Response of lemon (*Citrus limon* L.) to foliar spray with organic Optimus Plus and Fe-chelate

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Abstract

The experiment was carried out in the main orchard of the Horticulture Department / Al-Hindiya Station for the production of certified citrus seedlings / Karbala Governorate / Iraqi Ministry of Agriculture, during the 2018 season. The experiment included 9 treatments and three replicates to study the interaction between two factors, The first factor was Optimus plus nutrient solution in three concentrations (0, 1, 2 ml. L^{-1}) which contains (5% nitrogen, 30% amino acid and 3% organic nitrogen) and the second factor was Fe-chelate with three concentrations (0, 500, 1000 mg.L^{-1}). Local lemon grafted on sour were sprayed at a rate of three applications (before sour, month after the last spray). The results showed that spraying with nano-fertilizer Optimus plus at concentration of 2 ml.L^{-1} and Fe- chelate a concentration of 1000 mg.L^{-1} resulted in the highest increase in all studied traits including the leaf area, the leaf content of total chlorophyll, and carbohydrates, the number of fruits, fruit weight and total yield, with significant differences compared to the control treatment.

Keywords: Optimus plus, Fe-chelate, growth and productivity, *Citrus limon* L.

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Introduction

Lemon (*Citrus limon* L.) belongs to the genus *Citrus* in the Rutaceae family. The northeastern regions of India and southwestern China are the original habitats of this species (10). *Citrus limon* is one of the types of citrus cultivated in Iraq widely since a long time ago due to the availability of appropriate conditions for its cultivation. The lemon fruits are desired by consumers Lemon fruits are enriched in minerals needed for the human body such as potassium, calcium, iron, magnesium, sodium, sulfur, phosphorus, and it is an important source of vitamin C and a good amount of vitamin A, B1, B2, B12 and Niacin (17).

One of the cultivars of sour lemon is the local cultivar and it is a very desirable in Iraq because of its excellent quality, small size, juicy , thin peel and contains less acidity than the other international cultivars (10). The Nano-materials possess all the necessary properties for use in agriculture as they are highly efficient with high solubility and effectiveness . They are used in small quantities and lead to good results without the need for repeated application and thus increase the efficiency of the use of fertilizers (20). Amino acids are the basic unit for building all proteins. They are also precursors for generating some hormones, purines, vitamins, plant tissue formation , chlorophyll biosynthesis. Amino acids are vital stimulants that absorb and transfer quickly within plants and have a direct effect on the enzymatic activity as they accelerate the absorption , transmission of nutrients inside the plant , help in the process of opening , closing stomata and providing the energy needed to the within the plant (1, 4 and 11).

Ahmed *et. al.* (6) mentioned in their study the effect of spraying amino acid tryptophan on Valencia orange trees (14 years old) with a concentration of 25, 50 and 100 ppm that led to a significant increase in the studied vegetative growth characteristics (branch length, branch diameter, number of leaves, leaf area, quotient Tree, number of fruits in the tree, the) compared to the comparison treatment.

Ahmed *et. al.*(7) found that spraying tryptophan amino acid on orange trees (*Citrus sinensis* L. Osbek) (age 40 years) at a concentration of 25.50 ppm was found to improve vegetative properties (leaf area, number of leaves, branch diameter, length of branches and yield indicators including the fruit weight and the fruit size. It was also noted that spraying with Nano-treated fertilizer for the growth of *Citrus aurantifolia* seedlings at a concentration of 1.5 $ml.L^{-1}$ resulted in a significant improvement in all vegetative traits(9).

The iron spray has been used for the importance of chelating compounds in treating the lack of micronutrients in the plant, especially in Iraqi soil with a high calcine content that makes them have a basic reaction that leads to fixation of the micronutrients and the difficulty of their absorption. Iron is involved in helping to The iron even though it is not included in its composition, as well as what recent studies have indicated about the role of iron in the RNA formation process and the importance of its role in the protein formation process(12). In a study conducted by Abdel Wahed *et al.*(2) spraying chelated iron with a concentration of (0, 150, 250 $mg.L^{-1}$) on

seedlings of sour orange resulted in increased rates of studied vegetative traits (plant height, number and, length of branches, number of leaves and Foliar area, leaf content of total chlorophyll and carbohydrates). Similar results were achieved by spraying the sour lemon seedlings with iron at a concentration of (50, 100, and 150 mg.L^{-1}), which led to a significant increase in all characteristics of vegetative growth(3). Spraying sweet lemon trees *Citrus limetta* with iron at low concentrations (0, 5 and 10 mg.L^{-1}) resulted in a significant increase in the characteristics of the yield including the size of the fruit and the tree yield and. Therefore, this research aims to evaluate the effect of different combinations of nano-organic fertilization and chelated Iron in the vegetative traits and nutritional contents of local sour lemon trees and their reflections on tree productivity and the natural and qualitative characteristics of the fruits.

Materials and Methods

This experiment was conducted in the main citrus orchard of the Horticulture Department in Al-Hindiya Station, Krbala Government, Iraq for certified citrus production on 10 -12 years old local sour lemon. Before starting the experiment, random samples were taken from the field soil from different regions at a depth of 0-60 cm, then mixed homogeneously and a representative sample was taken to estimate some chemical and physical properties in the laboratory of the Department of Soil Science and Water Resources, Faculty of Agriculture, University of Kufa (Table 1). According to the station cultivation program, all the crop services were performed including irrigation and insect control using insect traps and insecticides as needed. The trees were fertilized with animal manure compost at 4 kg/tree in mid of December and tree pruning was also performed by removing dead and crowded branches.

The experiment designed two factors according to Randomized Complete Block Design (R.C.B.D) with nine treatments and three replicates for each treatment.. The nine treatments and three replicates for each treatment. included spraying with Optimus plus (5% nitrogen, 30% amino acids and 3% organic nitrogen) with three concentrations (0, 1 , 2 ml.L^{-1}) and nine treatments and three replicates for each treatment. Fe-chelate at three concentrations (0, 500, 1000 mg.L^{-1}). In the early morning and until the complete wetness, the trees were sprayed three times (after flowering, after fruit formation , and 30 days after the last spray) during the experiment using backpack sprayer. Five months after the last spray, data were recorded including leaf area (cm^2.$leaf^{-1}$), leaf content of total chlorophyll mg.100g^{-1}FW(13), and

Table1. Physical and chemical characteristics of the orchard soil

pH	E.C. ds.m^{-1}	Organic matter %	N mg.kg^{-1}	P mg.kg^{-1}	K mg.kg^{-1}	Clay	Silt g.Kg^{-1}	Sand	Soil texture
7.20	1.8	1.31	130	10.9	206	82	113	805	Sandy loam

carbohydrates mg.100g^{-1}DW(15), number of fruits (fruit.tree^{-1}), fruit weight (g.fruit-1), total yield (Kg.tree^{-1}), fruit size cm^3 and fruit length cm. All the collected data were analyzed and analysis of variance ANOVA was performed using GenStat 2012 computing program. Means were compared by the least significant difference L.S.D. ($P\leq0.05$).

Results and Discussion

Regarding the effect of different treatments on vegetative growth parameters of lemon trees, results (Table2) showed that spraying with Optimus plus at a concentration of 2ml.L^{-1} led to the highest values of the tested growth and yield indicators compared to the 1ml.L^{-1} of the same fertilizer and the control. The results also show that the Fe-chelate concentrations did not differ significantly ($P\leq0.05$) in their effect on growth and obtained yield when excluding the effect of the organic fertilizers Optimus plus. In general, the values of growth and yield indicators under study wre higher in the case of higher Fe-chelate concentrations (1000mg.L^{-1}) especially were interacted with the highest concentration of the organic Nano-fertilizer. The interaction treatment of Fe-chelate at 1000mg.L^{-1} and the Optimus plus 2ml.L^{-1} resulted in significantly higher values in the fruit weight and the total yield compared to all other treatments and interactions (Table2). The improvement of the vegetative growth characteristics of trees mg.kg^{-1}with Optimus plus in both concentrations 1 and 2 ml.L^{-1} is often due to the direct or indirect effect of amino acids on the physiological processes of the trees. It is due to the role of amino acids in stimulating the vital activities that occur within plant tissues and their effects in building and stimulating enzymatic systems, enzymatic accompaniments, different bases of the Purine and Pyrimidine, and increasing the formation of nucleic acids DNA and RNA (16).

Table2. Effect of spraying with Nano-organic fertilizer Optimus plus and Fe-chelate on growth and yield characteristic of sour lemon trees

Optimus plus ml.L^{-1} (Org.) X Iron-chelate mg.L^{-1} (Fe)		Leaf area cm^2. Leaf^{-1}	Total chlorophyll mg.100g^1 FW	Total carbohydrates mg.100g^1 DW	No. of fruits (fruit.tree-1)	Fruit weight g.fruit^{-1}	Total yield Kg.tree^{-1}
Org. 0	Fe0	24.31	48.90	4.02	123.6	77.07	9.525
	Fe500	24.98	47.58	4.01	129.1	77.81	10.045
	Fe1000	26.46	51.78	4.09	130.7	79.09	10.337
Org. 1	Fe0	25.66	50.36	4.09	135.2	79.77	10.784
	Fe500	26.93	48.50	3.89	135.2	80.10	10.829
	Fe1000	27.56	53.66	4.68	137.1	79.10	10.844
Org. 2	Fe0	25.11	52.52	4.69	136.0	80.09	10.892
	Fe500	28.12	53.41	4.95	141.2	80.84	11.414
	Fe1000	27.50	51.58	5.33	147.5	83.33	12.291
L.S.D.(P≤0.05)		1.73	0.71	0.25	3.98	1.79	1.157

This leads to increased tree growth due to increased protein combinations and carbohydrate formation by stimulating photosynthesis through its contribution to

increased chlorophyll combinations. As the amino acids Glycine and Glutamine are essential components in combinations, so their availability increases the efficiency of photosynthesis, which reflects positively in the leaf area and the leaf content of chlorophyll and increases the carbohydrate content (7 and 9).

The Optimus plus nanoparticle contains nitrogen, which has an important role in increasing vegetative growth and is one of the components of the chlorophyll molecule, which results in increased photosynthesis. Nitrogen is involved in the synthesis of Porphyrins groups involved in the synthesis of chlorophyll, which leads to an increase in the leaf content of chlorophyll. It also participates in the formation of the amino acid Tryptophan, the first initiator in the formation of IAA that stimulates cell elongation and this reflects positively on vegetative growth indicators (7) .

The increase in the number of fruits, the weight of the fruits, and the total yield when spraying trees with the iron component in general is due to the effect of the iron element in increasing vegetative growth and the importance of iron in biological processes within the plant. Iron participates in accelerating the conversion of some vegetative buds to flower buds, and then increases the flower buds and this leads to an increase in the number of flowers in the plant (Hurly et al., 1986). The results of the study were similar to the results of previous studies and agree with the results of Obaid (19) in his experiment on mandarin *Citrus reticulata* trees cultivate Clementine, Aboutalebi and Hamad (5) on sweet lime *Citrus limmeta* trees and the results of a study by Al-Hamdani and Al-jubouri(8) in their study conducted on local orange *Citrus sinensis* trees.

The increase in the yield of trees treated with Optimus plus is due to the amino acids and their positive role in increasing the growth of trees and improving the nutritional status as well as increasing the trees' tolerance to environmental stresses, which reflected positively in increasing the efficiency of photosynthesis and producing more quantities of carbohydrates and reduces the competition of the fruits formed on the nutrients produced in the leaves (6). Which leads to an increase in the number of fruits obtained in general (7), likewise the role of Iron (Fe) in increasing the yield and the number of fruits (18).

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