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THE EFFECT OF SPRAYING WITH NUTRIENT SOLUTION AND ORGANIC FERTILIZATION ON THE VEGETATIVE AND CHEMICAL CHARACTERISTICS OF SEEDLINGS OF DOMESTIC SOUR LEMON (*CITRUS LIMON* L.)

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Abstract: The study was conducted in a wooden canopy covered with saran in (the palm nursery) one of the private nurseries in Al-Muthanna Governorate, Al-Samawah district for the period from 01.03.2020 to 01.07.2020 on seedlings of domestic sour lemon which grafted on the origin of the seed of bitter orange at the age of one year, to study the effect of organic fertilization (Leftover palm fronds) with four additives (0, 25, 50, 75) gm.soil^{-1} and spraying with nutrient solution Bio-20 at four concentrations (0, 100, 200, 300) ml.l^{-1} and their interactions on the characteristics of vegetative and chemical. The experiment was applied according to a randomized complete block design (R.C.B.D) as a factorial experiment with two factors. The experiment included 16 treatments with three replications, so the number of experimental units was 48 units, with 3 seedlings for each treatment in each repeat. Hence, the number of seedlings used in the experiment were 144. The averages were compared using the LSD test at a probability level of (0.05). The results indicated the superiority of the addition treatment (75 g.Soil^{-1}) of organic fertilizer and spraying with the nutrient solution at a concentration of (300 ml.l^{-1}). The interaction treatment (300 ml.l^{-1} nutrient solution + 75 g.Soil^{-1} organic fertilizer) was significant in vegetative characteristics.

***Key words*:** Lemon seedlings, Organic fertilization, Nutrient solution, Randomized complete block design (R.C.B.D) .

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1. Introduction

Sourlemon trees *Citrus Limon* L. belong to the genus Citrus, which belongs to the family Rutaceae and the regions of north eastern India and southwestern China are the original home of this species [Al-Khafaji *et al*. (1990)]. Sour lemon is one of the types of citrus fruits cultivated in Iraq for a long time due to the availability of suitable conditions for their cultivation. Because the fruits have qualities that are desired by consumers, the fruits are characterized by being rich in mineral salts, which are necessary to build the human body such as potassium, calcium, iron, magnesium, sodium, sulfur, phosphorous and it is a source of vitamin C and good amounts of vitamins A, B1 and B2 [Al-Jumaili *et al.* (1989)]. The number of Sour lemon trees planted in Iraq, according to the data of the Central office of Statistics (2019), is about 291,537 trees and Iraq's production of Sour lemon fruits is estimated at 5178 tons, while the average production of one tree is 17.8 kg. The availability of citrus seedlings in good and strong growth is one of the most important means of spreading and developing citrus cultivation in Iraq and this requires adequate care, especially fertilization, as the seedlings annually consume many nutrients from the soil for use in various biological processes. Therefore, it is replaced by appropriate fertilization, N, P, K are the essential elements of plant growth for fruit seedlings. The frequent use of large quantities of

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chemical fertilizers leads to adverse health and environmental effects. As a result, modern concerns in many countries have tended to use sustainable agriculture (organic agriculture) as a challenge to traditional agricultural methods in order to preserve natural resources from deterioration and the continued availability and use of them by Next generations [Abu Al-Eis (2016)].

Foliar fertilization is not an alternative to ground fertilization. However, it is complementary to it, as the plant gets 98% of its nutritional needs through the soil and 2% of its other needs through the leaves [Jones (1991)]. Therefore, spraying seedlings with foliar fertilization increases the percentage of nutrients, increases vegetative growth and their stock of total carbohydrates more than if they were used separately [Nafeh (1984)].

This study was conducted to find out the effect of spraying with the nutrient solution and organic fertilization and their interactions in improving the growth of seedlings of local sour lemon grafted on the seed of Citrus aurantium in order to obtain the production of seedlings of high-quality specifications during a specific period to contribute to the development of citrus orchards in Iraq.

2. Materials and Methods

The study was carried out in the Palm Nursery, one of the private nurseries in Al-Muthanna Governorate - Al-Samawah district for the period from 01.03.2020 to 01.07.2020 to study the effect of the OMEX BIO-20 nutrient solution and organic fertilizer (Leftover palm fronds) on the growth of seedlings of domestic sour lemon which grafted on the origin of the seed of bitter orange and studying the effect of these factors on vegetative and chemical characteristics. Seedlings of lemon sour local which grafted on the origin of the seed of bitter orange were selected at the age of one year, nearly homogeneous in height and size, which planted in plastic bags from the certified citrus production nursery belonging to the Iraqi Ministry of Agriculture- the General Directorate of Horticulture and Forests in the Holy Karbala Governorate- Al-Hindiya District. The seedlings were transformed into plastic anvils with a capacity of 5 kg of soil a month before the date of implementation of the treatments, the samples were taken from the soil which the seedlings were growing it and then mixed homogeneously after which a soil analysis was performed to find out some of its physical and chemical characteristics in the laboratories of the Department of Soil Science and Water Resources at the College of Agriculture, Al- Muthanna University, according to the methods mentioned by Page *et al*. (1982).

Table 1: Chemical and physical features of the experimental soil pre-planting the seedling.

Features	Units	Value
pH	-	7.2
E.C.	$Des.m^{-1}$	1.5
Ready N.	%	0.33
Ready P.	%	0.09
Total N.	%	0.71
Total P.	%	0.27
Sand	g. kg $soil^{-1}$	810
Silt	g. kg $soil^{-1}$	108
Clay	g. kg $soil^{-1}$	82
Texture		Sandy loam

The results of the analysis are shown in Table 1. The experiment was carried out as a factorial experiment using a randomized complete block design (RCBD) with three replications [Al-Rawi and Abdul Aziz (2000)] and with two factors; the first factor included four additions of organic fertilizer (Leftover palm fronds) (0, 25, 50, 75) g.Kg $soil^{-1}$ and the second factor was the nutrient solution in four concentrations (300, 200, 100, 0) $ml.l^{-1}$ and thus the number of treatments was 16 treatments with three replications, so the number of experimental units was 48 experimental units by 3 seedlings for each treatment in each repeat, so that the number of total seedlings of lemon sour 144 seedlings. Dissolving organic fertilizer was added to a depth of 5 cm in the soil and the spraying treatments of the nutrient solution were carried out at a rate of 4 sprays, the first spray on 03.10.2020, the second spray on 04.10.2020, the third one 05.10.2020 and the last spray on 06.10.2020. The data were analyzed statistically using the computer and the ready-made statistical program GenStat and the differences between the averages were compared according to the least significant difference test (L.S.D) at a probability level of 0.05.

At the end of the experiment, the amount of increase in the height of the seedlings was measured (cm), the amount of the increase in the number of branches (branch.$Seedling^{-1}$), the amount of increase in the number of leaves (leaf.$Seedling^{-1}$), the average leaf area (cm^2.$Seedling^{-1}$), the percentage of nitrogen,

phosphorous andpotassium in the leaves.

3. Results and Discussion

3.1 Seedling height (cm)

The results presented in Table 2 indicate that the nutrient solution had a significant effect on the amount of increase in the height of the seedlings, as the spraying treatment with the nutrient solution at a concentration of 300 ml.l^{-1} was significantly superior in giving the highest rate of increase in the height of the seedlings it was 38.80 cm compared to the lowest rate of increase in the height of 30.51 cm when compared to spraying with distilled water. The reason for this may be due to the nutrient solution containing the macro elements N, P, K and the microelements, in balanced quantities to meet the plant's need of the mineral elements necessary for photosynthesis, respiration andvarious metabolic processes that lead to cell division and elongation and then increase the length of the main stem [Awad and Atawia (1995)].

The results presented in the same table indicate that organic fertilization had a significant effect on the rate of increase in seedlings' height, as the treatment of adding 75 g.soil^{-1} gave an average height of 40.39 cm compared to the lowest rate of increase in the height of 31.19 cm when the comparison treatment (without addition). Also, the results indicate that the interaction treatment (spraying the nutrient solution at a concentration of 300 ml.l^{-1} and adding organic fertilizer 75 g.Soil^{-1}) among the experiment factors had a significant effect on the rate of increase in the height of the seedling, as the highest rate of height reached 44.66 cm compared to the comparison treatment which gave the lowest average height of 25.55 cm (Table 2).

3.2 Branches of seedlings number (branch.Seedling^{-1})

The results in Table 3 show that there are significant differences for the increase in the number of branches

Table 2: Effect of organic fertilization and nutrient solution and their interactions on the height of seedlings of domestic sour lemon (cm).

Organic fertilization (O)	Nutrient Solution (F)				Mean O
	0	100	200	300	
0	25.55	28.25	34.74	36.22	31.19
25	28.22	31.93	36.55	34.33	32.76
50	29.77	33.77	38.25	40.00	35.45
75	38.48	39.25	39.15	44.66	40.39
Mean F	30.51	33.30	37.17	38.80	
L.S.D $_{0.05}$	O= 1.923	F= 1.923	O×F= 3.846		

Table 3: The effect of organic fertilization and nutrient solution and their interactions on the number of branches of seedlings of domestic sour lemon (branch. Seedling^{-1}).

Organic fertilization (O)	Nutrient Solution (F)				Mean O
	0	100	200	300	
0	2.54	3.03	3.22	4.11	3.22
25	3.07	4.44	4.11	5.11	4.18
50	3.23	4.10	4.00	5.66	4.25
75	4.33	6.11	5.07	7.22	5.68
Mean F	3.29	4.42	4.10	5.52	
L.S.D $_{0.05}$	O= 0.156	F= 0.156	O×F= 0.313		

due to the effect of spraying with the nutrient solution, as the spray with a concentration of 300 ml.l^{-1} was superior in this characteristic to give the highest rate of increase in the number of branches, which reached 5.52 branches.Seedling^{-1} compared with the control treatment, which was reached 3.29 branches.Seedling^{-1}.

Also, the results in the same table indicate that the treatment of adding organic fertilizer has an apparent effect on the amount of the increase in the number of branches, as the addition treatment 75 g.Soil^{-1} gave the highest rate of increase in the number of branches, reaching 5.68 branches.Seedlings^{-1}, while the control treatment (without adding) gave the lowest rate of the number of branches 3.22 branches.Seedlings^{-1}. It is noticed from the results of Table 3 that the interaction between the nutrient solution and the organic fertilizer has a significant effect on the amount of the increase in the number of branches, as the interaction treatment gave the highest rates of increase of 7.22 branches.Seedlings^{-1} compared to the comparison treatment, which gave the lowest rates of increase in the number of branches, amounting to 2.54 branches. seedling^{-1}.

3.3 Number of leaves (leaf.seedling^{-1})

It is noticed from the results presented in Table 4 that the treatment of spraying the seedlings with the nutrient solution had a significant effect on the amount of increase in the number of leaves of the seedlings, as the spray treatment with a concentration of 300 ml.l^{-1} was significantly superior in giving the highest rate of increase in the number of leaves, which reached 63.80 leaves.Seedling^{-1}, compared to the control treatment, which gave the lowest rate of increase in the number of leaves when spraying with distilled water and it reached 49.72 leaves.Seedling^{-1}.

The results in Table 4 indicate that the treatment

Table 4: Effect of organic fertilization and nutrient solution and their interactions on the number of leaves of seedlings of domestic sour lemon (leaf.seedling^{-1}).

Organic fertiliz-ation (O)	Nutrient Solution (F)				Mean O
	0	100	200	300	
0	30.78	35.66	36.33	40.78	35.89
25	31.44	37.22	38.22	42.33	37.30
50	54.33	59.67	67.89	73.55	63.86
75	82.33	89.11	95.11	98.55	91.28
Mean F	49.72	55.41	59.39	63.80	
L.S.D $_{0.05}$	O= 1.838	F= 1.838	O×F= 3.677		

of adding organic fertilization has a highly significant effect on the rate of increase in the number of leaves, as the addition treatment gave 75 g.Soil^{-1}, the highest rate of increase in the number of leaves was 91.28 leaves.Seedling^{-1} is compared to the lowest rate of increase in the number of leaves. Upon transaction (without addition), it amounted to 35.89 leaves.Seedling^{-1}. The interaction treatment between the two experiment factors had a significant effect on the rate of increase in the number of leaves, as the treatment (300 ml.l^{-1} nutrient solution + 75 g soil^{-1}) significantly out performed the rest of the treatments in giving the highest rate of increase in the number of leaves for seedlings was 98.55. Seedling^{-1}, this treatment did not differ significantly from the interaction treatment (200 ml.l^{-1} nutrient solution + 75 g.Soil^{-1} organic fertilizer) as the rate of increase in the number of leaves was 95.11 leaves.Seedling^{-1} compared to the lowest rate of increase in the number of leaves when the comparison treatment 30.78 leaves.Seedling^{-1}.

3.4 Average leaf area (cm^2.seedling^{-1})

The results shown in Table 5 indicate that there are significant differences between the fertilizer treatments in the experiment, as the spraying treatment with the nutrient solution at a concentration of 300 ml.l^{-1} outperformed the rest of the treatments in giving the highest rate of leaf area of 802.3 cm^2.Seedling^{-1}, while the lowest average reached 636.7 cm^2.Seedling^{-1} when spraying with distilled water. Also, the results showed that organic fertilization has a significant effect on the rate of leaf area, as the treatment of adding organic fertilizer 75 g.Soil^{-1} significantly outperformed the rest of the treatments in the rate of leaf area amounted to 1006.5 cm^2.Seedling^{-1}, compared to the lowest rate of leaf area, reached 557.5 cm^2.Seedling^{-1} when using the comparison (without addition). The reason for this may be due to the organic fertilizer containing nitrogen, which

Table 5: The effect of organic fertilization and nutrient solution and their interactions on average Leaf area of seedlings of domestic sour lemon (cm^2.seedling^{-1}).

Organic fertiliz-ation (O)	Nutrient Solution (F)				Mean O
	0	100	200	300	
0	511.9	543.0	577.3	598.0	557.5
25	527.2	594.0	620.2	666.1	601.9
50	616.5	713.7	796.8	821.0	737.0
75	891.2	958.5	1051.7	1124.4	1006.5
Mean F	636.7	702.3	761.5	802.3	
L.S.D $_{0.05}$	O= 23.80	F= 23.80	O×F= 47.60		

is included in the construction of the chlorophyll pigment, which has a fundamental role in the process of photosynthesis and increases its carbohydrates in the plant and also enters into building and cytokinins that increase the activity of meristematic peaks, cell division and elongation, increasing plant growth and the number of branches and the number of leaves and leaf area, which are important indicators in measuring plant activity [Muhammad and Muayyad (1991)].

As for the interaction between the two experimental factors, it is evident from the results of Table 5 that there are significant differences in the average of leaf area, as the highest average was 1124.4 cm^2.Seedling^{-1} with the interaction of (300 ml.l^{-1} nutrient solution + 75 g.soil^{-1} Organic fertilizer) compared to the comparison treatment that gave the lowest average leaf area of 511.9 cm^2.Seedling^{-1}.

3.5 Leaves content of nitrogen (%)

The results of Table 6 indicate that the spraying with the nutrient solution BIO-20 on the seedlings had a significant effect on the content of the leaves of nitrogen, as the treatment with a concentration of 300 ml.l^{-1} gave the highest percentage of nitrogen in the seedlings' leaves, reaching 1.62% compared to the comparison treatment, spraying with distilled water. It gave the lowest nitrogen content in the leaves, 1.30%.

Table 6: The effect of organic fertilization and nutrient solution and their interactions on Leaves content of nitrogen of seedlings of domestic sour lemon (%).

Organic fertiliz-ation (O)	Nutrient Solution (F)				Mean O
	0	100	200	300	
0	0.76	0.84	0.93	1.05	0.89
25	1.09	1.25	1.32	1.52	1.30
50	1.58	1.61	1.72	1.74	1.66
75	1.76	1.84	1.90	2.17	1.92
Mean F	1.30	1.38	1.47	1.62	
L.S.D $_{0.05}$	O= 0.047	F= 0.047	O×F= 0.094		

The reason for this may be attributed to the nutrient solution containing the major and minor elements that are absorbed directly through the leaves and to a cycle in activating the root system and increasing the absorption of nitrogen, as well as the effect of the elements in increasing the efficiency of carbon representation, which increases the absorption of potassium and phosphorus, which explains the increase in their concentration in the leaves [Devlin & Whitham (1998)].

The organic fertilizer also had a significant effect, as the results show in the same table to the superiority of the treatment of adding 75 g.Soil^{-1}, which gives the highest percentage of nitrogen in the seedlings, leaves 1.92% compared to the lowest nitrogen percentage of 0.89% when the comparison treatment (without adding fertilizer).

The results in the same table indicate that the interaction between the two workers had a significant effect on the percentage of nitrogen in the leaves, as the interaction treatment (300 ml.l^{-1} nutrient solution + 75 g.Soil^{-1} organic fertilizer) gave the highest percentage of nitrogen in the leaves, which reached 2.17% compared to the comparison treatment that gave the lowest nitrogen content in the leaves 0.76%.

3.6 Leaves content of phosphorous (%)

Table 7 showed that the foliar spray with the nutrient solution had a significant effect on the characteristic of the phosphorous percentage in the leaves, as the treatment with a concentration of 300 ml.l^{-1} gave the highest percentage of phosphorus in the leaves which reached 0.522%, while the comparison treatment gave the lowest percentage of phosphorus in the leaves, which amounted to 0.398%.

The treatment of adding organic fertilizer was significantly superior to the phosphorous content of the leaves, as the treatment of adding 75g.soil^{-1} organic fertilizer gave the highest percentage of phosphorus in the leaves, which reached 0.549% compared to the comparison treatment (without adding fertilizer), which gave the lowest percentage of phosphorus in the leaves 0.378% (Table 7). It is evident from the results presented in the same table that the interaction between the two experiment factors had a significant effect on the characteristic of the phosphorus percentage in the seedling leaves, as the highest percentage of phosphorus in the leaves was 0.617% compared to the lowest phosphorous percentage when compared to 0.313%.

Table 7: The effect of organic fertilization and nutrient solution and their interactions on Leaves content of phosphorousof seedlings of domestic sour lemon (%).

Organic fertiliz-ation (O)	Nutrient Solution (F)				Mean O
	0	100	200	300	
0	0.313	0.340	0.410	0.447	0.378
25	0.380	0.423	0.450	0.487	0.435
50	0.417	0.430	0.517	0.537	0.475
75	0.480	0.530	0.570	0.617	0.549
Mean F	0.398	0.431	0.487	0.522	
L.S.D 0.05	O= 0.0121	F= 0.0121	O×F= 0.0242		

3.7 Leaves content of potassium (%)

According to Table 8 we noticed the superiority of the spraying treatments with the nutrient solution significantly in the characteristic of the potassium percentage in the leaves, as the spray treatment with a concentration of 300 ml.l^{-1} gave the highest percentage of potassium in the leaves, reaching 1.47%. In contrast, the comparison treatment gave the lowest percentage of potassium in the leaves, reaching 1.27%.

The results in Table 8 indicate that the addition of organic fertilizer had a significant effect on the potassium content of the leaves, as the treatment of adding 75 g.soil^{-1} gave the highest percentage of potassium in the leaves, which reached 1.54% compared to the comparison treatment that gave the lowest potassium content in the leaves of 1.22%.

As for the interaction between the two experiment factors, the results of the same table indicate the presence of significant differences in the potassium content of the leaves, as the interaction treatment (300 ml.l^{-1} nutrient solution + 75 g.Soil^{-1} organic fertilizer) gave the highest content of potassium in the leaves, reaching 1.61. While the comparison treatment gave the lowest percentage of potassium in the leaves, it

Table 8: The effect of organic fertilization and nutrient solution and their interactions on Leaves content of potassium of seedlings of domestic sour lemon (%).

Organic fertiliz-ation (O)	Nutrient Solution (F)				Mean O
	0	100	200	300	
0	0.93	1.24	1.33	1.37	1.22
25	1.31	1.35	1.37	1.41	1.36
50	1.37	1.45	1.47	1.51	1.45
75	1.49	1.53	1.53	1.61	1.54
Mean F	1.27	1.39	1.43	1.47	
L.S.D 0.05	O= 0.027	F= 0.027	O×F= 0.054		

reached 0.93% (Table 8).

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