Response of three cultivars of mandarin seedlings to spraying and ground adding with nanofertilizer

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Abstract

The experiment was conducted in lath house of Al-Furat Al-Awsat Technical University / Al-Musayyib Technical College in Babylon province during the period from March to the beginning of December 2023 to study the effect of spraying with nano-fertilizer at three levels (0, 2 and 3g.l^{-1}) and ground application. With nanofertilizer at three levels (0, 0.5 and 1g.pot^{-1}) on seedlings of three cultivars of mandarin. The most important results can be summarized as follows: The Clementine cultivar excelled in most of traits of vegetative growth, represented by the number of branches and the number of leaves, as it reached (4.42 branches.$plant^{-1}$, 80.55 leaves.$plant^{-1}$) respectively. The chemical traits (iron, zinc, and manganese) in the leaves amounted to (43.56 mg. kg^{-1} dry weight, 36.65 mg. kg^{-1}, 15.05 mg. kg-1 dry weight), respectively. The treatment of spraying vegetative growth with nano-fertilizer showed a significant effect on most of traits of vegetative growth and the content of the leaves of mineral elements, as the highest average was recorded when the treatment of spraying vegetative growth with 3 g.l^{-1} increased the number of branches, the number of leaves, and iron. Zinc, manganese. The treatment of adding nanofertilizer had a significant effect on most of traits of vegetative and root growth and the leaf content of elements, as the highest rate was recorded when adding g/pot, an increase in the number of branches, the number of leaves, iron, zinc, and manganese. The binary interaction between the Clementine cultivar and spraying with nano-fertilizer at a concentration of 3 g.L^{-1} (A2B3) showed a significant increase in the studied traits: number of branches, number of leaves, iron, zinc, and manganese. Bi-interaction between the Clementine cultivar and the addition of nano-fertilizer at a concentration of 1 g. pot^{-1} ((A2C3) A significant increase in the studied traits: number of branches, number of leaves, iron, zinc, and manganese. The two-way interaction between spraying nano-fertilizer with a concentration of 3 g.l^{-1} and adding nano-fertilizer with a concentration of 1 gm. Pot^{-1} (B3C3) showed a significant increase in the traits: number of branches, number of leaves, , iron, zinc, and manganese. The triple interaction between the study factors showed a significant increase in the studied traits, as the treatment (A2B3C3) excelled in the number of branches, number of leaves, iron, and zinc and the treatment (A3B3C3) excelled in the percentage of manganese.

introduction

Citrus fruits (Citrus) belong to the Rutaceae family, which contains oil glands in most parts of the plant, which gives it a distinctive aromatic smell. This family includes three genera of citrus, the most important of which is the genus Citrus, which is of economic importance, and due to the large number of species belonging to this genus. It was divided into five groups (orange group, tangerine group, citrus group, grapefruit group, and hybrid group) [1] The fruits of citrus trees occupy a distinguished position among fruit trees due to their nutritional, economic, aesthetic and medical importance, because they are rich in mineral salts necessary for building the human body such as (Na, Mg, Fe, Ca, K). . Mandarin trees belong to the citrus genus, which belongs to the Rutaceae family, and whose trees grow in tropical and

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subtropical regions, which extend from Southeast Asia and the Malay Islands to central China and India [2] . Mandarin trees have a high nutritional value and are characterized by containing a high percentage of vitamins. They are also a major source of vitamin C, and their fruits contain many organic acids such as citric and malic acid. In addition to its nutritional benefits, that is, it is used in food processing, as juices are made from it, volatile aromatic oils are extracted from its peels, and pectin (insoluble dietary fiber) is also extracted, which is used in the manufacture of jam [3] . The presence of plant nutrients is a necessary factor for its growth, so researchers turned to finding modern techniques and methods in order to use them in supplying the plant with the necessary nutrients and increasing the efficiency of using fertilizers without causing losses or pollution, including the use of nanotechnology, which is considered one of the important techniques in plant growth. Increase the development of agricultural and food capabilities, especially in fertilization programs[4] . Many studies and research have shown that the use of nanotechnology has had a positive impact in increasing production and reducing the excessive use of fertilizers, as well as reducing waste and purifying the soil from heavy elements that affect the absorption of nutrients, and that nanotechnology provides new windows with many specializations. In the field of agricultural and food sciences, through which many agricultural problems are solved [5] . Nanomaterials are characterized by their high hardness due to their small size and the presence of large numbers of atoms on the outer surface. Their role is to increase their hardness and resistance to stress, in addition to having a lower melting point than they would be in their natural state [6]

Materials and methods

The experiment was conducted in the lath house of Al-Furat Al-Awsat Technical University / Technical College / Al-Musayyab during the period from the beginning of March to the beginning of December 2023 to study the response of seedlings of three cultivars of mandarin grafted to spraying and ground adding with nano-fertilizer. 243 seedlings as homogeneous as possible were selected, planted in 5 kg bags at one year of age, from certified citrus propagation nurseries located in Al- Hindiyah District / Holy Karbala province. These seedlings were transferred to 8 kg plastic pots on 2/15/2023, filled with plastic + peat moss (German).) at a ratio of (1:1) and placed in lathhouse covered with saran and experimental treatments were applied to it. Agricultural service operations were conducted on the seedlings, which included watering, removing weeds manually, and combating leaf miners.

Studied traits

Vegetative fresh weight (g.seedling^{-1}):

Vegetative Dry weight (g.seedling^{-1}):

Protein (%):

Magnesium (%):Carbohydrate (%):

Results

Vegetative fresh and dry weight (g.seedling^{-1})

The results shown in Tables (1 and 2) indicated that the difference between the study cultivars had risen to the level of significance in the wet and dry weight of vegetative growth, as the Clementine cultivar was distinguished by having the highest weight of (53.12) and (27.74) g.seedling^{-1}, respectively. . The results of the research show that foliar spraying had a significant effect in increasing this trait. Treatment B3 gave the highest value, reaching (53.78) and (29.00) gm.seedling^{-1}, respectively. The results of the research showed the significant effect of ground

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addition in increasing fresh and dry weight. For the vegetative total, treatment C3 excelled by giving it the highest value, reaching (53.71) and (28.12) g.seedling^{-1}, respectively.

The results of the bi- interaction between the study cultivars and foliar spraying with nanofertilizer showed that there were significant differences between the treatments. The A2B3 interaction treatment was characterized by the highest wet and dry weight of vegetative growth, reaching (56.13) and 29.66) g.seedling^{-1}, respectively. The effect of bi- interaction between the study cultivars and the ground addition of nano-fertilizer in increasing this trait, where the A2C3 interaction treatment gave the highest fresh weight, reaching (56.15) and (29.03) g.seedling^{-1}, respectively. This was due to bi-interaction between the foliar spray treatments and the ground addition. Nanofertilizer had a significant effect on this trait, as the B3C3 interaction treatment was characterized by giving the highest wet and dry weight of vegetative, reaching (55.96) and (30.40) gm.seedling-1, respectively. Regarding the triple interaction between the study factors, the results showed the excelled of the A2B3C3 interaction treatment by giving it the highest wet and dry weight of vegetative growth, amounting to (58.44) and (30.66) gm.seedling-1, respectively.

Table 1. effect of cultivars and the two application methods: spraying and ground fertilization with nanofertilizer and their interactions on the average fresh weight of vegetative(gm. seedlings $^{-1}$)

B×A	**Ground fertilization**			**Foliar spraying**	**Cultivars**
	C3	**C2**	**C1**		
44.30	**49.00**	**47.89**	**36.00**	**B 1**	**A 1**
51.59	**52.78**	**52.55**	**49.44**	**B 2**	
51.69	**54.22**	**51.53**	**49.33**	**B 3**	
48.96	**52.67**	**50.33**	**43.89**	**B 1**	**A 2**
54.26	**57.33**	**55.55**	**49.89**	**B 2**	
56.13	**58.44**	**56.33**	**53.63**	**B 3**	
46.51	**49.44**	**49.77**	**40.33**	**B 1**	**A 3**
52.62	**54.31**	**54.00**	**49.55**	**B 2**	
53.71	**55.22**	**56.11**	**49.22**	**B 3**	
	53.71	**52.67**	**46.81**	**C average**	
B×A	**C**		**C× B ×A**	**L.S.D$_{(0.05)}$**	
1.656	**0.956**		**2.867**		
A average	**interaction of Cultivars and Ground Fertilization**				
49.19	**52.00**	**50.66**	**44.92**	**A 1**	**C×A**
53.12	**56.15**	**54.07**	**49.13**	**A 2**	
50.88	**52.99**	**53.29**	**46.37**	**A 3**	
0.956				**1.656**	**L.S.D$_{(0.05)}$**
B average	**Foliar spraying and ground fertilization interaction**				
46.59	**50.37**	**49.33**	**40.07**	**B 1**	**C×B**
52.82	**54.81**	**54.03**	**49.63**	**B 2**	
53.78	**55.96**	**54.66**	**50.73**	**B 3**	

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0.956		**1.656**	**L.S.D$_{(0.05)}$**

Table (2): effect of Cultivars and the two methods of application: spraying and ground fertilization with nanofertilizer and their interactions on the average dry weight of vegetative growth (g. seedlings $^{-1}$)

B×A	Ground fertilization			Foliar spraying	Cultivars
	C3	C2	C1		
20.52	23.22	22.44	15.89	B 1	A 1
25.59	28.11	25.22	23.44	B 2	
27.81	29.89	28.22	25.33	B 3	
25.55	27.11	26.11	23.44	B 1	A 2
28.00	29.33	28.33	26.33	B 2	
29.66	30.66	29.89	28.44	B 3	
23.15	24.22	23.55	21.66	B 1	A 3
28.77	29.89	28.66	27.77	B 2	
29.52	30.66	30.44	27.44	B 3	
	28.12	26.99	24.42	C average	
B×A	C		C× B ×A	L.S.D$_{(0.05)}$	
1.156	0.667		2.002		
A average	interaction of Cultivars and Ground Fertilization				
24.64	27.07	25.29	21.55	A 1	C×A
27.74	29.03	28.11	26.07	A 2	
27.15	28.26	27.55	25.63	A 3	
0.667			1.156	L.S.D$_{(0.05)}$	
B average	Foliar spraying and ground fertilization interaction				
23.07	24.85	24.04	20.33	B 1	C×B
27.45	29.11	27.40	25.85	B 2	
29.00	30.40	29.52	27.07	B 3	
0.667			1.156	L.S.D$_{(0.05)}$	

The effect of foliar spraying and ground adding with nanofertilizer on the chemical traits of seedlings of three cultivars of mandarin. Tables (3, 4, and 5) show that the difference in the cultivars led to a significant increase in the percentage of (protein, magnesium, and carbohydrates) in the leaves, where the cultivar (A2) excelled in the average percentage of protein. Carbohydrates recorded (16.30 and 28.69)%, respectively, while magnesium recorded the highest average in A3, reaching (1.17)%. When foliar spraying with nanofertilizer, treatment B3 was excelled, recording (16.59, 0.61, and 29.04)%, respectively. There was also a significant effect when adding nano-fertilizer, as treatment C3 was excelled in providing (15.73) and 1.47%, respectively, while the value of carbohydrates was (29.21)% in treatment C2. The results of the table also show the positive moral effect of the bi-interaction between the cultivars and foliar spraying, as treatment A2B3 excelled on all treatments in the percentage of protein by giving it (19.23), magnesium in treatment A3B3, which reached (1.65)%, and carbohydrates in treatment A2B2, which amounted to (29.81)%. . As for the bi-

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interaction between the cultivars and the ground addition, a significant excelled was obtained for treatment A2C3 on all treatments in the percentage of protein by giving it (18.07)%, magnesium in treatment A3C3, which reached (1.58)%, and carbohydrates in treatment A2C2, which reached (29.99)%. It is noted that the interaction effect between foliar spraying and ground addition had a significant effect, so all treatments excelled on the comparison treatment, where treatment B3C3 gave higher values, reaching (18.07, 2.01, and 30.66)%, respectively. Between the triple interaction. The percentage of protein for treatment A2B3C3 was significantly excelled to the rest of the treatments, reaching (23.06)%. Regarding the effect of the triple interaction factors among the study factors, the results of the research showed that a significant excelled was obtained when the interaction treatment A3B3C3 was given by giving it the highest average magnesium content of the leaves, which amounted to (2.12)%. On the effect of the triple interaction between the factors of the study, the results of the statistical analysis showed the excelled of the interaction treatment A2B2C2 by giving it The highest average percentage of total carbohydrates reached (32.01.%(

Table 3. The effect of cultivars and the two application methods: spraying and ground fertilization with nanofertilizer and their interactions on the average percentage of protein %

B×A	Ground fertilization			Foliar spraying	Cultivars
	C3	C2	C1		
11.89	13.54	12.67	9.46	B 1	A 1
13.63	13.83	13.69	13.38	B 2	
14.56	14.67	14.60	14.40	B 3	
13.83	14.85	15.15	11.50	B 1	A 2
15.83	16.29	15.88	15.31	B 2	
19.23	23.06	18.27	16.35	B 3	
11.74	13.48	13.85	7.87	B 1	A 3
14.78	15.40	14.85	14.10	B 2	
15.99	16.48	16.00	15.48	B 3	
	15.73	15.00	13.09	C average	
B×A	C		C× B ×A	L.S.D$_{(0.05)}$	
0.896	0.517		1.552		
A average	interaction of Cultivars and Ground Fertilization				
13.36	14.01	13.65	12.41	A 1	C×A
16.30	18.07	16.43	14.39	A 2	
14.17	15.12	14.90	12.49	A 3	
0.517				0.896	L.S.D$_{(0.05)}$
B average	Foliar spraying and ground fertilization interaction				
12.49	13.96	13.89	9.61	B 1	C×B
14.75	15.17	14.81	14.26	B 2	
16.59	18.07	16.29	15.41	B 3	
0.517				0.896	L.S.D$_{(0.05)}$

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Table (4): effect of Cultivars and the two application methods: spraying and ground fertilization with nanofertilizer and their interactions on the average magnesium content of leaves (%)

B×A	Ground fertilization			Foliar spraying	Cultivars
	C3	C2	C1		
0.57	0.67	0.69	0.34	B 1	A 1
1.19	1.58	1.32	0.68	B 2	
1.48	1.90	1.77	0.76	B 3	
0.58	0.69	0.68	0.38	B 1	A 2
1.07	1.69	0.81	0.72	B 2	
1.58	2.00	1.85	0.88	B 3	
0.67	0.82	0.79	0.41	B 1	A 3
1.19	1.79	0.97	0.82	B 2	
1.65	2.12	1.94	0.89	B 3	
	1.47	1.20	0.65	C average	
B×A	C		C× B ×A	L.S.D$_{(0.05)}$	
0.05106	0.02948		0.08844		
A average	interaction of Cultivars and Ground Fertilization				
1.08	1.38	1.26	0.59	A 1	C×A
1.08	1.46	1.11	0.66	A 2	
1.17	1.58	1.23	0.71	A 3	
0.02948	0.05106				L.S.D$_{(0.05)}$
B average	Foliar spraying and ground fertilization interaction				
0.61	0.73	0.72	0.38	B 1	C×B
1.15	1.69	1.03	0.74	B 2	
1.57	2.01	1.85	0.84	B 3	
0.02948	0.05106				L.S.D$_{(0.05)}$

Table (5): effect of Cultivars and the two application methods: spraying and ground fertilization with nanofertilizer and their interactions on the average percentage of total carbohydrates %

B×A	Ground fertilization			Foliar spraying	Cultivars
	C3	C2	C1		
26.40	26.72	27.25	25.24	B 1	A 1
27.78	28.34	28.33	26.66	B 2	
28.96	30.39	30.20	26.29	B 3	
26.87	27.50	27.55	25.57	B 1	A 2
29.81	30.36	32.01	27.08	B 2	
29.37	30.91	30.42	26.79	B 3	
26.55	27.05	27.25	25.35	B 1	A 3
28.94	29.73	30.18	26.92	B 2	
28.77	30.69	29.72	25.91	B 3	
	29.08	29.21	26.20	C average	
B×A	C		C× B ×A	L.S.D$_{(0.05)}$	
0.7324	0.4228		1.2685		
A average	interaction of Cultivars and Ground Fertilization				
27.72	28.49	28.59	26.06	A 1	C×A
28.69	29.59	29.99	26.48	A 2	
28.09	29.16	29.05	26.06	A 3	
0.4228				0.7324	L.S.D$_{(0.05)}$
B average	Foliar spraying and ground fertilization interaction				
26.61	27.09	27.35	25.39	B 1	C×B
28.85	29.48	30.17	26.89	B 2	
29.04	30.66	30.11	26.33	B 3	
0.4228				0.7324	L.S.D$_{(0.05)}$

Discussion

The results of Tables (1-5) show that the Clementine cultivar is excelled in most vegetative traits. This may be due to the difference in the nature of the genetic structures of the cultivars. The increase in vegetative traits can be attributed to spraying and adding nano-fertilizer and its effect on vegetative traits, Table (1-2). The reason may be due to the small size of the fertilizer particles and its content of major and micro fertilizer elements necessary for the growth and development of the plant (nitrogen and Potassium, phosphorus, iron, zinc, manganese and magnesium). The reason for the effect of foliar spraying with nanofertilizer in increasing the fresh weight of vegetative growth (Table 1) is that the levels used in the added fertilizer helped to form new vegetative growth of the plant, which leads to the absorption of large amounts of water, and thus the water content in the parts increases. Various plants. This is consistent with what [19] found in figs and [13] found in olives. The reason foliar spraying increases the dry weight of vegetative growth (Table 2) is due to the role of each of the elements included in the nanofertilizer, which include nitrogen, phosphorus, potassium, iron, magnesium, manganese, and zinc, as these elements affect

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meristematic growth and stimulate the fixation of CO2 gas. Then the process of photosynthesis is activated and the products of this process are used to build the vegetative system, in addition to the role of potassium in absorbing nutrients and increasing their concentration in the leaves, in addition to activating the starch synthetase enzyme, which helps in manufacturing starch, stimulating the process of photosynthesis and increasing its products. (Marschner, 1986) In addition to the vital role it plays in the formation of chlorophyll and its activation of enzymes for the photosynthesis process (Yassin, 2001), in light of these functions and the solidarity between the above elements, it has led to improving the vegetative growth traits of seedlings, especially increasing the number of branches and the number of Leaves, leaf area, and an increase in the rate of carbohydrates in seedlings, leading as a result to an increase in the dry weight of vegetative. These results are based on what was reported by Qureshi et al. (8201). The small size of the particles and the large surface area of nanofertilizer help to increase their solubility in various solvents such as water, which leads to increased penetration of these particles into surfaces in contact with them, such as leaves, as they provide larger areas for various metabolic reactions in plants, in addition to increasing the rate of photosynthesis, which causes Increase in dry matter formation. These results are consistent with what [3, Al-Taie (2018) and Ali (2015) found in citrus roots in terms of an increase in the dry weight of vegetative growth due to fertilization with the complete fertilizer NPK. These results are consistent with what was found by [4 and Al-Murayb (2008). The results showed that spraying with nanofertilizer significantly affected the concentrations of nutrients in the leaves (Tables 3, 4, and 5), as the increase in the percentage of protein, magnesium, and carbohydrates in the leaves of seedlings treated with nanofertilizer may be due to the direct absorption of these elements present in the nanofertilizer. Through the leaves, which leads to an increase in its concentration there. The positive role of nanofertilizer in forming a strong vegetative and root system has increased the efficiency of the process of absorption of other nutrients by the roots, which has increased their concentration within the plant. In addition, the high entry of nutrient particles into the nanofertilizer requires the withdrawal of important nutrients to complete the process of photosynthesis. The increase in elements may also be due to the role of nanofertilizer in encouraging vital processes in the plant and the formation of enzymes involved in the process of photosynthesis, which encourages the growth of seedlings and thus increases the demand for nutrients, increasing their concentration in the plant [24]. These results, in terms of increased levels of elements in plant leaves when sprayed with nanofertilizer, agree with what was found by [19] in figs, [28] and [23] in mango and [13] in olive. The increase in the amount of carbohydrates manufactured (Table 5) in the leaves may be due to the effect of spraying with nano-fertilizer due to the increase in leaf area and the chlorophyll content of the leaves, and then part of these carbohydrates is used for root growth and provides the energy needed to absorb nutrients from the soil [2] which may coincide with the foliar spraying process and the ease of absorbing nutrients by the leaves and not losing them or fixing them in the soil, as the benefit rate through foliar feeding reaches 85% compared to feeding through the roots, and nutrients are absorbed through the stomata and the leaf petiole. As well as the cracks in the cuticle layer and the cytoplasmic threads extending through it. This increases the efficiency of the photosynthesis process and the production of carbohydrates [1]

References :

1. Abdul, Karim Saleh. 1988. It contains the nutrients in the plant. Directorate of Dar Al-Kutub for Printing and Publishing. Saladin University. The Republic of Iraq.
2. Al-Araji, Jassim Muhammad Alwan, Raeda Ismail Al-Hamdani, and Nabil Muhammad Amin Al-Imam. 2006. The effect of nitrogen and phosphorus fertilization on vegetative growth traits and the N and P content of leaves of Truestrange seedlings. Tikrit Journal of Agricultural Sciences. 6(2):181-184.
3. Ali, Tahani Muhammad Jawad. 2015. The effect of the mycorrhizal fungus Glomus mosseae and spraying with polyamines and foliar fertilizer on the growth and yield of orange trees, a local cultivar Citrus sinensis L.. Doctoral thesis. Technical College - Musayyib. Al-Furat Al-Awsat University, Republic of Iraq.
4. Al-Jubouri, Hadi Kazem. 2013. The effect of spraying nutrient solution and gibberellic acid on the growth of local orange (Citrus sinensis L.) seedlings. Master Thesis . faculty of Agriculture . University of Kufa . The Republic of Iraq.
5. Almureib, Kawthar Sahib Ahmed. 2008. The effect of spraying with gibberlic acid, naphthalene, acetic acid, and ferrous sulphate on the growth of orange (L Citrus aurantium) seedlings. Master Thesis. faculty of Agriculture. University of Kufa. The Republic of Iraq .
6. Al-Rifai, Fouad Nimr (2015). Basic concepts in nanotechnology. College of Science, Dhi Qar University, Ministry of Higher Education and Practical Research, Iraq.
7. Al-Sahhaf, Fadel Hussein Reda. 1989. Applied plant nutrition. Ministry of Higher Education and Scientific Research. University of Baghdad. House of Wisdom for Publishing, Translation and Distribution. Iraq . p. 259.
8. Alsalhy, A.; M. Al-Wasfy; I. Badawy; F. Gouda and A. Shamroukh. 2021. Effect of nano-potassium fertilization on fruiting of Zaghloul datepalm. SVU-International Journal of Agricultural Sciences. 3: 1-98
9. Al-Taie, Zainab Turki Ismail. 2018. The effect of fertilizer type on the growth of three citrus roots. Doctoral thesis. faculty of Agriculture . University of Kufa . The Republic of Iraq
10. Chapman, H. D. and P. F. Pratt .1961. Methods of Analysis for Soils. Plant and Water. University of California. Dives. Agriculture Sciences. USA . pp. 33-35.
11. Davarpanah, S.; A.Tehranifar ; G. Davarynejad ; M. Aran ; J. Abadía ; and Khorassani, R. 2017. Effects of foliar nano-nitrogen and urea fertilizers on the physical and chemical properties of Pomegranate(*Punica granatum* cv. Ardestani) fruits. HortScience, *52*(2): 288-294
12. Ghormade V., Deshpande MV, Paknikar KM .2011. perspectives for nano –biotechnology enabled

ISSN 2072-3857

protection and nutrition of plants . biotechonl adv 29:792-803.

13. Hagagg, L.F.; N. S. Mustafa ; E.A.E. Genaidy and El-Hady, E. S. 2018a. Effect of spraying nano-NPK on growth performance and nutrients status for (Kalamat cv.) olive seedling. Bioscience Research, 15(2): 1297-1303.
14. Hagagg, L.F.; N. S. Mustafa ; E.A.E. Genaidy and El-Hady. E. S. 2018b. Impact of nanotechnology application on decreasing used rate of mineral fertilizers and improving vegetative growth of Aggizi olive seedlings. Bioscience Research, 15(2): 1304-1311.
15. Ibrahim, Atef Mohamed and Mohamed Nazif Haggag Khalif. 1995. Citrus fruits, their cultivation, care and production. Al-Ma'arif facility. Alexandria.
16. Joslyn, M.A. 1970. Methods in food Analysis, Physical , Chemical, and Instrumental Methods of Analysis . 2nd .ed. Acadeemic press, Newyork and London.
17. Kashyap, P.L.; X. Xiang and P. Heiden. 2015. Chitosan nanoparticle baseddelivery systems for sustainable agriculture. Int. J Biol. Macromol. http://dx.doi.org/10.1016/j.ijbiomac.02.039.
18. Marschner. (1986). Mineral nutrition of higher plant. Acdemic press, Harcourt Brace Tovanovich, publishers. London.
19. Mustafa,N.S. ; H.H. Shaarawy ; M.F. El-Dahshouri and Mahfouze,S.A.2018. Impact of nano-fertilizer on different aspects of growth performance,nutrient status and some enzymes activities of (Sultani) fig cultivar. BioScience research,15(4):3429-3436.
20. O. A. C,(1970). Official Methods of Association of Official Analytical.
21. Qureshi , A., D.K. Singh and S. Dwivedi .2018. Nano-fertilizera : Anovel way for enhancing nutrient use efficiency and crop productivity , J. of curr. Microbiol .App. Sci., 7(2):3325-3335.
22. Rohi Vishekaii, Z.; A. Soleimani; A. Hasani; M. Ghasemnezhad; K. Rezaeiand S. Kalanaky. 2021. Nano-Chelated Nitrogen Fertilizer as a NewReplacement for Urea to Improve Olive Oil Quality. InternationalJournal of Horticultural Science and Technology, 8, 191-2018
23. Saied, H. H.M. 2018. Response of Keitte Mango Trees to Spraying Nano NPK Mg Fertilizers. Researcher, 10(12):1-5. http://www.sciencepub.net/researcher. 1.
24. Sekhon, A. M., Cristiano, G., Rubino, P., De Lucia, B. & Cazzato, E. 2013 Nitrogen uptake, nitrogen partitioning and N-use efficiency of container-grown Holm oak (Quercus ilex L.) under different nitrogenlevels and fertilizer sources. J. Food Agric. Environ, 11, 990-9948