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ROLE OF BIOFERTILIZER, ORGANIC MANURE AND MORINGA LEAVES EXTRACT SPRAY IN GROWTH AND YIELD OF LOCAL ORANGE TRANSPLANTS

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ABSTRACT

The experiment was carried out in 2023 season of spring and autumn growth cycle in a private canopy in Al-Radwaniyah city, Baghdad Governorate, study included addition of bacterial biofertilizer at four treatments: no addition (A_1), addition of *Stenotrophomonas maltophilia* bacteria (A_2) , addition of *Azospirillum brasilense* bacteria (A_3) and addition of both types of bacteria (A_4) and organic fertilizer (Decomposing buffalo manure) at three levels (0, 250 and 500 gm.soil^{-1}), which are denoted by B_0, B_1, and B_2, respectively and spray moringa extract at three levels (0, 20 and 40 gm.L^{-1}), which are denoted M_0, M_1, and M_2, respectively. Treatments were replicated three times (one transplant per experimental unit) at factorial experiment in a RCBD and thus number of transplants used was 108. Experimental results showed that adding two types of bacteria (A_4) and buffalo manure at a level of 500 gm.soil^{-1} (B_2) and spraying moringa extract at a concentration of 40 gm.L^{-1} (M_2) as interaction treatment $A_4B_2M_2$ gave best results in Plant height, leaf area, leaf nitrogen and phosphorus content, while gave interaction treatment $A_4B_1M_1$ best results in number and weight of fruits, It reached (43.33) cm, (47.91) cm^2, (2.830)%, (0.575)%, (4.33) fruit.plant^{-1}, (544.3) gm, respectively, compared to the comparison treatment (without addition and without spraying). respectively, compared to control treatment (without addition and without spraying).

Keywords: orange, biofertilizer, organic manure, moringa extract, growth, yield.

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دور السماد الحيوي والسماد العضوي ورش مستخلص أوراق المورينجا في نمو وحاصل شتلات البرتقال المحلي

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الخلاصة

أجريت التجربة اثناء موسم النمو 2023 خلال دورتي النمو الربيعية والخريفية في ظلة خاصة في منطقة الرضوانية الواقعة في محافظة بغداد، تضمنت الدراسة إضافة السماد الحيوي البكتيري بأربعة مستويات هي: بدون إضافة (1A)، إضافة بكتريا (*Stenotrophomonas maltophilia* (A_2)، لإضافة بكتريا (*Azospirillum brasilense* (A_3) وإضافة كلا نوعي البكتريا (A_4) والسماد العضوي (مخلفات الجاموس المتحللة) بثلاث مستويات (0 و 250 و 500 غم.تربة$^{-1}$) والتي يرمز لها بالرموز B_0 و B_1 و B_2 على التوالي ، ورش مستخلص المورينجا بثلاث مستويات (0 و 20 و 40 غم.لتر$^{-1}$) والتي رمز لها بالرموز M_0 و M_1 و M_2 على التوالي. تكررت المعاملات ثلاث مرات (شتلة واحدة للوحدة التجريبية) في تجربة عاملية RCBDوبذلك يكون عدد الشتلات المستعملة في التجربة 108 شتلة. أظهرت نتائج الدراسة أن إضافة نوعي البكتريا معاً (A_4) والسماد العضوي للجاموس بتركيز 500 غم.تربة$^{-1}$ (B_2) والرش بمستخلص المورينجا بتركيز 40 غم.لتر$^{-1}$ (M_2) متمثلة بمعاملة التداخل $A_4B_2M_2$أعطت أفضل النتائج في ارتفاع النبات، مساحة الورقة الواحدة، محتوى الورقة من النتروجين والفسفور بينما اعطت معاملة التداخل $A_4B_1M_1$ افضل النتائج في عدد و وزن الثمار، بلغت (43.33) سم، (47.91) سم^2 ، (2.830) %، (0.575) %، (4.33) ثمرة. شتلة$^{-1}$، (544.3) غم، على التوالي، قياساً بمعاملة المقارنة (بدون إضافة وبدون رش).

الكلمات المفتاحية: البرتقال، السماد الحيوي، السماد العضوي، مستخلص المورينجا، النمو، الحاصل.

INTRODUCTION

The word "citrus" refers to a group of fruit trees that are characterized by presence of oil glands in their leaves, which give them a distinctive aromatic scent that distinguishes them from other types of fruit. Citrus fruits belong to Rutaceae family, which includes 13 genera and 65 species spread in tropical and subtropical regions, including the genus Citrus, which is considered one of most important genera because it includes most species and genera of economic importance **(Bashiri & Imad, 2023)**. Most historians and scientists believe that original homeland of different types of citrus is not precisely known and is likely to be tropical and subtropical regions of Southeast Asia, specifically Western India, China, Indonesia, some parts of Burma and some regions of Southwest Asia **(Bal, 2005; Shah, 2014)**. Its cultivation has now spread in large areas of the world and has taken its global economic place because citrus trees are characterized by a special position among fruit trees, because their fruits are of great importance from a nutritional, economic, and even cosmetic standpoint, as they are included in human food in different shapes and forms, and may be eaten fresh, uncooked. Therefore, it retains the largest amount of vitamins and therefore has a high nutritional value. This may be due to its chemical composition, which includes many chemical elements, including carbohydrates, fats, proteins, and some organic acids, addition to fibers **(Hashash & Ruqaya, 2022).**

Biofertilizers are known as preparations that contain microscopic organisms that have ability to supply plants with nutrients they need from natural sources, with the aim of reducing dependence on various chemical fertilizers **(Hamid & Bashir, 2019)**, as these fertilizers are capable of continuously releasing nutrients. This makes it able to meet the plants' need for chemical fertilizers. Biofertilizer consists of an organism or group of organisms that produce

substances that help enrich soil with nutrients. It also helps plants absorb nutrients by interfering with root zone, which represents most active area in soil **(Menaka *et al.*, 2023)**. by accelerating certain vital processes that convert nutrients into forms and shapes available to the plant so that it can easily absorb and assimilate them **(Wang *et al.*, 2019).** Plant nutrition is greatly affected by interaction that occurs between roots and soil microbes through direct and indirect mechanisms represented by manufacture of plant hormones, nitrogen fixation, organic phosphate mineralization, and others **(Singh *et al.*, 2022)**. There are some currently produced biofertilizers that are added scattered or mixed with soil or with seeds **(Muthusamy *et al.*, 2023)**, most important of which are nitrogenous biofertilizers that fix atmospheric nitrogen in soil, such as *Stenotephilia* bacteria that fix nitrogen freely and *Azospirillium* that fix nitrogen freely association with plant **(Patra *et al.*, 2017; Asghari *et al.*, 2020)**. Many studies have proven role of biofertilizers in plant growth, as it was confirmed (**Al-Hadethi, 2019)** that adding biofertilizers (*A. brasilense* + *B. megatherium*) to Hawthorn transplants led to obtaining highest values in vegetative characteristics and leaves mineral content. (**Latif & Abood, 2023)** Also found in his study on response of three citrus rootstocks to organic and biological fertilizers that addition of biological fertilizers, especially *A. brasilense* showed a significant superiority in most vegetative growth traits and leaves mineral content.

Organic agriculture is a production system that maintains health of agricultural productivity and maintains soil health and ecosystem, as organic fertilization is one of important means and methods that provide plants with their need for nutrients without a negative impact on environment, and increasing it does not lead to damage to plant that occurs. When fertilizing with mineral fertilizers in large quantities, organic matter also has a role in plant growth and yield, whether it is added to soil or sprayed on shoots (**Nardi *et al.*, 2016**; **Al-Hayani & Al-Hadethi, 2023)**. Among most important organic fertilizers are decomposed buffalo waste, which contains large quantities of ready-made nitrogen and also contains large quantities of phosphorus and potassium. It is considered most potassium content among rest of waste and has a major role in conserving water and improving soil physical and chemical properties **(Irshad *et al.*, 2013)**. As for plant extracts, they have recently gained attention of scientists and researchers by using them as alternatives or supplements to fertilizers and agricultural pesticides, as they can be added to soil or used as a spray on plant's shoots, because some of these extracts contain some nutrients and some substances that work action of growth regulators is an alternative to them, in addition to containing some compounds that are used to combat diseases and insects, and among these extracts is moringa leaf extract **(Bulgari *et al.*, 2019)**. There are many studies that indicated positive effect of spraying moringa extract on plant growth. In a study (**Mohammed & Majeed, 2023)** which included spraying moringa extract at concentrations of 0, 5, and 10%, it led to a significant increase in vegetative and fruiting characteristics of strawberry plants .So, among benefits of organic and biofertilizers are increasing soil nutrients availability, increasing tree productivity, improving fruit quality, in addition to improving soil characteristics and increasing microorganisms numbers in root zone, as well as improving plant tolerance to biotic and abiotic factors **(Al-Hadethi *et al.*, 2020; Singh *et al.*, 2022).** The study aims to effect of biofertilizer and buffaloes manure and moringa extract spray in vegetative growth characteristics of local orange transplants.

MATERIALS AND METHODS

The experiment was carried out in 2023 season of spring growth cycle in a special canopy in Al-Radwaniyah city, Baghdad Governorate to study effect of adding bacterial biofertilizer, buffalo organic fertilizer, and spraying moringa extract on growth and leaves mineral content of local orange transplants of two years old planted in plastic pots, as 108 are selected. A transplants of uniform in their vegetative growth , as far as possible, free of disease and insect infestations, study included addition of bacterial biofertilizer at four treatments: no addition (A_1), addition of *Stenotrophomonas maltophilia* bacteria (A_2) , addition of *Azospirillum brasilense* bacteria (A_3) and addition of both types of bacteria (A_4) and organic fertilizer (Decomposing buffalo manure) at three levels (0, 250 and 500 gm.soil^{-1}), which are denoted by B_0, B_1, and B_2, respectively and spray moringa extract at three levels (0, 20 and 40 gm.L^{-1}), which are denoted M_0, M_1, and M_2, respectively. Bacterial biofertilizer and buffalo organic fertilizer were added once during spring growth cycle in 15th January. Moringa leaves extract were sprayed five time period between one spraying and next is 15 days, as first spraying was done on 1st March and last spray was in 1st May of spring growth cycle. Treatments were replicated three times (one transplant per experimental unit) at factorial experiment in a RCBD and thus number of transplants used was 108.The results of study were statistically analyzed and averages were compared according to (L.S.D) at 0.05 according to **(Elsahookie & Wuhaib, 1990)**, The following parameters were determined in experimental season:

1. **Vegetative characteristics (Plant height, leaf area):** Plant height was measured by a metric tape from grafting area to plant top was calculated at end of spring growth cycle on 1/July/2023 then at end of autumn growth cycle on 20/December/2023 difference between them is increase in plant height. As for leaf area, leaf samples (5 leaves are fully developed) were taken from each experimental unit on 20 December 2023, and leaf area was calculated using Digimizer program.
2. **Leaf Mineral Content:** In 20 December 2023 samples of fife leaves are fully developed, were taken from each experimental, Leaves were washed with tap water, rinsed with distilled water, and then dried at 70 c^{o} until a constant weight, ground and digested according **(Chapman and Pratt, 1978)**. Nitrogen was estimated by micro-kjeldahl method of **(A.O.A.C, 1980)**. Phosphorus was estimate by using spectrophotometer by **(Estefan and Ryan, 2013)**.
3. **Yield characteristics** (number and weight of fruits): number of fruits for each experimental unit was calculated when the color of the fruits turns from green to orange, and weight of the fruits was calculated using a small scale.

RESULTS AND DISCUSSIONS

Effect of biofertilizer and buffaloes manure and moringa leaves extract spray in increasing of plant height and leaf area:

Tables (1-2) showed that experimental factors had a significant effect on studied vegetative traits, as treatment of adding two types of bacterial biofertilizers (A_4) excelled in giving it highest increase in plant height and leaf area of 26.78 cm and 37.94 cm^2 , respectively,

compared to control treatment (A_1). The organic fertilization treatment (B_2) also excelled in giving highest increase in plant height and leaf area of 32.22 cm, 40.78 cm^2 respectively, compared to control treatment (B_0). Moringa leaves extract spraying treatment (M_2) also excelled it gave highest values for studied traits of 22.89 cm and 36.36 cm^2 respectively,

compared to control treatment (M_0). As for twice interactions between experimental factors, they showed significant superiority in vegetative traits, as treatments (A_4B_2), (A_4M_2), and (B_2M2) excelled by giving them highest increase in plant height and leaf area of (39.22 cm, 44.19 cm^2) and (29.89 cm, 39.70 cm^2) and (34.50 cm, 42.80 cm^2) respectively. Triple interactions between study factors had a significant effect in these traits.

The results show that adding bacteria to pots soil had a positive effect on studied vegetative growth traits. Increase in vegetative traits may be attributed to effect of these bacteria in improving soil's biological and physical characteristics as well as its chemical properties, which resulted in release of larger amounts of soil nutrients available for absorption by roots and thus increased influence on physiological processes such as increasing efficiency of photosynthesis in leaves **(Yu *et al.*, 2014)** and increasing its products represented by carbohydrates, thus increasing vegetative growth of transplants. Reason may also be due to increased ability of these bacteria added to soil to produce plant growth regulators such as auxins, cytokinins, and gibberellins, as auxin produced from these organisms increases vegetative growth of transplants due to its role in increasing divisions and thus increasing transplants growth, as **(Hassan & Jumaa, 2013)** indicated spraying tangerine plants with tryptophan, which is initiating acid for building natural auxin (IAA), works to increase most of vegetative growth characteristics of transplants. Cytokinins resulting from these organisms added to soil also works to encourage buds formation on vegetative growths growing on transplants and to increase plant height, in addition to about vital role of cytokinin in reducing inhibitory effect of auxins present in lateral shoots, and then encouraging these shoots to grow, which works to improve vegetative characteristics. Therefore, it affects increase in vegetative growth of orange transplants **(Bhardwaj *et al.*, 2014).** These results are consistent with **(Al-Abbasi & Al-Zuhairi, 2018)** on Pomelo transplants.

Table (1): effect of adding biofertilizer, buffalo manure and moringa leaves extract spray and their interaction on increase in plant height (cm) of local orange transplants (**autumn season 2023**).

Biofertilizers (A)	Buffalo Manures (B)	Moringa Extract (M)			A × B
		M_0	M_1	M_2	
A_1	B_0	4.33	6.00	6.67	5.67
	B_1	10.00	16.00	16.33	14.11
	B_2	16.67	20.67	21.00	19.44
A_2	B_0	8.33	8.67	11.67	9.56
	B_1	12.33	23.33	25.00	20.22
	B_2	31.33	36.00	39.00	35.44
A_3	B_0	7.67	8.33	9.00	8.33
	B_1	19.67	21.00	21.67	20.78
	B_2	31.33	38.33	34.67	34.78
A_4	B_0	8.00	13.33	13.33	11.56
	B_1	26.67	29.00	33.00	29.56
	B_2	34.00	40.33	43.33	39.22
LSD 5%		3.91			2.26
A × M					**A**
A_1		10.33	14.22	14.67	13.07
A_2		17.33	22.67	25.22	21.74
A_3		19.56	22.56	21.78	21.30
A_4		22.89	27.56	29.89	26.78
LSD 5%		2.26			1.30
B × M					**B**
B_0		7.08	9.08	10.17	8.78
B_1		17.17	22.33	24.00	21.17
B_2		28.33	33.83	34.50	32.22
LSD 5%		1.95			1.13
M		17.53	21.75	22.89	
LSD 5%		1.13			

It was observed from results of Tables (1 and 2) an increase in vegetative growth indicators of orange transplants, reason for this increase may be due to role of organic manures in increasing proportion of elements in soil solution, which leads to an increase in cell expansion and division, which leads to an increase in leaves size and an increase in growth strength in trees, thus improving vegetative growth. In addition, participation of major elements, especially nitrogen, which contributes to building plant's vegetative system and representation of vital chlorophyll pigment, thus increasing leaves mineral content and increasing their area and other vegetative characteristics, in addition to role of these dissolved elements in soil solution and ready for absorption in formation of compounds and some components of the basic processes of photosynthesis and respiration, in addition to its contribution to synthesis and increase in activity of a large number of enzymes, which is reflected in increase in vegetative growth **(Zamzami *et al.*, 2023).**

Table (2): effect of adding biofertilizer, buffalo manure and moringa leaves extract spray and their interaction on leaf area (cm^2) of local orange transplant**s (autumn season 2023).**

Biofertilizers (A)	Buffalo Manures (B)	Moringa Extract (M)			A × B
		M_0	M_1	M_2	
A_1	B_0	26.97	25.78	28.79	27.18
	B_1	30.32	32.52	32.28	31.71
	B_2	32.65	32.84	33.49	32.99
A_2	B_0	27.33	31.15	32.18	30.22
	B_1	32.82	34.26	36.55	34.54
	B_2	41.06	44.23	44.95	43.41
A_3	B_0	28.49	29.56	30.75	29.60
	B_1	32.58	33.26	33.35	33.06
	B_2	40.22	42.49	44.84	42.52
A_4	B_0	30.49	31.42	32.00	31.30
	B_1	37.78	38.06	39.19	38.34
	B_2	42.47	42.19	47.91	44.19
LSD 5%		4.079			2.355
A × M					A
A_1		29.98	30.38	31.52	30.63
A_2		33.74	36.55	37.89	36.06
A_3		33.76	35.10	36.31	35.06
A_4		36.91	37.22	39.70	37.94
LSD 5%		2.355			1.360
B × M					B
B_0		28.32	29.48	30.93	29.58
B_1		33.38	34.52	35.34	34.41
B_2		39.10	40.44	42.80	40.78
LSD 5%		2.039			1.177
M		33.60	34.81	36.36	
LSD 5%		1.177			

The decomposition of organic manure in soil also leads to formation of organic acids such as humic and fulvic acids, and formation of natural chelates that contribute to release of potassium and other elements from soil elements in root system area. This release of elements increases with increase in release of organic acids produced by decomposing organic materials, as these increase in elements coincided with an increase in levels of buffalo waste, which indicates an effect of these levels (**Taha & Abood, 2018; Khalil, 2023).**

These results may be due to Moringa leaf extract containing plant hormone IAA and a number of amino acids, including Tryptophan, which is initiator in building natural auxin IAA, as latter works to increase vegetative growth due to its role in increasing divisions and thus its impact on growth. **(Hassan & Jumaa, 2013)** Indicated that spraying tangerine transplants with tryptophan increases most of vegetative growth characteristics. It is also due to fact that moringa leaf extract contains large amounts of zeatin, which natural cytokinin is found in plant.

Cytokinin works to encourage buds formation on vegetative growths growing on plants and increase his growth, in addition to vital role of cytokinin in reducing inhibitory effect of auxins present in buds then encouraged growing, which improves vegetative growth. The results are also attributed to fact that this extract contains some necessary nutritional elements, which may contribute to increasing plants vegetative growth (**Salman & Abdulrasool, 2022; Mohammed & Majeed, 2024)**. These results are consistent with what was found by **(Al-Sabbagh, 2020)** on orange transplants, **(Alghanim *et al*., 2023)** on apple trees.

Effect of biofertilizer and buffaloes' manure and moringa leaves extract spray in leaves nitrogen and phosphor content:

It was shown from Tables (3 and 4) that addition of bacterial biofertilizer had a significant effect in Leaf nitrogen and phosphorus content, as (A_4) treatment gave highest leaf content of 2.163% and 0.347%, for nitrogen and phosphor respectively compared to control treatment (A_1), and organic fertilization treatment (B2) also gave highest content of 2.470% and 0.399%, for nitrogen and phosphor respectively compared to control treatment (B_0). Moringa leaves extract spraying treatment (M_2) also excelled it gave highest leaf content of 2.236% and 0.364% for nitrogen and phosphor respectively, compared to (M_0) treatment. twice interaction treatments between study factors also showed a significant superiority in leaves content of N & P as the treatments (A_4B_2), (A_4M_2), and (B_2M_2) were they gave (2.645 % and 0.449%), (2.459 % and 0.405 %), and (2.595 and 0.461)%, for nitrogen and phosphor respectively. The triple interactions between study factors had a significant effect on leaves mineral content.

Table (3): effect of adding biofertilizer, buffalo manure and moringa leaves extract spray and their interaction on leaf nitrogen content (%) of local orange transplants **(autumn season 2023).**

Biofertilizers (A)	Buffalo Manures (B)	Moringa Extract (M)			A × B
		M_0	M_1	M_2	
A_1	B_0	1.170	1.363	1.410	1.314
	B_1	1.630	1.820	2.270	1.907
	B_2	1.870	2.340	2.410	2.207
A_2	B_0	1.720	2.060	1.610	1.797
	B_1	1.970	2.120	2.320	2.137
	B_2	2.510	2.570	2.590	2.557
A_3	B_0	1.690	1.760	1.950	1.800
	B_1	2.030	2.050	2.350	2.143
	B_2	2.380	2.480	2.550	2.470
A_4	B_0	1.970	2.060	2.040	2.023
	B_1	2.180	2.310	2.507	2.332
	B_2	2.460	2.645	2.830	2.645
LSD 5%		0.540			0.312
A × M					A
A_1		1.557	1.841	2.030	1.809
A_2		2.067	2.250	2.173	2.163

A_3	2.033	2.097	2.283	2.138
A_4	2.203	2.338	2.459	2.334
LSD 5%		0.312		0.180
B × M				**B**
B_0	1.637	1.811	1.752	1.734
B_1	1.952	2.075	2.362	2.130
B_2	2.305	2.509	2.595	2.470
LSD 5%		0.270		0.156
M	1.965	2.132	2.236	
LSD 5%		0.156		

As for increase in leaves mineral content as a result of adding bacteria, it is due to fact that adding these organisms to soil led to an increase in concentration of these elements in soil solution, thus increasing their readiness and thus increasing their absorption by plant roots and increasing their transport, thus increasing concentration of these elements in leaves. Many researchers have also confirmed that increasing element concentration in soil solution leads to increased absorption by plant **(Mosa *et al.*, 2018; Al-Silmawy & Abdul-Ratha, 2023)**. Adding these organisms to soil leads to an increase in leaves mineral content as a result of increased growth and photosynthesis efficiency by increasing plant height, leaf area (tables 1 and 2) and leaves chlorophyll content and increasing soil's content of these elements as a result of adding them to soil, which led to increased absorption **(Thakur, 2014)**. These results are consistent with **(Al-Hadethi *et al.*, 2017)** found on peaches, and with **(Mohamed & Massoud, 2017)** on oranges, as they found that adding this bacteria led to significant differences in leaf mineral content compared to not adding it.

As for effect of moringa leaf extract spray, tables (3 and 4) show that there is an increase in leaf mineral content in orange transplants, and that this increase may be due to this extract containing macronutrient, especially nitrogen and potassium, in addition to micronutrient, which are absorbed directly, especially when spray it on leaves and thus increase its percentage in plant.

Table (4): effect of adding biofertilizer, buffalo manure and moringa leaves extract spray and their interaction on leaf phosphor content (%) of local orange transplants **(autumn season 2023).**

Biofertilizers (A)	Buffalo Manures (B)	Moringa Extract (M)			A × B
		M_0	M_1	M_2	
A_1	B_0	0.245	0.225	0.225	0.231
	B_1	0.218	0.330	0.353	0.300
	B_2	0.355	0.385	0.445	0.395
A_2	B_0	0.234	0.253	0.297	0.261
	B_1	0.297	0.310	0.383	0.330
	B_2	0.322	0.385	0.430	0.379
	B_0	0.237	0.283	0.283	0.268

A_3	B_1	0.270	0.312	0.341	0.308
	B_2	0.350	0.379	0.395	0.374
A_4	B_0	0.250	0.262	0.287	0.266
	B_1	0.304	0.316	0.354	0.324
	B_2	0.345	0.429	0.575	0.449
LSD 5%			0.071		0.041
A × M					**A**
A_1		0.272	0.313	0.341	0.309
A_2		0.284	0.316	0.370	0.323
A_3		0.286	0.324	0.340	0.317
A_4		0.299	0.336	0.405	0.347
LSD 5%			0.041		0.023
B × M					**B**
B_0		0.241	0.256	0.273	0.256
B_1		0.272	0.317	0.358	0.316
B_2		0.343	0.394	0.461	0.399
LSD 5%			0.035		0.020
M		0.285	0.322	0.364	
LSD 5%			0.020		

Effect of biofertilizer and buffaloes manure and moringa leaves extract spray in increasing of number and weight of fruits:

Tables (5-6) showed that experimental factors had a significant effect on studied vegetative traits, as treatment of adding two types of bacterial biofertilizers (A_4) excelled in giving it highest number and weight of fruits of 3.04 fruit. plant^{-1} and 399.0 gm , respectively, compared to control treatment (A_1). The organic fertilization treatment (B_1) also excelled in giving highest number and weight of fruits of 3.39 fruit. plant^{-1} and 477.2 gm respectively, compared to control treatment (B_0). Moringa leaves extract spraying treatment (M_2) gave highest number for fruits of 2.75 fruit. plant^{-1} , while treatment (M_1) gave highest weight for fruits of 368.0 gm, compared to control treatment (M_0). As for twice interactions between experimental factors, they showed significant superiority in yieald traits, as treatments A_4B_1 (4.11 fruit. plant^{-1} and 522.2 gm) to number and weight of fruits, respectively, A_4M_2 (3.22 fruit. plant^{-1}), A_4M_1 (418.6 gm), B_1M_2 (3.75 fruit. plant^{-1}), B_1M_1 (497.3 gm). Triple interactions between study factors had a significant effect in these traits.

It is clear from the previous results that increasing the vegetative growth of the plant Tables (1 and 2) and increasing the content of the transplants leaves of mineral elements, especially nitrogen and phosphorus Tables (3 and 4), led to directing the plant towards fruiting, as increasing the percentage of phosphorus leads to the formation of flower buds and thus an increase in The number of fruits, and this is consistent with what he found **(Kumar *et al.*, 2021; Dawood *et al.*, 2023).**

Table (5): effect of adding biofertilizer, buffalo manure and moringa leaves extract spray and their interaction in number of fruits (fruit. plant^{-1}) of local orange transplants **(season 2023).**

Biofertilizers (A)	Buffalo Manures (B)	Moringa Extract (M)			A × B
		M_0	M_1	M_2	
A_1	B_0	0.67	1.33	1.00	1.00
	B_1	2.33	2.67	2.67	2.56
	B_2	1.33	1.67	2.00	1.67
A_2	B_0	1.33	2.00	2.33	1.89
	B_1	2.67	3.67	4.00	3.44
	B_2	1.67	2.67	2.67	2.33
A_3	B_0	1.33	1.67	2.00	1.67
	B_1	2.67	3.67	4.00	3.44
	B_2	1.67	2.33	2.67	2.22
A_4	B_0	1.67	2.00	2.33	2.00
	B_1	3.67	4.33	4.33	4.11
	B_2	3.00	3.00	3.00	3.00
LSD 5%		2.288			1.321
A × M					A
A_1		1.44	1.89	1.89	1.74
A_2		1.89	2.78	3.00	2.56
A_3		1.89	2.56	2.89	2.44
A_4		2.78	3.11	3.22	3.04
LSD 5%		1.321			0.763
B × M					B
B_0		1.25	1.75	1.92	1.64
B_1		2.83	3.58	3.75	3.39
B_2		1.92	2.42	2.58	2.31
LSD 5%		1.144			0.660
M		2.00	2.58	2.75	
LSD 5%		0.660			

Table (6): effect of adding biofertilizer, buffalo manure and moringa leaves extract spray and their interaction in weight of fruits (gm) of local orange transplants **(season 2023).**

Biofertilizers (A)	Buffalo Manures (B)	Moringa Extract (M)			A × B
		M_0	M_1	M_2	
A_1	B_0	91.00	181.0	140.3	137.4
	B_1	324.6	425.0	310.3	353.3
	B_2	209.0	259.6	329.0	265.8
A_2	B_0	191.3	360.0	292.6	281.3
	B_1	334.6	437.6	531.3	434.5
	B_2	252.6	367.3	401.6	304.5
A_3	B_0	191.3	227.6	183.0	200.6
	B_1	391.3	582.3	462.6	478.7
	B_2	318.3	320.3	372.6	337.1
A_4	B_0	220.0	352.0	331.0	301.1

	B_1	511.6	544.3	510.6	522.2
	B_2	396.3	359.3	365.6	373.7
LSD 5%			7.356		4.247
A × M					**A**
A_1		208.2	288.5	259.8	252.2
A_2		259.5	388.3	408.5	352.1
A_3		300.3	376.7	339.4	338.8
A_4		376.0	418.6	402.4	399.0
LSD 5%			4.247		2.452
B × M					**B**
B_0		173.4	280.2	236.7	230.1
B_1		390.5	497.3	453.7	477.2
B_2		294.0	326.6	367.2	329.3
LSD 5%			3.678		2.124
M		286.0	368.0	352.5	
LSD 5%			2.124		

REFERENCES

1. A.O.A.C. 1980. Official Methods of Analysis. 13th. Ed. Association of Official Analytical Chemists. Washington, D.C.
2. Al-Abbasi, Gh. B.A and F.F, Al-Zuhairi.2018. Effect of bio and organic fertilization on the growth of Pomelo seedlings Citrus grandis L. grafted on different rootstocks. Kufa Journal of Agricultural Science. 10(2):39-61.
3. Alghanim, F.S.R; Mustafa. E.A, Al-Hadethi and A, Yavic A .2023. Response of apple trees performance to moringa extract, humic acid, and liquid organic fertilizers (Vit-Org). J. Plant Prod. Mansoura Univ.14 (6):313-317.
4. Al-Hadethi, M. E. A. 2019. Response of hawthorn transplants to biofertilizers and poultry manure. Iraqi Journal of Agricultural Sciences, 50(2): 734-740.
5. Al-Hadethi, Mustafa E.A; Ali S.T. AL-Dulaimi and B.M.K. Almashhadani. 2017. Influence of biofertilizers on growth and leaf mineral content in Peach transplants. IOSR Journal of Agriculture and Veterinary Science. 10(9):90-93.
6. Al-Hadethi, Mustafa E.A; Fadia H. Taha and Shamil M. Abbood. 2020. Effect of compost prepared from plant residues on olive transplants growth. International Journal of Agricultural and Statistical Sciences. 16 (Supplement 1): 1385-1389.
7. Al-Hayani, M.A.M and M. E. A. Al-Hadethi. 2023. Effect of amino acids addition and spraying with glutathione and kaolin in growth apricot transplants. IOP Conference Series: Earth and Environmental Science. 1262(4), 042025.
8. Al-Sabbagh, M.N.A. 2020. Effect of some natural extracts and nutrients on growth and natural status of Washington Navel orange transplants. M. Sc. Thesis, faculty of Agriculture. Benha University, Egypt.
9. Al-Silmawy, N.J.K and H.A. Abdul-Ratha. 2023. Effect of biofertilizer, Vermicompost and phosphate fertilizer on growth and yield of cauliflower (Brassica *oleraceae* Var.botrytis). Iraqi Journal of Agricultural Sciences .54(2):505-515.

10. Asghari, B., R. Khademian and B.Sedaghati. 2020. Plant growth promoting rhizobacteria (PGPR) confer drought resistance and stimulate biosynthesis of secondary metabolites in pennyroyal (*Mentha pulegium* L.) under water shortage condition. Scientia Horticulturae. 263: 109-132.
11. Bal, J.S. 2005. Fruit Growing. 3td edt. Kalyani Publishers, New Delhi-110002.
12. Bashiri, Z and B, Imad. 2023. A theoretical study on Citrus (Agrume). M. Sc. Thesis, College of Natural and Life Sciences. Constantine Mentouri Brotherhood University. People's Democratic Republic of Algeria.
13. Bhardwaj, D; M.W, Ansari; R.K, Sahoo and N, Tuteja. 2014. Biofertilizers function as key player in sustainable agriculture by improving soil fertility, plant tolerance and crop productivity. Microb. Cell Fact. 13:66.
14. Bulgari, R; G, Franzoni and A, Ferrante. 2019. Biostimulants application in horticultural crops under abiotic stress conditions. Agronomy. 9(306):1-30.
15. Chapman, H,D. and P. E, Pratt. 1978. Methods of Analysis for Soils, Plants, and Waters. First Edition. Univ. of Calif., Div. Agric. Sci., Priced Pub., 4034.pp.
16. Dawood, A., Majeed, A., Ul-Allah, S., Naveed, M., Farooq, S., Sarwar, N., & Hussain, M. 2023. Combined Application of Organic and Inorganic Nitrogen and Seed Inoculation with Rhizobacteria (Stenotrophomonas maltophilia FA-9) Improved Productivity, Nitrogen Use Efficiency, and Economic Returns of Pearl Millet. *Sustainability*, *15*(10):1-22.
17. Elsahookie,M.M and K.M, Wuhaib. 1990. Design and Analysis of experiments. First Edition. Dar al hekma.Univ. Of Bagh. pp.488.
18. Estefan, G; R.Sommer and J.Ryan. 2013. Methods of soil, plants and water analysis, ICARDA, International for Agriculture Research in the dry areas, third edition. www.icarda.org.
19. Hamid, B., Bashir, Z. 2019. Potassium solubilizing microorganisms: an alternative technology to chemical fertilizers, J. Res. Dev. 19: 79–84.
20. Hashash, E and B,Ruqaya. 2022. Extensive biological study of citrus Agrume, *Citrus limon*. M. Sc. Thesis, College of Natural and Life Sciences. Constantine Mentouri Brotherhood University. People's Democratic Republic of Algeria.
21. Hassan, A.M and F.F, Jumaa. 2013. Effect of pruning and some growth stimulators on vegetative growth of Mandarine transplants, cv. Clementine. Euphrates Journal of Agricultural Science. 5(4):244-255.
22. Irshad, M; A. E. Eneji ; Z. Hussain and M. Ashraf.2013. Chemical characterization of fresh and composted livestock manures. Journal of Soil Science and Plant Nutrition. 13(1):115-121.
23. Khalil, N.H. 2023. The effect of organic fertilization on leaf mineral content of three citrus species. IOP Conf. Ser.: Earth Environ. Sci. 1158 .042049
24. Kumar, Munish Renu, R.K. Pathak, Sarvesh Kumar, Durgesh Kumar and Mohd Shahid. 2021. Integrated Nutrient Management In Mungbean (Vigna Radiata L.) Through Npk And Biofertilizers. International Journal Of Community Science And Technology, 4(1) :30-37.
25. Latif, M.T.A.; Abood, M.R. 2023. Response of Three Citrus Rootstocks to Organic and Biological Fertilizers. Revis Bionatura;8 (2): 1-9.

26. Menaka, M., Chandana, M. R., & Brunda, N. B.2023. Biofertilizers: A Novel Approach for Sustainable Fruit Production. the Science World, 3(5):860-863.
27. Mohamed, S.A and O.N, Massoud. 2017. Impact of inoculation with Mycorrhiza and Azotobacter under different N and P rates on growth, nutrient status, yield and some soil characteristics of Washington Navel orange trees. Middle East Journal of Agriculture Research. 6(3): 617-638.
28. Mohammed, R. R., & Majeed, B. H. 2023. Effect of moringa leaves extract, calcium, and Potassium silicate on the growth, yield, and quality of strawberry fruits. Iraqi Journal of Agricultural Sciences, 54(6), 1703-1715.
29. Mohammed, R. R., & Majeed, B. H. 2024. Response of strawberry growth, yield and marketable fruit quality to spraying with moringa leaf extract, calcium and potassium silicate. Iraqi Journal of Agricultural Sciences .55(1):440-452.
30. Mosa, W.F.A; L. S, Paszt; M, Frąc; P, Trzciński; W, Treder and K, Klamkowski. 2018. The role of biofertilizers in improving vegetative growth, yield and fruit quality of apple. Hort. Sci. (Prague). 45(4): 173-180.
31. Muthusamy, Y., Sengodan, K., Arthanari, M., Kandhasamy, R., & Gobianand, K. 2023. Biofertilizer and Consortium Development: An Updated Review. Current Agriculture Research Journal, 11(1):1-17 .
32. Nardi, S.; D, Pizzeghello; M, Schiavon and A, Ertani. 2016. Plant biostimulants: physiological responses induced by protein hydrolyzed based products and humic substances in plant metabolism. Scientia Agricola. 73(1):18-23.
33. Patra, A. K., K. N. Mishra,L. M. Garnayak and A. K. Mohanty. 2017. Influence of long-term organic nutrient management on soil quality and crop productivity in rice (*Oryza sativa*)-potato (*Solanum tuberosum* L.)-okra (*Abelmoschus esculentus*) cropping system under irrigated condition. Indian Journal of Agronomy, 62: 268-274.
34. Salman, A.D and I. J. Abdulrasool. 2022. Effect of ozone enrichment and spraying with coconut water and moringa extract on vegetative growth and yield of broccoli plant under hydroponic system with modified NFT technology. Iraqi Journal of Agricultural Sciences .53(2):406-414.
35. Shah, N.C. 2014. Citrus fruits in India. 33 the SciTech journal, 1 (12).
36. Singh, R.P., Pandey, D.M., Jha, P.N. and Ma, Y. 2022. ACC deaminize producing rhizobacterium Enterobacter cloacae ZNP-4 enhance abiotic stress tolerance in wheat plant. PLoS ONE 17(5), e0267127. DOI: 10.1371/journal.pone.0267127.
37. Taha, F.H and M.R, Abood. 2018. Influence of organic fertilizer on date palm CV. Barhi 2. Leaves mineral content. Iraqi Journal of Agricultural Sciences. 49(3): 372-376.
38. Thakur, K. 2014. Effect of bioregulators and plant growth promoting rhizobacteria on growth, yield and quality of apricot (Prunus armeniaca L.) cv. New Castle. M.Sc. Thesis. College of Horticulture. Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni. India.
39. Wang, X.H., Li, Q., Sui, J.K., Zhang, J.M., Liu, Z.Y. et al. 2019. Isolation and characterization of antagonistic bacteria paenibacillus jamilae HS-26 and their effects on plant growth. Biomed Research International 2019, 3638926. DOI: 10.1155/2019/3638926.

40. Yu, Xuan; Xu Liu and Tian-hui Zhu. 2014. Walnut growth and soil quality after inoculating soil containing rock phosphate with phosphate-solubilizing bacteria. Science Asia. 40(1): 21-27.
41. Zamzami, A; Rev. Puri I. W; Angga Jawi A; Herlinda Putri U and Desy Cahya W. 2023. The effectiveness of organic fertilizers of chicken, cow and sheep manure against the growth of cabbage, caisim, chicory plants vegetatively. Proceeding International Conference on Religion, Science and Education. 2: 591-596.