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(Original Article)

Enhancing Yield and Fruit Quality of Sweet Orange (*Citrus Sinensis*) in Response to Foliar Application of Amino Acids and Micronutrients

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Abstract

Compared to other citrus cultivars, the sweet orange (*Citrus sinensis*) species provides the greatest quantity of fruit and is grown throughout the world. The current study's experiment was conducted during two consecutive seasons in 2019 and 2020 in the Experimental Orchard of the Faculty of Agriculture, Assiut University. The aim of the research study was to investigate how foliar application of micronutrients and amino acids influenced the sweet orange (*Citrus sinensis*) yield as well as quality. Sixteen uniform sweet orange trees (Balady cultivar), aged 25 years, were chosen, and they were arranged in a complete randomized block design with four treatments, one of which was control. The treatments included T_1 (spraying 1000 mg/l of "Strong Amino Gold" amino acids), T_2 (spraying 2000 mg/l of "Omega Mix" micronutrients), T_3 (spraying a mixture of micronutrients and amino acids), and T_4 control (spraying water only). Throughout the two seasons, the trees got four sprays from each treatment at the onset of new growth (mid-February), following fruit setting (first week of April), first week of July, and first week of September. Yield and fruit quality observations were conducted and recorded. The study showed that, over the course of the two studied seasons, the combined treatment (T_3) outperformed the others, recording the highest yield weight, fruit weight, fruit length, diameter, juice weight, volume, rind weight, rind thickness, rags %, TSS%, total sugars %, reducing sugars %, non-reducing sugars %, and vitamin C with the lowest titratable acidity.

Keywords: *Amino acids, Fruit quality, Micronutrients, Sweet orange, Yield.*

Introduction

Throughout the world, citrus is a significant fruit group that is cultivated in tropical and subtropical regions with appropriate soils and enough precipitation to support the plants. It is believed that citrus originated in Southeast Asia. Including that extending from the Himalayas south to Indonesia or Australia, and from eastern Arabia east to the Philippines (Davies and Albrigo, 1994). Egypt is one of the world's top producers of citrus, ranking fourth among the nations that make up the Mediterranean Sea basin. Of all the citrus species, the sweet orange (*Citrus sinensis*) is the most widely planted and provides the greatest fruit production.

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Because of their wide range of uses and nutritional importance, horticultural crops are essential to the world economy. Traditionally, characteristics including size, shape, and color have played a major role in determining the quality of these crops (Ariesen-Verschuur *et al*., 2022). But as consumer consciousness increased, there was a shift toward more intrinsic attributes, with an emphasis on sensory aspects like flavor, texture, and aroma as well as elements that improve health like antioxidants, vitamins, and minerals (Petrescu *et al*., 2020 and Souza *et al*., 2023). However, leaching, runoff, denitrification, and volatilization may cause the majority of the fertilizer given to the soil to be lost (Zoremtluangi *et al*., 2019). Additionally, a number of studies indicate that the increased frequency and duration of heatwaves and droughts brought about by climate change limit the nutrients acquired from soil (Ishfaq *et al*., 2022). The restrictions imposed by the interplay of various nutrients and soil losses have an impact on crop output, while foliar fertilization can help to minimize these effects. Foliar fertilization is a contemporary and efficient technology that may significant help preserve the physiological balance between growth and fruiting (Abd El-Gleel *et al*., 2015).

Enhancing vegetative growth, fruit set, yield, and quality characteristics has made the application of amino acids to increase fruit yield in agriculture increasingly important in the current day (Arabloo *et al*., 2017 and Khan *et al*., 2019). Amino acids are organic molecules having a bio-stimulatory influence on plant growth and the absorption of nutrients and on productivity in many plants (Noroozlo *et al*., 2019; Mohamad *et al*., 2022 and Al-Karaki and Othman, 2023). Additionally, amino acids are a good source of nitrogen for plants, affecting productivity, inducing the development of shoots and roots, and, owing to their chelating properties, improving nutrient uptake, photosynthesis efficiency, and stomata movement (D'Mello, 2015 and Teixeira *et al*., 2018). Amino acids could boost the development of plant cells, as well as enzyme activation to decompose organic compounds, which liberates the elements, resulting in better growth averages (Abo-Elmagd *et al*., 2015 and El-Aal and Eid, 2018).

Micronutrient foliar spraying is superior to soil treatment because of its high efficacy and quick reaction time by plants (Bhanukar *et al*., 2018). Foliar treatment is 7–21 times more effective than soil application (Zaman *et al*., 2019). This is because nutrients are put directly onto the leaves, where they are metabolized, and because they are easier to reach, the leaves respond more quickly (Harris and Puvanitha, 2018). Micronutrients are necessary components that plants need in trace amounts for healthy growth, development, and reproduction. These are relatively modest quantities, yet they are essential for many different physiological and metabolic activities. Each of the physiological and biochemical processes they are involved in makes a distinct contribution to the productivity and health of plants (Aftab and Hakeem, 2020). Reduced production, poor crop quality, and physiological disturbances might result from a shortage or imbalance. These trace elements are essential for helping to activate and support the enzymes that power essential metabolic reactions, even though they are frequently found in minute levels (Gomes *et al*., 2020). For instance, iron (Fe) is the building block of several enzymatic processes and is not merely a simple element. Its presence guarantees the effective operation of processes like respiration, nitrogen metabolism, and photosynthesis (Li *et al*., 2021). Zn is a crucial component of various biological processes, including glucose metabolism and DNA synthesis (Balandrán-Valladares *et al*., 2021). It is another player in this arena." Additionally, tryptophan synthesis relies on it; this amino acid regulates seed formation and viability, helps elongate cells, produces auxin, and branches roots. (Balafrej *et al*., 2020; Suganya *et al*., 2020; Otiende *et al*., 2021 and Tripathi *et al*., 2022). As we go more into the cellular domain, micronutrients become more prominent as designers and protectors. B, for example, has a variety of functions, including directing pollen tube formation and aiding in calcium absorption (Zhang *et al*., 2022). The synthesis of cell walls is one of its essential roles. This trace element provides protection and stiffness to plant cells by ensuring that their walls are robustly formed (Shireen *et al*., 2018 and Zhang *et al*., 2022). Mo, an additional important participant, affects the production of abscisic acid, a crucial hormone involved in the stress response (Bajguz and Piotrowska-Niczyporuk, 2023). Its assistance to plants in navigating drought and high salinity conditions makes its job even more important (Weber *et al*., 2023 and Zhao *et al*., 2023). The goal of the current study was to evaluate the effects of applying amino acids and micronutrients on sweet orange trees in order to determine their yield and fruit quality.

Materials and Methods

1-Plant materials and treatments

The current study's experiment took place over the progression of two consecutive seasons in 2019 and 2020 at the Experimental Orchard of Assiut University's Faculty of Agriculture. This study aimed to determine how foliar application of micronutrients and amino acids affected the fruit quality and yield of a particular of sweet orange (*Citrus sinensis*). Sixteen alike sweet orange trees (Balady cultivar) were chosen, and four treatments, including a control, were applied. Each treatment was carried out on four trees (Replicates), which were arranged in a complete randomized block design. At the beginning of the experiment, the trees were 25 years old, planted in a clay loam soil at 5 x 5 meters apart, and given similar horticultural managing. The treatments were as follows: T_1 (spraying with amino acids "Strong Amino Gold" which contains 20% total nitrogen and 49% amino acid at 1000 mg/l); T_2 (spraying with micronutrients "Omega Mix" which contains Fe 6%, Zn 5%, Mg 6%, B 0.5%, Mn 2%, Cu 12%, Mo 0.01%, and S 15% at 2000 mg/l); T_3 (spraying with both amino acids and micronutrients simultaneously) and T_4 control (spraying with water alone). Using a knapsack sprayer, the trees were sprayed four times for each treatment throughout the two seasons: in the middle of February, right after fruit set (first week of April), in the first week of July, and in the first week of September. Four trees might be sprayed with a total volume of 20 L until runoff. The following parameters were noted.

2-Plant measurements

Yield components

The fruits of all treated trees were collected during harvest season, which occurs in the last week of December. The total yield weight (kg/tree) was estimated by counting and weighing the fruits on each tree. Ten fruits from each tree were randomly selected for sampling, and an electronic balance was used to weigh each sample in grams.

Physical properties

A vernier caliper was used to measure the fruit's length and diameter in cm before an estimate of the form index was made. The 10 fruits were pared, and the average rind weight (g) was recorded. The rind thickness measured in cm using a vernier caliper were determined, along with the rind's ratio to the fruit's weight. Additionally, the juice weight (g), the volume of juice (cm^3) and its percentage per fruit weight were calculated. Accordingly, the average rags weight (g) and its percentage to the fruit were calculated.

Fruit sensory attributes

Juice's total acidity was calculated using phenolphthalene as an indicator and titration with NaOH at 0.1 N. Citric acid was then calculated and expressed using the following equation (A.O.A.C; 1995):

$$\textbf{Acidity}\ \% = \frac{\textbf{NaOH volume in titration x NaOH molarity x equivalent weight of citric acid}}{\textbf{1000 x sample volume}}\ \textbf{x 100}$$

Where

Equivalent weight of citric acid = 64, NaOH molarity = 0.1N, Sample vol. = 5 ml.

Using a hand refractometer, the total soluble solids (TSS%) was determined, and the TSS/Acid ratio was then computed. The Lane and Eynon volumetric technique (A.O.A.C., 1995) was used to calculate the percentages of total, reducing, and non-reducing sugars. Titration against 2,6-diclorophenol indo phenol dye was used to assess vitamin C content (as mg ascorbic acid per 100 ml juice) in accordance with (A.O.A.C., 1995).

3-Statistical analysis

With four treatments and four replicates for each treatment, the experiment was set up as a complete randomized blocked design (CRBD). Proc Mixed of the SAS package version 9.2 (SAS, 2008) was used for the analysis of variance (ANOVA), and the revised L.S.D. values at the 5% probability level were used to compare the treatment means (Snedecor and Cochran, 1990).

Results and Discussion

1-Yield components

Table 1 revealed that all the studied treatments significantly increased yield weight during the two studied seasons. The best treatment concerning yield weight during the two seasons of study was spraying with the combined treatment, which led to 74.6 and 62.1% increase over the control treatment, followed by micronutrients treatment at 2000 mg/l in both seasons, respectively. On the other side, the control treatment produced the least value. The results took the same trend of yield weight during both seasons of study. Hence, spraying with the combined treatment recorded the highest fruit weight, which led to 46.1 and 44.0% over the control treatment. Followed by micronutrients at 2000 mg/l in both seasons, respectively (Table 1).

Amino acids are essential for the synthesis of proteins and are essential for the metabolism of nitrogen, which allows the plant to use them as organic nitrogen shuttle molecules. Furthermore, it has been reported that certain amino acids function as signal molecules and that others serve as precursors for the synthesis of phytohormones or other secondary metabolites with signal function. Amino acids also restore particular enzymes for protein synthesis and play major roles during metabolic processes (Pratelli and Pilot, 2014 and Hildebrandt *et al*., 2015). The results for the amino acid treatments in the present study are consistent with other research on several fruit types that have been published (Noroozlo *et al*., 2019; Mohamad *et al*., 2022; Al-Karaki and Othman, 2023). They all came to the same conclusion: applying foliar sprays containing amino acids greatly increased fruit set, fruit weight, and overall fruit output. The enhanced pollen tube ovule penetration and delayed ovule senescence, which enhance fruit set and yield, may be responsible for the overall beneficial effects of amino acid foliar spray treatments (Arabloo *et al*., 2017).

Micronutrients are crucial components of plant growth and development. They are crucial for several enzymatic processes, including synthesis (Yadav and Solanki, 2015). By treating the deficit, micronutrient use increases yield and growth. Micronutrients applied foliarly enhance the amount of photosynthetic chemicals within plant tissue, reducing leaf drop and improving production (Suresh *et al*., 2018). For the best tree development and fruit yield, a balanced supply of macro and micronutrients is needed (Macedo *et al*., 2017). According to several studies (Balafrej *et al*., 2020; Suganya *et al*., 2020; Otiende *et al*., 2021; Tripathi *et al*., 2022; Zhang *et al*., 2022 and Bajguz and Piotrowska-Niczyporuk, 2023), spraying citrus trees with micronutrients can effectively increase the yield.

Table 1. Effect of amino acids, micronutrients and their combined on total yield (kg/tree) and fruit weight (g) of sweet orang during 2019 and 2020 seasons.

Characteristic / Treatment	Total yield (kg/tree)		Fruit weight (g)	
	2019	**2020**	**2019**	**2020**
Amino acids 1000 mg/l	46.6	47.6	166.9	157.1
Micronutrients 2000 mg/l	47.5	54.2	177.2	172.6
Amino acids + Micronutrients	55.7	63.2	201.0	193.2
Control	31.9	39.0	137.6	134.2
LSD at 5%	**7.9**	**3.9**	**14.3**	**16.3**

Means within columns are significant at 0.05 levels of the probability

2-Fruit physical characteristics

Fruit length, diameter and shape parameter:

Table 2 showed that all treatments significantly increased the average fruit length and diameter compared to the control during the two seasons of study. The combined treatment gave the highest fruit length values of 9.0 and 7.4 cm and fruit diameter of 9.2 and 7.6 cm in the two studied seasons, respectively, followed by the micronutrient’s treatment at 2000 mg/l, then the amino acids treatment at 1000 mg/l. The differences between such treatments were not significant. In addition, there were no significant differences between all the treatments concerning the fruit shape parameter (L/D ratio).

Fruit juice weight, volume and its percentage/fruit

Concerning juice weight and volume/fruit, Table 2 revealed that the best results obtained from the trees spraying with the combined treatment in both seasons. It gave the highest juice weight of 70.3 and 71.8 g with a percentage of 34.7 and 37.0%, as it gave the highest juice volume of 73.2 and 69.8 cm^3 with an increment of 33.8 and 40.7% over the control treatment in the two seasons of study, receptively. On the other hand, the control treatment gave the lowest values. As for the juice percentage, the results were opposite, as all treatments led to a decrease in juice percentage during the two seasons of study, with no significant differences between them and the control treatment.

Rind weight, thickness and its percentage/fruit

Data presented in Table 2 revealed that all the treatments led to a significant increase in fruit rind weight compared to the control treatments, but the significant differences between them were not significant. The highest average fruit rind weight was recorded for the combined treatment during the two seasons of the study, while the lowest value was recorded for the control treatment. As for rind thickness and rind percentage, no significant difference was observed between the treatments and the control during the two seasons of the study, although preference was also given to the combined treatment.

Rags weight and its percentage/fruit

The rags’ weight and its percentage in relation to the weight of the fruit also increased because of the treatments. The most effective treatment was the combined treatment, followed by the micronutrient’s treatment at 2000 mg/l, then the amino acids treatment at 1000 mg/l, respectively, while the control treatment recorded the lowest values during the two studied seasons (Table 2).

Amino acids have a beneficial effect on tree development and nutritional condition, allowing for the rise in fruit quality on treated trees. Additionally, it makes trees more resistant to environmental stresses, which has a positive impact on photosynthesis efficiency, increases the production of carbohydrates, and reduces the competition between fruits for the nutrients produced by leaves (Ahmed *et al*., 2012). According to research by Kumar *et al*. (2017), Suleiman *et al*. (2019), Helal *et al*. (2019), Rakhonde and Zope (2020), and Sawale *et al.*

(2021), micronutrients can improve the quality of fruit. They concluded that applying micronutrients improved the quality of the fruit.

Table 2. Effect of amino acids, micronutrients and their combined-on fruit length (cm), fruit diameter (cm), L/D ratio, Juice weight (g), juice volume (cm^3), juice %, rind weight (g), rind thickness (cm), rind %, rag weight (g) and rag % of sweet orange during 2019 and 2020 seasons.

Characteristic \ Treatment		Amino acids at 1000 mg/l	Micronutrients at 2000 mg/l	Amino acids + Micronutrients	Control	LSD at 5%
Fruit length (cm)	**2019**	8.7	8.7	9.0	8.3	0.2
	2020	6.9	7.0	7.4	6.6	0.6
Fruit diameter (cm)	**2019**	8.8	8.9	9.2	8.4	0.3
	2020	7.2	7.3	7.6	7.1	**0.7**
L/D ratio	**2019**	0.99	0.98	0.98	0.99	**0.02**
	2020	0.96	0.97	0.97	0.94	**0.04**
Juice weight (g)	**2019**	59.7	59.7	70.3	52.2	**6.1**
	2020	60.1	64.3	71.8	52.4	**7.5**
Juice volume (cm^3)	**2019**	61.9	61.9	73.2	54.7	**6.3**
	2020	57.6	62.1	69.8	49.6	**7.0**
Juice %	**2019**	37.1	35.0	36.5	39.9	**3.7**
	2020	38.2	37.3	37.2	39.0	**1.8**
Rind weight (g)	**2019**	43.8	48.2	54.7	34.7	**6.9**
	2020	42.8	44.4	52.1	35.3	**5.2**
Rind thickness (cm)	**2019**	0.40	0.42	0.48	0.42	**0.06**
	2020	0.27	0.29	0.25	0.31	**0.10**
Rind %	**2019**	26.3	27.2	27.2	25.3	**3.3**
	2020	27.3	25.7	27.0	26.4	**3.0**
Rag weight (g)	**2019**	61.2	67.2	73.1	48.2	**9.0**
	2020	54.0	63.9	68.9	46.5	**7.1**
Rag %	**2019**	36.7	37.9	36.4	34.9	**3.6**
	2020	34.5	37.1	35.7	34.7	**2.0**

Means within rows are significant at 0.05 levels of probability.

3-Fruit chemical characteristics

Total soluble solids % (TSS %)

Data presented in Table 3 suggested that all the treatments led to an increase in TSS % compared to the control treatment, but this increase was not significant in the two seasons of study. The highest percentage of TSS was observed with the combined treatment, followed by the micronutrients treatment at 2000 mg/l in both seasons. On the other side, the control treatment gave the lowest value.

Protein synthesis, carbohydrate synthesis, and hexokinase are three enzyme processes that need zinc. Furthermore, boron accelerates the breakdown of carbohydrates into simple sugar and aids in the transportation of sugar in the form of boron-sugar complex. Additionally, copper contributes to increasing photosynthetic efficiency, which raises the rate of photosynthesis. Since sugar is the primary byproduct of photosynthesis, an increase in photosynthesis is caused by the combined actions of zinc, boron, and copper produces more sugar compounds, which in turn causes an increase in the total soluble solids in fruit juice. The present study's findings are consistent with those of Singh *et al*. (2018), Helal *et al*. (2019), and Reetika *et al*. (2020).

Total acidity percentage

During the 1st season, the differences between the treatments and the control were significant in their effect on the total acidity, but these differences were not significant in the 2nd season. The best treatment on decreasing the percentage of acidity was the combined treatment, followed by the micronutrient's treatment at 2000 mg/l in the two studied seasons. The percentages of this treatment were 1.4 and 1.9 in both seasons, respectively (Table 3).

TSS/Acid ratio

The presented data (Table 3) demonstrated that all the treatments had a positive effect on the TSS/acid ratio compared to the control treatment during the two studied seasons. The TSS/acid ration in the 1st season was higher than the 2nd season. The best ratio achieved as a result of spraying was the combined treatment, which gave a ratio of 9.0 and 7.6 in the two study seasons, respectively, followed by the micronutrients treatment at 2000 ppm. On the other hand, the control treatment recorded the lowest values.

Vitamin C (mg/100 ml)

All applied treatments significantly increased vitamin C compared to the control treatment during the two study seasons. The best treatment in this respect was the combined treatment, which recorded 55.9 and 57.4 mg/100 ml in the two seasons, respectively, while the control treatment gave the least values (Table 3).

According to Nawaz *et al.* (2008), zinc promotes the synthesis of auxin, which elevates the amount of ascorbic acid. According to Meena *et al*. (2017) and Singh *et al.* (2018), the foliar application of Zn, B, and Cu also plays a role in elevating the ascorbic acid content in the fruit juice of Sweet orange cv. Mosambi.

Sugars content

The results showed how positive all treatments were in their effect on total, reducing and non-reducing sugars compared to the control treatment during the two seasons. The combined treatment recorded the best results for these respects, followed by the micronutrients treatment, while the control treatment recorded the lowest values (Table 3).

The citrus fruit juice's has greater amount of sugar (total sugar, reducing sugar, and non-reducing sugar) may be the consequence of Zn, Cu, and B's active roles in photosynthesis as well as the sugars' faster translocation from the site of synthesis to the growing fruits. The other possible cause might be the rapid movement of sugars inside the fruit and the subsequent decrease in starch content caused by acid degradation. The results reported by Bhatt *et al*. (2012), Ilyas *et al*. (2015), Deshlehra *et al*. (2022), and Rajamanickam *et al*. (2022), therefore, are consistent with the current findings.

Table 3. Effect of amino acids, micronutrients and their combined on TSS %, total acidity %, TSS/acid ratio, vitamin C (mg/100 ml), total sugars %, reducing sugars % and non-reducing sugars % of sweet orange during 2019 and 2020 seasons.

Characteristic \ Treatment		Amino acids at 1000 mg/l	Micronutrients at 2000 mg/l	Amino acids + Micronutrients	Control	LSD at 5%
TSS %	**2019**	12.7	12.8	12.9	12.5	**0.5**
	2020	13.5	13.8	14.2	13.6	**0.8**
Total acidity %	**2019**	1.5	1.5	1.4	1.8	**0.1**
	2020	2.7	2.2	1.9	2.7	**0.6**
TSS/acid ratio	**2019**	8.3	8.7	9.0	7.2	**0.9**
	2020	5.1	6.5	7.6	5.2	**1.7**
Vitamin C (mg/100 ml)	**2019**	50.8	53.9	55.9	44.2	**4.3**
	2020	44.2	47.9	57.4	40.2	**4.0**
Total sugars %	**2019**	8.10	8.44	8.82	7.92	**0.30**
	2020	9.08	9.50	9.57	8.66	**0.70**
Reducing sugars %	**2019**	4.47	5.29	5.04	4.31	**0.33**
	2020	5.56	5.48	5.34	5.36	**0.33**
Non-reducing sugars %	**2019**	3.64	3.15	3.77	3.61	**0.39**
	2020	3.53	4.02	4.23	3.30	**0.72**

Means within rows are significant at 0.05 levels of probability.

Conclusion

The study thus revealed that the use of amino acids at 1000 mg/l combined with micronutrient at 2000 mg/l proved superior and recorded the best results with respect to the yield and fruit quality in sweet orange.

Conflict of Interest

There is no conflict of interest.

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تحســـين محصـــول وجودة ثمار البرتقال الحلو (*Citrus sinensis*) اســـتجابةً للرش الورقي للأحماض الأمينية والمغذيات الدقيقة

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الملخص

بالمقارنة بأصـــناف الموالح الأخرى يعد البرتقال الحلو أكثر الأنواع انتشـــارا لزراعته في جميع أنحاء العالم. أجريت تجربة الدراســـة الحالية خلال موســـمين متتاليين عامي 2018-2019 ،2019-2020 في المزرعة البحثية الخاصة بكلية الزراعة جامعة أسيوط. كان الهدف من الدراسة البحثية هو معرفة كيفية تأثير الرش الورقي للمغذيات الدقيقة والأحماض الأمينية على المحصـــول وجودة ثمار البرتقال (*Citrus sinensis*).

تم اختيار ستة عشر شجرة برتقال حلو متماثلة (الصنف البلدي) بعمر 25 سنة، ورتبت في تصـميم القطاعات الكاملة العشـوائية بأربعة معاملات، إحداها معاملة المقارنة (الكنترول). تم ري الأشـجار سـطحياً وزرعت على مسـافة 5 × 5 أمتار في تربة طينية. شـملت المعاملات T1 (رش 1000 ملجم/لتر من الأحماض الأمينية "Strong Amino Gold")، T2 (رش 2000 ملجم/لتر من المغذيات الدقيقة "Omega Mix")، T3 (رش خليط من المغذيات الدقيقة والأحماض الأمينية)، وT4 الكنترول (رش الماء فقط). خلال الموسمين، تلقت الأشـجار أربع رشـات من كل معاملة عند بداية النمو (منتصـف فبراير)، وبعد عقد الثمار (الأسـبوع الأول من أبريل)، والأسـبوع الأول من يوليو، والأسبوع الأول من سبتمبر. تم إجراء وتسجيل الملاحظات على مكونات المحصول وجودة الثمار. أظهرت الدراسة أنه خلال موسمي الدراسة تفوقت المعاملة المركبة (T3) على المعاملات الأخرى حيث سـجلت أعلى وزن للمحصـول، ووزن الثمرة، طول الثمرة، قطرها، وزن العصـير، حجمه، وزن القشــرة، ســمك القشــرة، النســبة المئوية للقشــرة، TSS%، الســكريات الكلية %، السكريات المختزلة %، السكريات غير المختزلة %، وفيتامين C مع قلة نسبة الحموضة الكلية.

الكلمات المفتاحية: *البرتقال الحلو، الأحماض الأمينية، المغذيات الدقيقة، المحصول، جودة الثمار*