

Effect of fertilization with Vermicompost and spraying with Moringa leaf extract on some vegetative and root growth traits of *Citrus aurantifolia* saplings.

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Abstract

The study was conducted in one of the private nurseries in Babylon province for the period from 1/9/2020 to 6/1/2021 to study the effect of fertilization with Vermicompost and spraying with Moringa leaf extract and the interaction between them on the growth of lemon saplings. The 144 saplings of homogeneous growth were selected as much as possible and at the one-year age, a factorial experiment was conducted according to the randomized complete blocks design R.C.B.D and with three replications. The experiment included the addition of Vermicompost fertilizer with four concentrations (0, 10, 20, 30 g. saplings⁻¹), and four levels of spraying with Moringa leaf extract (0, 50, 100, 150 ml .L⁻¹). The results can be summarized as follows:

The treatment of the addition of (V3) of Vermicompost fertilizer was excelled and gave the highest averages in the studied traits (the rate of increase in plant height, the average of increase in stem diameter, main root length, main root diameter, and the percentage of nitrogen, phosphorous and potassium in the leaves) which reached (16.48 cm, 3.45 mm, 42.10 cm, 11.34 mm, 1.69%, 0.31%, 2.62%) respectively, The Spraying treatment (B2) with Moringa leaf extract was excelled and gave the highest averages in the studied traits which (14.47 cm, 3.30 mm, 42.92 cm, 11.08 mm, 1.62%, 0.30%, 2.52%) respectively, but in terms of the best interaction treatment between them, the (V3B2) combination excelled in giving the highest averages for the above-mentioned traits.

Introduction

Lime trees (*Citrus aurantifolia* L.), locally called (Numi Basra) in Iraq, belong to the genus Citrus belonging to the Rutaceae family, whose trees grow in tropical and sub-tropical regions in Southeast Asia (10), estimated The number of fruitful lemon trees in Iraq is (291487) trees, and Iraq's production of lemon fruits is estimated at 5375 tons, while the average production of one tree is (18.4) kg (6). Lemon is one of the fruit trees whose fruits are used for dry consumption in Iraq. Lemon is of nutritional and medical importance, where the pulp of the peel contains a high percentage of citric acid and volatile oils such as Limonene, Linalol, Linalyl Acetate, Turpinol and Cymen. Its dry fruits are used in Traditional medicine as a stomach tonic and against scurvy, and lemon oil that drips from the peel is mainly used to give

flavor and taste to foods, as well as in cosmetics and perfumes (13). Its fruits are also distinguished by being rich in mineral salts needed to build the human body, such as potassium, calcium, iron, magnesium, sodium and phosphorous. It is also a source of many vitamins, including vitamin A, B1, B2, and it contains quantities of vitamin C (2). Specialists in the agricultural field tended to use natural materials such as organic and biological fertilizers and plant extracts as an alternative to chemical fertilizers to reduce the harm arising from the use of chemical fertilizers on soil and human health (11). Vermicompost is a natural organic fertilizer resulting from the various biological activities of earthworms, which is rich in nutrients such as nitrogen, phosphorous, potassium, calcium, magnesium, iron and other minerals. It increases the dissolution of these

elements in water so that they are easily absorbed by the plant, as well as rich in beneficial organisms for the plant and the secretion of some growth hormones such as auxin, gibberellin, cytokinin and some enzymes (14). The use of natural plant extracts is one of the technologies that help in increasing the growth traits of many plants, and this is due to the fact that they contain many natural chemical compounds naturally occurring. Which differ in quantity and quality according to different species and plant parts, as well as according to different environmental conditions and plant growth stages (8). Among these plant extracts is Moringa leaf extract, which has the ability to improve the vegetative and root growth traits of plants as a source of macro and micronutrients and plant hormones and amino acids contribute to increasing plant strength and increasing growth indicators, and thus positively affect the plant, both quantitatively and qualitatively (12). Based on what was mentioned above and the lack of studies on lemon saplings in the conditions of Babylon province, and accordingly, the study aims to Study the effect

of the Vermicompost fertilizer and Moringa leaf extract on vegetative, root and chemical growth traits in order to obtain strong-growing saplings of lemon.

Materials and Methods

The research was conducted In one of the private nurseries in Babylon province for the period from 9/1/2020 to 6/1/2021 to study the effect of fertilization with Vermicompost and spraying with Moringa leaf extract and the interaction between them on the growth of lemon saplings. One-year-age lemon saplings were brought from the certified citrus production nursery in Al-Hindiya District - Holy Karbala province, which belongs to the Iraqi Ministry of Agriculture - General Directorate of Horticulture and Forests. The saplings were transferred to the study site and were cultivated in plastic bags of 1 kg, then they were transferred to a larger pot of 5 kg capacity and filled with the medium containing a mixture of riverine and peat moss in a ratio of (1:3). The saplings were placed in the lathhouse covered with saran as shown in the table (1).

Table 1 Properties of the media culture

traits	units	values
availability nitrogen	mg.kg ⁻¹ soil	21.00
availability phosphorous	mg.kg ⁻¹ soil	11.18
availability potassium	mg.kg ⁻¹ soil	30.00
pH	-	7.8
E.C . electrical conductivity	Ds.m ⁻¹	1.51
Organic matter	g.kg ⁻¹ soil	2.01
CaCo3	g.kg ⁻¹ soil	13.3
Soil Separators	Sand	820
	Silt	85
	clay	95
Soil Texture	Sandy Loam	

10 g.saplings⁻¹, V2 20 g.saplings⁻¹ and V3 30 g. saplings⁻¹).

The first-factor "Vermicompost" was addition to the soil included the following concentrations (V0 control treatment (without addition) , V1

The process of adding vermicompost was conducted twice, the first on 9/1/2020 and the second on 3/1/2021. The second factor "Moringa

leaf extract" was spraying the vegetative growth with Moringa leaf extract prepared in the Horticulture and Landscaping Laboratory - College of Agriculture / Al-Qasim Green University. The extract was prepared with a weight of 100 g of moringa leaf powder and placed in a beaker. One liter of distilled water was added to it and placed on an electric vibrator for one hour. The solution was filtered

using several layers of medical gauze and completed the volume to a liter. The result was a concentration of 100%, which is the original (crude) concentration from which the final concentrations used were made. The extract was placed in plastic bottles and kept in the refrigerator until use. Its components are shown in Table (2).

Table 2 Some components of dry Moringa leaves (100 g) (Witt, 2013)

8.2	Niacin	-5	Mineral composition (mg)		No.
Amino acids (g 100g⁻¹)			297	phosphorous	-1
0.891	Lysine	-1	1467	potassium	-2
0.196	Histidine	-2	473	magnesium	-3
0.487	Phenyl alanine	-3	1897	Calcium	-4
0.123	Methionine	-4	220	Sodium	-5
0.140	Cysteine	-5	-	manganese	-6
0.517	Glycine	-6	32.5	Iron	-7
1.035	Glutamic acid	-7	2.4	zinc	-8
0.920	Aspartic acid	-8	0.9	copper	-9
0.411	Threonine	-9	other compounds		No.
0.532	Arginine	-10	24 g	Protein	-1
0.705	Alanine	-11	36 g	carbohydrates	-2
0.611	Valine	-12	216.93 mg	IAA	-3
0.791	Leucine	-13	170.07 mg	phenol compounds	-4
			Vitamins (mg 100 g⁻¹)		No.
0.451	Isoleucine	-14	172	Vit.C	-1
0.347	Tyrosine	-15	113 – 56	Vit.E	-2
0.414	Serine	-16	2.4	Vit.B6	-3
0.451	Proline	-17	1.29	Riboflavin	-4
0.144	Tryptophan	-18			

Moringa leaf extract was spraying with four concentrations (B0 control treatment (spraying with distilled water only), B1 50 ml L⁻¹, B2 100 ml L⁻¹ and B3 150 ml L⁻¹).

The spraying process was conducted for the vegetative growth with Moringa leaf extract until full wetness in the early morning at an average of 7 sprays (4 sprays in the fall season and 3 sprays in the spring season) between one spray and another one month according to the following times: 15/9/2020 and 15/10/2020 and

15/11/2020, 15/12/2021, 15/3/2021, 15/4/2021 and 15/5/2021. A factorial experiment (4*4) was conducted with three replications, and each experimental unit included 3 saplings, thus bringing the total number of saplings of the experiment to 144 saplings. Randomized Complete Block Design (RCBD) was used, the data were analyzed statistically and the arithmetic averages were compared with the LSD test at the 0.05 probability level (3).

The Measured Traits

The following responses were measured throughout the study:

- 1- the average increase in sapling height (cm)
- 2- The rate of increase in the stem diameter of the sapling (mm)
- 3- main root length (cm)
- 4- Main root diameter (mm)
- chemical properties
- 5- Percentage of nitrogen, phosphorous and potassium in leaves (%)

Results and Discussion

1- The average increase in sapling height (cm)

The results in Table 3 showed a significant effect of fertilizing with Vermicompost on the average of increase in sapling height. The treatment V3 gave the highest increase for this height, reaching 16.48 cm, compared to the control treatment V0, which gave 9.68 cm. Spraying with Moringa leaf extract caused a positive effect on the average increase in the height of saplings, where treatment B2 was significantly excelled with the highest increase of 14.47 cm compared to control treatment B0, which gave 9.29 cm. The bi-interaction between Vermicompost and Moringa leaf extract (V*B) had a significant effect on the rate of increase in sapling height. The treatment V3B2 outperformed by recording the highest increase of 19.86 cm compared to the control treatment V0B0, which gave the lowest average of increase of 5.05 cm.

Table 3 Effect of fertilization with Vermicompost and spraying with Moringa leaf extract and their interactions on the average of increase in sapling height (cm) of lemon sapling

Vermicompost g.sapling ⁻¹	Moringa Leaf Extract ml.L ⁻¹				Average V
	B0	B1	B2	B3	
V0	1.80	3.07	3.15	3.35	2.84
V1	2.89	3.08	2.88	3.14	3.00
V2	3.56	3.09	3.19	3.55	3.34
V3	3.77	3.96	3.98	2.78	3.45
Average B	3.00	3.13	3.30	3.20	
LSD 0.05	V=0.3804 B=0.3804 V*B=0.7609				

3- main root length (cm)

The results in Table 5 show that the treatment of fertilizing with Vermicompost was significantly excelled in the trait of root length. Where, treatment V3 gave the highest value of 42.10 cm compared to the control treatment V0, which gave the lowest value of 38.25 cm. Moringa leaf extract also led to a significant

increase in root length, where treatment B2 was excelled and gave the highest value of 42.92 cm. It was measured by B1 and B0, which gave 37.60 cm and 37.61 cm, respectively. The bi-interaction between Vermicompost fertilizer and Moringa leaf extract (V*B) had a significant effect on root length. Where, treatment V3B2 achieved the highest value of 45.23 cm compared to the control treatment V0, which gave the lowest value of 32.07 cm.

Table 5: Effect of Vermicompost Fertilization and Moringa Leaf extract and their Interactions on Main Root Length (cm) of lemon sapling

Vermicompost g.sapling ⁻¹	Moringa Leaf Extract ml.L ⁻¹				Average V
	B0	B1	B2	B3	
V0	32.07	36.57	43.00	41.37	38.25
V1	33.37	40.27	41.45	42.67	39.44
V2	42.90	35.75	42.00	36.30	39.24
V3	42.10	37.80	45.23	43.27	42.10
Average B	37.61	37.60	42.92	40.90	
LSD 0.05	V=2.028 B=2.028 V*B=4.056				

4- Main root diameter (mm)

the results in Table 6 that the fertilizing treatment with Vermicompost was significantly excelled on the root diameter traits. Whereas, treatment V3 had the highest value, which reached 11.34 mm, compared to the control treatment V0, which gave 10.08 mm. Moringa

leaf extract led to a significant increase, where treatment B2 was excelled, which amounted to 11.08 mm, compared to control treatment B0, which gave 10.21 mm. The bi-interaction between Vermicompost and Moringa leaf extract (V*B) had a significant effect, where the treatment V3B2 achieved the highest rate of 12.14 mm compared to the control treatment V0B0, which gave the lowest value of 8.56 mm.

Table 6: Effect of ground fertilization with Vermicompost and spraying with Moringa leaf extract and their interactions on main root diameter (mm) of lemon sapling

Vermicompost g.sapling ⁻¹	Moringa Leaf Extract ml.L ⁻¹				Average V
	B0	B1	B2	B3	
V0	8.56	11.42	10.33	10.02	10.08
V1	10.53	10.07	10.59	10.19	10.34
V2	11.15	10.45	11.25	10.68	10.88
V3	10.62	11.19	12.14	11.42	11.34
Average B	10.21	10.78	11.08	10.58	
LSD 0.05	V=0.4717 B=0.4717 V*B=0.9435				

5 -Percentage of nitrogen in leaves (%)

The results in Table 7 indicate a significant effect on the percentage of nitrogen in leaves when treated with Vermicompost fertilizer. The treatment V3 gave the highest average, which was 1.69% compared to the control treatment V0, which gave 1.41%. The spraying with

Moringa leaf extract had a significant effect. As treatment B2, which amounted to 1.62%, compared to control treatment B0, which gave 1.51%. The bi-interaction between Vermicompost fertilizer and Moringa leaf extract (V*B) had a significant effect, where the treatment V3B2 excelled by giving the highest average of 1.77% compared to the control treatment V0B0 which gave the lowest value of 1.28%.

Table 7: Effect of ground fertilization with Vermicompost and spraying with Moringa leaf extract and their interactions on the percentage of nitrogen in leaves (%) of lemon sapling

Vermicompost g.sapling ⁻¹	Moringa Leaf Extract ml.L ⁻¹				Average V
	B0	B1	B2	B3	
V0	1.28	1.42	1.43	1.53	1.41
V1	1.47	1.50	1.64	1.64	1.56
V2	1.55	1.54	1.66	1.64	1.60
V3	1.75	1.64	1.77	1.61	1.69
Average B	1.51	1.53	1.62	1.60	
LSD 0.05	V=0.0806 B=0.0806 V*B=0.161				

6 -Percentage of phosphorous in leaves (%)

The results in Table 8 show a significant effect when treated with Vermicompost fertilizer on the percentage of phosphorous in the leaves, Where, treatment V3 gave the highest average, which amounted to 0.31%, compared to the control treatment V0, which gave 0.27%. Spraying with Moringa leaf extract had a

positive effect, where treatment B2 was significantly excelled with the highest value of 0.30% compared to control treatment B0 which gave 0.27%.The bi-interaction between Vermicompost fertilizer and Moringa leaf extract (V*B) had a significant effect on the percentage of phosphorous in the leaves.The treatment V3B2 excelled by recording the highest average of 0.37% compared to the control treatment V0B0, which gave the lowest value of 0.20%.

Table 8: Effect of ground fertilization with Vermicompost and spraying with Moringa leaf extract and their interactions on the percentage of phosphorous in leaves (%) of lemon sapling

Vermicompost g.sapling ⁻¹	Moringa Leaf Extract ml.L ⁻¹				Average V
	B0	B1	B2	B3	
V0	0.20	0.30	0.31	0.29	0.27
V1	0.30	0.28	0.26	0.28	0.28
V2	0.28	0.27	0.28	0.30	0.28
V3	0.30	0.30	0.37	0.26	0.31
Average B	0.27	0.29	0.30	0.28	
LSD 0.05	V=0.02768 B=0.02768 V*B= 0.05535				

7- Percentage of potassium in leaves (%)

The results in Table 9 indicated that there was a significant effect of the treatment with Vermicompost fertilizer on the percentage of potassium in the leaves, where the treatment V3 gave the highest rate, reaching 2.62% compared to the control treatment V0, which gave 2.19%.

Treatment B2 was significantly excelled with the highest value of 2.52% compared to control treatment V0, which gave 2.20%. The bi-interaction between Vermicompost fertilizer and Moringa leaf extract (V*B) caused a significant effect on the percentage of potassium in the leaves, as the treatment V3B2 excelled by giving the highest average of 2.79% compared to treatment V0B0 which gave the lowest value of 1.47%

Table 9: Effect of ground fertilization with Vermicompost and spraying with Moringa leaf extract and their interactions on the percentage of potassium in leaves (%) of lemon sapling

Vermicompost g.sapling ⁻¹	Moringa Leaf Extract ml.L ⁻¹				Average V
	B0	B1	B2	B3	
V0	1.47	2.38	2.51	2.42	2.19
V1	2.46	2.38	2.24	2.45	2.38
V2	2.23	2.32	2.55	2.53	2.41
V3	2.64	2.65	2.79	2.43	2.62
Average B	2.20	2.43	2.52	2.46	
LSD 0.05	V= 0.1505 B=0.1505 V*B=0.3010				

The reason for the increase in most of the vegetative traits is due to the role of Vermicompost on improving the fertile soil condition and providing the soil with humus, which improves its physical properties by increasing its ability to absorb and retain water, increasing the nutrient availability of the plant, organic matter and beneficial biological activity in the soil. Its components are also quick to dissolve in water, which facilitates The plant has to absorb and utilize it (1), As well as its role in the readiness of macro and micro nutrients, which led to an increase in the readiness of these elements in the soil solution and then obtaining them in the quantities needed by the plant in order to be able to build a strong root system through which it can absorb these nutrients to build a dense vegetative system (4),The decomposition of vermicompost works to release nutrients to the soil solution in the root system area, and then they are absorbed by the plant, in addition to forming a quantity of organic acids. And the natural chelators that contain effective aggregates reduce the interaction of nutrients on the fixing surfaces and thus increase the availability and quantity of nutrients necessary for plant growth (16), Moringa leaf extract had an effective role in increasing growth because it contains nutrients necessary for photosynthesis and respiration And the various metabolic processes that have a major role in the process of cell division and

elongation, which is positively reflected on the characteristics of vegetative growth (7),In addition, Moringa leaf extract contains auxins and a number of amino acids, including the amino acid Tryptophan (Table 2), which is the initiating compound in the formation of auxins that have a role

In increasing the division and elongation of cells and thus its reflection on vegetative growth such as plant height, stem diameter and main root length And the diameter of the main root, as for the effect of the moringa leaf extract in increasing the percentage of nutrients is due to the fact that this extract contains major nutrients, especially N, P, K and Mg As well as the microelements (Table 2), which are directly absorbed when sprayed on the leaves, thus increasing their percentage in the plant.

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