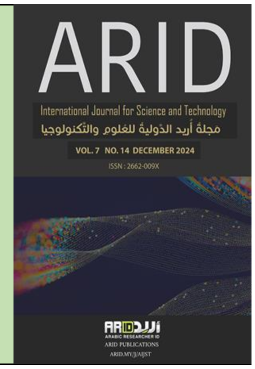
المحفل العلمي الدولي

ARID Journals

ARID International Journal for Science and Technology (AIJST)
ISSN: 2662-009X

Journal home page: http://arid.my/j/aijst



مَجلةُ أُريد الدَّوليةُ للعُلومِ والتِّكنولوجيا

المجلد 7 ، العدد 14 ،كانون الأول 2024 م

Effect of Fertilization NPK-Nano and Humic Acid on Some Vegetative Growth Characteristics and Mineral Content of Apple Seedlings (*Malus Domestica*) *Cv. Ibrahimi.*

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تأثير سماد NPK النانوي وحامض الهيوميك في بعض صفات النمو الخضري والمحتوى المعدني لشتلات التفاح صنف إبراهيمي

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arid.my/0004-1659
https://doi.org/10.36772/arid.aijst.2024.7142

ARTICLE INFO
Article history:
Received 17/08/2024
Received in revised form 22/09/2024
Accepted 10/11/2024
Available online 15/12/2024
https://doi.org/10.36772/arid.aijst.2024.7142

ABSTRACT

The research was carried out in lathhouse on one-year-old apple seedlings of the Ibrahimi variety in the Karma-Fallujah region for the 2021 growing season to study the effect of methods of adding nano-fertilizer and humic acid on seedling growth. A two-factor experiment was designed according to a randomized complete block design, with three replicates and two seedlings per experimental unit, so the number of seedlings was 54. The first factor includes NPK nanofertilizer at three levels (0- and 2-ml L^{-1} foliar spray and 5 ml L^{-1} soil application). The second factor is humic acid at three levels (0 and 5 g of seedlings $^{-1}$ foliar spray and 10 g of seedlings $^{-1}$ soil application). The results of the study show that the NPK nano-fertilizer and the method of adding caused a significant effect on most of the studied traits. The treatment with a concentration of (5 ml L^{-1} soil application) gave the highest rate for the trait, Plant height, number of leaves, and number of branches. As for humic acid and the procedure of adding it, the treatment with a concentration of (10 g seedlings - 1 soil application) gave the highest rate for number of leaves, number of branches and the chlorophyll total phenols content of the leaves. The results show that the interaction between the levels of nano-NPK and humic acid had a significant effect in increasing the rates of the measured traits, the treatment with 5 ml L^{-1} of the soil application NPK nanoparticles and 5 g of seedlings-1 foliar spraying of humic acid achieved the highest rate in some measured traits, including, chorophyll and total phenols content of the leaves. The Means of the coefficients were compared according to the L.S.D. test at a probability level of 0.05.

Keywords: apple, humic acid, nano-NPK, total phenols, Cv. Ibrahimi

الملخص

نفذ البحث في ظلة خشبية على شتلات التفاح صنف الإبراهيمي بعمر سنة في منطقة الكرمة - الفلوجة لموسم النمو 2021 لدراسة تأثير طرق الإضافة للسماد النانوي وحامض الهيومك في نمو الشتلات. صممت تجربة عامليه بعاملين على وفق تصميم القطاعات الكاملة المعشاة وبثلاثة مكررات وشتلتين للوحدة التجريبية الواحدة، وبذلك يكون عدد الشتلات 54 شتلة، حيث تضمن العامل الأول سماد NPK النانوي وبثلاثة مستويات (0 و 2مل لتر$^{-1}$ رش ورقي و 5مل لتر$^{-1}$ إضافة أرضية) والعامل الثاني حامض الهيومك بثلاثة مستويات (0 و 5غم شتله $^{-1}$ رش ورقي و10غم شتلة$^{-1}$ إضافة أرضية). بينت نتائج الدراسة أن سماد NPK النانوي وطريقة إضافته تأثيراً معنوياً لمعظم الصفات المدروسة فقد أعطت المعاملة بتركيز (5مل لتر$^{-1}$ إضافة أرضية) أعلى معدل لصفة ارتفاع النبات، عدد الأوراق، عدد الأفرع. أما بالنسبة لحامض الهيومك وطريقة إضافته فقد أعطت المعاملة بتركيز (10غم شتلة$^{-1}$ إضافة أرضية) أعلى معدل لصفة عدد الأوراق، عدد الأفرع ، محتوى الأوراق من الكلوروفيل والفينولات الكلية. وقد أظهرت النتائج أن التداخل بين مستويات NPK النانوي وحامض الهيومك تأثيراً معنوياً في زيادة معدلات الصفات المقاسة، وقد حققت المعاملة 5مل لتر$^{-1}$ الإضافة الأرضية NPK النانوي مع 5 غم شتلة$^{-1}$ الرش الورقي لحامض الهيومك أعلى معدل في بعض الصفات المقاسة منها محتوى الأوراق من الكوروفيل والفينولات الكلية. وقورنت متوسطات المعاملات حسب اختبار L.S.D وبمستوى احتمال 0.05 .

الكلمات المفتاحية: التفاح، حامض الهيوميك، NPK النانوي، الفينولات الكلية، صنف إبراهيمي

1. Introduction

Apple fruits *Malus domestica* have great economic importance, especially in countries with high productivity, as they constitute an essential financial resource in exporting countries due to the ability of the fruits to be transported and stored for a long time. Apple fruits are rich in pectin and contain many vitamins, proteins, and carbohydrates [1]. Agricultural systems in many countries are facing significant challenges, including the deterioration of farm soils and plant nutrition in fruit orchards due to contamination from chemical fertilizer leftovers. For the growth and production of trees, it is crucial to have balanced nutrient quantities that meet the requirements of tree growth. Researchers have sought ways to increase fertilizer efficiency and reduce loss and pollution. Nanotechnology has become helpful in developing the agricultural domain, especially fertilization. An alternative to conventional fertilizers is nano-fertilizer because they reduce the chemical fertilizer amounts used and increase its absorption speed by the plant, thus increasing the amount of the nutrients stored within the plant for a more extended period, as well as improving the quality of crops, ensure their sustainability, and increasing productivity [2]. Nano-fertilizers act uniquely due to their high property of increasing absorption through the leaves as a result of the small size of their particles and being available to the plant, leading to an increase in photosynthesis, thus stimulating plant growth, provided that adding them in low concentrations, appropriate for the plant [3] [4] [5].

Humic acid is a humic substance created by decomposing organic matter in soil. It comprises a group of compounds with high molecular weights, and it helps transport nutrients from the soil to plants. Humic acid also has numerous benefits for soil quality. It can loosen the soil, break down clay particles, and increase the soil's water retention capacity. These improvements improve soil's physical, chemical, biological, and nutritional characteristics, ultimately benefiting plant growth. [6]. Humic acids are valuable, representing a reserve source of plant nutrients, especially nitrogen. Humus is, by its nature, a porous substance with little cohesion and adhesiveness compared to mineral colloids. It can retain water and thus swell and shrink due to the physical and chemical nature of the compounds involved in its composition. [7].

Much research has been conducted to study the effect of nano-NPK and humic acid on plant growth. [8] explained that adding nano-NPK fertilizer at 4g.L^{-1} increased the leaf dry weight and leaf chlorophyll and peroxidase content. [9] reported that using humic acid on seedlings at a concentration of 200 ml. L^{-1} significantly increased vegetative growth traits (seedling length, stem diameter, number of branches. seedling^{-1}, number of leaves, chlorophyll. seedling^{-1}, and leaf area). It also significantly increased the leaves' nutritional element content (N, P, K, and B) [10], also found that adding humic acid to strawberry plants significantly increased the number of flowers, set percentage, number of fruits, fruit weight, and plant yield. [11] found that adding organic fertilizers exhibited a significant superiority in most of the studied traits compared to the control treatment. [12] found that using NPK fertilizer at a concentration of 1.5 g.l and humic acid at a concentration of 40 g.m. tree resulted in a significant increase in the vegetative growth characteristics of trees of Date Palm. According to previous studies, the research aimed to increase the vegetative growth of apple seedlings affected by the nano-fertilizer and humic acid applied as a foliar spray or added to the soil and determine the most appropriate application method.

2. **Materials and methods**

The research was conducted in lathhouse on one-year-old apple seedlings, variety Al-Ibrahimi, (Restaurant on the origin of quince) in Karma - Fallujah region in 2021 to study the importance of nano-fertilizer and humic acid in increasing the growth of apple seedlings based on the methods of application. The experiment involved two factors. The first factor was NPK nano-fertilizer applied at three levels (0 without addition and 2 ml L^{-1} foliar spray and 5 ml L^{-1} soil application), symbolized by N0, NF, and NS. The second factor was humic acid applied at three levels (0 without addition and 5 g of seedlings $^{-1}$ foliar spray and 10 g of seedlings $^{-1}$ soil application), symbolized by H0, HF, and HS. The experiment was designed as a factorial of two factors according to the randomized complete block design (RCBD), involving three replicates where two seedlings represented each experimental unit. Hence, the number of seedlings was 54.

Studied traits:

2.1.Main stem height (cm):

The main stems of all seedlings were standardized by pruning them at the beginning of the experiment, and at the end of the growing season (1/ December), the main stem height was measured.

2.2.Mean number of leaves (leaves. seedling^{-1}):

The number of leaves in the experimental unit was calculated at the end of the experiment and divided by the number of plants to calculate the mean.

2.3.Mean number of main branches (branch. Seedling^{-1}):

The number of branches of seedlings was standardized at the beginning of the season, and the number of new branches formed on the main stem was calculated.

2.4.Chlorophyll content in the leaves (mg.100g fresh weight^{-1}):

Chlorophyll content was calculated using a spectrophotometer. After 24 hours soaked in leaf acetone and then centrifuged for 5 minutes, 15,000 g. The supernatant was taken 100 l and put into 96-well plates. The absorption was measured using Thermo Scientific Multiskan GO 3.2 Spectrophotometry at two wavelengths 646 and 663 nm. Chlorophyll a, b, and total chlorophyll, were calculated according to [13]

A. Chlorophyll a (µg/mL) = -1.93 A646 + 11.93 A663

Chlorophyll b (µg/mL) = 20.36 A646 – 5.50 A663

Total chlorophyll (µg/mL) = 6.43 A663 + 18.43 A646

B. Chlorophyll a (µg/mL) = 12.7 A663 – 2.69 A645

Chlorophyll b (µg/mL) = 22.9 A645 – 4.68 A663

Total chlorophyll (µg/mL) = 20.2 A645 + 8.02 A663

The concentration of chlorophyll content was obtained after substitution of absorbance for each wavelength in the equation. The result is expressed in mg.100g fresh weight^{-1}

2.5.Macronutrients in leaves:

The samples were dried using a German-made electric oven, Memmert type, at 70°C until the weight was constant. The leaf samples were ground using a hand mill. A known weight was taken from the ground sample, and it was digested using the wet digestion method using concentrated sulfuric acid H2SO4 and perchloric acid HClO4.

The following macronutrients were estimated:

1-Nitrogen, estimated using the Microkijldahl device [14].

2-Phosphorus: using the Spectrophotometer as explained in [15]

3-Potassium: using the Flame photometer as mentioned in [16]

2.6.*Total phenolic compounds concentration (mg. g^{-1} dry weight):*

Total phenolics in the leaves were estimated using the Folin-Ciocalteau method [17] by weighing 1 g of dried and ground leaves. 10 ml of 80% methanol solution containing 1% HCL acid at room temperature was added. The samples were then centrifuged, after which 200 microliters of the extract were taken and 1.5 ml of Folin-Ciocalteau reagent diluted with distilled water was added. Then 1.5 ml of sodium carbonate solution was added, which was prepared by dissolving 60 g. L-1 of distilled water. The absorbance was then read using a spectrophotometer at a wavelength of 765 nm. Gallic acid was used as a standard criterion to determine the concentration of total phenolics in plant samples.

3. Results and Discussion

3.1. Main stem height Mean (cm)

Table 1 shows that the nano-fertilizer (NPK) and the method of application significantly affected the main stem height, as adding the fertilizer to the soil (NS) was significantly distinguished, producing the highest stem, averaging 156.89 cm, compared to the spray treatment (NF) which came at the second rank, and finally the of no adding (N0), recording the lowest Mean of the main stem height. It is also noticed from the same table that humic acid and the method of applying caused a significant effect in increasing stem height, as the foliar spray treatment (HF) exhibited the highest stem Mean 153.44 cm, compared to the treatment without adding (H0). Concerning the interaction between the two factors, the interaction treatment between adding the nano-NPK to the soil and the foliar spray of humic acid (NSHF) displayed the highest Mean of the main stem height reached 164.67cm compared to the treatment without adding nor spray (N0H0).

Table (1): Effect of the nano-NPK and humic acid on the main stem height Mean (cm) of the apple seedlings

Nano-NPK (N)	Humic acid (H)			Mean (N)
	H0	HF	HS	
N0	138.33	147.33	147.00	144.22
NF	145.67	148.33	150.67	148.22
NS	150.33	164.67	155.67	156.89
LSD 5%	3.27			1.88
Mean (H)	144.78	153.44	151.11	
LSD 5%	1.88			

3.2. Mean number of leaves (leaves. seedling^{-1})

Results in Table 2 show that nano-NPK fertilizer and its applied method significantly impacted the number of leaves. The treatment of soil application (NS) was superior, producing the highest Mean number of leaves amounted 302.8 (leaves. seedling^{-1}) however, it did not differ significantly from the treatment of foliar spray (NF). The table also illustrates that humic acid, and its application method significantly affected the Mean number of leaves. The treatment of soil application (HS) was superior, achieving the highest number of leaves amounted 292.4 (leaves. seedling^{-1}) and it did not differ significantly differed from the treatment of foliar spray (HF). As for the interaction between the two factors, the treatment of soil application the nano-NPK and foliar spray humic acid (NSHF) significantly superior achieved the highest Mean number of leaves and it did not differ significantly differed from the treatment (NSHS) of compared to the control treatment (N0H0).

Table (2): Effect of the nano-NPK and humic acid on the Mean number of leaves (leaves. seedling^{-1}) of the apple seedlings

Nano-NPK (N)	Humic acid (H)			Mean (N)
	H0	HF	HS	
N0	243.0	252.7	274.0	256.6
NF	293.3	299.3	299.3	297.3
NS	294.3	310.0	304.0	302.8
LSD 5%	14.55			8.40
Mean (H)	276.9	287.3	292.4	
LSD 5%	8.40			

3.3. Mean number of the main branches (branches. seedling^{-1})

It is clear from Table 3 that the nano-fertilizer (NPK) and the method of its application had a significant effect on the Mean number of branches. The soil application (NS) was superior, producing the highest Mean number of branches amounted 27.89 (branches. seedling^{-1}). It varied significantly from the treatment of the foliar spray (NF), while the treatment of control (N0) produced the lowest Mean number of branches. It can be seen in the same table that humic acid and the method of application significantly affected the Mean number of branches, as the soil application treatment (HS) achieved the highest number Mean of branches amounted 24.11 (branches.seedling^{-1}) and was significantly different from the treatment the foliar spray (HF). Concerning the interaction, the interaction treatment of adding nano-NPK to the soil and the foliar spray of humic acid (NSHF) produced the highest Mean number of branches compared to the control treatment (N0H0).

Table (3): Effect of the nano-NPK and humic acid on the Mean number of branches (branches. seedling^{-1}) of the apple seedlings

Nano-NPK (N)	Humic acid (H)			Mean (N)
	H0	HF	HS	
N0	10.67	14.00	17.00	13.89
NF	21.00	24.33	27.0	24.11
NS	25.67	29.67	28.33	27.89
LSD 5%	2.61			1.50
Mean (H)	19.11	22.67	24.11	
LSD 5%	1.50			

3.4. Chlorophyll content in the leaves (mg. g^{-1}fresh weight)

It is clear from Table 4 that NPK fertilizer and the method of its adding had a significant effect on the chlorophyll content in the leaves. The soil application treatment (NS) exhibited the highest Mean chlorophyll content amounted 276.7 (mg. g^{-1}fresh weight), which did not differ significantly from the treatment of foliar spray (NF) and the control treatment (N0), which recorded the lowest chlorophyll content on Mean. It is also noticed from the mentioned table that fertilizing with humic acid and the method of its application had a significant effect in increasing the chlorophyll content of the leaves. The treatment of adding to the soil (HS) recorded the highest chlorophyll Mean amounted 266.0 (mg.g^{-1}fresh weight) , compared to the control treatment (H0Regarding the interaction effect, the treatment of soil application of NPK and humic acid to the soil (NSHS) recorded the highest Mean of chlorophyll content amounted 282.3 (mg.g^{-1}fresh weight), which differ insignificantly from the (NSHF) treatment, compared to the control treatment (N0H0).

Table (4): Effect of the nano-NPK and humic acid on the Chlorophyll content in the leaves (mg. g^{-1}fresh weight) of the apple seedlings

Nano-NPK (N)	Humic acid (H)			Mean (N)
	H0	HF	HS	
N0	204.9	217.2	241.7	221.3
NF	258.5	271.5	274.2	268.1
NS	267.5	280.2	282.3	276.7
LSD 5%	26.55			9.55
Mean (H)	243.6	256.3	266.0	
LSD 5%	9.55			

3.5. Leaf nitrogen content (%)

Results in Table 5 demonstrate that NPK fertilizer and the method of its application significantly affected the trait through increasing the nitrogen content in the leaves, as the soil-adding treatment (NS), which recorded the highest Mean amounted 1.79(%) , but did not varied significantly from the treatment (NF) 1.70 (%) and comparison to the control (N0) which recorded lowest nitrogen content in seedling leaves. It is also noticed from the same table that humic acid fertilizer and the method of its adding had a significant effect in increasing the nitrogen content in the leaves, as humic acid added to the soil (HS) recorded the highest nitrogen content Mean in the leaves amounted 1.72(%) , but did not varied significantly from the treatment (HF) 1.70 (%) comparison the treatment of without adding (H0). As for the interaction between the two factors, the treatment of adding NPK and humic acid to the soil (NSHS) achieved the highest nitrogen content Mean in the leaves amounted 1.84(%), but did not vary significantly from the treatment NSHF, In comparison to the treatment control (N0H0).

Table (5): Effect of the nano-NPK and humic acid on the nitrogen content (%) in the leaves of the apple seedlings

Nano-NPK (N)	Humic acid (H)			Mean (N)
	H0	HF	HS	
N0	1.52	1.59	1.60	1.57
NF	1.64	1.73	1.72	1.70
NS	1.72	1.82	1.84	1.79
LSD 5%	0.05			0.03
Mean (H)	1.63	1.71	1.72	
LSD 5%	0.03			

3.6. Leaf phosphorus content (%)

Table 6 reveals that the NPK fertilizer and the method of its addition significantly affected the phosphorus content in the leaves, as the treatment of adding it to the soil (NS) displayed the highest phosphorus content Mean a mounted 0.62 %, while the N0 treatment recorded the lowest content Mean of phosphorus. From the table, it was recorded that humic acid fertilizer, and the method of its adding had a significant effect in increasing the phosphorus content of the leaves, as the foliar spray (HF) resulted in the highest phosphorus content amounted 0.58%, which did not differnt significantly from the treatment of adding it to the soil (HS). but H0 treatment, recording the lowest value of phosphorus content. The interaction effect between the two studied factors also significant on this trait. The treatment adding NPK and spraying the humic acid (NSHF) exhibited the highest phosphorus content in the seedling leaves 0.69%, compared to the control treatment (N0H0); nevertheless, did not different significantly from the treatment between NSHF and NSHS.

Table (6): Effect of the nano-NPK and humic acid on the phosphorus content (%) in the leaves of the apple seedlings

Nano-NPK (N)	Humic acid (H)			Mean (N)
	H0	HF	HS	
N0	0.38	0.45	0.48	0.44
NF	0.59	0.61	0.53	0.57
NS	0.53	0.69	0.65	0.62
LSD 5%	0.07			0.04
Mean (H)	0.50	0.58	0.55	
LSD 5%	0.04			

3.7. Leaf potassium content (%)

Table 7 shows that the NPK nano-fertilizer and the method by which it was applied had a significant impact in increasing the leaf potassium content, as the treatment NS was characterized by showing the highest Mean of the trait 1.77%, differing significantly from the foliar spray treatment (NF), while the treatment N0 recorded the lowest Mean of potassium content in the seedling leaves. It is also apparent in the same table that humic acid and its application method significantly affected the Mean potassium content in the leaves, as the treatment of adding it to the soil (HS) achieved the highest potassium content Mean 1.75%, which was significantly outperformed the foliar spray treatment (HF). In contrast, the treatment without addition displayed the lowest potassium content in the seedling leaves. Concerning the interaction between the studied factors, the treatment of adding nano-NPK to the soil and foliar spray of the humic acid (NSHF) was superior, achieving the highest potassium content Mean amounted 1.80, compared to the control (N0H0), which recorded the lowest Mean of the potassium content in the apple seedling leaves.

Table (7): Effect of the nano-NPK and humic acid on the potassium content (%) in the leaves of the seedlings

Nano-NPK (N)	Humic acid (H)			Mean (N)
	H0	HF	HS	
N0	1.62	1.64	1.69	1.65
NF	1.74	1.74	1.76	1.75
NS	1.73	1.80	1.79	1.77
LSD 5%	0.02			0.01
Mean (H)	1.69	1.73	1.75	
LSD 5%	0.01			

3.8. Total phenolic compounds content (mg. g^{-1} dry weight)

Table 8 illustrates that the nano-NPK fertilizer and the way it was applied significantly increased the total concentration of the phenolic compounds contained in the apple seedling leaves. The treatment NS was superior, producing the highest phenolic compound concentration amounted 8.58(mg. g^{-1} dry weight), did not differing significantly from the foliar spray (NF) treatment. In contrast, N0 recorded the lowest concentration of the total phenolic compounds on Mean. The same table also shows that the humic acid and its application method significantly affected the concentration of total phenolic compounds in the leaves, increasing it in the seedling leaves treated with adding the humic acid to the soil (HS), producing the highest Mean of the phenolic compound concentration amounted8.27(mg.g^{-1} dry weight) ; however this treatment did not differ significantly from the treatment of foliar spray (HF), while the treatment of without addition revealed a lower concentration of total phenolic compounds in the apple seedling leaves. Regarding the binary interaction, the interaction treatment of adding the nano-NPK and foliar spray of humic acid (NSHF) produced the highest concentration of total phenolic compounds amounted 9.16, compared to the control treatment (N0H0), yet it differs insignificantly from the NSHS.

Table (8): Effect of the nano-NPK and humic acid on the phenolic compound's concentration (mg. g-1 dry weight) in the leaves of the seedlings

Nano-NPK (N)	Humic acid (H)			Mean (N)
	H0	HF	HS	
N0	5.43	6.23	7.43	6.36
NF	7.93	8.23	8.46	8.21
NS	7.66	9.16	8.93	8.58
LSD 5%	0.74			0.43
Mean (H)	7.01	7.87	8.27	
LSD 5%	0.43			

Through studying data related to vegetative growth and chemical characteristics, it was found that NPK nano-fertilizer has a significant effect in increasing the parameters of the traits mentioned above, which can be since the use of nano-fertilizers increased the efficiency of the fertilization process and eased the absorption of the macronutrients (NPK) through the vegetative and root systems. Furthermore, Nano-fertilizers have tiny particles that offer physiological benefits. Their increased efficiency allows for more effective ion exchange, which results in better control over nutrient supply due to their high surface area ratio [18]. Moreover, it can quickly enter the leaf surface through stomata, holes, and cracks in the waxy layer (cuticles), and it can move quickly through cell membranes from one cell to another, arriving at the bio components inside the tissues and cells to benefit from the nutrients added by the nano method [19]. These nutrients, in particular, nitrogen, phosphorus, and potassium, play physiological and biological roles in plants. The reason behind the increase in the chlorophyll pigment is due to the role of nano-fertilizer. It promotes essential functions, such as the synthesis of chlorophyll pigment and the uptake of nutrients, especially nitrogen. A crucial element, nitrogen plays a direct and significant function in the synthesis of the chlorophyll pigment. Furthermore, it has a role in the production of auxins, specifically indole acetic acid. Because it forms tryptophan, an amino acid necessary for the synthesis of auxins, which aid in cell division, this acid is extremely effective in promoting cell division. As a result, plant growth and production are significantly enhanced through the vital role in the plant's biochemical and physiological functions [20] [21], which is an indicator of a vegetative growth increment [22]. Potassium is essential in synthesizing enzymes for growth, and phosphorus is critical for forming energy compounds, thus increasing root formation. This finding is consistent with [23]; [24], [25]; [26]; [27]; [28]. These materials contribute to building many essential compounds, including proteins, carbohydrates, purines, alkaloids, vitamins, enzymes, and chlorophyll. They stimulate carbon assimilation processes, providing many compounds during plant growth [29]. These results are consistent with those obtained by [30] in olives and [31] in figs regarding increasing the leaf area of seedlings treated with nano-fertilizer NPK.

The results listed in the tables of the traits mentioned above confirm that humic acid fertilization significantly affected the vegetative and chemical growth characteristics compared to the control treatment because it contains the major nutrients necessary for plant growth, including nitrogen, phosphorus, potassium, and amino acids, in addition to the organic matter which significantly impacting the vital plant activities [32], and thus enhances the plant's absorption of these elements, which results in increased vegetative growth and increased plant content of nutrients and active compounds [33]; [34]. The superiority in some vegetative growth traits described above is due to the role that this acid plays in increasing the plant metabolic activity and increasing the activation of enzymes that synthesize chlorophyll, which is necessary for photosynthesis and the formation of sugars, proteins, and energy compounds, all of which affect the plant through increasing its growth and size, and hence increasing the vegetative growth traits studied above [35] [36].

Furthermore, humic acid plays a part in controlling plant hormone levels and activating enzymes that promote cell division and elongation, leading to increased vegetative growth [37]. These results are consistent with the study conducted by [38] on date palms.

In terms of applying fertilizers, adding nano-fertilizer and humic acid to the soil proved more effective than foliar spray in most studied traits, possibly due to the anatomical characteristics of apple leaves, characterized by fluff on their lower surface. This fluff may hinder the absorption of fertilizers or the stability of the fertilizer on the leaves for an extended period. Also, the outperformance of the soil application method over the spray method may be due to the type of fertilizer, as the roots readily absorb nano-fertilizers. Likewise, humic acid is one of the organic acids that is produced naturally. It is a humic compound resulting from the decomposition of organic matter and is considered the most abundant form of organic carbon compounds in the environment. Some of them are chemically attractive to inorganic components, such as metals, oxides, and clay minerals, to form soluble and insoluble compounds in water that interact with the organic components [39]. Also, using organic fertilizers, either by adding them to the soil or spraying them on leaves, can enhance crop growth, productivity and yield. Moreover, using organic fertilizers can reduce the dependence on chemical fertilizers, which in turn helps maintain the consumers' health when they consume food [4,41].

4. Conclusion:

- Recommended to use foliar fertilization to enhance soil addition and to use a combination of nano and organic fertilizers as an alternative to traditional chemical fertilizers.

- suggest using other fertilizers such as potassium, magnesium, nano microelements and organic acids to reduce soil pH and thus increase the absorption of nutrients.

Abbreviations

NO.	Symbol	Whole word
1.	H0	without adding fertilizer
2.	NF	2 ml L^{-1} foliar spray
3.	HF	5 g $seedlings^{-1}$ foliar spray
4.	NS	5 ml $liter^{-1}$ soil application
5.	HS	10 g $seedlings^{-1}$ soil application
6.	NSHF	5 ml $liter^{-1}$ soil application + 5 g $seedlings^{-1}$ foliar spray
7.	NFHF	2 ml L^{-1} foliar spray + 5 g $seedlings^{-1}$ foliar spray
8.	HSNF	10 ml $liter^{-1}$ soil application + 2 ml L^{-1} foliar spray
	NSHS	5 ml $liter^{-1}$ soil application + 10 g $seedlings^{-1}$ soil application
9.	LSD	Least Significant Difference

References:

1. W.J., Bramlage. Fruit Notes. *Department of Plant and Soil Science*. University of Massachusetts. (2001) val.66.
2. S. H. J. Al-Hchami and T.K.Alrawi. Nano fertilizer, benefits and effects on fruit trees: a review, *Plant Archives*.20 (1) (2020) 1085-1088. https://www.researchgate.net/publication/339289743_NANO_FERTILIZER_BENEFITS_AND_EFFECTS_ON_FRUIT_TREES_A_REVIEW
3. B. S. Sekhon., Nanotechnology in agri-food production: an overview. *Nanotechnology, science and applications*, (2014) 31-53. https://doi.org/10.2147/NSA.S39406
4. C. Kole, D. S. Kumar and Khodakovskaya, M. V. *Plant nanotechnology*. New York: Springer (2016). . https://doi.org/10.1007/978-3-319-42154-4
5. S., Shende, V.,Rajput, T.,Minkina, S., Sushkova, and S., Mandzhieva, . Strategic role of nanotechnology in plant growth improvement and crop production. In *Nanotechnology in Agriculture and Agroecosystems* (2023) pp. 25-49. Elsevier. https://doi.org/10.1016/B978-0-323-99446-0.00015-5
6. N., Vikram, A., Sagar, C., Gangwar, R.,Husain, and R. N., Kewat. Properties of humic acid substances and their effect in soil quality and plant health. In *Humus and Humic Substances-Recent Advances*. (2022) IntechOpen. https://doi.org/10.5772/intechopen.105803
7. J. M., Alwan, and R. I. A. Al-Hamdani. Organic agriculture and environment book. College of Agriculture and Forestry. (2012) University of Al Mosul.
8. S. M., Jubeir, S. M., and Ahmed, W. A. E=effect of nanofertilizers and application methods on vegetative growth and yield of date palm. *The Iraqi Journal of Agricultural Science*, *50*(1), (2019). 267-274. https://doi.org/10.36103/ijas.v50i1.292
9. M. A., Shaymaa, Z. R., Ibrahim, and H, S., Nabi. Response Of Almond Seedling (Prunus Amygdalus) To Spray of Aminoplasmal, Humic Acid and Boron. *Iraqi Journal of Agricultural Sciences*, *53*(2), (2022) 415-428. https://doi.org/10.36103/ijas.v53i2.1550
10. H.N.R., Al-Karawi, and W.A.,Al-Rawi. Effect Of Foliar Application of Organic Extract And Hamic Acid Application On Strawbery Prodaction. *Iraqi Journal of Agricultural Sciences*, *47*(3). (2016) https://doi.org/10.36103/ijas.v47i3.564
11. A.W. Majeed. A.F.Altaai. Effect of liquid organic fertilizer on lemon transplants exposed to water stress. *Revista Bionatura* ;8 (2) 63. (2023) http://dx.doi.org/10.21931/RB/CSS/2023.08.04.12
12. H.M. Hakeem, K. J.M., Al-ecehagy, and R.A., Medan. Effect of Humic Acid and Nano-NPK on Vegetative Growth of Young Trees of Date Palm Cultivars Phoenix dactylifera L. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1252, (2023) No. 1, p. 012098). IOP Publishing. https://doi.org/10.1088/1755-1315/1252/1/012098
13. T.W., Goodwin. Chemistry and Biochemistray of Plant Pigment. 2nd Academic. Press. London. Newyork. San Francisco:(1976) P.373.
14. H.D., Chapman, and P.F. Pratt. Method of analysis for soils plant and water. University of california, division of Agricultural Science (1961).
15. A. I., Page, Methods of soil analysis. Part 2. Chemical and micro biological properties. Amer. Soc. Agron. Midison . Wisconsin. USA. (1982).
16. R.J., Haynes. .acomparison of two modified kjedhal digestion techniques for multi elements plant analysis with convertional wet and dry ashing methods . Communein . Soil sci. Plant analysis. 11(5): (1980) 459 _ 467.

17. L. S., Vernon, R. Orthofer, M. Rosa and L.Raventos. Analysis of total phenols and other oxidation substrates and antioxidants by means of folin-ciocalteu reagent. 299: (1999) 152-178.
18. K. S., Subramanian, A. Manikandan; M. Thirunavukkarasu and C. S. Rahale, Nano-fertilizers for balanced crop nutrition.In Nanotechnologies in food and agriculture (2015). pp. 69-80. Springer, Cham. https://doi.org/10.1007/978-3-319-14024-7_3
19. R. A., Jassim. Effect of levels and times of foliar application of Nano fertilizer Super micro plus on concentration of some micronutrients in dry matter and yield of Rice (*Oriza sativa L*.). *Karbala Journal of Agricultural Sciences*. The third agricultural scientific conference. College of Agriculture - University of Karbala. Page 255-264. (2018) https://doi.org/10.59658/jkas.v5i5.203
20. S.L., Jahan, A. Niaz M. Ghulam H. Abdul Hafeez Laghari. H. Khalid. A. tofique.A. Safdar, An Ayaz. Role of Nitrogen in Plant Growth and Development: *a review of advances in en-viro Mental Biology*, 10 (9) (2016) P 209-218 . https://link.gale.com/apps/doc/A472372583/AONE
21. N.F., Yasir, and Al-Salihy, A.A. Effect of Trichoderma and Nitrogen Fertilizer on the Growth and Yield of Tomato. Iraqi Journal of Biotechnology, Vol. 21, (2022) No. 1, 42-49. https://jige.uobaghdad.edu.iq/index.php/IJB/article/view/449/339
22. R., Mckenzie, Wheat nutrition and fertilizer requirements: *nitrogen.agriculture, food and Rural development*, Canada Grains Council's complete guide to wheat management (2001).
23. T.M., Saad, F.H., Issa, and R.H., Agaab. Effect Of Different Organic Fertilizer On N, P, K For Tomato Hybrid (Waaed And Alyste).). *Al-Muthanna Journal of Agriculture Sciences*.2 (2) (2014) 119-123. https://www.iasj.net/iasj/download/eed41b3242abad7f
24. F. H., Issa. Evaluation of Minitubers Yield and Scaling which Produced from Microtubers Transplanting Using Soilless Culture Technique. *Journal of Biotechnology Research Center*, *11*(2), (2017) 42–46. https://doi.org/10.24126/jobrc.2017.11.2.521
25. J. M., Alwan, and R. I. A., Al-Hamdani. Organic Agriculture and Environment. *College of Agriculture and Forestry-University of Mosul*. (2012) pp, 273.
26. S. Loddo, M.J., Gooding, Semi-dwarfing (Rht-B1b) Improves nitrogen-use efficiency in wheat, but not at economically optimal levels of nitrogen availability. *Cereal Research Communication* 40 (1) (2012) 116-121. https://doi.org/10.1556/crc.40.2012.1.13
27. B.N.I. Alkaram, Effect of nano and non-nano NPK fertilizer on the growth of pear seedlings. *PhD Thesis. University of Baghdad, College of Agriculture.Iraq*. (2021).
28. N.M.A.A., Alimam, and M.G.S., Al-Qasim, The effect of compound fertilizer (NPK) and gibberellic acid on the growth of two transplants grape cultivars Zarik and Thompson seedless (Vitis vinifera L.). *Journal of Genetic and Environmental Resources Conservation*, 10(2), (2022) 138-145. https://www.gercj.com/index.php/gercj/article/view/177/150
29. M.R., Shafeek, Y.I. Helmy, Magda, A.F. Shalaby and N. M. Omer.2012. Response of onion plants to foliar application of sources and levels of some amino acid under sandy soil conditions. *Journal of Applied Sciences Research*, 8(11): 5521-5527 http://www.aensiweb.com/jasr/jasr/2012/5521-5527.pdf
30. L. F., Hagagg, N. S. Mustafa; E.A.E. Genaidy and El-Hady, E. S. Effect of spraying nano-NPK on growth performance and nutrients status for (Kalamata cv.) olive seedling. *Biosci. Res.* 15(2) (2018) 1297-1303. https://www.isisn.org/BR15(2)2018/1297-1303-15(2)2018BR18-98.pdf
31. N.S., Mustafa, H. H. Shaarawy; M.F. El-Dahshouri and Mahfouze, S. A. Impact of nano-fertilizer on different aspects of growth performance, nutrient status and some enzymes

activities of (Sultani) fig cultivar. *Biosci. Res*.15(4) (2018) 3429-3436. https://doi.org/10.9734/jaeri/2022/v23i6505

32. S.M., Osman and I.E., Abd El–Rhman, Effect of organic and Bio N fertilization on growth, productivity of fig tree Fcus caracal L. Journal of Agriculture and Biologyical Sciences, 6 (2010) 319 – 328. https://www.aensiweb.net/AENSIWEB/rjabs/rjabs/2010/319-328.pdf
33. L. Taiz, and E. Zenger, Plant Physiology. 4th ed. Sinauer Associates, In C., Publishers.www.Sinauer.Com. (2006) https://doi.org/10.1086/523151
34. S.M., Singer, M.M., Sawan, A. Mouty and S.R.Salman. Study of the effects of Delta mix TM and organic matter on grow and productivity of bean plants grown under calcareous soil conditions. *Egyptian Journal of Horticulture,* (25) (1998) 35-47.
35. J. Martin, Impact of marine extracts application on cv syrah grape Vitis Vinifera L. Yield components harvest juice quality parameters and nutrient uptake. Thesis the faculty of Cakiforina polytechnic stae university, San Luis Obispo 2012. https://core.ac.uk/download/pdf/19160883.pdf
36. A., Al-hallaq, B.A., Al-Makdami, N.E., Suliaman, and A.M., Ismael, Effect of the Aquatic Plant Hydrella vorticellata as a Fertilizer on Seed Germination and some Chemical and Cytogenetics Parameters in the cell of Hordeum vulgare and Vicia faba. *Baghdad Science Journal*, *13*(2) (2016) https://doi.org/10.21123/bsj.2016.13.2.0228
37. A.R.T.M., Blackett, and A. H. A. M. Salman, Effect of humic and fulvic organic acids and irrigation water quality on some indicators of vegetative growth of young date palm trees (Phoenix dactylifera L.) cultivar Barhi. *Kufa Journal of Agricultural Sciences*, *7,* (2015) 22-40. https://www.iasj.net/iasj/article/110197
38. F.H., Taha, and M.R., Abood, Influence of some organic fertilizers on date palm cv. barhi. *Iraqi Journal of Agricultural Sciences*, *49*(4), (2018) 632-638. https://doi.org/10.36103/ijas.v49i4.72
39. R.S.R., El-Mohamedy, and M. A., Ahmed, Effect of biofertilizers and humic acid on control of dry root rot disease and improvement yield quality of mandarin (Citrus reticulate Blanco). *Research Journal of Agriculture and Biological Sciences*, *5*(2), (2009) 127-137. https://www.aensiweb.net/AENSIWEB/rjabs/rjabs/2009/127-137.pdf
40. F.T., Rasheed, and M.S., Mahdy, Partial replacement of Chemical Fertilizers with Organic and Biofertilizers of Anabaena circcinalis and Oscillatoria lymentica in rice Fields. *Iraqi Journal of Science*, (2017) 230-236. https://www.ijs.uobaghdad.edu.iq/index.php/eijs/article/view/6151

41.Ahmeda, A.K., C.W.Zanariah, Mohd, S.H.,(2020). EFFECT OF WASHING ON HEAVY METALS CONTENTS ON DATE FRUITS. ARID International Journal for Science and Technology (AIJST) VOL: 3, NO 5,. https://doi.org/10.36772/arid.aijst.2020.351.