

Impact of O-DAP Application and Nano-iron Spraying on some growth traits of Apple Saplings cv. Sharabi

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Abstract

This study was conducted during the growth season of 2025 within the lath house at the Dpt. of Horticulture and Landscape Gardening, College of Agriculture, Anbar University. One-year-old Sharabi apple saplings to study the influence of Added organic fertilizer (O-DAP) and spray with nano-iron on some growth traits. The experiment comprised three fertilization levels of O-DAP at concentrations (0 without addition, 5 g plant⁻¹, and 10 g plant⁻¹, denoted as (D0, D1, and D2), respectively, alongside nano Fe₂O₃ spraying at concentrations (0, 10, 20, and 30) mg L⁻¹, represented by (F0, F1, F2, and F3). The initial treatment occurred on April 15, the subsequent treatment on May 15, and the last treatment on June 15, during which fertilization and spraying were conducted concurrently. An experiment was executed with two factors (3 × 4) and three replicates, employing three saplings per experimental unit in accordance with the randomized complete block design (R.C.B.D).

Dry matter percentage of the shoots system, content of chlorophyll a and b in the leaves, and dry matter percentage of the root system when there is a bilateral interaction between the two study factors, especially the treatment D2F2, which resulted in values of 63.43 %, 35.33 mg 100 g⁻¹ fresh weight, 23.67 mg 100 g⁻¹ fresh weight, and 43.20 %, respectively. The interaction treatment of D2F3 demonstrated a significant rise in the rate of increase in plant height, the rate of increase in scion and rootstock diameter, with the corresponding values reaching 87.67cm, 1.3500cm, and 2.1833.

Keywords: : *Malus domestica*, Organic fertilizer, Nanotechnology, foliar spraying, Iron.

Introduction

The apple (*Malus domestica* Borkh) is a member of the Rosaceae family [1]. It is thought to have come from temperate Southeast Asia and spread to other places, like Europe. The Sharabi apple variety is common in central Iraq. It has medium-sized fruit that is white and tasty, but it may also have a purple hue [2].

Apples are delicate horticultural crops that need special care in the early stages of growth to help them grow quickly and strongly. So, fertilization is necessary for the best growth of roots and plants. Fertilization is an important farming practice for apple seedlings because it improves their nutritional value and helps them grow vegetatively. Additionally, various fertilizers that contain a variety of components are applied to the soil or sprayed on the leaves of plants so that they flourish, Organic fertilizers are considered the cornerstone of sustainable agriculture, playing a pivotal role in improving the soil's physical, chemical, and biological properties. They work to break up clay soils and increase their aeration, while simultaneously enhancing the water and nutrient retention capacity of sandy soils. Regarding plant growth, these fertilizers provide balanced and slow-release nutrition, ensuring a continuous supply of the macro and micronutrients essential for Healthy root and vegetative development [3]. Nanoscience, or nanotechnology, is

Material and Methods

Experimental Site

The investigation was carried out on January 3, 2025, using the lath house that was located inside the Department of Horticulture and Landscape gardening at the College of Agriculture - University of Anbar. The purpose of this study was to investigate the effects of organic fertilizer

the field that studies how to change materials at the atomic level, which is 10^{-9} meters. This is because nanoparticles have different properties than materials that are 100 nanometers or larger [4]. Recent advancements have shown that nanomaterials can be made in different sizes and shapes for use in many fields, such as food processing, science, engineering, medicine, and especially agriculture to help plants grow [5]. Nano fertilizers have amazing properties that make them better at being absorbed because they are so small and have such a large surface area [6]. Iron (Fe) is a vital micronutrient, playing an essential and intermediary role in the formation of chlorophyll, the green pigment responsible for photosynthesis. It is also a key component of cytochrome enzymes, which are essential for cellular respiration and energy production in the plants. Furthermore, iron contributes to the conversion of absorbed nitrogen into proteins. its deficiency, particularly in alkaline soils, leads to interveinal chlorosis on newly developed leaves, where the leaf tissue turns yellow while the veins remain green [7]. In light of the information presented above, the purpose of this research is to evaluate the impact that the addition of organic fertilizer and the application of nano-iron spray have on the vegetative and chemical properties of Sharabi apple seedlings, as well as the interaction between these different factors.

O-DAP and nano iron foliar application on the growth parameters of Sharabi apple saplings were planted in 5 kg pots, and the growing medium consisted of soil and peat moss in a 1:1 ratio. one year old and had been budded onto quince rootstock. The seedlings were chosen for their uniform size of one year.

Experimental Implementation:

First factor

O-DAP Fertilizer was added to the soil, and the vegetative system of the saplings were sprayed with iron (Fe_2O_3) on the same day in the early morning throughout three treatments. The initial treatment occurred on April 15, the subsequent treatment on May 15, and the third therapy on June 15.

Treatments and Experimental Design:

Adding organic DAP at three concentrations

1. Without adding (0 g plant^{-1}), symbolized by (D0).
2. Adding at a concentration of (5 g plant^{-1}), symbolized by (D1).
3. Adding at a concentration of (10 g plant^{-1}), symbolized by (D2).

Table1. Constituents of the O-DAP fertilizer designated for the experiment, as specified by the agricultural fertilizer factory associated with the College of Agriculture at the University of Kufa.

Component	%Ratio	Component	%Ratio	Component	%Ratio
Major elements		Minor elements		Acids	
Nitrogen	16.5	Iron	0.005	Humic acid	2.38
Phosphorus	48.2	Copper	0.008	Fulvic acid	5.64
Potassium	2.14	Manganese	0.024	Organic acids	14.30
Calcium	8.64	Zinc	0.008		
Magnesium	0.264	Boron	0.0003		

Second factor

Different levels of nano-iron [8] spraying in the form of Fe_2O_3

1. Spray plants with only distilled water, symbolized by F0.
2. Spray plants with a concentration of (10 mg L^{-1}), symbolized by (F1).
3. Spray plants with a concentration of (20 mg L^{-1}), symbolized by (F2).
4. Spray plants with a concentration of (30 mg L^{-1}), symbolized by (F3).

In the experiment, there were three different doses of O-DAP fertilizer and four different concentrations of nano- Fe_2O_3 spray. The experiment was designed as a two-factor factorial design using a randomized complete block design (R.C.B.D.). There were three replicates, and each replicate consisted of three saplings for each treatment.

Statistical Analysis:

The results were analyzed, and the means were compared using the least significant difference (L.S.D) test at a significance level of 5%, the statistical program known as GenStat was used [9].

Studied traits:

1. Dry Matter Percentage of the Shoots (%)

The shoots were weighed after the separation of the vegetative system, washing, and drying, and then put in an oven at 65°C for 5 days until the weight stabilized in 1/10/2025. The proportion of dry matter was then determined using the following equation [10]:

Percentage of dry matter in the vegetative parts = $\text{dry weight} / \text{wet weight} \times 100$

2. The content of chlorophyll a and b in the leaves ($\text{mg } 100\text{g}^{-1}$ fresh weight).

Eight fully expanded leaves were taken from the very middle of fully grown new branches, originating from different directions in the seedling, in the first week

of July. The concentration of chlorophyll was estimated using a methodology based on by Bajracharya [12].

3. Average increase in plant height (cm)

The plants' overall height was noted on 1st March 2025, and then again on 31st October 2025 when the experimental period ended. The increment rate of height was calculated as follows:

Average increase in plant height = Plant height at the end of the experiment – Plant height at the beginning of the experiment.

4. Average increase in scion and rootstock diameter (mm)

The initial measurements of the scion and rootstock diameter were made on 1/3/2025 at a height (10 cm) above and under the bud union with a Vernier Calliper, as referred by Head [11]. This was followed by a second measurement date on 1/11/2025. The mean of these measurements was determined using the formula:

Average increase in scion and rootstock diameter = Second reading – First reading

5. Dry Matter Percentage of the Root System (%)

The roots were weighed after thorough separation from the vegetative system, including a gentle and systematic washing in order to remove dust. The sample was dried after this cleaning process. It was subsequently placed in a tightly regulated oven at 65°C for five days, until the weight stabilised. Then the dry matter ratio was

computed with the following equation [10]:

Dry Matter Percentage of Root System = (Dry Weight / Wet Weight) × 100

Results and Discussion

1- Dry Matter Percentage in the Vegetative Body

As shown in Table (2), data obviously show extreme superiority of the dry matter (%) of the vegetative body across all studied factors and their interactions. The influence of organic fertilizer, O-DAP also has a remarkable effect on dry matter percent and (D2) treatment produced fairly high average of 62.45%. This result was statistically different from that of treatment (D1), with a mean DM percentage of 56.64% and treatment (D0) which under no supplement additions had an average DM percentage as low as 53.45%. Moreover, a significant increase in the dry foliage mass percent was recorded after applying nano-iron suggesting an improvement in overall nutritional plant and vigor. Treatment (F3) exhibited the highest average at 59.21%, followed by treatment (F2) at 57.71%, which was not substantially different from treatment (F1) at 57.07%. Conversely, treatment (F0) exhibited the lowest average at 56.06% for the dry matter percentage in the leaves. Regarding the interaction of the two components, treatment D2F2 attained the greatest dry matter percentage in the foliage at 63.43%, which was not statistically different from treatment D2F3 at 62.78%. The control treatment D0F0, which did not include spray applications, yielded the lowest dry matter percentage in the foliage at 51.86%.

Table 2. Impact of O-DAP fertilizer application and nano-iron spraying on the percentage of dry matter in foliage (%)

Adding O-DAP D	Spraying with nano Fe ₂ O ₄				Mean D
	F0 (water only)	F1 (10 mg L ⁻¹)	F2 (20 mg L ⁻¹)	F3 (30 mg L ⁻¹)	
D0 (without adding)	51.86	52.97	53.82	55.15	53.45
D1 (5 gm plant ⁻¹)	55.18	55.78	55.88	59.71	56.64
D2 (10 gm plant ⁻¹)	61.13	62.46	63.43	62.78	62.45
Mean F	56.06	57.07	57.71	59.21	
LSD = 0.05	D= (0.3339)		F= (0.3856) (0.6679)		D×F=

2- leaves content of chlorophyll a (mg 100 g⁻¹ fresh weight)

Based on the findings shown in Table 3, it can be concluded that the incorporation of the organic fertilizer O-DAP had a noteworthy impact on the chlorophyll levels. A content in the leaves, as treatment (D2) achieved the highest value of 33.25 mg 100 g⁻¹ fresh weight in comparison to the other concentrations, as well as treatment (D1), which achieved a value of 32.17 mg 100 g⁻¹ fresh weight, which demonstrated a significant difference from treatment (D0) without addition, which gave the lowest value of 29.67 mg 100 g⁻¹ fresh weight. When compared to the other concentrations, treatment (D2) achieved the highest value. As far as the application of nano-iron is concerned, the same table reveals that treatment (F3) produced the highest value, which was 34.00 mg per 100 g⁻¹ of fresh weight. This was followed by treatment

(F2), which produced 32.89 mg per 100 g⁻¹ of fresh weight, and then treatment (F1), which produced 31.56 mg per 100 g⁻¹ of fresh weight. In contrast, the treatment (F0) attained the lowest value for chlorophyll throughout the experiment. In the leaves, the amount was found to be 28.33 mg per 100 g⁻¹ of fresh weight. The treatment D1F3 demonstrated a considerable increase in chlorophyll, which is related to the interaction between the two parameters that were investigated. The control treatment D0F0, which did not include the administration of sprays, recorded the lowest result at 27.33 mg 100 g⁻¹ fresh weight. This was in contrast to the content, which was measured to be 35.67 mg 100 g⁻¹ fresh weight. A significant increase in chlorophyll was also observed in the case of the contact treatment D1F3, which did not involve the application of nano-iron. There is a content of 35.67 mg 100 g⁻¹ fresh weight.

Table 3. Impact of O-DAP fertilizer application and nano-iron spraying on leaves chlorophyll content

Adding O-DAP D	Spraying with nano Fe ₂ O ₄				Mean D
	F0 (water only)	F1 (10 mg L ⁻¹)	F2 (20 mg L ⁻¹)	F3 (30 mg L ⁻¹)	
D0 (without adding)	27.33	29.00	30.33	32.00	29.67
D1 (5 gm plant ⁻¹)	28.67	31.33	33.00	35.67	32.17
D2 (10 gm plant ⁻¹)	29.00	34.33	35.33	34.33	33.25

Mean F 28.33 31.56 32.89 34.00
 LSD = 0.05 D= (0.706) F= (0.815) D×F= (1.411)

3- The content of chlorophyll b in the leaves (mg 100g⁻¹ fresh weight)

The results in Table (4) show that the addition of the organic fertilizer O-DAP had a significant effect on the chlorophyll B content of the leaves, as treatment (D2) recorded the highest value and reached 21.75 mg 100 g⁻¹ fresh weight compared to the rest of the concentrations, while treatment (D1) gave a value of 19.50 mg 100g⁻¹ fresh weight, with a significant difference from treatment (D0), which was without addition and recorded the lowest value and reached 17.08 mg 100 g⁻¹ fresh weight. The same table demonstrated that spraying with nano-iron is associated with a substantial impact. Treatment (F3) achieved the highest value, which reached 22.44 mg 100 g⁻¹ fresh weight, followed by

treatment (F2), which reached 20.67 mg 100 g⁻¹ fresh weight, and then treatment (F1), which reached 19.11 mg 100 g⁻¹ fresh weight. In comparison, treatment (F0) recorded the lowest value for the content of chlorophyll b in the leaves, which reached 15.56 mg 100 g⁻¹ fresh weight. However, treatment (F3) achieved the highest value. As far as the interaction coefficients between the two study factors are concerned, the D1F3 treatment achieved a significant increase in the leaf content of chlorophyll B, which reached 24.00 mg 100 g⁻¹ fresh weight. On the other hand, the D0F0 control treatment (which did not include the application of sprays) recorded the lowest value, which reached 14.67 mg 100 g⁻¹ fresh weight leaf content of chlorophyll b.

Table 4. Impact of O-DAP fertilizer addition and nano-iron spraying on leaves chlorophyll b content (mg 100g⁻¹ fresh weight)

Adding O-DAP D	Spraying with nano Fe ₂ O ₄				Mean D
	F0 (water only)	F1 (10 mg L ⁻¹)	F2 (20 mg L ⁻¹)	F3 (30 mg L ⁻¹)	
D0 (without adding)	14.67	16.00	17.67	20.00	17.08
D1 (5 gm plant ⁻¹)	15.33	18.00	20.67	24.00	19.50
D2 (10 gm plant ⁻¹)	16.67	23.33	23.67	23.33	21.75
Mean F	15.56	19.11	20.67	22.44	
LSD = 0.05	D= (0.666)		F= (0.769)		D×F= (1.332)

4- Rate of Increase in Plant Height (cm)

Table (5) demonstrates a significant increase in plant height with the use of the organic fertilizer O-DAP. Treatment (D2) produced the largest average height increase of 84.82 cm, notably differing from treatment (D1) with an average of 80.48 cm, and markedly above treatment

(D0) without the addition, which recorded the lowest average height increase of 68.25 cm. The use of nano-iron by spraying markedly enhanced plant height growth. Treatment (F3) also yielded a significant average height increment and attained a whopping 81.91 cm in comparison to the next succeeding treatment (F2), where it achieved an excellent average height of

79.94 cm. Treatment (F1) was closely followed and it recorded a significant ascend which reached 76.88 cm in height on the average. Treatment (F0) meanwhile had the least mean height gain of 72.66cm. Considering the complexity of association between both parameters studied, this is shown by treatment D2F3 which recorded the highest improvement

in plant height from 58.24 cm to 87.76 cm. This interesting reading was not significantly different compared to treatment D2F2, which had the highest averages (87.28 cm). In contrast, the control D0F0 for which there was no application of spray showed the smallest height value with a lower 60.10 cm.

Table 5. Impact of O-DAP fertilizer application and nano-iron spraying on the rate of plant height (cm)

Adding O-DAP D	Spraying with nano Fe ₂ O ₄				Mean D
	F0 (water only)	F1 (10 mg L ⁻¹)	F2 (20 mg L ⁻¹)	F3 (30 mg L ⁻¹)	
D0 (without adding)	60.10	67.51	71.30	74.07	68.25
D1 (5 gm plant ⁻¹)	77.86	78.90	81.24	83.90	80.48
D2 (10 gm plant ⁻¹)	80.03	84.22	87.28	87.76	84.82
Mean F	72.66	76.88	79.94	81.91	
LSD = 0.05	D= (0.613)	F= (0.708)	D×F= (1.226)		

5- Rate of augmentation in graft diameter (cm)

Inclusion of the organic fertilizer O-DAP in the soil system had a very highly significant effect on graft diameter increment, thereby as shown in Table 6. The most impressive average growth was shown by treatment (D2) as a remarkable 1.3096 cm, which was far superior to that of treatment (D1), with a decent estimated overall average of 0.9642mm. This remark underlines a significant difference in comparison to D0 mean value, since in treatment (D0) and without any additional application it was 0.4900 cm the lowest average growth registered. In addition, the

incorporation of nano-iron into the treatment course exhibited a significant improvement in graft diameter with F3 showed the highest mean reading value (1.0667 cm) followed fairly by F2 (0.9589 cm), and then by F1 (0.8728 cm). In contrast, treatment (F0) has provided with the worse results--mean diameter only 0.7867 cm (Table 5). Analogously, the best treatment (D2F3) was detected when their relationship with the two rheological response variables was studied, which has maximum of 1.3500 cm. The D0F0 control, with no spray application being evident, measured the smallest (0.3600 cm) among all diameters of the grafts.

Table 6. Impact of O-DAP fertilizer application and nano-iron spraying on the rate of scion diameter growth (cm)

Adding O-DAP D	Spraying with nano Fe ₂ O ₄				Mean D
	F0 (water only)	F1 (10 mg L ⁻¹)	F2 (20 mg L ⁻¹)	F3 (30 mg L ⁻¹)	
D0 (without adding)	0.3600	0.4400	0.5200	0.6400	0.4900
D1 (5 gm plant ⁻¹)	0.7400	0.8800	1.0267	1.2100	0.9642
D2 (10 gm plant ⁻¹)	1.2600	1.2983	1.3300	1.3500	1.3096
Mean F	0.7867	0.8728	0.9589	1.0667	
LSD = 0.05	D= (0.01686)	F= (0.01946)	D×F= (0.03371)		

6- Rate of increment in rootstock diameter (cm)

Table (7) clearly shows the great and significant effect of O-DAP organic

fertilizer on expansion rate in terms of rootstock diameter. The maximum rate of 1.9833 cm was impressively achieved by Treatment (D2), and this is very significantly different from the one (rate = 1.5875 cm) obtained by treatment (D1),

which also a rated distinctly divergent with its precursor, treatment (D0) with a lowest rate of 0.8375 cm where no enhancement nor additive material applied there to in. Furthermore, the application of nano-iron led to a remarkable increase in the rootstock diameter (RD), as this was recorded to be 1.7144 cm in effect treatment F3, and then followed by treatment F2 that exhibited diameter 1.6044 cm that almost equaled that obtained with iron-sulfate (F1) which indicated RD: 1.3533 cm opposite to

control plants obtaining lowest values at RD: 1.2056 cm. In terms of the combination of the two factors, D2F3 treatment displayed the largest and most outstanding diameters (an amazing 2.1833 cm) for parent material when MOGOPA dots were included while the control treatment D0F0 with no workshop additions appeared to show a negligible enhancement in diameter and exhibited the smallest value reachable (0.4867 cm) for parent material's diameter.

Table 7. Impact of O-DAP fertilizer application and nano-iron spraying on rootstock diameter growth rate (cm)

Adding O-DAP D	Spraying with nano Fe ₂ O ₄				Mean D
	F0 (water only)	F1 (10 mg L ⁻¹)	F2 (20 mg L ⁻¹)	F3 (30 mg L ⁻¹)	
D0 (without adding)	0.4867	0.5700	1.0733	1.2200	0.8375
D1 (5 gm plant ⁻¹)	1.4300	1.5400	1.6400	1.7400	1.5875
D2 (10 gm plant ⁻¹)	1.7000	1.9500	2.1000	2.1833	1.9833
Mean F	1.2056	1.3533	1.6044	1.7144	
LSD = 0.05	D= (0.02530)		F= (0.02921)		D×F= (0.05060)

7- Percentage of dry matter in roots (%)

Findings of the full statistical analysis are shown in Table (8), an unusually high percentage (level) of dry matter in the root system when organic fertilizer pressed O-DAP was applied as a direct consequence. Treatment (D2) had the highest percentage among all treatments performed at 41.24%, which can be distinguishably different from 37.61% by treatment (D1). In addition, treatment (D2) presented a significant contrast with treatment (D0), that without any additive, estimated the minimum percentage of dry matter in the root system to be 36.16%. The proportion of D.M. in the root system was also markedly affected by nano-iron

application. In particular, treatment (F3) shows the maximum value of 39.09% which is significantly different from treatment (F2) and was 39.07%. This processing also showed a marked contrast to treatment (F1) that resulted in the lowest value of 37.80%. Treatment (F0), on the other hand, gave the poorest response with only 37.40% of total dry matter in the shoot system. In addition, the interaction of the two primary focuses of the research offered interesting results (the maximum percentage of dry matter in root system was 43.20%, and treatment D2F2 reached a significant level). On the other hand, D0F0 treatment (without any spraying operation) had 35.67% as the lowest value reported.

Table 8. Impact of O-DAP fertilizer application and nano-iron foliar treatment on root dry matter percentage (%)

Adding O-DAP D	Spraying with nano Fe ₂ O ₄				Mean D
	F0 (water only)	F1 (10 mg L ⁻¹)	F2 (20 mg L ⁻¹)	F3 (30 mg L ⁻¹)	
D0 (without adding)	35.67	35.93	36.23	36.82	36.16
D1 (5 gm plant ⁻¹)	37.00	37.30	37.79	38.36	37.61
D2 (10 gm plant ⁻¹)	39.51	40.16	43.20	42.09	41.24
Mean F	37.40	37.80	39.07	39.09	
LSD = 0.05	D= (0.4998)		F= (0.5771)		D×F= (0.9996)

Discussion

The findings from Tables (2, 3, 4, 5, 6, 7 and 8) impressively demonstrated the deepening and the wide impact of mixing O-DAP organic fertilizer (at a concentration of 10 kg plant⁻¹). This significant response can be added up to the active role of the different components of those fertilizer, with covering either vital macronutrients, and important micronutrients (as carefully described in Table.(1). Each of these elements is necessary to satisfy the wide-ranging requirements of the plant including the essential minerals needed for photosynthesis, respiration, and countless physiological functions. These are not only beneficial, indeed they play a vital role in increasing either cell proliferation/elongation and hence the overall development of plant [12]. The striking increase in dry matter followed by the increase of chlorophyll a and b demonstrated in apple seedlings leaves is closely associated with the richness of essential nutrients present in O-DAP fertilizer. The high levels of these essential nutrients are an important factor in promoting and triggering many key processes that occur at the cellular level which are essential for growth and development of the plants. That is, this increased activity at the biological level then results in a significant increase of various chemical ingredients (both organic and inorganic including the important pigment chlorophyll itself). Nitrogen, magnesium, iron and manganese are especially important among the essential nutrients because they are

necessary for the efficient production of chlorophyll which gives apple seedlings the ability to manufacture its own food with photosynthetic ability needed for all-over healthiness and vitality. The nitrogen, iron, and magnesium in the fertilizer used in the study are all parts of chlorophyll pigment, specifically the four porphyrin groups (which are made up of pigments and iron). This makes the leaves have a higher concentration of chlorophyll [14]. The results showed that using O-DAP fertilizer made plants much taller, made the diameter of the scion and rootstock bigger, and increased the amount of dry matter in the root system. This could be because of the nitrogen in the fertilizer, which is an important part of the plant's growth process. It makes the meristematic tips work better, which helps cells divide and grow longer. This makes the plant taller, the scion and rootstock wider, and the shoot and root systems heavier. This happens because plant hormones are more active or because the body makes more important growth materials, such as amino acids and coenzymes like NAD and NADP, which contain nitrogen. The phosphorus in the fertilizer is also very important for plants to grow. The plant can photosynthesize better when both elements are present, along with the main and minor elements that are already there. This leads to better root and vegetative growth. Nitrogen and phosphorus help build cell membranes and make energy molecules [15].

We cannot ignore how important other important nutrients in the fertilizer mix are for plant growth. These nutrients include potassium, magnesium, calcium, and micronutrients like iron, zinc, copper, and manganese. The important role these elements play in starting the enzymes that are involved in photosynthesis in the leaves and helping to move and use the products of photosynthesis for the growth of the shoot and root systems is clear from the fact that their growth metrics have improved.

According to Khaled and Hassan [16], the organic acids found in O-DAP fertilizer, specifically humic and fulvic, have the ability to raise soil nutrient levels and enhance root absorption of water and nutrients. This, in turn, satisfies growth requirements, promotes the development of meristematic tissue, and supports vital physiological processes in plant tissues that are connected to the biosynthesis of photosynthetic products in the leaves. As a result, vegetative growth is encouraged. Doaa and Sefan [17], Aljabary et al. [18], Noori et al. [19], and Al-Akkam et al. [20] all reached similar conclusions.

On the other hand, all of the parameters looked at in Tables (2, 3, 4, 5, 6, 7, 8) showed a lot of improvement when treated with nano

Conclusion:

The majority of the apple seedlings' chemical, root, and vegetative development properties were enhanced by applying the organic fertilizer O-DAP. Nano-Fe₂O₃ applied to the leaves, however, improved

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Fe₂O₃ at a concentration of 30 mg L⁻¹. Iron plays a big role in increasing the plant's leaf area because it boosts the plant's pigment content and energy compound formation, and it also activates different enzymes that are involved in this process. This leads to a higher amount of photosynthetic products, which helps the plant grow and spread faster and raises its dry matter content, which is important for photosynthesis [21]. These results are in line with what El-Gioushy et al. [22] found about navel orange trees. The high amounts of chlorophyll a and b in the leaves may be because iron, which is an important part of the enzymatic system, works. Iron helps move electrons, make chlorophyll, and take in nitrogen. Signs of iron deficiency include young leaves turning yellow between the veins and, in severe cases, the edges and tips of branches dying [23, 24]. The increase in dry matter percentage in both the shoot and root systems may be due to nano-iron therapy. Increasing the concentration of this element in the leaves is linked to better photosynthetic efficiency and a higher percentage of dry matter in the seedlings' branches, leaves, and roots [25]. The results are in line with what Oudah and Hamad [26] said about orange trees and what Hussien and Hamad [27] said about apple trees.

every single one of the measured characteristics. Most of the characteristics that were evaluated showed a substantial degree of interaction between the two study variables.

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