | 78.8 d | 75.3 e |
| **AC1.5g+CZ0.8g** | 15.5 g | 16.97de | 117.6 b | 120.3 b | 83.4 bc | 81.2 bc |

- **Values followed by the same letter (s) are not significantly different at 5% level each column**
- **CZ =chelate zinc -AC = algae *Amphora Coffeaeformis***

*Chemical properties:*

Total sugar % and total soluble solids % (TSS %):

Results presented in Table (7) indicated that total sugar content % and total soluble solids % in mandarin cv. "Murcott" fruits were significantly increased by different treatments of chelate zinc, algae *Amphora coffeaeformis* either alone or in combination compared with the control in the two seasons. However, total sugar content % tended to increase gradually through spraying algae *Amphora coffeaeformis* at 1 g/l combined the chelate zinc at 0.8g/l or algae *Amphora coffeaeformis* at 1 g/l combined the chelate zinc at 0.4g/l in comparison with untreated trees (control) and other treatments in both studied seasons. Referring to total soluble solids (TSS%), it is obvious that algae *Amphora coffeaeformis* at 1 g/l concentration combined with chelate zinc at 0.8g/l recorded ( 14.2 and 14.6 %) of TSS % as a best value and the chelate zinc at 0.4g/l recorded ( 10.9 and 11.0 % ) of TSS % as a lowest value in seasons 2020 and 2021 . Meanwhile, other treatments represented an intermediate values in this concern.

*Titratable acidity:*

Output data presented in Table (7) indicated that titratable acidity % in mandarin cv. "Murcott" fruits were significantly decreased by different combined treatments of chelate zinc and algae *Amphora coffeaeformis* compared with the control and other treatments in the two seasons. However, fruit total acidity % tended to increase gradually through spraying untreated trees (control ) water spray ,and chelate zinc(C) at 0.4g/l in comparison with other treated trees in both studied seasons . On the other hand, it is obvious algae *Amphora Coffeaeformis* at 1g/l+ Chelate zinc at 0.8g/l recorded ( 0.41 and 0.39 %) of acidity % as lowest value of fruit titratable acidity % in seasons 2020 and 2021. Meanwhile, other treatments represented an intermediate values in this concern.

*L- ascorbic acid (mg /100 ml juice):*

The results presented in Table (7) exhibited the effect of spraying mandarin tree on fruit content of L- ascorbic acid (mg /100 ml juice) with various treatments of chelate zinc and algae *Amphora coffeaeformis* sprays either alone or in combination when compared with the untreated trees (control) in both studied seasons. In this respect, algae *Amphora coffeaeformis* at 1g/l + chelate zinc at 0.8g/l gave the highest values (31.1 and 34.1 mg /100 ml juice) of L- ascorbic acid when compared with control water spray (21.8 and 23.4 mg /100 ml juice) and other treatments in the two seasons, respectively. Meanwhile, other treatments represented an intermediate values in this concern.

Salama, (2015) reported that fruit quality was improved by foliar spraying algae extract and/or zinc sulfate together. Razzaq et al., (2013) determined that trees treated with 0.6% zinc sulfate showed the greatest rise in ascorbic acid concentrations. Also, Zinc sulfate foliar spray up to 0.6% increased fruit quality in "Kinnow" mandarin

Fruit quality are mostly enhanced by algae extract due to the physiological action of growth regulators, vitamins, and minerals (Abd El-Migeed et al., 2004; Abd el Moniem et al., 2008 and Abd El-Moniem and Abd-Allah, 2008) which reflected on fruit quality. Additionally, as photosynthesis increased and reserves of carbohydrates accumulated the total chlorophyll content of leaves increased. These factors all had a good impact on the quality of the fruit.

The algae extract results obtained are consistent with the findings of Hegab et al., (2005) who revealed that algae extract improves the fruit quality of Balady orange trees. Abd El-Moniem and Abd-allah, (2008) noted that applying a 50% algal extract spray to Williama banana plants enhanced the quality of their fruit. Abd El-Motty et al., (2010) demonstrated that, when compared to the control, spraying "Keitte" mango trees once at full bloom with algae at 2% alone or in conjunction with yeast at 0.2% increased fruit length, fruit breadth, fruit weight, pulp/fruit percentage, and total soluble solids. It also decreased fruit drop and the weight of peel and seed.

These findings could be explained by the fact that *Amphora coffeaeformis* is regarded as a good source of total protein, amino acids, polyunsaturated fatty acids, β-glucans, α-tocopherol, and vitamins A, C, B1, B2, B9, and E (Chtourou et al., 2015, El- Sayed et al., 2018 and Hassan et al., 2020). Noha and Shimaa, (2020) concluded that combining of NEM and of *Amphora coffeaeformis* improved fruit chemical properties of "Le- Conte" pear trees The potential reason for the enhanced impact of zinc on Valencia orange fruit quality is that zinc actively contributes to the synthesis of auxin within plants. (Bose and Tripathi, 1996 and Alloway, 2008), and how it impacts the metabolism of starch (Marchner, 1995 and Hafez et al., 2007), biological mechanisms including carbohydrate biosynthesis and the photosynthetic reaction (Yamdagni et al., 1979), protein, cell division, and the metabolism of nucleic acids all contributed to the increased buildup of metabolites in fruit. (Babu and Singh, 2001 and Dickinson et al., 2003). Furthermore, zinc has a significant impact on the functions of the many enzymes engaged in this biochemical reaction, which promotes the synthesis of organic molecules. (Brown et al., 1993 and Alloway, 2008) Valencia orange fruit quality consequently improved.

The findings of zinc match the data obtained from Dawood et al., (2000) on Washington navel orange trees and EL-Baz, (2003) on Balady mandarin trees They claimed that applying zinc sulfate enhanced the chemical and physical characteristics of fruit. Hanafy Ahmed et al., (2012) demonstrated that applying a zinc foliar spray to Valencia orange plants increased the fruit's quality. Abd El-Motty and Orabi, (2014) claimed that foliar spraying the Navel orange tree with zinc sulfate at a dosage of 1000 mg/l enhanced the fruit's quality.

*Leaf mineral content (N%, P% and k% content ):*

Results presented in Table (8) indicated that leaf nitrogen content percentage (N%) in mandarin cv. "Murcott" fruits were significantly increased by different treatments of chelate zinc and algae Amphora Coffeaeformis either alone or in combination compared with the control in the two seasons. However, nitrogen leaf content percentage (N%) tended to increase gradually due to the combinations of chelate zinc and algae Amphora coffeaeformis followed by other treatments each alone. In this respect algae Amphora coffeaeformis at 1 g/l spray combined with chelate zinc at 0.8g/l concentration spray gave the higher values of leaf content percentage (N%) when compared with control and other treatments in the two seasons, respectively. Concerning phosphorus leaf content percentage (P %) it's obvious that, spraying mandarin trees with algae Amphora coffeaeformis at 1 g/l combined with chelate zinc at 0.8g/l concentration increased the phosphorus leaf content percentage (P %) by recording (0.48 and 0.52% )in both seasons followed by other treatments in comparison with control treatment. While, the control in the first season and second one recorded the lowest values (0.24 and 0.25 %) of the phosphorus leaf content percentage (P %) , respectively. Concerning the potassium leaf content percentage (K %) as shown in the same Table ( 8 ) ,the obtained results indicated that untreated trees exhibited the lowest K % (0.83 and 0.91 %), respectively in the two studied seasons. On the other hand, trees treated with algae Amphora coffeaeformis at 1 g/l spray combined with chelate zinc at 0.8g/l concentration or algae Amphora coffeaeformis at 1.5g /l spray combined with chelate zinc at 0.8g/l concentration exhibited superiority and gave the higher percentages of mandarin k % , meanwhile, the same trend of results was given in both seasons, respectively.

**TABE 7. Effect of chelate zinc, algae *Amphora Coffeaeformis* spray and their combination on total sugar (%), T.S.S (%), *Titratable acidity (%)*and L. ascorbic acid (mg /100 ml juice) of "Murcott" mandarin trees during 2021 and 2022 seasons.**

| Treatments | Total Sugar (%) | | T.S.S (%) | | Titratable acidity (%) | | L. ascorbic acid (mg /100 ml juice) | |
|---|---|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| **Control** | 8.8 h | 9.5 d | 10.9 g | 11.2 e | 0.61 a | 0.58 a | 21.8 g | 23.4 g |
| **CZ 0.4g** | 9.3 gh | 9.5 d | 10.9 g | 11.0 e | 0.57 ab | 0.55 ab | 23.4 f | 25.1 ef |
| **CZ 0.8g** | 10.5def | 10.2 cd | 12.1 de | 12.5 c | 0.47 cd | 0.42 d | 26.3cd | 27.5 d |
| **AC 0.5g** | 10.3 def | 10.0 cd | 11.7 ef | 12.0 cd | 0.52 bc | 0.50 bc | 24.5 e | 25.4 ef |
| **AC0.5g+CZ0.4g** | 11.2 cd | 10.9 bc | 12.2 de | 11.9 cd | 0.48 cd | 0.45 cd | 25.7de | 24.7 f |
| **AC0.5g+CZ0.8 g** | 12.1bc | 11.9 ab | 13.1 c | 13.4 b | 0.46 cd | 0.44cd | 28.6 b | 29.3 c |
| **AC 1g** | 10.1 efg | 9.8 d | 11.9 e | 11.5 de | 0.52 bc | 0.51 ab | 24.8 e | 26.1 e |
| **AC1g+CZ0.4g** | 13.0 ab | 12.6 a | 13.9 ab | 14.3 a | 0.44 d | 0.40 de | 30.7 a | 32.5 b |
| **AC1g+CZ0.8g** | 13.2 a | 12.3 a | 14.2 a | 14.6 a | 0.41 d | 0.39 e | 31.1 a | 34.1 a |
| **AC1.5g** | 9.8 fg | 9.7 d | 11.1 fg | 11.7 de | 0.53 bc | 0.47 cd | 23.0 f | 25.7 ef |
| **AC1.5g+CZ0.4g** | 11.3 cd | 11.0 bc | 12.7 cd | 13.4 b | 0.44 d | 0.42 d | 27.2 c | 28.9 c |
| **AC1.5g+CZ0.8g** | 13.0ab | 12.6 a | 13.3 bc | 13.9 ab | 0.46 cd | 0.43 cd | 28.5 b | 27.7 d |

- **Values followed by the same letter (s) are not significantly different at 5% level each column**
- **CZ =chelate zinc -AC = algae *Amphora Coffeaeformis***

Salama (2015 ) increased leaf mineral content with foliar spray application of algal extract and/ or zinc sulfate. Razzaq et al (2013) mentioned that Zinc sulfate foliar treatments on tree nutrition were investigated on "Kinnow" mandarin. Trees treated with 0.2% zinc sulfate had the highest leaf nitrogen (N), 0.6% zinc sulfate produced the highest phosphorus (P), and 0.8% zinc sulfate produced the highest potassium (K). Finally, zinc sulfate foliar spray up to 0.6% enhanced tree mineral nutrition in "Kinnow" mandarin. Noha and Shimaa (2020) concluded that, "Le-Conte" pear trees combining of NEM and of *Amphora coffeaeformis* improved macro nutrients content of "Le-Conte" pear trees.

The physiological actions of growth regulators, vitamins, and minerals are primarily responsible for the improved effect of algae extract on leaf mineral content (Abd El-Migeed et al., 2004; Abd el Moniem et al., 2008 and Abd El-Moniem and Abd-Allah 2008). This resulted in an enhanced nutritional state for the tree.

The outcomes of the algae extract on the mineral content of the leaves are consistent with the findings of Abd El-Motty et al., (2010) demonstrated that the nitrogen and potassium contents of the leaves were enhanced by spraying "Keitte" mango trees once during full bloom with algae at 2% alone or in combination with yeast at 0.2%.

These findings could be explained by the fact that protein from algae extract breaks down into naturally occurring amino acids, which are immediately utilized in metabolism (Marrez et al., 2014). Additionally, it includes certain macronutrients like N, P, and K. In the meanwhile, algal extract affects how well roots absorb nutrients (Abd El-Mawgoud et al., 2010). In this respect, Enan et al., (2016) discovered that applying alga extract topically to sugar beet leaves at a rate of up to 2.5 g/l significantly increased their N, P, and K contents. Thus, algae extract may help supply some nutrients to plants.

Since zinc is a necessary metal for healthy plant growth and development, zinc sprays may have a greater impact on leaf mineral content (Cakmak, 2000). Zinc is critical to numerous vital physiological processes, including IAA and protein metabolism (Marschner, 1995). It is commonly recognized that zinc plays a crucial role in the manufacture of numerous essential enzymes, such as ribulose-1 and 5-bisphosphate carboxylase, which are involved in photosynthesis. (Brown et al., 1993). It keeps membrane and DNA-binding protein structures stable. (Aravind and Prasad, 2004). Plants' nitrogen metabolism depends heavily on zinc, and plants with low zinc levels have lower protein contents (Mengel et al., 2001 and Hassan et al., 2010). As a result, the tree's nutritional status improved.

Regarding leaf mineral content, the outcomes of zinc spray treatments that were obtained are consistent with the findings of Hanafy Ahmed et al. (2012) who stated that Valencia orange trees' leaf nutritional condition (N, P, and K concentrations) was improved by zinc foliar spray.

## Conclusion

The results indicate that the combination between algae Amphora Coffeaeformis (AC) at 1g spray and chelate zinc(CZ) at 0.8g recorded the best results of vegetative growth ,fruit set percentage , number of fruits /tree, yield / tree, yield / feddan , fruit physical properties, fruit chemical properties and leaf N%,P%,K% content.

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*Conflict of interest*

The authors declare that they have no competing interests.

**TABLE 8. Effect of chelate zinc , algae *Amphora Coffeaeformis* spray and their combination on N %, P%, and K % leaves content of "Murcott" mandarin trees during 2021 and 2022 seasons.**

| Treatments | N % | | P% | | K% | |
|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| **Control** | 1.63 e | 1.77 d | 0.24g | 0.25d | 0.83 d | 0.91 e |
| **CZ 0.4g** | 1.84cde | 1.92 cd | 0.27efg | 0.29cd | 0.86 d | 0.94 e |
| **CZ 0.8g** | 1.88cde | 2.03bcd | 0.27efg | 0.26d | 0.91 cd | 0.87 e |
| **AC 0.5g** | 1.87cde | 1.91cd | 0.29ef | 0.31c | 0.93 cd | 1.05 d |
| **AC0.5g+CZ0.4g** | 2.03cd | 1.97 cd | 0.30e | 0.32c | 0.97 c | 1.17 c |
| **AC0.5g+CZ0.8 g** | 2.46ab | 2.52 a | 0.42 b | 0.39b | 1.14 ab | 1.21 bc |
| **AC 1g** | 1.78de | 1.94 cd | 0.25 fg | 0.27cd | 0.84 d | 0.94 e |
| **AC1g+CZ0.4g** | 2.63 a | 2.46 a | 0.43 ab | 0.41b | 1.17 ab | 1.15 cd |
| **AC1g+CZ0.8g** | 2.60 a | 2.31 ab | 0.48 a | 0.52a | 1.22 a | 1.32 ab |
| **AC1.5g** | 1.97 cd | 2.01bcd | 0.32 de | 0.30cd | 0.87 cd | 0.85 e |
| **AC1.5g+CZ0.4g** | 2.16 bc | 2.23abc | 0.35 cd | 0.38b | 1.08 b | 1.26 bc |
| **AC1.5g+CZ0.8g** | 2.36 ab | 2.47 | 0.39 bc | 0.43b | 1.21 a | 1.39 a |

- **Values followed by the same letter (s) are not significantly different at 5% level each column**
- **CZ =chelate zinc -AC = algae *Amphora Coffeaeformis***

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## تحسين الإنتاجية وجودة الثمار في أشجار اليوسفي " الموركيت" عن طريق الرش الورقي بالزنك المخلبي وطحالب Amphora Coffeaeformis تحت ظروف الوادي الجديد

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تم اجراء تجربة حقلية خلا موسمي 2020 & 2021 علي أشجار يوسفي صنف الموركيت عمر 7 سنوات تم زراعتها في تربة رملية تحت نظام الري بالتنقيط بمزرعة خاصة علي طريق الفرافرة – محافظة الوادي الجديد – مصر.

يهدف البحث لتقييم دراسة تأثير الرش باربع مستويات من طحلب 90% Amphora Coffeaeformis ( صفر،0.5 ،1.0 ، 1.5 جم /لتر) و ثلاث مستويات من الرش بالزنك المخلبي بتركيزات ( صفر ،0.4 و 0.8 جم/لتر ) علي الصفات الخضرية ، المحصول و جودة ثمار لأشجار اليوسفي صنف الموركيت.

أظهرت النتائج المتحصل عليها ان رش المزيج من الزنك المخلبي و الطحالب90 % *Amphora Coffeaeformis* معا تحسن صفات النمو الخضري ، المحصول و صفات الجودة في الثمار عند مقارنتها بالأشجار غير المعاملة.

وبذالك يوصي الرش بطحالب *Amphora Coffeaeformis* بتركيز 1جم مع زنك مخلبي بتركيز 0.8جم و التي أعطت افضل النتائج للنمو الخضري ،نسبة العقد ، عدد الثمار / شجرة، المحصول الكلي / شجرة ، محصول/ فدان، الصفات الطبيعية للثمار، الصفات الكميائية للثمار و محتوي الورقة من النتروجين و الفوسفور و البوتاسيوم .

**الكلمات الدالة :** اليوسفي – الموركيت –الطحالب – االزنك المخلبي – المحصول – عقد الثمار.