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IMPACT OF SHADING AND FOLIAR APPLICATION WITH NUTRIENT SOLUTION ON THE GROWTH AND QUALITY OF SWEET ORANGE FRUITS CV. LOCAL.

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ABSTRACT
The experiment was conducted in one of the private orchards affiliated to village of Al-Budayab, 8 km northwest of the city of Ramadi, from the beginning of March to the end of December, on sweet orange trees cv. Local with age 8 years to study the effect of shading with saran and spraying with the nutrient solution under the commercial name (Brexil Duo) on the vegetative growth characteristics and chemical content of the fruits. The experiment included three levels of shading (0% (without shading), 50%, and 75%) and spraying with the nutrient solution (Brexil Duo) at three levels (0% (spraying with distilled water) as control, 3, and 6 g L^{-1}) sprayed in five times on the beginning of (March, April, May, June, and September). The results showed that the level shading (50%) led to a significant increase in the chlorophyll content, increment in branch length, plant height, total soluble solids (T.S.S), total sugars, and vit. c content, compared to the other shading treatments (0% and 75%). While the shading treatments did not record any significant effect on the fruit acidity. Concerning of spraying with the nutrient solution with concentration (6 g L^{-1}) had a significant effect on the fruit acidity, while no significant increase on TSS, total sugars, and vitamin c content.

Keywords: Sweet orange, Shading, Light, foliar application, Nutrient Solution

INTRODUCTION
Sweet orange (*Citrus sinensis* L. Osbek) is one of the most important and widely grown citrus species in the world. It belongs to the genus Citrus L., which is the only source of commercial citrus fruits. Sweet orange is grown in tropical and subtropical climates around the world and belongs to the orange breed Aurantioideae of the Rutaceae family [1]. The productivity of local orange trees in Iraq is low compared to global production. There are also limited cultivated areas and a decline in old orchards. Many obstacles affect the establishment of citrus orchards. In Iraq, most citrus cultivars are grown in the central and southern regions due to the favorable climatic conditions. In these areas, the solar radiation is very high, especially in summer, where the temperature rises significantly. This can lead to stomatal closure, reducing the net CO_2 assimilation rate [2]. Sunburn can damage a large part of the fruit and leaves, resulting in significant financial losses due to reduced marketability. Sunburned fruit becomes hard and its water content decreases. However, more importantly, sunburn causes discoloration, necrosis, and irregular growth of the fruit peel. Sunburned fruit is undesirable for both producers and consumers [3]. Protected cultivation techniques have been used to control environmental conditions such as temperature, light, relative humidity, and carbon dioxide content. Therefore, in terms of guaranteeing product quality, plant production under protected growing settings provides numerous benefits over open field culture. Protecting plants against abrupt changes in the environment that might impair their quality, productivity, and development is one of the main benefits [4]. Shading is one way to avoid damage caused by high solar radiation and temperatures. Shading reduces leaf temperature and increases the net CO_2 assimilation rate to its optimal range, as well as increasing water use efficiency [5]. One of the reasons for fruit sunburn is high air temperatures ranging from(32-35) C° under strong sunlight between 11 am and 3 pm [6]. In order to directly contribute to the composition of one or more significant chemicals in the plant's metabolic processes, nutrients are necessary for the growth and development of plants. These elements are present in the soil, but because of their limited mobility, unavailability, washing, or volatilization, they could not be sufficient for the demands of the plant. This leads to the low absorption of some elements from the soil by the roots. Therefore, using some elements as foliar sprays is an effective way to regulate the added fertilizers, ensure their uniform distribution, and accelerate the treatment of

deficiencies during critical and sensitive stages in the plant's life [7]. Citrus productivity depends largely on nutrition because it is a crop highly responsive to nutrients. Nutrient utilization also limits its productivity [8]. Although the micronutrient requirements are lower compared to macronutrients, they are no less important in plant metabolism, growth, and development [9]. The basic idea of foliar fertilization is to allow rapid absorption and utilization of nutrients sprayed on plants in a short time and to remove deficiency symptoms on leaves due to nutrient deficiency. In addition, this method has the advantage of being economical by reducing the need for large amounts of nutrients, especially macronutrients. Moreover, the absorption of nutrients through foliar feeding is considered more efficient than soil application by a factor of (8 - 20). However, this efficiency is not usually available in common agricultural practices [10].

MATERIALS AND METHODS

The study was conducted in an orchard of local orange trees in the village of Al- Budayab, 8 km northwest of the city of Ramadi, Iraq. The trees were grafted onto sour orange rootstock with age 8 years and uniform as much as possible. The study period was from March 2023 to December 2023.

Table 1. Physical and chemical properties of the soil

Unit	Value	Characteristics
ms	3.17	**(1:1) EC**
g\L	1.59	**TDS**
%	6.2	**NaCl**
	7.2	**pH**
	Loamy sand	**Texture**
ml mol. L^{-1}	17.23	**Ca**
ml mol. L^{-1}	5.14	**Mg**
ml mol. L^{-1}	2.27	**Na**
ml mol. L^{-1}	2.16	**HCO_3**
mlg.g^{-1}	0.31	**N**
mlg.g^{-1}	0.8	**P**
ml mol. L^{-1}	1.33	**K**
g.Kg^{-1}	3.70	**O.M**
cmol electric.Kg^{-1}	24	**CEC**
g.Kg^{-1}	16.2	**Gypsum**
g.Kg^{-1}	258	**Lime**

The study was conducted on 27 local orange trees that were uniform as much as possible. Two factors were used in the study: the first factor was covering with Saran nets, where the orange grove was divided into three sections, each representing a different light level. The first section represented the control treatment, while the second and third sections had wooden structures built around them, each representing an isolated block. The shading levels were (0(control) 50 and 75%) and are denoted by the symbols (A0, A1, A2), respectively. The trees were covered on 11/3/2023. The light intensity was measured using a LUX meter (Table 2).

Table 2. shows the average monthly readings of the LUX meter for solar radiation at different shading treatment

Treatments / Months	LUX		
	A0 (0%)	**A1 (50%)**	**A2 (75%)**
April	3688	1849	921
May	4776	2395	1189
June	5327	2669	1336

July	5412	2710	1350
August	5539	2771	1388
September	4932	2472	1237
October	4018	2014	1006
November	3786	1995	948

The second factor was the spraying of the nutrient solution (Brexil Duo), which is a powdered mixture of macro and micronutrients (Table 3) . The concentrations used in the treatment were (0, 3 and 6 g L^{-1}) and were coded as (B0, B1, B2) respectively. Foliar spraying was carried out one hour before sunset using a 20 L hand-held shoulder-mounted sprayer with the addition of a spreader of liquid soap solution at a concentration of 1 ml L^{-1}. The spraying was carried out until complete wetting during the thirteenth day of the months (March, April, May, June and September).

Table 3. Composition and proportions of PREXIL DUO powder of elements

Element	Percentage	Symbol
Calcium	18.0	CaO
Boron	0.5	B
Zinc	2.0	Zn
Manganese	2.0	Mn
Magnesium oxide	4.0	MgO
Copper	0.5	Cu

The experiment was a factorial design (Nested Design) with three cover treatments and three spray treatments, and it was replicated three times, resulting in a total of 27 experimental units. The GenStat software was used to perform the statistical analysis and to find the significant differences between the treatments using the LSD test at a probability level of 0.05.

Studied traits

chlorophyll (mg 100g^{-1} fresh weight): Chlorophyll content was estimated at the time of full emergence of flower buds on beginning of March, where 0.25 g fresh weight sample of leaves was taken and ground in a porcelain mortar with 10 ml of acetone. The mixture was then filtered using filter paper, and 1 ml of the filtrate was taken and the volume made up to 10 ml with acetone. The optical density of the extract was then read using a Spectrophotometer at wavelengths of 660 and 642.5 nm, and the total chlorophyll was calculated using the following formula [11]:

Total chlorophyll = A660 [7.12 × + A642.5 16.8] × (V /W1000)

A = Reading of the device (reading of the optical absorption)

V = Volume of the extraction solution (mL)

W = Weight of the sample (g)

Increment in Branch Length (cm): Two readings were taken using a measuring tape, where the first reading was on the beginning of March and the second was on the end of December. The branch length growth rate was calculated using the following equation:

Growth Rate in Branches Length = Second Reading - First Reading

Plant height (m): Plant height was measured using a metric measuring tape on the end of December.

Total soluble solids content in fruits (TSS%): A hand refractometer was used to determine the fruit's percentage of total soluble solids. After being sliced, the fruits were blended for two to three minutes using an

electric blender. After filtering the juice through a cotton cloth, the device's readings were recorded, and the average for each experimental unit was determined.

Total sugar content in fruits (%): Total sugar content of the fruits was estimated according to the method of [12]. 0.2 g of the sample was taken and 8 ml of 80% ethanol was added. The mixture was placed in a water bath at 60°C for half an hour. The liquid was then extracted from the filtrate using a centrifuge at 3000 rpm for 15 minutes. The precipitate was re-extracted with ethanol. The filtrate was then collected and the volume was made up to 50 ml with ethanol. 1 ml of this was taken and placed in a test tube with 1 ml of 5% phenol solution and 5 ml of concentrated sulfuric acid (98%). After the mixture had cooled, the absorbance was read using a spectrophotometer at a wavelength of 490 nm after zeroing the instrument with 80% ethanol. The concentration of total sugar in mg. g-1 of fruit pulp was then calculated by multiplying the value by 50 after the readings were displayed on a standard glucose curve.

A glucose standard curve was created by dissolving known glucose weights (0.05, 0.10, 0.15, and 0.20) in 100 milliliters of distilled water to create solutions of these concentrations. Then, the previously stated amounts of concentrated sulfuric acid and 1 milliliter of phenol solution were added. In order to draw a standard curve for glucose, the absorbance values were finally measured to get readings matching to these amounts.

Vitamin C (mg 100ml^{-1}): Vitamin C was estimated by titration with 2,6- Dichlorophenolindophenol [12] according to the following equation: Vitamin C (mg 100ml juice) = (F x T x 100) / V

F = Strength of the dye.

T = Volume of dye used in the titration (cm^3).

V = Volume of the juice (cm^3).

Total Acidity of Fruits (%): The total acidity of the fruit pulp was estimated as a percentage of malic acid according to the method followed by [13]. This was done by titrating the fruit juice with sodium hydroxide (NaOH) at a concentration of (0.1 N) using phenolphthalein indicator and according to the following equation: Total acidity (%) = (Eq x N x T x 100)/ Vx 100

Taking into account that the main acid in orange is citric acid. The symbols in the equation represent the following:

T = Volume of the base used in the titration (cm^3).

N = Normality of the base used in the titration (0.1N).

Eq. = Equivalent weight of citric acid (64).

V = Volume of the juice (cm^3).

RESULTS AND DISCUSSION

Chlorophyll Content (mg 100g^{-1} Fresh Weight):
The results presented in Table 4 show that there were significant differences in leaf chlorophyll content due to saran cover. Treatment A1 recorded the highest mean value of 177.9 mg 100g^{-1} fresh weight, which did not differ significantly from treatment A2. Treatment A0 recorded the lowest mean value of 140.3 mg 100g^{-1} fresh weight. These results are consistent with those of [14] who studied the covering of Cleopatra mandarin rootstock seedlings and Valencia orange seedlings with fabric nets to avoid high solar radiation.

Regarding the levels of Brexil Duo nutrient solution spraying, there were significant differences. Treatment B2 recorded the highest mean value of 171.4 mg 100g^{-1} fresh weight, which did not differ significantly from treatment B1. Treatment B0 recorded the lowest mean value of 150.1 mg 100g-1 fresh weight. These results are consistent with those of [15] who studied the effect of foliar spraying with a licorice extract which contain micro

and macronutrient. Regarding the interaction levels between the two study factors, there was an increase in leaf chlorophyll content, but it did not reach the significant level. Treatment A1B2 recorded the highest value, while treatment A0B0 (control) recorded the lowest value.

Table 4. Effect of shading, spraying with nutrient solution, and their interaction on the chlorophyll content (mg $100g^{-1}$ fresh weight).

Mean A	Foliar spraying with BREXIL DUO solution			Shading (A)
	B2 (6gm L^{-1})	B1 (3gm L^{-1})	B0 (water only)	
140.3	153.0	137.0	131.0	**A0 (without shading)**
177.9	193.2	179.3	161.2	**A1 (50% shading)**
165.9	168.1	171.4	158.1	**A2 (75% shading)**
	171.4	**162.6**	**150.1**	**Mean B**
L.S.D. (P≤0.05)	**A: (12.15)**		**B: (14.01)**	**A.B: (N.S)**

Increment in Branch length (cm)

The results of the statistical analysis in Table 5 show an increase in branch length as a result of Saran coating. Treatment A1 significantly outperformed the other treatments with the highest rate of 38.06 cm, while treatment A0 had the lowest rate of 20.25 cm. These results are in line with those of [14] in a study on Eureka lemon trees.

As for the foliar application of Brexil Duo nutrient solution, treatment B2 significantly outperformed the other treatments with the highest rate of 34.63 cm. It did not differ significantly from treatment B1, while treatment B0 had the lowest rate of 25.45 cm. These results are in line with those of [16] in a study on sweet orange trees.The results also indicate that the interaction between the two factors had a significant effect, with all treatments outperforming the control treatment, especially treatment A1B2, which gave the highest rate of increase in branch length of 42.28 cm. It did not differ significantly from treatment A1B1, while the control treatment A0B0 gave the lowest rate of increase in branch length of 17.34 cm.

Table 5. Effect of shading, spraying with nutrient solution, and their interaction on the increment in branch length (cm) .

Mean A	Foliar spraying with BREXIL DUO solution			Shading (A)
	B2 (6gm L^{-1})	B1 (3gm L^{-1})	B0 (water only)	
20.25	22.97	20.43	17.34	**A0 (without shading)**
38.06	42.28	40.67	31.23	**A1 (50% shading)**
35.55	38.63	40.24	27.77	**A2 (75% shading)**
	34.63	**33.78**	**25.45**	**Mean B**
L.S.D. (P≤0.05)	**A: (0.934)**		**B: (1.151)**	**A.B: (1.772)**

Plant Height (m):

The results of Table 6 show that saran cover had a significant effect on plant height. Treatment A1 had the highest value of 3.164 m, which was not significantly different from treatment A2. Treatment A0 had the lowest value of 2.806 m. For the Brexil Duo solution treatments, there were significant differences between treatments. Treatment B2 had the highest value of 3.084 m, while treatment B0 had the lowest value of 2.978 m. The results of the same table also showed that there were significant differences in the interaction treatments between the two study factors. Treatment A1B2 had the highest value of 3.200 m, which was not significantly different from treatments A1B1, A2B1, A1B0, A2B2, and A2B0. Treatment A0B0 had the lowest value of 2.686 m.

Table 6. Effect of shading, spraying with nutrient solution, and their interaction on the plant height (m) .

Mean A	**Foliar spraying with BREXIL DUO solution**			**Shading (A)**
	B2 (6gm L^{-1})	**B1 (3gm L^{-1})**	**B0 (water only)**	
2.806	2.920	2.813	2.686	A0 (without shading)
3.164	3.200	3.156	3.136	A1 (50% shading)
3.131	3.133	3.146	3.113	A2 (75% shading)
	3.084	**3.038**	**2.978**	Mean B
L.S.D. (P≤0.05) A: (0.0904) B: (0.0453) A.B: (0.1018)				

The increase in plant height may be due to the low light intensity, which in turn leads to an increase in the concentration of auxins in the shaded part compared to the unshaded part. This leads to an increase in cell elongation and division, which leads to an increase in plant height. This increase may be attributed to the shading, as 50% saran coverage improves the efficiency of photosynthesis, which enhances plant height [17].

As for the increase in branch length due to increased shade, the reason for this is that plants growing in the shade are deprived of near-red light, while far-red light penetrates their tissues, especially the internodes. When exposed to far-red light, the activity of gibberellin increases, which leads to an increase in their length in an attempt to reach the light. This happens in the wild when plants compete with each other for light to carry out photosynthesis. This agrees with what [18] found, who found that the increase in branch length is due to the increase in the percentage of shading. The reason for this is that the phytochrome, which activates photosynthesis, is in the pr form when exposed to light or in low light conditions. It turns into pfr, which affects the growth of seedlings in the dark environment so that their stems can elongate to reach the light to perform their functions in food production.

As for the reason for the increase in chlorophyll pigment and minerals in the leaves in the part shaded by saran by 50%, it may be due to the fact that chloroplasts have the ability to change their location in the cell towards the incident light. Under low light conditions, chloroplasts arrange their shapes along the upper and lower surfaces of the leaf to take the largest amount of incident rays and photons necessary for photosynthesis. Thus, the leaves are dark green, because they contain the largest amount of chlorophyll.

Other changes that a shade-grown plant makes are to shorten the palisade cells in the mesophyll so that the leaf appears thinner and ensures that light reaches the farthest cell in the leaf. Under high light conditions, chloroplasts move to places away from the leaf surface and parallel to the cell membrane to avoid the intensity of incident light [19]. It may also be destroyed as a result of exposure to high light intensity, which leads to damage to chlorophyll molecules. This process is called photo-oxidation and may explain the reasons for the decrease in leaf chlorophyll content in the unshaded part [20].

Therefore, the shading network creates a favorable environment for the synthesis of light enzymes, which leads to an increase in the chlorophyll content of the leaves [21]. These results agree with what [22] found, who found that the chlorophyll content of the leaves decreases under high light conditions or levels, where the auxiliary pigments help protect the chlorophyll pigment from photo-oxidation.

The results showed that the B2 level (6 g L^{-1}) of the nutrient solution Brixel Doux significantly outperformed in terms of vegetative growth characteristics, as shown in Tables 4, 5, and 6. This superiority is attributed to the mineral elements in the composition of Brexil Duo. Boron plays a major role in cell wall formation, cell division,

and increasing the rate of photosynthesis. It is also important for increasing proteins and carbohydrates and transporting sugars from their sites of synthesis in the leaves to different growth and storage areas in the plant [23]. These results are consistent with those reported by [24] on lemon trees.

Growing tips and leaves, which are physiologically active regions, experience accelerated cell division due to the production of auxin precursor (IAA), which is mostly mediated by zinc. New cells are created as a result, and these cells positively influence the development of new leaves. The function of zinc in the production of tryptophan, the building block for the synthesis of the natural hormone (IAA) required for the growth and elongation of plant cells, is what causes the rise in branch lengths [25]. Additionally, zinc is essential for promoting the synthesis of growth chemicals in plants and preventing their breakdown. Additionally, it aids in the process of absorbing water, keeping the plant from being dwarfed [26].

As for manganese, it plays an important role in the plant, where it participates in oxidation-reduction processes in the electron transport system in light reactions in photosynthesis. It leads to increased enzyme activity, such as dehydrogenase enzyme in the Krebs cycle (TCA), and plays an important role in chlorophyll production. It also works to represent and increase sugar in the leaves, and it also plays a role in the exchange of nitrogenous compounds [27]. These results agree with those of [28] on orange trees.

Copper is a component of chloroplasts, so it is essential for photosynthesis. Copper also works to increase the efficiency of the plant in the photosynthesis process through its role in stabilizing the chlorophyll molecule and protecting it from early breakdown [29]. These results agree with those reported by [16] in a study on sweet orange trees.

The explanation for calcium may be due to the importance of calcium, as it contributes with some other elements to the regulation of osmotic potential, in addition to its role in the production of plant hormones such as (IAA) and getting rid of acid toxicity, where it participates in the precipitation of oxalic acid. In addition to that, it enters into the composition of the middle lamella in cell walls in the form of calcium pectate and participates in the composition of cell membranes, which is important in controlling their permeability and effectiveness. These results agree with those reported by [30] in a study on apricot trees.

The presence of magnesium in the spray solution is the main reason for the increase in the chlorophyll content of the leaves, because the metal key for this substance [31] and magnesium plays a major role in activating the enzymes necessary to fix the CO_2 molecule in the Calvin cycle in the photosynthesis process [32]. This leads to an increase in the production of manufactured food materials necessary for plant growth. It also plays a role in protein metabolism, where magnesium works to activate the enzymatic systems involved in the metabolism of DNA and RNA and links the ribosome particles that take their way to protein metabolism [33]. These results are consistent with those reported by [34] in a study on citron seedlings.

Total soluble solids content in fruits (TSS (%):

The results shown in Table 7 indicate that the saran coating treatments had a significant effect on the total soluble solids content of the fruits. Treatment A1 recorded the highest percentage, reaching 11.36%, and did not differ significantly from treatment A2, while treatment A0 recorded the lowest percentage, reaching 10.58%. These results are consistent with those of [35] who covering bunch of date palm.

As for the nutrient solution spraying treatments (Breixl Duo) and the interaction treatments between the two study factors, they did not record a significant effect on the total soluble solids content in the fruits. However, it was observed from the results of the same table that the total soluble solids content increased with increasing spraying concentrations, but it did not record a significant increase.

Table 7. Effect of shading, spraying with nutrient solution, and their interaction on the total soluble solids content (T.S.S%).

Mean A	Foliar spraying with BREXIL DUO solution	Shading (A)

	B2 (6gm L^{-1})	B1 (3gm L^{-1})	B0 (water only)	
10.58	10.86	10.56	10.33	**A0 (without shading)**
11.36	11.73	11.23	11.13	**A1 (50% shading)**
11.01	11.03	11.36	10.63	**A2 (75% shading)**
	11.21	**11.05**	**10.70**	**Mean B**
L.S.D. (P≤0.05)		**A: (0.5647)**		**B: (N.S)**
		A.B: (N.S)		

Total sugars content in fruits (%):

The results shown in Table (8) showed the significant superiority of Saran coating treatments in the total sugars content in the fruits, as treatment A1 recorded the highest percentage of 11.07%, which did not differ significantly from treatment A2, while treatment A0 recorded the lowest percentage of 9.67%. These results agree with [36] in their study on orange trees. As for the foliar application treatments with Brexil Duo nutrient solution and the interaction treatments between the two study factors, they did not record any significant increase in the total sugars content in the fruits, but the sugar content increased with increasing concentrations of the foliar application with the nutrient solution.

Table 8. Effect of shading, spraying with nutrient solution, and their interaction on the total sugars content in fruits (%) .

Mean A	Foliar spraying with BREXIL DUO solution			Shading (A)
	B2 (6gm L^{-1})	B1 (3gm L^{-1})	B0 (water only)	
9.67	10.54	9.37	9.08	**A0 (without shading)**
11.07	11.62	11.12	10.46	**A1 (50% shading)**
10.32	10.17	10.50	10.29	**A2 (75% shading)**
	10.78	**10.33**	**9.94**	**Mean B**
L.S.D. (P≤0.05)	**A: (0.767)**		**B: (N.S)**	**A.B: (N.S)**

Vitamin C content of juice (mg $100ml^{-1}$)

The results presented in Table 9 show a clear significant effect of saran coating treatments on the vitamin C content of the juice. Treatment A1 recorded the highest value of 98.8 mg $100ml^{-1}$, which was not significantly different from treatment A2, while treatment A0 recorded the lowest value of 79.4 mg $100ml^{-1}$. These results are consistent with those of [37] who studied blueberries (*Vaccinium myrtillus*).

As for the nutrient solution spraying treatments, there was a significant increase in vitamin C content with increasing concentration of the spray. Treatment B2 recorded the highest value of 97.4 mg $100ml^{-1}$, which was not significantly different from treatment B1, while treatment B0 recorded the lowest value of 80.6 mg $100ml^{-1}$.The interaction treatments between the two study factors did not show any significant increase in the vitamin C content of the juice, although treatment A1B2 recorded the highest value.

Table 9. Effect of shading, spraying with nutrient solution, and their interaction on the vitamin C content in local orange juice (mg $100ml^{-1}$)

Mean A	Foliar spraying with BREXIL DUO solution			Shading (A)
	B2 (6gm L^{-1})	B1 (3gm L^{-1}	B0 (water	

		1)	only)	
79.4	80.8	79.8	77.5	**A0 (without shading)**
98.8	112.7	102.9	80.8	**A1 (50% shading)**
89.9	98.6	87.3	83.6	**A2 (75% shading)**
	97.4	**90.0**	**80.6**	**Mean B**
L.S.D. (P≤0.05) A: (10.09) B: (8.94) A.B: (N.S)				

Total acidity in fruits (%)

The results in Table (10) showed that Saran coating treatments did not have a significant effect on the acidity ratio in the fruits, although treatment A1 recorded the lowest percentage, while treatment A0 recorded the highest percentage. As for the Brexil Duo nutrient solution spraying treatments, treatment B2 recorded the lowest percentage of 1.408%, which did not differ significantly from treatment B1, while treatment B0 recorded the highest percentage of 1.212%. These results agree with those of [23] on nine-year-old Almayer lemon trees. The interaction treatments between the two study factors did not record any significant effect on the acidity ratio in the fruits, although treatment A1B2 recorded the lowest percentage.

Table 10. Effect of shading, spraying with nutrient solution, and their interaction on the total acidity (%).

Mean A	**Foliar spraying with BREXIL DUO solution**			**Shading (A)**
	B2 (6gm L^{-1})	**B1 (3gm L^{-1})**	**B0 (water only)**	
1.384	1.312	1.350	1.489	**A0 (without shading)**
1.215	1.075	1.169	1.401	**A1 (50% shading)**
1.264	1.250	1.207	1.335	**A2 (75% shading)**
	1.212	**1.242**	**1.408**	**Mean B**
L.S.D. (P≤0.05) A: (N.S) B: (0.1447) A.B: (N.S)				

The reason for the high content of total soluble solids (TSS) and total sugars in the fruits is due to the increase in the amount of carbohydrates produced under the optimal level of shading (50%) and thus stored in the fruits [39]. These results are consistent with those reported by [35]in a study on the degree of shadowing in plam trees. The robust growth features of the vegetative development may account for the fruits' high vitamin C content by increasing the quantities of generated carbs and, therefore, total soluble solids.

After the fruit juice was sprayed with the Brexil Duo nutrition solution, its overall acidity reduced. This may be explained by the inverse relationship between acidity and sugar content. Given that higher photosynthetic efficiency boosts sugar content and decreases overall juice acidity, this might be the consequence of the juice's high concentration of total sugar. The diluting process that bigger fruits go through is undoubtedly a significant cause to the decrease in fruit acidity. The fruits become less acidic as a result of this process, which also decreases the content of essential organic acids. These treatments also result in higher vegetative growth characteristics and increased efficiency of photosynthesis, which yields a range of sugars and reduces the overall acidity of the juice [40].

CONCLUSION

It can be concluded that shading at 50% and spraying with the nutrient solution Brexil Duo at a concentration of 6 g L^{-1} improved the condition of local orange trees in terms of vegetative characteristics and fruit chemical content.

Therefore, it is recommended to shade at 50% and increase the concentrations of the nutrient solution Brexil Duo to more than 6 g L^{-1}.

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