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Effect of Foliar Application with Some Nutrients and Antioxidants on Yield, Physical and Chemicals Properties of Muorcet Mandarin Cv. Fruits

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ABSTRACT:

This study was carried out during two seasons in 2021 and 2022, on ten-year-old Muorcet Mandarin cv. (*Citrus reticulata* L.) trees were grafted on Volcamarina rootstock. The selected trees were grown in a private orchard located in Wadi Elmoulak, Ismailia Governorate, Egypt were studied in sandy soil with drip irrigation. The experiments were designed to investigate to evaluate the effects of foliar spray some nutrients and antioxidants (treatments) on yield, physical and chemical fruit quality of Muorcet Mandarin cv. Spraying was done till runoff (5 L / tree spraying) twice (late May and late July) in both seasons. Used randomized complete block design with three replicates. The results showed that significant between treatments for all studies characters. Most treatments significantly outperformed the control on fruit number per tree, fruit yield per tree (kg), fruit yield per feddan (ton) and chemicals fruit quality as well as with minor variations among treatments. Generally, this study demonstrates that foliar spraying with some nutrients and antioxidants, especially, vitamin B12 at 100 mg/l, ascorbic acid at 1000 mg/l and mixture of chelated (Fe, Zn and Mn) at 500 or 1000 mg/l treatments can enhance yield, physical fruit quality (for instance weight, volume, peel color, waste weight of fruit) and chemicals constituent (TSS %, total acidity %, TSS/acid ratio, vitamin C, total sugars and total phenols in fruits juice of Muorcet Mandarin cv.

Conclusion: Vitamin B12 at 100 mg/l, ascorbic acid at 1000 mg/l and mixture of chelated (Fe, Zn and Mn) at 500 or 1000 mg/l treatments can enhance yield, physical fruit quality and chemicals constituent of fruits juice of Muorcet Mandarin cv

Keywords: Muorcet Mandarin, nutrients, antioxidant, physical, chemical, yield.

INTRODUCTION

Citrus one of the most important of fruit crops all over the world, especially in warm temperate regions and grows and well adapted successfully in Egypt. Citrus occupied the third position among to fruit crops production in the world after grapes and apples. Citrus is a backbone of fruit crop cultivation in Egypt, since, its rank the first order among all other fruits. Citrus fruits are one of the major fruit crops with dietary significance, worldwide accessibility, and recognition **(Abouzari and Nezhad 2016; FAO 2021; Rivera *et al.,* 2022)**.

Egyptian citrus production extends total cultivated area nearly (529405 fed.) fruit area 486271 fed, total production 5142829 ton, average yield 10.58 ton /fed, while mandarin cultivated area 12866 fed, fruit area 119125 fed, total production 12669682 ton, average yield 10658 ton/fed. according to data from the Egyptian Ministry of Agriculture (2023).

Mandarin (***Citrus reticulate*** Blanco) is the most important edible citrus cultivar after Balady orange. It's delicious, taste and nutrition, besides being rich in vitamin C and minerals. In addition, it has a good flavor and aroma and it can be exported to the European markets. For commercial exploitation, mandarins have several disorders for instance; the tree has a tendency toward alternate or irregular bearing. Additionally, the mandarin fruit harvested too late on January and February or later loses moisture and become shriveled and unmarkeTable. Accordingly, the fruit quality of mandarins must be maintained to increase the exportation and net income.

Vitamins participate in plant growth and development indirectly by enhancing the endogenous levels of various growth factors such as cytokinins and gibberellins. Most vitamins are synthesized in the leaves and translocate in the pholem to the other organs. For more than two decades studying of the role of vitamins in plants attracted sporadic attraction. These studies indicated that various physiological process such as nutrient uptakes, absorption of water, translocation of organic foods, building of natural hormones, respiration, photosynthesis as well as chlorophyll and protein synthesis depended more or less on the availability of vitamins (**Samiullah *et al.*, 1988).** Ascorbic acid (Vit. C) have catch all free radicals produced during plant metabolism, hence increasing plant resistance to stress. Moreover, they provide adequate protection against the deleterious effects of activated oxygen species **(Alscher *et al.,* 1997).**

Antioxidants are put forward for improving yield, safety and producing organic fruits in different fruit trees. There are two types of antioxidants, the first type of antioxidants is the enzymatic antioxidants like superoxide dismutase, catalase, glutathione-s-transferase, glutathione peroxidase, ascorbate oxidase and polyphenol oxidase, and the second type of antioxidants is non-enzymatic antioxidants such as total reduced glutathione, vitamins (A, C, E, and M (folic acid)), organic acids (ascorbic acid, citric acid and salicylic acid) **(Vinoth *et al.*, 2017).**

Antioxidant compounds which have an auxinic action, and synergistic effect on flowering and fruiting of fruit trees, their practical use on fruit trees under field conditions is favorably possible further and additional studies are needed to evaluated their action on fruit trees and to find cheap and safe antioxidants that are beneficial for enhancing growth and productivity at the same time (**Elad ,1992).**

These compounds as antioxidants have useful effects on catching free radicals such as the active oxygen species namely superoxide anion, singlet oxygen, hydroxyl radicals, hydrogen peroxide and ozone that biosynthesized during plant metabo-lism. Leaving free radicals without chelating or catching causing loss of plasma membrane per-meability, oxidation of lipids and death of cells (**El Sayed *et al.,* 2000**). Antioxidants have an important role in enhancing the biosynthesis of natural hormones, photo-synthesis, nutrient uptake, plant protection from biotic and abiotic stresses and biosynthesis of plant pigments and sugars, as they increase anti-oxidant defense systems and reduce the reactive oxygen species, then suggested recently that it is mainly involved in the growth of flowering plants and the development of fruit (**Rao *et al.,* 2000**). Salicylic acid is also involved in minimizing of the stresses during inducing antioxidant system when plants are exposed to it, and now is considered a hormonal substance that plays a key part in regulating plant growth and development, **(Senaratna *et al.,* 2004).**

Zinc is known to stimulating growth and its deficiency leads to short of internodes. This led to the discovery that this addition, it was thought that Zn deficiency causes the destruction of IAA by an increasing in oxidation that causes the promotion of peroxides activity. Moreover, it was clearly shown that a lower auxin level in the plant due to Zn deficiency is an account of reduced synthesis of tryptophan, a precursor of IAA (**Nason and McElroy, 1963**).

Calcium is one of the essential elements in plant nutrition. It plays an important role in improving yield and fruit quality **EL-Shobaky and Mohamed (2000).**

Spraying citrus trees with nutrient and antioxidant compounds generally improves yield and fruit quality of grapevines citrus **(Samra *et al.,* 2012, Amro 2015, Randa 2015, El-Gioushy, 2016, Eman *et al.,* 2019, Gad El- Kareem and Hussein, 2021, Hiba and Mohamed Saleh, 2022, Khazaal 2023 and Randa Habasy 2023)** and other fruits **(Mohamed *et al.*, 2025)** of Keitt mango trees **and (Thakur *et al.*, 2025)** of apricot (*Prunus armeniaca* L.) cv. New Castle

Therefore, the main purpose of the current study was to evaluate the effectiveness of some nutrients and antioxidants on fruiting and fruit quality of Muorcet Mandarin.

MATERIALS AND METHODS:

This study was carried out during two consecutive seasons (2021 and 2022) on - 10 years - old Muorcet Mandarin cv. (*Citrus reticulata* L.) trees grafted on Volcamarina Rootstock. The selected trees were grown in a private Orchard located in Wadi Elmoulak, Ismailia Governorate, Egypt. The experiments were designed to investigate to evaluate the effects of foliar spray some nutrients and antioxidants (treatments) on yield, Physical and Chemical fruit quality of Muorcet Mandarin cv.

The selected trees were planted at 3x5 meters about (280 tree / Fed) similar size and vigor in sandy soil under drip irrigation. The trees way subjected to agricultural practices, which usually done in this area.

The experimental design and treatments:

This study designed as a randomized complete block design and treatments (14). Each treatment was replicated three times, one tree per each. Muorcet Mandarin cultivar were foliar spray all treatments twice (late of May and late of July) in both seasons, were additionally carried out using a 25-liter knapsack power sprayer (Model HT-767; Taizhou Tianyi Agricultural and Forestry Machinery Co., Zhejiang, China). Spraying was done till runoff (5 L / tree spraying) as follows: control (tap water), Ascorbic acid at concentrations of 500 mg/l and 1000 mg/l, Citric acid at concentrations of 500 mg/l and 1000 mg/l, Salicylic acid at concentrations of 100 mg/l and 200 mg/l and Vitamin B12 at concentrations of 50 mg/l and 100 mg/l.

1. Effect of nutrients and antioxidants on yield:

Fruits were harvested in 15 January, when fruit juice TSS reached about 10 % in both seasons, respectively, then measurements were carried as well as yield / tree (kg) and yield / feddan (ton).

Yield / feddan (ton) calculated as follows: = {tree yield (kg) x Number of tree per faddan} ÷ 1000.

2. Effect of nutrients and antioxidants on physical characteristics of fruits:

At harvesting time, fruit samples were taken at random from each replicate and directly transported to the laboratory of Plant Production Department, Faculty of Technology and Development, Zagazig University and then measurements were carried out in ten fruit per replicate:

Fruit Volume (cm^3)

By immersing the fruit in a container filled with water and measuring the volume of the displaced water, which corresponds to the fruit volume according to **Mohsenin (1986)**

Fruit weight (g)

At harvest, average fruit weight for each treatment was evaluated by using a digital balance. and expressed as (g) according to Miller **(1987).**

Fruit Firmness: Fruit firmness was measured using fruit penetrometer by manually penetrating a plunger tip into orange peel.

Fruit Specific Gravity (g /cm^3) was calculated by the following equation:

Fruit Specific Gravity (g /cm^3). = fruit weight (g) / fruit volume (cm^3) according to **Sahin, and Sumnu (2006).**

Fruit dimensions and fruit shape index:

At harvest, fruit length and width (cm) was determined using Digital Vernier Caliper. Fruit shape index was calculated as follow:

Fruit shape index = fruit height / fruit width according to **Cohen *et al.*, (1972)**.

3. Effect of nutrients and antioxidants on chemical characteristics of fruits:

Soluble Solids Content percentage (TSS %): was measured using the hand refractometer apparatus of fruit juice.

The titrable acidity (%): was determined as Citric acid equivalent using Na OH (0.1 N) of mandarin juice **(A.O.A.C., 2016).**

TSS/TA Ratio: was calculated by the following equation

TSS/TA ratio = Soluble Solids Content/ titrable acidity

Ascorbic acid (Vit. C as mg/100 g fresh weight): was determined by titrating the 2, 6- dicholor-phenol-indo- phenol sodium salt. (**A.O.A.C., 2016).**

Total, reducing and non-reducing sugars percentage: were determined as described by **Dubois, *et al*., (1956).** Non-reducing sugars were calculated (total soluble sugars -reducing).

Statistical analysis:

Data were analyzed using the MSTAT-C statistical package in a randomized complete block design (RCBD) as described by **Snedecor and Cochran (1980),** and means were compared using mean comparison at 0.05 level **(Duncan, 1955).**

RESULTS AND DISCUSSIONS:

1. Data in Table (1) show fruits number/tree, fruit yield/tree and fruit yield/Fed. (ton) as affected by some foliar nutrients and antioxidants for Mourcet Mandarin in two seasons (2021and 2022).

1-1 The tap water (control) treatment recorded the highest fruits number/tree compared with the other 13 treatments under this study in the two growing seasons. The control treatment followed by T_5, T_6, T_7, T_{12} and T_{14} treatments in this respect in the two growing seasons. But, the T_5 (citric acid 1000 mg/L) recorded lest fruits number/tree (249.0 and 253.3) in the two growing season. No significant differences between T_2, T_3, T_9, T_{10}, T_{11} and T_{13} treatments approximately were recorded, in the two growing seasons.

1-2 The 9 treatment (vitamins B_{12} at 100 mg/L) gave the highest fruit yield/tree (kg) followed by T_8, T_{13} and T_{14} treatments on the other hand, control treatment gave the lowest record in this characters (43.7 and 41.7 kg) in the two growing seasons. The fewer difference between the others treatments T_3, T_6, T_{10}, T_7, T_{12}, T_4, T_5 and T_2 recorded in the two growing seasons.

1-3 The same results and their trend were found in the fruit yield/fad (ton) in the two growing seasons. The T_9 treatment, vitamins B12 at 100mg/L was superior to the other different treatments, (22.3 and 20.9 ton/fad) seasons. While, the control treatment gave (12.3 and 11.70 ton/fad) fruits/ Fadden in the two growing.

In generally, (T_{13} and T_{14}) mixture of chelated (Fe, Zn and Mn) followed by vitamin B12 at 50 or 100 mg/L treatments, CaCl2 at 3%, 2% and 1% and salicylic acid at 100 and 200 mg/L. gave the highest fruit yield /tree (kg) and fruits yield/fad. (ten) compared with control and the other studies treatments under this study in the two growing seasons. Vitamin B12 at 100 mg/L or 50 mg/L were treatments were superior than CaCl2 treatment followed by salicylic acid treatments. While, Ascorbic acid recorded the least fruit in ton/fed. Similar results approximately recorded in fruit yield/tree (kg) in the two growing seasons under these studies.

Table 1: Effect of some foliar nutrients and antioxidants on fruits number /tree, fruit yield /tree. (Kg) and fruit yield /fed (Ton) for Mourcet Mandarin in two seasons (2021/2022)

Characters	**Fruits Number /Tree**	**Fruit Yield / Tree. (Kg)**	**Fruit Yield /Fad (Ten)**

Season / Treatments	2021	2022	2021	2022	2021	2022
Control	**292.3a**	**291.0a**	**43.7h**	**41.7f**	**12.3g**	**11.7f**
Ascorbic acid at 500 mg/l	**259.7h**	**258.0ef**	**55.4f**	**58.3e**	**15.5ef**	**16.3e**
Ascorbic acid at 1000 mg/l	**262.3gh**	**262.3c-f**	**67.2bc**	**68.2bc**	**18.8bc**	**19.1bc**
Citric acid at 500 mg/l	**260.3gh**	**259.7ef**	**49.8g**	**56.1e**	**13.9fg**	**15.7e**
Citric acid at 1000 mg/l	**249.0i**	**253.3f**	**62.8de**	**57.3e**	**17.6cd**	**16.0e**
Salicylic acid at 100 mg/l	**274.0bc**	**272.3b**	**64.4cd**	**66.1cd**	**18.0bcd**	**18.5cd**
Salicylic acid at 200 mg/l	**271.0bcd**	**269.7bcd**	**66.8bc**	**63.3d**	**18.7bc**	**17.7d**
Vitamin B12 at 50 mg/l	**270.3bcd**	**272.0bc**	**66.2cd**	**69.7b**	**18.5bc**	**19.5b**
Vitamin B12 at 100 mg/l	**264.3e-h**	**264.7b-e**	**79.5a**	**74.5a**	**22.3a**	**20.9a**
$CaCl_2$ at 1%	**268.0def**	**271.0bc**	**65.8cd**	**64.4d**	**18.4bc**	**18.0d**
$CaCl_2$ at 2%	**265.7d-g**	**261.0def**	**59.1ef**	**63.0d**	**16.5de**	**17.6d**
$CaCl_2$ at 3%	**275.0b**	**272.0bc**	**65.2cd**	**66cd**	**18.3bc**	**18.5cd**
Mixture of chelated (Fe, Zn and Mn) at 500 mg/l	**268.7cde**	**270.3bcd**	**76.8a**	**69.9b**	**21.5a**	**19.6b**
Mixture of chelated (Fe, Zn and Mn) at 1000 mg/l	**270.3bcd**	**272.0bc**	**70.1b**	**69.6b**	**19.6b**	**19.5b**

Values having the same alphabetical letter(s) in each column did not significantly different according to Duncan multiply range at (0.05) of probability

These results are in agreement with many investigators **Samra *et al.,* (2012)** of Balady mandarin, **Amro (2015)** of orange trees cv. Valencia, **Randa (2015)** on Valencia orange trees, **El-Gioushy (2016)** on Washington navel orange trees**, Singh (2018)** on sweet orange (Citrus sinensis L.) cv. Mosambi, **Eman (2019**) on ‘Navel orange‘ trees, **Tanany and Hanaa (2019)** on Valencia orange trees, **Gad El- Kareem and Hussein (2021)** on Valencia orange trees, **Nandita *et al.,* (2020)** on sweet orange cv. Mosambi trees, **Hiba and Mohamed Saleh (2022)** on'Balady' mandarin trees, **Shoug *et al.,* (2023)** on Balady mandarin trees, **Khazaal (2023)** on lemon trees and **Randa Habasy (2023)** on Washington Navel orange trees as well as with other fruit trees **Ahmed *et al.,* (2007)** on Anna apple trees, **Gad El-Kareem and Abd El- Rahman (2013)** on Ruby seedless grapevines, **Mohamed (2014**) on Superior grapevines, **Ahmed (2016)** on Aggezie, Manzanello and Picual olive trees, **Amin (2025)** on Picual olive trees, **Mohamed *et al.*, (2025)** on Keitt mango trees and **Thakur *et al.*, (2025)** on apricot.

2. Effect of nutrients and antioxidants on physical characteristics of fruits:

2- Data in Table (2) fruit weight (g), fruit volume (cm^3) and fruit specific gravity for Mourcet Mandarin in the two growing season (2021 and 2021) as affected by some foliar nutrients and antioxidants.

2-1 T_9 treatment (Vitamin B_{12} at 100 mg/L) gave the highest fruit weight 300.00 and 282.5 g followed by T_{13} and T_{14} (mixture of chelated (Fe, Zn and Mn) at 500 mg/L and 1000 mg/L treatments compared with the control treatment which recorded the fewest fruit weight (149.7 and 143.2 g) in the two growing seasons. Increasing the CaCl concentration from 1% to 3% increased the fruit weight (g) in the two growing seasons. The same results were recorded when increased concentration Ascorbic acid, Citric acid, vitamin B_{12} and Salicylic acid treatments were studied under this studies in the two seasons.

Table 2: Effect of some foliar nutrients and antioxidants on fruit weight (g), fruit volume (cm^3) and fruit specific gravity for Mourcet Mandarin in two seasons (2021/2022)

Characters	Fruit Weight (g)		Fruit Volume (cm^3)		Fruit Specific Gravity	
Season / Treatments	2021	2022	2021	2022	2021	2022
Control	149.7j	143.2i	141.2h	130.0f	1.061a	1.102a
Ascorbic acid at 500 mg/l	213.2h	223.9gh	200.2fg	218.1d	1.067a	1.023a
Ascorbic acid at 1000 mg/l	256.5c	260.1b	255.7ab	246.2b	1.0003a	1.060a
Citric acid at 500 mg/l	191.3i	215.7h	184.8g	197.6e	1.055a	1.105a
Citric acid at 1000 mg/l	253.5cd	226.2fg	230.9b-e	201.4e	1.098a	1.129a
Salicylic acid at 100 mg/l	235.2f	243.0cd	220.0def	230.9c	1.069a	1.051a
Salicylic acid at 200 mg/l	246.7d	234.7def	240.0bcd	229.5c	1.029a	1.036a
Vitamin B12 at 50 mg/l	245.6de	256.2b	240.9bcd	251.4ab	1.018a	1.019a
Vitamin B12 at 100 mg/l	300.0a	282.5a	251.4ab	256.7a	1.054a	1.103a
$CaCl_2$ at 1%	245.9d	233.8ef	248.6abc	201.8e	0.990a	1.160a
$CaCl_2$ at 2%	222.4g	242.0df	210.0efg	232.9c	1.063a	1.039a
$CaCl_2$ at 3%	237.4ef	252.2bc	222.9c-f	229.5c	1.067a	1.058a
Mixture of chelated (Fe, Zn and Mn) at 500 mg/l	286.1b	258.9b	275.7a	248.6ab	1.037a	1.042a
Mixture of chelated (Fe, Zn and Mn) at 1000 mg/l	258.6c	255.4b	248.6abc	245.7b	1.042a	1.042a

Values having the same alphabetical letter(s) in each column did not significantly different according to Duncan multiply range at (0.05) of probability

2-2 The same result trend approximately, were found in fruit volume (cm^3) characters whereas the T_9 (Vitamin B_{12} at 100 mg/L) gave the beast value in fruit volume (cm^3) followed by T_{13} and T_{14} treatments. But, the least value was recorded under the control treatment followed by citric acid treatments, 500 or 1000 g/L) in the two growing seasons. The T_{13} (mixture of chelated Fe, Zn and Mn) at 500 mg/L were superior to T_{14} (mixture of chelated Fe, Zn and Mn) at 1000 mg/L in the fruit weight (g) and fruit volume (cm^3).

Finally, vitamin B_{12} treatments (T_8 and T_9) were the best treatments followed by antioxidants treatments followed by $CaCl_2$ treatments while Ascorbic acid treatments (500 or 1000 mg/L) was lowest fruit volume cm^3 in the two growing seasons.

The fruit weight (g) and fruit volume (cm^3) were gave the same trend under different treatments under this study in the two growing seasons.

4-2-3 Different between foliar applications treatments were no significant under these studies of fruit specific gravity in the two growing seasons (2021 and 2022).

Mourcet Mandarin tree treated with B_{12} at 100 mg/L (T_9) gave the highest fruit specific gravity 1.103 in the 2022 growing seasons. While the lowest fruit specific gravity 0.99 in 2021 growing seasons was recorded under T_{10} CaC_2 at 1%.

4-3- Data presented in Table (3) showed that the fruit length (cm), fruit diameter (cm) and fruit shape index as affected by of some foliar nutrients and antioxidants foliar for Mourcet Mandarin in the two seasons (2021 and 2022).

3-1 Mourcet Mandarin trees treated with vitamin B_{12} at 100 mg/L (T_9) gave the highest fruit length 6.97 cm in the first season 2021 but this results was recorded under antioxidant treatments (T_{14}) mixture of chelated (Fe, Zn and Mn) at 1000 mg/L in the second season 7.29 cm. No significant difference between different $CaCl_2$ treatments T_{10}, T_{11} and T_{12} in fruit length in the two growing seasons. The T_4 (citric acid at 500 mg/L gave the lowest fruit length in the two seasons 6.21 and 6.20) compared with the other foliar nutrients and antioxidants treatments under this study followed by control treatments. In generally, no significant affects grave by increasing concentration on different treatments under this study on fruit length in the two seasons.

Table 3: Effect of some foliar nutrients and antioxidants on fruit length (cm), fruit diameter (cm), and shape index for Mourcet Mandarin in two seasons (2021/2022)

Characters	Fruit Length (cm)		Fruit Diameter (cm)		Fruit Shape Index	
Season / Treatments	2021	2022	2021	2022	2021	2022
Control	**5.807e**	**5.66e**	**6.99h**	**7.20d**	**0.83a**	**0.78a**
Ascorbic acid at 500 mg/l	**6.31cd**	**6.38cd**	**7.72g**	**7.98bc**	**0.82a**	**0.80a**
Ascorbic acid at 1000 mg/l	**6.70ab**	**6.71bc**	**8.32b**	**8.19b**	**0.81a**	**0.82a**
Citric acid at 500 mg/l	**6.21cd**	**6.20d**	**7.84fg**	**7.73c**	**0.79a**	**0.80a**
Citric acid at 1000 mg/l	**6.73ab**	**6.54cd**	**8.35ab**	**8.14b**	**0.81a**	**0.80a**
Salicylic acid at 100 mg/l	**6.44bcd**	**6.47cd**	**8.05c-f**	**8.14b**	**0.80a**	**0.79a**
Salicylic acid at 200 mg/l	**6.77ab**	**6.56cd**	**8.26bcd**	**8.25b**	**0.82a**	**0.79a**
Vitamin B12 at 50 mg/l	**6.44bcd**	**6.42cd**	**8.03def**	**8.04bc**	**0.80a**	**0.80a**
Vitamin B12 at 100 mg/l	**6.97a**	**7.06ab**	**8.56a**	**8.64a**	**0.81a**	**0.82a**
$CaCl_2$ at 1%	**6.44bcd**	**6.31d**	**7.98ef**	**8.06b**	**0.81a**	**0.78a**
$CaCl_2$ at 2%	**6.19d**	**6.29d**	**7.88fg**	**8.07b**	**0.78a**	**0.78a**
$CaCl_2$ at 3%	**6.48bcd**	**6.46cd**	**8.16b-e**	**8.10b**	**0.79a**	**0.80a**
Mixture of chelated (Fe, Zn and Mn) at 500 mg/l	**6.52bcd**	**6.58cd**	**8.26bc**	**8.23b**	**0.79a**	**0.80a**
Mixture of chelated (Fe, Zn and Mn) at 1000 mg/l	**6.57bc**	**7.29a**	**8.31b**	**8.60a**	**0.79a**	**0.85a**

Values having the same alphabetical letter(s) in each column did not significantly different according to Duncan multiply range at (0.05) of probability

3-2 The T_9 (Vitamin B_{12} at 100mg/L) gave the highest fruit diameter cm 8.56 and 8.04 cm) in the two seasons followed by T_{14} (mixture of chelated Fe, Zn and Mn) at 1000 mg/L (8.31 and 5.60 cm) in the two seasons. While, T_2 (Ascorbic acid at 500 mg/L gave the lowest fruit diameter 6.31 and 6.38) followed by T_1 in the two growing seasons under this study.

Generally, treatment with vitamin B_{12} followed by antioxidant by $CaCl_2$ by Salicylic acid and Ascorbic acid was ranked in fruit diameter in the two growing seasons.

3-3 Foliar application of nutrients and antioxidants treatments were no significant difference on fruit shape index in the two growing seasons under this study.

4- Data presented in Table (4) showed that the effect of some foliar nutrients and antioxidants on fruit firmness (kg/cm) and fruit waste percentage for Mourcet Mandarin in two seasons (2021 and 2022).

4-1 The T_{13} (mixture of chelated Fe, Zn and Mn at 500 mg/L) gave the highest fruit firmness 4.81 kg/cm in the first season 2021 but T_{11} ($CaCl_2$ at 2%) recorded the highest fruit firmness in the second season (4.78 kg/cm) in this respect. Without significant difference between T_{11}, T_{12}, T_{13} and T_{14} treatments were of fruit firmness in the two growing season. The lowest number of fruit firmness was recorded by T_6 (Salicylic acid at 100 mg/L) in the first season 2.92 kg/cm but, T_3 (Ascorbic acid at 1000 mg/L) was recorded in the second season (2.75 kg/cm), respectively.

In Generally results bears that, treated with antitoxins, (Fe, Zn and Mn) and $CaCl_2$ treatments gave the heights number of fruit firmness (kg/cm) followed by Vitamin B_{12} and Citric acid treatments without any significant difference between them.

4-2 the effect of the other foliar application treatments on the fruit waste % were significance in the first season only.

Salicylic acid at 200 mg/L (T_7) gave the highest fruit waste % followed by T_4 and T_9, but, T_{11} ($CaCl_2$ at 2%) gave the lowest fruit waste % in the first seasons compared with control treatment.

Table 4: Effect of some foliar nutrients and antioxidants on fruit firmness and fruit waste for Mourcet Mandarin in two seasons (2021/2022)

Characters	Fruit Firmness (kg/cm)		Fruit Waste %	
Treatments / Season	2021	2022	2021	2022
Control	3.14efg	3.48bc	53.5cde	43.80a
Ascorbic acid at 500 mg/l	3.75cd	3.11cde	56.2abc	41.4a
Ascorbic acid at 1000 mg/l	3.35d-g	2.75e	53.8cde	42.5a
Citric acid at 500 mg/l	2.92fg	2.96de	52.4de	41.7a
Citric acid at 1000 mg/l	3.71cd	3.53b	58.1ab	41.3a
Salicylic acid at 100 mg/l	2.92g	3.52b	53.1cde	43.0a
Salicylic acid at 200 mg/l	3.73cd	3.30bcd	59.4a	41.90a
Vitamin B12 at 50 mg/l	3.42c-f	3.53b	55.9a-d	42.90a
Vitamin B12 at 100 mg/l	3.55cde	3.51b	58.2ab	42.3a
$CaCl_2$ at 1%	3.89bc	3.61b	53.7cde	41.5a
$CaCl_2$ at 2%	4.34ab	4.78a	51.7e	42.3a
$CaCl_2$ at 3%	4.64a	4.40a	54.7b-e	42.0a
Mixture of chelated (Fe, Zn and Mn) at 500 mg/l	4.81a	4.72a	54.4cde	42.1a
Mixture of chelated (Fe, Zn and Mn) at 1000 mg/l	4.67a	4.62a	54.9b-e	41.6a

Values having the same alphabetical letter(s) in each column did not significantly different according to Duncan multiply range at (0.05) of probability

5-The results in Table (5) showed that Number of fruit segments, weight of segments (g) and segments waste weight (g) as influenced by some foliar nutrients and antioxidants for Mourcet Mandarin in the two growing seasons (2021 and 2022).

5-1 Data were recorded significant different between the foliar treatments were used under this study on number of fruit segments in first season only.

The highest number of fruit segments was recorded by T_6 (Salicylic acid 100 mg/L) followed by T_{13}, T_{14} and T_8 compared with control treatment in the first season only. While, the least number of fruit segments were recorded under T_4 (Citric acid at 500 mg/L) followed by T_9 (Vitamin B_{12} at 100 mg/L), T_8 (vitamin B_{12} 50 mg/L) and T_{10} foliar application compared with control treatment in the first seasons yet.

Generally, Citric acid treatments were obtained the lowest number of number of segments but, mixture of chelated (Fe, Zn and Mn) and Salicylic acid treatments gave the highest segments number in the first seasons.

5-2 The highest weight of segments (g) and segments waste weight (g) were recorded under T_9 (vitamin B_{12} at 100 mg/L) and the lowest weight of segments and segments waste weights (g) under T_2 (Ascorbic acid at 500 mg/L compared) and control treatment in the two growing seasons. The highest weight of segments (g) was found under T_9 (Vitamin B_{12} at 100 mg/L) followed by T_{13}, T_4 and T_5 in the first season (2021), but the same trend under the second season was reported under T_9 followed by T_3, T_{13} and T_{14} foliar application treatments, respectively.

On the other hand, the lowest weight of segments (g) was recorded with T_4, T_6 and T_3 in the first season but, with T_2, T_5 and T_4 in the second season compared with control treatment.

5-3 The segments waste weight (g) as affected by different foliar treatments was used under this study. The best results recorded in segments waste weight (g) under T_9, followed by T_{13}, T_5 and T_5 in the first seasons but T_2 followed by T_9, T_8 , T_3 , T_{13} and T_{14} in the second seasons were reported highest segments weight (g).

Meanwhile, the lowest segments waste weight (g) were found under T_2 followed by T_4, T_6 and T_{11} in the first seasons but this results were found by T_2 and T_4, T_5 and T_{10} in the second seasons (2022).

Table 5: Effect of some foliar nutrients and antioxidants on number of fruit segments, weight of segment (g) and segments waste weight (g) for Mourcet Mandarin in two seasons (2021/2022)

Characters	Number of Fruit Segments		Weight of Segment (g)		Segments Waste Weight (g)	
Treatments \ Season	2021	2022	2021	2022	2021	2022
Control	9.8f	10.6a	56.70g	54.40f	42.17h	46.67i
Ascorbic acid at 500 mg/l	11bcd	10.9a	82.20de	67.97e	68.07g	95.07h
Ascorbic acid at 1000 mg/l	11.8a	11.2a	80.23e	94.97ab	96.17cd	128.80bc
Citric acid at 500 mg/l	10.2ef	10.8a	73.20f	78.17d	74.97f	102.30g
Citric acid at 1000 mg/l	10.8cde	11.20a	90.80c	76.80d	101.77bc	106.80fg
Salicylic acid at 100 mg/l	11.6ab	11.0a	80.07e	83.03cd	86.27e	113.37e
Salicylic acid at 200 mg/l	11.1abcd	10.8a	82.53de	83.33cd	96.20cd	114.67e
Vitamin B12 at 50 mg/l	11.13abcd	11.8a	91.50c	84.67cd	102.50bc	131.40b
Vitamin B12 at 100 mg/l	10.5def	11.5a	106.27a	99.57a	115.87a	147.40a

$CaCl_2$ at 1%	**10.9b-e**	**11.4a**	**86.20cd**	**86.73bc**	**91.87de**	**112.27ef**
$CaCl_2$ at 2%	**11.0bcd**	**11.3a**	**81.00de**	**84.83cd**	**89.07e**	**117.10de**
$CaCl_2$ at 3%	**10.9bcde**	**11.5a**	**82.80de**	**84.00cd**	**90.87de**	**115.63e**
Mixture of chelated (Fe, Zn and Mn) at 500 mg/l	**11.4abc**	**10.7a**	**98.33b**	**93.77ab**	**107.90b**	**126.50bc**
Mixture of chelated (Fe, Zn and Mn) at 1000 mg/l	**11.2abcd**	**11.1a**	**90.33c**	**90.73bc**	**100.73c**	**122.63cd**

Values having the same alphabetical letter(s) in each column did not significantly different according to Duncan multiply range at (0.05) of probability.

6 Data presented in Table (6) showed that the effected of some foliar application of nutrients and antioxidants on peel weight (g), peel thicknesses (mm) and weight of fruit waste (g) for Mourcet Mandarin in two growing seasons (2021 and 2022). Generally, significant difference between the different application treatments were applied under this study on peel weight (g) peel thickness (mm) and weight of fruit waste (g) in the two growing seasons respectively compared the control treatment. T_9 (Vitamin B_{12} at 100 mg/L) was superior than the others treatments under this study in peel weight (g) and weights of fruit waste (g) in the two growing seasons.

6-1 T_2 (Ascorbic acid at 500mg/L) came the last recorded treatments compared the T_1 (tap water) control in this respect. But, the highest peel weight (g) was recorded under T_9 treatment followed by T_{13}, T_3, T_7 and T_{14} in the first season (2021) meanwhile in the second season were T_9 followed by T_4, T_3, T_5 and T_{12} respectively. The T_4 (Citric acid at 500 mg/L) treatments gave the least peel weight (g) in the first season followed by T_6, T_{11} and T_2. On the other band, in the second season were T_6 (Salicylic acid at 100 mg/L) followed by T_2, T_4, T_8 and T_{11}, in this respect, compared the control treatment.

6-2 The more thicknesses (mm) was reported by T_{14} followed by T_{12}, T_{11}, T_9 and T_{13} in the first seasons (2021), but this results were found by T_{12} followed by T_{14}, T_{10}, T_9 and T_{11} treatments compared the control treatments (tap water T_1) in the second season (2022). On the other hand, the least thicknesses (mm) were recorded by T_6 followed by T_4, T_2, T_8 and T_1 in first season (2021 season). On the other side T_6 followed by T_8, T_4, T_5 and T_2 in the second season (2022) gave the lowest thickness compared with the T_1 (control treatment).

6-3 Weight of fruit waste (g) was affected by different treatments were applied under this study whereas T_9 (Vitamin B_{12} at 100 mg/L) was superior than the others treatments followed by T_{13}, T_{14}, T_5, T_8 and T_3 in the first seasons. But, T_{13}, T_3, T_{14} and T_{12} in the second season, respectively. On the other side T_4 followed by T_2, T_6, T_{11} and T_7 in the first season but T_2 followed by T_4, T_6 and T_5 recorded the light weight of fruit waste weight (g) compared with T_1 (control treatment).

Table 6: Effect of some foliar nutrients and antioxidants on peel weight (g), peel thicknesses (mm) and weight of fruit waste (g) for Mourcet Mandarin in two seasons (2021/2022)

Characters	**Peel Weight (g)**		**Peel Thicknesses (mm)**		**Weight of Fruit Waste (g)**	
Season / Treatments	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
Control	**23.97g**	**23.07g**	**2.67f**	**2.33g**	**66.13g**	**69.70f**
Ascorbic acid at 500 mg/l	**42.77cde**	**38.63ef**	**3.00ef**	**3.50b-e**	**110.83f**	**133.70e**
Ascorbic acid at 1000 mg/l	**51.67ab**	**45.03bcd**	**3.73abc**	**3.57b-e**	**147.83c**	**173.80b**

Citric acid at 500 mg/l	**32.13f**	**40.67def**	**2.97f**	**3.33def**	**107.03f**	**142.97de**
Citric acid at 1000 mg/l	**48.83abc**	**44.63bd**	**3.50cd**	**3.40cdef**	**150.57c**	**151.43cd**
Salicylic acid at 100 mg/l	**35.33ef**	**37.16f**	**2.87f**	**2.97f**	**121.63e**	**150.50cd**
Salicylic acid at 200 mg/l	**50.40abc**	**44.43bcd**	**3.43cde**	**3.57b-e**	**146.27c**	**159.07c**
Vitamin B12 at 50 mg/l	**45.70bc**	**43.20cde**	**3.10def**	**3.23ef**	**148.17c**	**174.63b**
Vitamin B12 at 100 mg/l	**53.97a**	**53.70a**	**3.83abc**	**3.87abc**	**169.83a**	**201.10a**
$CaCl_2$ at 1%	**43.40cd**	**46.37bc**	**3.67bc**	**3.97ab**	**135.60d**	**158.60c**
$CaCl_2$ at 2%	**36.37def**	**42.67cde**	**3.97ab**	**3.80a-d**	**128.77de**	**159.80c**
$CaCl_2$ at 3%	**47.13abc**	**43.97cd**	**4.03ab**	**4.30a**	**134.73d**	**159.60c**
Mixture of chelated (Fe, Zn and Mn) at 500 mg/l	**51.97ab**	**47.67bc**	**3.63bc**	**3.67a-d**	**159.90b**	**174.17b**
Mixture of chelated (Fe, Zn and Mn) at 1000 mg/l	**50.10abc**	**49.30ab**	**4.13a**	**4.00ab**	**150.83c**	**171.93b**

Values having the same alphabetical letter(s) in each column did not significantly different according to Duncan multiply range at (0.05) of probability

3. **Effect of nutrients and antioxidants on chemical characteristics of fruits:**

7. Data presented in Table (7): showed that the effect of some foliar nutrients and antioxidants on TSS % percentage, total acidity %, TSS /Acid ratio and vitamin C mg/100 m/juice for Maurcet Mandarin fruits two growing seasons (2021 and 2022).

7-1 In the first growing season, the highest TSS percentage in fruits juice was recorded by T_6 followed by T_{11}, T_2, T_{12} and T_{14} applied compared with T_1 (control treatment). Meanwhile, T_9 followed by T_5, T_7, T_8 and T_{10} were recorded the least TSS % values in this respect. Difference effect between T_5, T_7 and T_8 and in between T_2 and T_2 foliar application treatments were insignificant in TSS %.

On the other side, in the second season gave the highest values of TSS by T_{12} followed by T_{11}, T_2, T_{14}, T_6 and $T_{10,}$ but the T_9 followed by T_8, T_7 and T_{13} gives the lowest values of TSS % compared the control treatment applied. Meanwhile, no significant difference effects on TSS %, between T_{13}, T_8, T_4, T_3 and T_{10} and in between T_{14}, T_{16} and T_2 were applied.

7-2 Total acidity percentage in fruits juice in fruit juice was affected by the others treatments were applied in this study. The low value was recorded by T_3 followed by T_5, T_7, T_{10} and T_8 were applied compared with the T_1 (control treatment), but the high value of total acidity percentage was recorded by T_6 followed by T_2, T_{13}, T_{14}, T_2, T_{11} and T_9 compared with control treatment were applied and no significant difference between T_{12}, T_{10}, T_9, T_8, T_7, T_5 and T_3 and in between T_{13} and T_{14} treatments in the first season (2021). In the second season (2022) the T_2 (Ascorbic acid at 500mg/l) treatment gave the highest value of total acidity % followed by T_{13}, T_5, T_6, T_{10} and T_{12} treatments were applied compared with T_1 as control treatments was applied. While the T_3 followed by T_9, $T_{11,}$ T_4 and T_8 were gives the lowest total acidity percentage values compared the control treatment was applied. Different effects not found significant between T_{14}, T_8, T_7 and T_4 treatments effect in total acidity percentage in this respect.

7-3 TSS/Acid ratio was affect by some foliar nitrites and antioxidants application under this study were used. This ratio was high under to applied T_3 followed by T_{12}, T_{10}, T_8, T_7 and T_{14} treatments compared with T_1 (control treatment). While, T_2 followed T_6, T_4, T_{13}, T_9 and T_{14} were recorded the low values of this ratio and no significance difference between T_{13}, T_9 and in between T_2 and T_6 and in between T_{14}, T_{10} and T_8 and in between T_{11} and T_5 in this respected. These results were received in the first season only.

Table 7: Effect of some foliar nutrients and antioxidants on TSS%, total acidity %, TSS/acid ratio and vitamin C mg/100ml juice for Mourcet Mandarin in two seasons (2021/2022)

Characters	TSS%		Total Acidity%		TSS/Acid ratio		Vitamin C mg/100ml juice	
Season / Treatments	2021	2022	2021	2022	2021	2022	2021	2022
Control	13.73a	13.97a	1.01ab	1.13a	13.77bcd	12.40e	42.13abc	42.57a
Ascorbic acid at 500 mg/l	12.37bcd	12.07cd	0.99abc	0.96b	12.56d	12.53e	45.10a	35.10cd
Ascorbic acid at 1000 mg/l	12.07b-e	11.50de	0.81d	0.81e	14.8a	14.13abc	37.40def	39.57abc
Citric acid at 500 mg/l	11.77cde	11.83cde	0.90cd	0.86cde	13.00d	13.77a-d	38.50cde	41.07ab
Citric acid at 1000 mg/l	11.47de	11.83cde	0.81d	0.90bcd	14.06a-d	13.10cde	43.63ab	41.07ab
Salicylic acid at 100 mg/l	12.83ab	11.97cd	1.02a	0.89b-e	12.57d	13.50b-e	40.70b-e	34.37d
Salicylic acid at 200 mg/l	11.53de	11.47de	0.83d	0.88cde	14.00a-d	13.07cde	34.10f	37.70bcd
Vitamin B12 at 50 mg/l	11.70cde	11.43de	0.83d	0.86cde	14.16abc	13.43b-e	37.03ef	37.33bcd
Vitamin B12 at 100 mg/l	11.27e	11.17e	0.85d	0.83de	13.30cd	13.47b-e	40.33b-e	40.33ab
$CaCl_2$ at 1%	11.77cde	11.77cde	0.83d	0.89b-e	14.20abc	13.17b-e	40.33b-e	40.33ab
$CaCl_2$ at 2%	12.50bc	12.53bc	0.89cd	0.85cde	13.97a-d	14.70a	38.87cde	38.10a-d
$CaCl_2$ at 3%	12.33bcd	12.87b	0.85d	0.89b-e	14.53ab	14.33ab	34.27ef	41.43ab
Mixture of chelated (Fe, Zn and Mn) at 500 mg/l	11.97b-e	11.67de	0.91bcd	0.92bc	13.13cd	12.67de	37.03ef	40.30ab
Mixture of chelated (Fe, Zn and Mn) at 1000 mg/l	12.20bcd	12.00cd	0.91bcd	0.87cde	13.40bc	13.73a-d	41.43a-d	38.47a-d

Values having the same alphabetical letter(s) in each column did not significantly different according to Duncan multiply range at (0.05) of probability

In the other side in the second season the high values of TSS/Acid ratio were recorded by T_{11} followed by T_{12}, T_3, T_4, T_{14} and T_6 were applied compared with control treatment was used. No significant differences between T_{10}, T_9 and T_8 in between T_5, T_6 and T_7 in TSS/Acid ratio were recorded in the second season.

7-4 The Vitamin C mg/100ml in fruits juice was affected by different foliar application treatments were applied under this study in the two growing seasons.

Whereas, the high vitamin C content in Mourcet Mandarin in fruit juice was recorded by T_2 followed by T_5, T_{14}, T_6, T_9 and T_{10} were applied. But the low vitamin C content were received by T_7 followed by T_{12}, T_{13}, T_8, T_3 and T_{13} compared with the T_1 (control treatment) was applied and no significance difference between T_{13}, T_8, T_3) and in between T_6, T_9, T_{10} and T_2 in vitamin C content. These results were recorded in the first season only.

In the second season, the vitamin C mg/l00 ml juice for Mourcet Mandarin was superior under the $T_{1,}$ $T_{12,\ T13}$ followed by T_4, T_5, T_9, T_{10} and T_3 were applied. Meanwhile, the lowest vitamin C content were recorded under T_6 treatment followed by T_2, T_8, T_7 and T_{11} were applied compared with the control treatment was applied. While, no significant difference between T_{13}, T_{12}, T_{10}, T_9, T_5 and T_4 and in between T_8, T_7 and T_2 were recorded in this respect.

8. Illustrate data presented in Table (8) showed that the effect of some foliar nutrients and antioxidants application on total, reducing, non-reducing sugars percentage and total phenols (mg/100ml) juice for Mourcet Mandarin in fruit juice in the two growing seasons (2021 and 2022).

8-1 Total sugars percentage in fruits juice was affected by different foliar application treatments were applied under this study, whereas T_5 (Citric acid at 1000 mg/l) was highest values in total sugars percentage followed by T_6, T_{14}, T_{12} and T_4 compared with the tap water treatment (control treatment) was applied. But, the lowest values of total sugars percentage were received by T_9 (vitamin B_{12} at 100mg/l) followed by T_8, T_{10}, T_3, T_7 and T_{13} were applied compared with control treatment in the two seasons. Differences between T_4 and T_{14} and in between T_2 and T_7 treatments on total sugars percentages were insignificant.

In the second growing season (2022) the highest total sugar percentage in fruit juice results were reported by T_5 followed by T_6, T_{12}, T_{11} and T_4, meanwhile, T9 followed by T_3, T_{13}, T_2, T_8 and T_{10} recorded the lowest values total sugars % compared with T_1 (control treatments) was applied approximately.

Table 8: Effect of some foliar nutrients and antioxidants on total sugars%, reducing sugars %, non-reducing sugars % and total phenols (mg/100 ml Juice) for Mourcet Mandarin in two seasons (2021/2022)

Characters	Total Sugars%		Reducing Sugars %		Non-Reducing Sugars %		Total Phenols (mg/100 ml Juice)	
Season / Treatments	2021	2022	2021	2022	2021	2022	2021	2022
Control	8.49a	8.70a	4.65ab	4.62a	3.84abc	4.08a	62.8i	61.60f
Ascorbic acid at 500 mg/l	8.15cde	8.08cde	4.30cd	4.32bcd	3.86abc	3.77bcd	66.97gh	67.33de
Ascorbic acid at 1000 mg/l	8.09de	7.85ef	4.51bc	4.21de	3.57de	3.64d	71.00c-f	69.37b-e
Citric acid at 500 mg/l	8.36abc	8.41a-d	4.42bc	4.46ab	3.94ab	3.95abc	72.00b-e	71.37bcd
Citric acid at 1000 mg/l	8.50a	8.60ab	4.80a	4.48ab	3.70cde	4.12a	74.47ab	73.93ab
Salicylic acid at 100 mg/l	8.43ab	8.55ab	4.55b	4.42bc	3.87abc	4.13a	73.2bcd	73.70ab
Salicylic acid at 200 mg/l	8.15cde	8.21b-e	4.65ab	4.25cd	3.50e	3.96abc	77.7a	76.53a
Vitamin B12 at 50 mg/l	7.95ef	8.10cde	4.11d	4.06e	3.83abc	4.04ab	68.83efg	69.17b-e
Vitamin B12 at 100 mg/l	7.80f	7.48f	3.82e	3.84f	3.98a	3.64d	72.43bcd	72.63abc
$CaCl_2$ at 1%	8.03def	8.16b-e	4.30cd	4.19de	3.73b-e	3.97abc	65.03hi	64.60ef
$CaCl_2$ at 2%	8.27a-d	8.45abc	4.45bc	4.40bc	3.82abc	4.05ab	68.30fgh	67.63cde
$CaCl_2$ at 3%	8.36abc	8.50abc	4.50bc	4.48ab	3.86abc	4.02ab	73.80bc	73.13ab
Mixture of chelated (Fe, Zn and Mn) at 500 mg/l	8.21bcd	8.00de	4.28cd	4.32bcd	3.93abc	3.68cd	69.80d-g	70.67bcd
Mixture of chelated (Fe, Zn and Mn) at 1000 mg/l	8.40abc	8.31abcd	4.60ab	4.35bcd	3.80a-d	3.96abc	72.50bcd	72.83ab

Values having the same alphabetical letter(s) in each column did not significantly different according to Duncan multiply range at (0.05) of probability

No significant difference between T_{11} and T_{12} and in between T_6 and T_5 foliar application treatments were applied.

8-2 Reducing sugars percentage in fruits juice was affected by different foliar application treatments were applied under this study. Whereas, the highest values of reducing sugars percentage were received by T_5 followed by T_7, T_{14}, T_6 and T_{14} treatments were applied compared with control treatment was applied. These results were given in the first growing season only.

On the other hand, difference between T_{13}, T_{10} and T_2 and in between T_{12}, T_4 and T_3 treatments insignificant founded effects on total reducing percentage.

In the second season, the results showed that the highest values of reducing sugars percentage were reported by T_5 (Citric acid at 1000 mg/1) followed by T_{12}, T_4, T_{14}, T_{13} and T_2 treatments compared control treatment, but the lowest values of reducing sugars percentage were recorded by T_9, T_8, T_{10}, T_3 and T_7 were applied under this study compared with control treatment.

Different effect on reducing sugar % by T_{12}, T_{14}, T_7 and T_2 and by T_4, T_8 and by T_5 and T_4 were found insignificant.

8-3 Data in Non-reducing sugars % in fruits juice was resulted in the highest values were recorded under T_9 treatment was applied followed by T_4, T_{13}, T_6, T_{12} and T_2 treatments compared with the tap water treatment (T_1) was applied. But, the lowest values of non-reducing sugars % were received by T_7 followed by T_3, T_5 and T_{10} treatments were applied compared with T_1 (control treatment). These results were showed in the first season only. Difference between T_{13}, T_{12}, T_8 and T_2 and in between T_7 and T_4 and in between T_{13} and T_2 in non-reducing sugars was recorded insignificant in the first growing season, respectively. In the second hand, in the second growing season (2022), the big values of non-reducing sugars percentage were showed under T_6 (Salicylic acid at100mg/l) followed by T_5, T_{11}, T_{12}, T_{10}, T_{14} and T_7 were applied compared with T_1 (control treatment). But, the small values were recorded by T_9, followed by T_3; T_{13} and T_2 treatments were used under this study. Difference between T_5, T_6, T_7, T_{10}, T_{11} and T_{12} and in between T_4 and T_{14} in non-reducing sugars percentage were found in the second season.

8-4 Total phenols (mg/100 juice) in fruits juice were affected by the others foliar application treatments were applied under this study.

In the first season, the highest values of total phenols (mg/100ml) was recorded by T_7 (Salicylic acid at 200 mg/l) followed by T_5, T_{13}, T_6, T_{14} and T_4 were applied compared with T_1 (control treatment). Meanwhile, the smallest values were received by T_{10} followed by T_2, T_{11} and T_{13} treatments were applied compared with T_1 (control treatment). Effect between T_{14} and T_9, T_{14} and T_6 treatments were insignificant in total phenols mg/100ml juice.

In the other side, in the second season (2022) the highest total phenols (mg/100m) juice were found by T_7 (Salicylic acid at 200 mg/l) treatment followed by T_6, T_5, T_2, T_4 and T_9 treatments were applied compared with the control treatment was applied under this study. Meanwhile, the lowest number of total phenols (mg/100ml juice) were received by applied the T_{10} followed by T_2, T_4, T_8 and T_3 were applied compared the control treatment.

But, difference between T_4, T_{12}, T_6 and T_5 treatments and in between T_{13} and T_4 treatments effects were insignificant in total phenols (mg/100ml juices).

The results are in harmony with those obtained by **Samra, *et al.*, (2012)** of Balady mandarin, **Amro (2015)** of orange trees cv. Valencia, **Randa (2015)** found that treating Valencia orange trees, **Al-Hamadani and Ibrahim (2015)** on Citrus sinensis L trees, **El-Gioushy (2016)** on Washington navel orange trees**, Eman (2019**) on ‘Navel orange’ trees, **Gad El- Kareem and Hussein (2021)** on Valencia orange trees, **Nandita *et al.*, (2022)** on sweet orange cv. Mosambi trees, **Hiba and Mohamed Saleh (2022)** on 'Balady' mandarin trees, **Shoug *et al.*, (2023)** on Balady mandarin trees, and **Randa Habasy (2023)** on Washington Navel orange trees as well as with other fruit trees **Ahmed, *et al.*, (2007)** on Anna apple trees, **Gad El-Kareem and Abd El- Rahman (2013)** on Ruby seedless grapevines, **Mohamed (2014**) on Superior grapevines, **Amin (2025)** on Picual olive trees,

Mohamed *et al*., (2025) on Keitt mango trees and **Thakur *et al*., (2025)** on apricot (*Prunus armeniaca* L.) cv. New Castle.

From the foregoing results, it could be concluded some nutrients and antioxidants materials were affected significantly on Muorcet Mandarin yield and fruit quality.

Plant responses to different stresses are highly complex and involve changes at the transcriptome, cellular, and physiological levels. Plants respond to multiple stresses differently from how they do to individual stresses, activating a specific programme of gene expression relating to the exact environmental conditions encountered. Rather than being additive, the presence of an abiotic stress can have the effect of reducing or enhancing susceptibility to a biotic pest or pathogen, and vice versa.

Besides abiotic stresses, biotic factors are another restraint to global agricultural potency. Pests and pathogens have become tolerant to the use of conventional methods to improve agricultural production. This has resulted in low yields of crops worldwide.

The effect of some nutrients and antioxidants were positive action on growth and fruiting might be attributed to its essential effect on enhancing the tolerance of plants to biotic and abiotic stresses.

Micronutrients help in the uptake of major nutrients and play an active role in the plant metabolism process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity hormone synthesis, nitrogen fixation and reduction (**Das, 2003**)

This is due to that the zinc regulates metabolic activities, which increased stored food material in the tissue. This caused increase in volume of fruit.

Plant nutrients especially zinc and boron play an important role in growth, fruit set, fruit retention and development and cause efficient yield and quality improvement.

This increase in fruit number might be due to reduction in the fruit drop. **Nijjar (1985)** reported that Zn is required for preventing the abscission layer formation and consequently, the reduction in pre-harvest fruit drop.

Zinc plays a fundamental role in many essential cellular functions such as protein metabolism and IAA (**Marschner, 1995 and Kumar, 2002).** It is well known that zinc is an important component of many vital enzymes, including ribulose-1, 5-bisphosphate carboxylase involved in photosynthesis (**Brown *et al*., 1993).** It stabilizes the structure of membrane proteins and DNA-binding proteins (**Aravind and Prasad, 2004).** Zinc plays a key role in N metabolism of plant and zinc deficient plants have reduced protein content (**Mengel *et al*., 2001 and Hassan *et al*., 2010).**

Thus, it reflected on improved yield and fruits quality. Zinc play an important role in growth, fruit set, fruit retention and development and cause efficient yield and quality improvement on sweet orange cv. Mosamb **(Singh *et. al.,* 2018).**

Antioxidants have useful effects on catching free radicals such as the active oxygen species namely superoxide anion, singlet oxygen, hydroxyl radicals, hydrogen peroxide and ozone that biosynthesized during plant metabo-lism. Leaving free radicals without chelating or catching causing loss of plasma membrane per-meability, oxidation of lipids and death of cells (**El Sayed et al 2000**). Antioxidants have an important role in enhancing the biosynthesis of natural hormones, photo-synthesis, nutrient uptake, plant protection from biotic and abiotic stresses and biosynthesis of plant pigments and sugars, as they increase anti-oxidant defense systems and reduce the reactive oxygen species, then suggested recently that it is mainly involved in the growth of flowering plants and the development of fruit (**Rao *et al.,* 2000**).

The spraying with antioxidant materials was very effective in improving fruit physical properties of several different plants. The positive action of salicylic acid on fruiting and fruit quality parameters could be attributed to several processes such as enhancing cell division, the biosynthesis of sugar, plant pigments, and cell protection from free radicals that responsible of plant senescence and the tolerance of plants to all stresses **(Joseph et al 2010).** The improving fruit size could be explaining away by role both salicylic and citric acid as auxinic action **(Maksoud *et al* 2009)** and role of folic acid as a central cofactor for one-carbon transfer reactions **(Jabrin et al 2003).**

Salicylic acid is also involved in minimizing of the stresses during inducing antioxidant system when plants are exposed to it, and now is considered a hormonal substance that plays a key part in regulating plant growth and development, (**Senaratna *et al*., 2004**).

Salicylic acid (SA) was first discovered as a major component in the extracts from Salix (willow) whose bark from ancient time (**Shamsul and Aqil, 2007**). Also, plant growth and development are greatly affected by various biotic and a biotic stresses factors. Detection of compounds of reducing these stresses is great important. Previous studies emphasized the beneficial effects of salicylic acid in reducing biotic stress sensitivity in plants. It was also shown to influence a number of physiological processes including flowering, ion uptake and transport, photosynthesis rate and stomatal conductance (**Shah, 2003,** Horvath**, *et. al*., 2007 and Szepesi, *et. al*., 2009**). Using salicylic acid had beneficial effects on growth and fruiting of evergreen fruit crops (**Gobara, 2004** and **Ahmed, 2011).**

Ahmed (2011) found that salicylic acid was responsible for protecting the plants from all stresses and retarding reactive oxygen forms that destroyed the plant cells. They found that treating the trees with salicylic acid was very effective in enhancing metabolism of plants and the biosynthesis of all organic food.

The foliar application of antioxidant materials such as salicylic was very effective in improving yield, salicylic acid plays a definite role in solving the problem of poor yielding through enhancing growth, nutritional statues, yield in different evergreen fruit crops **(Prusky, 1988).**

Citric acid playing an important role in plant metabolism that led to enhancing fruit set, fruit retention, number of fruit per tree and yield (**Ahmed and Abdelaal, 2007).**

Citric acid has several influences on trees such as increasing photosynthetic pigment which reflected on photo-synthesis process and therefore increase in total soluble solids **(Fayed 2010).**

The promotive effects of these stimulants on growth and tree nutritional status in favor of enhancing C/N ratio and producing a higher number of flowers could improve the yield. It is suggested that the increase in bio productivity is mainly due to the positive effect of SA on root length and its density. **(Shaaban and Mahmoud, 2012).**

Lower acidity in fruits may have resulted in increased accumulation of sugars, better translocation of sugars via fruit tissues and transformation of organic acids into sugars **(Kumar *et al.,* 2015).**

The use of ascorbic acid has increased nowadays as a spray on the vegetative system of fruit trees because it is an antioxidant **(Samra, *et al.,* 2012).** And its effect on plant growth is similar to that of growth regulators that encourage growth **(Hagagg, *et al.,* 2020).** As well as its role in reducing stress caused by temperature, toxins, stimulating respiration and cell division, entering in the electron transport system, and protecting chloroplasts from oxidation Ascorbic acid is also important in increasing the growth and activity of the various organs of plants, including the roots **(El-Badawy *et al.,* 2017).**

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