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ROLE OF NPK FERTILIZER AND SPRAYING WITH SEAWEED EXTRACT AND NANO IRON ON GROWTH OF GRAPEFRUIT TRANSPLANTS

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ABSTRACT

This study was conducted in a lath house, Dept. Of Hort. and Landscape , College of Agricultural Engineering Sciences, Univ. Baghdad, during 2022 growing season to investigate influence of mineral fertilizers NPK and spraying with seaweed extract and Nano iron on some vegetative growth characteristics and leaf mineral content of two year's old Red blush of grapefruit transplants. Factors of study experiment included addition of three levels of mineral fertilizers NPK (without addition (C0), 2.5 g transplant^{-1} ($C_{2.5}$), and 5 g transplant^{-1} (C_5)), while seaweed extract spray was sprayed with two levels; without spray (S_0) and spraying at 4 g L^{-1} (S_4), As for Nano-iron fertilizer treatments, they were sprayed in three levels (0, 10, and 20 mg L^{-1}), which are denoted by symbols I_0, I_{10}, and I_{20}, respectively. Treatments were replicated three times (three transplants in experimental unit) at factorial experiment in a RCBD and thus number of transplants used was 162 transplants. The experimental results showed that chemical fertilizers at 5 g L^{-1}(C_5) significantly increased in leaves number of 47.44 leaf. plant^{-1}, leaf area of 29.99 cm^2, leaf phosphor content of 0.400 % and leaf iron content of 175.6 mg kg^{-1} . Results also showed that seaweed extract spray, significant superiority in increased in leaves number of 41.30 leaf plant^{-1}, leaf area of 28.92 cm^2, leaf phosphor content of 0.339 % and leaf iron content of 173.2 mg kg^{-1}. Nano- iron spray at 20 mg L^{-1} significantly effect in leaves number of 40.45 leaf plant^{-1}, leaf area of 28.27 cm^{2}and leaf iron content of 180.6 mg kg^{-1}. Twice and triple interactions between study factors significantly affected in all studied traits

Keywords: trees, foliar spraying, nano iron, algae extract, chemical fertilization.

دور سماد NPK والرش بمستخلص الأعشاب البحرية والحديد النانوي في نمو شتلات الجريب فروت

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الخلاصة

نفذت هذه التجربة في الظلة التابعة لقسم البستنة وهندسة الحدائق/ كلية علوم الهندسة الزراعية/ جامعة بغداد للموسم النمو 2022 على شتلات الكريب فروت صنف Red blush بعمر سنتين لمعرفة تأثير التسميد ب NPK والرش بمستخلص الطحالب البحرية والحديد النانوي في بعض صفات النمو الخضري ومحتوى الأوراق من العناصر الغذائية. اشتملت عوامل الدراسة على ثلاث مستويات من الاسمدة المعدنية NPK (بدون اضافة، 2.5 غم شتلة،5 غم شتلة، ورش مستخلص الطحالب البحرية بمستويين (0 و 4 غم لتر)، والرش بالحديد النانوي (0، 10، 20 ملغم لتر). نفذت كتجربة

[*]**The article is taken from the master's thesis of the first researcher.**

عاملية وفق تصميم القطاعات العشوائية الكاملة RCBD وبثلاث مكررات، و بثلاث شتلات لكل وحدة تجريبية وبذا يصبح عدد الشتلات الكلية 162 شتلة. أظهرت نتائج التجربة أن اضافة الأسمدة الكيماوية بتركيز 5 غم لتر$^{-1}$ تفوقت معنوياً في الزيادة في عدد الأوراق 47.44 ورقة نبات$^{-1}$ ومساحة الورقة29.99 سم^{2} ومحتوى الأوراق من الفوسفور0.400 % ومحتوى الاوراق من الحديد 175.6 ملغم كغم$^{-1}$. كما أظهرت النتائج تفوق رش مستخلص الطحالب البحرية معنوياً في زيادة عدد الأوراق41.30 ورقة نبات$^{-1}$ ومساحة الورقة 28.92 سم^{2} ومحتوى الورقة من الفسفور 0.339% ومحتوى الورقة من الحديد 173.2ملغم كغم$^{-1}$. كان لرش الحديد النانوي بمستوى 20 ملغم لتر$^{-1}$ تأثير معنوي في عدد الأوراق 40.45 **ورقة نبات-1 ومساحة الورقة 28.27سم2 ومحتوى الورقة من الحديد180.6 ملغم كغم - 1. كما أثر التداخل الثنائي والثلاثي بين عوامل الدراسة معنوياً في جميع الصفات المدروسة.**

الكلمات المفتاحية: أشجار، الرش الورقي، الحديد النانوي، مستخلص الطحالب، التسميد الكيميائي.

INTRODUCTION

Citrus paradisi L., the fruit of grapefruit trees, is a member of the Rutaceae family and the genus Citrus, which has five groups: the orange group, the tangerine group, the sour group, the Indian lemon group, which includes grapefruit, and the fifth group, which has other forms of citrus **(Shah, 2014)**. Fertilizers can be added directly to soil and are considered basic, while foliar spraying is a supplementary method for plants **(Ali, 2012).** Taking care of transplants growth at beginning of their lives will accelerate their growth and give them good growth strength. For their growth and development, plant needs necessary nutrients to enter into formation of important compounds in metabolic processes within plant directly, and these elements are present in soil, but their availability may not meet plant need is not ready due to high soil pH or its lack of movement, as well as the competition between the positive ions that affects absorption by roots in soil, therefore, use of compound fertilizers and their solutions is an important method to ensure speedy treatment of deficiency in elements during critical stages in plant life, supply of nutrients is main factor for plant growth, as it has a physiological, synthetic, chemical or biological role. Many of these elements are found in all biological molecules such as proteins, carbohydrates, chlorophyll, protein and nucleic acids **(Taiz & Zeiger, 2010).** Citrus trees respond to fertilization, especially compound fertilizers that contain major elements such as nitrogen, phosphorus and potassium, which are important for growth and plants development, using a balanced proportion of NPK compound fertilizer. Several studies have been conducted to determine effect of chemical fertilizers in growth on fruit transplants, (**Alkhafaji & Khalil, 2019)** found in an experiment on lemon transplants *Citrus limon* L. that addition of fertilizers led to a significant increase in vegetative growth and leaf nitrogen, phosphor and potassium content as compared with unfertilized transplants. **(Al-Hadethi *et al,* 2020)** Conducted an experiment to study effect of plant residues compost, NPK fertilizers and their interaction on growth and leaf mineral content of two year's old trees of "Khudiri" olive cultivar and found that NPK fertilizer at 5 gm.L^{-1} significantly increased in leaves number, leaf area, leaf nitrogen, phosphor, potassium and iron content as compared with control treatment.

For secondary metabolic activities that result in development of numerous plant growth processes, seaweed extracts are good biostimulants. The nutrients present in seaweed extracts, including nitrogen, phosphorus, potassium, sodium, calcium, boron, copper, iron, magnesium, manganese, and zinc, work with a variety of growth-stimulating compounds, including auxins, cytokinins, proteins, amino acids, and antioxidants, to improve the nutritional status of plants, increase photosynthesis efficiency, improve root growth; improve vegetative growth, and increase yield and quality **(Barsanti & Gualtieri, 2014 ; Calvo *et al.*, 2014)** .Numerous studies have been carried out to find out role of seaweed extract in growth and leaf mineral

content of fruit transplants. **(Al-Rawi *et al.*, 2016)** indicated that spraying seaweeds extract to peach transplants alone or in combination with gibberellic acids spray increased leaves number, leaf area and leaf nitrogen, phosphor, potassium and iron content as compared with control treatment, **(Al-Marsoumi & Al-Hadethi, 2020)** mentioned that seaweeds extracts spray with 2, 3 and 4 g L^{-1} caused a significant increase in leaves nitrogen, iron, phosphor and potassium compared to control treatment from his study on Qalib Al-thor mango cultivars. In another study carried out **Al-Rawi (2021)** to find out response of traditional lemon seedling to foliar fertilizer NPK, seaweed extract and gibberellin and it was found that spraying seaweed extract gave the highest leaf area and highest leaf nitrogen, phosphor and potassium content as compared with unsprayed transplants.

Iron is essential for lmprovement transplant growth and leaf mineral content. The inclusion of chelated iron nanoparticles boosts vegetative development and yield in fruit transplants. As the percentage of pollution remaining in various agricultural products increased and agricultural soils deteriorated, it became necessary to resort to various methods aimed at improving food production in full, improving productive efficiency of cultivated area, and increasing return from agricultural process, thus use of alternative methods, including nanotechnology, and its most important applications are Nano fertilizers, which have been used, Nanotechnology is increasingly widely used in agriculture and horticulture, with Nano fertilizer being used to boost vegetative growth, pollination, and fertility in flowers, resulting in increased yield and product quality for fruit trees **(Kashyap *et al.*, 2015 & Al-Hchami & Al-Rawi, 2020)** . Some studies were conducted to find out effect of Nano-fertilizers on growth and leaf mineral content of fruit trees, **(Jubeir & Ahmed, 2019)** conducted a study to investigate effect of Nano fertilizers and application method on growth and yield of date palm, they found that these fertilizers affect all studied traits such as leaf mineral content**.(Hamad,2021)** do an experiment to investigate effect of spraying iron-chelated Nano fertilizer at concentrations (0, 1, 2) gm L^{-1}on Jujube trees, found treatment iron chelated Nano fertilizer concentration 2 gm L^{-1} significantly increase leaves nitrogen, potassium, iron and phosphor content as compared with control treatment. The research aims to improving vegetative growth of transplants by this treatment and determine best fertilizer recommendation to improve vegetative growth.

MATERIALS AND METHODS

This study was conducted in a lath house, Dept. Of Hort. and Landscape, College of Agricultural Engineering Sciences, Univ. Baghdad, Al- Jadriya during 2022 growing season to investigate influence of mineral fertilizers NPK and spraying with seaweed extract and Nano iron on some vegetative growth characteristics and leaf mineral content of two year's old of grapefruit transplants. Factors of study experiment included addition of three levels of mineral fertilizers NPK (without addition (C0), 2.5 g transplant^{-1} ($C_{2.5}$), and 5 g transplant^{-1} (C_5)), while seaweed extract spray was sprayed with two levels; without spray (S_0) and spraying at 4 g L^{-1} (S_4), As for Nano-iron fertilizer treatments, they were sprayed in three levels (0, 10, and 20 mg.L^{-1}), which are denoted by symbols I_0, I_{10}, and I_{20}, respectively. Treatments were replicated three times (three transplants in experimental unit) at factorial experiment in a RCBD and thus number of transplants used was 162 transplants. NPK was added in spring growing season in 24-3-2022 and treatment was repeated in 17 -9- 2022 in autumn growing season. Spraying with seaweed extract and Nano-iron was done three times in spring growing season and two sprays in autumn growing season. The following parameters were determined in experimental season:

1. Increased in leaves number (leaf plant^{-1}): leaves number were measured at beginning and end of experiment, according to difference between them and that such an increase in leaves number.
2. Leaf area (cm2): five leaves were taken from middle position of shoot randomly and measuring leaf area (cm2). Using a Digimizer program Windows 7 operating system.
3. Leaf phosphor and iron content: samples of ten leaves from middle shoots according to **Chuntonarab & Cummings (1981),** Leaves were washed with tap water, rinsed with distilled water, and then dried at 70 c^0 until a constant weight, ground and digested according **Chapman & Pratt (1978).** Phosphorus was estimate the chromatic by using spectrophotometer by **Estefan *et al* (2013).** Iron was determined using atomic absorption as **(Page *et al*., 1982).**

Results of study were statistically analyzed and averages were compared according to (L.S.D) at 0.05 according to **Elsahookie & Wuhaib (1990).**

RESULTS AND DISCUSSIONS

Effects of NPK fertilizer and spraying with seaweed extract and Nano iron and their interaction on increased in leaves number and leaf area in grapefruit transplants: Data concerning effect of treatments on increased in leaves number and leaf area are listed in Tables (1 and 2). The data cleared that, chemical fertilizers at 5 g L^{-1}(C_5) significantly increased in leaves number of 47.44 leaf plant^{-1} and leaf area of 29.99 cm^2, while lower values of these traits was in C_0 treatment. Tables (1 and 2) also shows that seaweed extract spray, showed significant superiority in increased in leaves number of 41.30 leaf plant^{-1} and leaf area of 28.92 cm^2. Nano- iron spray especially spraying at 20 mg.L^{-1} was a significant effect in leaves number of 40.45 leaf plant^{-1} and leaf area of 28.27 cm^2. The interactions between chemical fertilizers and seaweed extract spray significantly affected in leaves number and leaf area especially the interaction treatment (C_5S_4) of 50.22 leaf. plant^{-1} and 31.13 cm^2, respectively. The interactions between chemical fertilizers and Nano-iron spray significantly affected especially when interaction treatment (C_5I_{20}) and gave 51.25 leaf plant^{-1} as increased in leaves number and 31.53 cm^2 as leaf area. The interaction between seaweed extract spray treatments and Nano-iron spray especially interaction treatment (S_4I_{20}) as it gave highest increased in leaves number of 44.67 leaf plant^{-1} and highest leaf area of 30.15 cm^2. Triple interactions between study factors had a significant effect in these traits.

Table (1): Effects of NPK fertilizer and spraying with seaweed extract and Nano iron and their interaction on increased in leaves number (leaf plant^{-1}) in grapefruit transplants**.**

Chemical fertilizer (C)	Seaweed Extract (S)	Nano-Iron (I)			C × S
		I_0	I_{10}	I_{20}	
C_0	S_0	27.00	28.33	28.67	28.00
	S_4	31.67	33.00	34.33	33.00
$C_{2.5}$	S_0	30.00	31.50	32.50	31.33
	S_4	37.33	40.00	44.67	40.67
C_5	S_0	41.00	45.50	47.50	44.67
	S_4	44.00	51.67	55.00	50.22
L.S.D 0.05		5.81			3.35
C × I					C
C_0		29.34	30.67	31.50	30.50
$C_{2.5}$		33.67	35.75	38.59	36.00
C_5		42.50	48.59	51.25	47.44
L.S.D 0.05		4.10			2.37
S × I					S
S_0		32.67	35.11	36.22	34.67
S_4		37.67	41.56	44.67	41.30
L.S.D 0.05		3.35			1.94
I		35.17	38.33	40.45	
L.S.D 0.05		2.37			

It's possible that the addition of NPK to soil increased plant uptake, which in turn increased vegetative growth, as seen by rise in leaves number and leaf area. The cause is also ascribed to the fact that improving nutrition with mineral fertilizers increases root surface area, which in turn increases absorption of nutrients and water, which in turn increases vegetative growth **(Al-Hadethi *et al*., 2020).** These results can be attributed to seaweed extract's role in promoting enzyme activity and transporting products of photosynthesis, such as carbohydrates, as well as its role in cell division and elongation, which had a significant impact on vegetative growth and this spraying resulted in an increase in macronutrient absorption, which was reflected favorably in vegetative growth characteristics **(Patel, *et al*., 2020).**These results are in agreement with those obtained by **Al-Hadethi (2019)**; **Azawi & Salih (2019)** on olive transplants; they found a significant increase in vegetative growth when spraying with seaweed extract. In addition to effect of iron and its role in vital processes of plant cell, due to fact that iron is an important nutrient for its entry as an enzymatic cofactor, especially in chlorophyll biosynthesis and increasing content of leaves from it, which works to increase efficiency of photosynthesis process, increase its outputs, and increase vegetative growth **(Ali *et al*., 2014).**

Table (2): Effects of NPK fertilizer and spraying with seaweed extract and Nano iron and their interaction on leaf area (cm^2) in grapefruit transplants**.**

Chemical fertilizer (C)	Seaweed Extract (S)	Nano-Iron (I)			C × S
		I_0	I_{10}	I_{20}	
C_0	S_0	19.66	20.80	22.28	20.91
	S_4	24.36	28.00	28.12	26.83
$C_{2.5}$	S_0	25.30	25.48	26.00	25.59
	S_4	27.44	28.80	30.16	28.80
C_5	S_0	27.50	28.20	30.88	28.86
	S_4	30.36	30.84	32.18	31.13
L.S.D 0.05			2.84		1.64
C × I					C
C_0		22.01	24.40	25.20	23.87
$C_{2.5}$		26.37	27.14	28.08	27.20
C_5		28.93	29.52	31.53	29.99
L.S.D 0.05			2.01		1.16
S × I					S
S_0		24.15	24.83	26.39	25.12
S_4		27.39	29.21	30.15	28.92
L.S.D 0.05			1.64		0.95
I		25.77	27.02	28.27	
L.S.D 0.05			1.16		

Effects of NPK fertilizer and spraying with seaweed extract and Nano iron and their interaction on leaf phosphor and iron content in grapefruit transplants: Data concerning effect of treatments on leaf phosphor and iron content are listed in Tables (3 and 4). The data cleared that, chemical fertilizers at 5 g L^{-1}(C_5) significantly increased in leaf phosphor content of 0.400 % and leaf iron content of 175.6 mg kg^{-1}, while lower values of these traits was in C_0 treatment. Tables (3 and 4) also shows that seaweed extract spray, showed significant superiority in leaf phosphor content of 0.339 % and leaf iron content of 173.2 mg kg^{-1}. Nano-iron spray was non significantly effect in leaf phosphor content but was significantly in leaf iron content especially at 20 mg L^{-1} and gave 180.6 mg kg^{-1}, while lower values of this trait was in I_0 treatment. The interactions between chemical fertilizers and seaweed extract spray significantly affected in leaf phosphor content and leaf iron content especially interaction treatment (C_5S_4) of 0.416 % and 178.6 mg kg^{-1} , respectively.

Table (3): Effects of NPK fertilizer and spraying with seaweed extract and Nano iron and their interaction on leaf phosphor content (%) in grapefruit transplants**.**

Chemical fertilizer (C)	Seaweed Extract (S)	Nano-Iron (I)			C × S
		I_0	I_{10}	I_{20}	
C_0	S_0	0.226	0.228	0.233	0.229
	S_4	0.248	0.244	0.249	0.247
$C_{2.5}$	S_0	0.302	0.306	0.300	0.303
	S_4	0.344	0.356	0.360	0.353
C_5	S_0	0.390	0.382	0.377	0.383
	S_4	0.412	0.416	0.421	0.416
L.S.D 0.05		0.093			0.054
C × I					C
C_0		0.237	0.236	0.241	0.238
$C_{2.5}$		0.323	0.331	0.330	0.328
C_5		0.401	0.399	0.399	0.400
L.S.D 0.05		0.066			0.038
S × I					S
S_0		0.306	0.305	0.303	0.305
S_4		0.335	0.339	0.343	0.339
L.S.D 0.05		N.S			0.031
I		0.320	0.322	0.323	
L.S.D 0.05		N.S			

The interactions between chemical fertilizers and Nano-iron spray significantly affected especially when interaction treatment (C_5I_0) and gave 0.401 % as leaf phosphor content and interaction treatment (C_5I_{20}) and gave 187.4 mg kg^{-1} as leaf iron content. Interaction between seaweed extract and Nano-iron spray did not significant in leaf phosphor content, while interaction treatment (S_4I_{20}) gave highest leaf iron content of 184.0 mg kg^{-1}. Triple interactions between study factors had a significant effect in these traits.

This increase in leaves mineral content may be due to addition chemical fertilizer to soil, which led to an increase in concentration of these elements in soil solution, then an increase in their availability for absorption by roots of grapefruit transplants and an increase in their transmission, and thus an increase in concentration of these elements in leaves, many researchers confirmed increasing concentration of element in soil solution leads to an increase in its uptake by plant **(Ali *et al*., 2014),** leaves mineral increases with increase fertilization level with chemical fertilizer. Also, reason may also be due to increase in leaf area (table 2) and leaves chlorophyll content, which it leads to absorption of these elements to meet transplants needs. These results are consistent with **Al-Zobaie & Al- Habbabi (2023)** on orange transplants; they found a significant increase in leaf nitrogen, phosphor, iron and potassium content when adding with NPK fertilizer.

Table (4): Effects of NPK fertilizer and spraying with seaweed extract and Nano iron and their interaction on leaf iron content ($mg.kg^{-1}$) in grapefruit transplants.

Chemical fertilizer (C)	Seaweed Extract (S)	Nano-Iron (I)			C × S
		I_0	I_{10}	I_{20}	
C_0	S_0	155.6	162.4	170.1	162.7
	S_4	160.2	164.8	176.7	167.2
$C_{2.5}$	S_0	160.7	167.2	178.0	168.6
	S_4	166.9	171.0	184.2	174.0
C_5	S_0	164.6	169.9	183.6	172.7
	S_4	170.2	174.3	191.2	178.6
L.S.D 0.05		12.09			6.98
C × I					C
C_0		157.9	163.6	173.4	165.0
$C_{2.5}$		163.8	169.1	181.1	171.3
C_5		167.4	172.1	187.4	175.6
L.S.D 0.05		8.55			4.94
S × I					S
S_0		160.3	166.5	177.2	168.0
S_4		165.7	170.0	184.0	173.2
L.S.D 0.05		6.98			4.03
I		163.0	168.3	180.6	
L.S.D 0.05		4.94			

As for leaves mineral content as a result of spraying seaweed extract, above tables show that there is a significant effect of spraying this extract on leaves phosphor and iron content in grapefruit transplants and its obvious effect on increasing, and this increase is due to containment of this extract it contains major nutrients, especially N, P, and K, as well as microelements, which are directly absorbed when sprayed on leaves, thus increasing their percentage in leaves **(Khan *et al.*, 2009).**As for increase in leaves iron content, it is due to direct spraying of this element, which leads to an increase in its concentration in plant tissues.

CONCLUSION

This study contributes valuable insights into optimizing the growth and mineral content of grapefruit transplants. The findings emphasize the significance of carefully tailored combinations of NPK mineral fertilizer, seaweed extract spray, and nano iron application to achieve desirable outcomes in terms of vegetative growth and leaf mineral composition. The results underscore the importance of understanding complex interactions between various growth-promoting agents for informed agricultural practices and improved crop cultivation strategies.

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