Plant Archives Vol. 20, Supplement 2, 2020 pp. 3955-3958 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF SOIL FERTILIZATION AND FOLIAR NANO-NPK ON GROWTH OF KEY LEMON *CITRUS AURANTIFOLIA* ROOTSTOCK SAPLINGS

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Abstract

The study aimed to assess the response of the three-month-old seedlings to soil fertilization with mineral NPK 0.5, 1.0, 2.0 g /L every 15 days, and spraying with Nano-NPK at concentrations of 150, 300 or 450 mm/L once every 30 days in addition to the control treatment (spraying with tap water) for a period of seven months from 1/5/2019 to 1/12/2019. The experiment was factorial according to Randomized Complete Block Design conducted in the Karbala nursery for certified citrus saplings production belongs to the Iraqi Ministry of Agriculture. The results showed that soil treatment of lemon saplings with mineral NPK at 2.0 $g.L^{-1}$ resulted in a significant increase in stem diameter that did not differ from the concentration of 1 $g.L^{-1}$, total leaf area, shoot and root dry weight and the absolute growth rate compared to the lowest values resulted from the control treatment. The results also showed that spraying the saplings with NPK nanoparticles at a concentration of 450 $mg.L^{-1}$ resulted in the highest values for the above indicators compared to other concentrations and the control treatment. The interaction treatment of 2.0 g/L^{-1} mineral NPK and 450 ml/L^{-1} Nano-NPK resulted in the highest values for all growth indicators under study except for the stem diameter which was at the highest value in the interaction treatment of 1.0 $g.L^{-1}$ mineral NPK and 450 $mg.L^{-1}$ Nano-NPK.
***Keywords*:** Citrus, Nano-fertilizers, lemon, stem diameter

Introduction

Key Lime *Citrus aurantifolia* is a citrus stimulant rootstock plant that well matching with most citrus grafts (Suntar *et al.*, 2018). Fertilization, especially "Macronutrients," including NPK elements that are required by the plant in large quantities, is an important service process for the plant and a critical means of production in improving both qualitative and quantitative production (Hawkesford *et al.*, 2012). In the past few years, many experiments have been conducted to study the possibility of using nanotechnology to improve the efficiency of fertilizers and the development of Nano-fertilizers that can be more soluble, effective and faster in absorption and metabolism in plant tissues than traditional fertilizers (Rastogi *et al.*, 2017).

In this regard, Dinnes *et al*. (2002) show that fertilization is important and effective in equipping the plant with the necessary mineral elements important to improving growth and increasing production. As for foliar fertilization, it is considered more economical in the amount of fertilizer used and its distribution is better and faster, as foliar feeding can equip the plant with a high percentage of its nutrient needs when the soil conditions are not suitable for nutrient absorption and thus nanoferta can be considered a good method, especially in alkaline soils (Srivastava and Malhotra, 2017) leafy area and fresh and dry plant weight are important growth indicators for nutritional status assessment, while stem diameter of the sapling is an important indicator for assessing success of the grafting process. In this regard, several studies have been conducted in the possibility of improving the characteristics of growth in citrus fruits and speeding up the production of sour orange saplings (Al-Jelaihawy, 2019).

The study aimed to assess the effect of fertilizing with mineral NPK and spraying with nanoparticles NPK individually or in conjunction with different concentrations on the growth of lemon seedlings in general and their effect on the possibility of increasing the diameter of the stem of the seedlings to obtain viable seedlings in a short time.

Materials and Methods

The experiment was carried out in the nursery of certified citrus production in Al-Hindiya district - Karbala governorate, which belongs to the Iraqi Ministry of Agriculture-General Directorate of Horticulture and Forests for the period from 1/5 to 12/12/2019. In this experiment, 192 homogeneous lemon seedlings, *Citrus aurantifolia* "Lime" seedlings, aged 3 months, were planted in plastic bags of 3.5 kg. The seedlings were transferred to 10 kg pots filled with standard seedling soil. The experiment was operative according to (RCBD) Randomized Complete Block (Narrator and Khalaf Allah, 2000). The first factor involved treating the seedlings soil every 15 days with mineral NPK in concentrations of 0.5, 1.0 or 2.0 $g.L^{-1}$, in addition to the control treatment (without fertilization). As for the second factor, it involves spraying the seedlings once every 30 days with NPK produced in nanotechnology at concentrations of 150, 300 or 450 mg. $Liter^{-1}$ or sprayed with tap water (control).

Data of stem diameter at 5 cm above the ground were recorded for all treatments every 30 days for the seven months experiment period. At the end of the experiment period, data were collected for other indicators including the total leaf area (using Image J program) shoot and root dry weight. Absolute growth rate was also calculated among treatments (Hunt, 1982). The data were analyzed using the GenStat computer program (Payne *et al.*, 2007). Analysis of variance ANOVA was performed for each measured parameter under study and means for each parameter were compared using Duncan's Multiple Range Tests ($P \le 0.05$).

Results and Discussion

The results of monitoring and measuring the growth of the seedlings stem diameter each month and for seven months showed that the seedlings diameter was affected by their age in terms of increasing, regardless of the fertilizers used (as in the untreated control treatment) and also increased for all mineral NPK concentrations treated in the seedling soil (Table 1). Generally, the nanoparticles and mineral fertilizers had significant and clear effects on stem diameter, and the effect increased with increasing concentration. The results indicated that the use of the mineral NPK fertilizer at a concentration of 1.0 $g.L^{-1}$ combined with 450 $mg.L^{-1}$ of the NPK nanostructure resulted in giving the largest seedling stem diameter (9.68 mm) at the end of the experiment period. The same interaction treatment resulted in significantly higher value of stem diameter than all the other interaction treatments throughout the trial period (Table1).

Table 1 : Effect of fertilization with mineral and nanoparticles NPK on the stem stem of lemon seedlings during seven months growth, at 10 kg pot

Mineral NPK soil treatment g/L	Nano-NPK foliar spray g/L	Stem diameter (mm) during the experiment period							
		May	June	July	August	September	October	November	December
0	0	2.917 a	2.967 cdef	3.108 E	3.267 e	3.433 e	4.400 D	4.600 f	5.850 G
	150	2.533 ab	2.927 Ef	3.250 De	3.350 de	3.500 e	4.433 D	4.683 f	6.763 F
	300	2.880 a	3.127 abcde	3.600 Cd	3.733 bcde	3.967 de	4.633 D	4.867 ef	7.270 ef
	450	2.483 ab	3.158 abc	3.908 Bc	4.260 abcd	4.800 bc	5.433 Bc	5.567 cd	8.050 bcd
0.5	0	2.458 ab	2.810 F	3.233 De	3.267 e	3.633 e	4.400 D	4.717 f	5.950 G
	150	2.467 ab	2.943 def	3.620 Cd	3.800 bcde	4.133 cde	4.900 Cd	5.392 de	7.150 ef
	300	2.617 ab	3.068 bcde	3.850 Bc	4.133 abcde	4.627 bcd	5.358 Bc	6.133 bc	7.450 def
	450	2.242 b	3.150 abcd	4.400 A	4.383 abc	4.977 ab	5.792 B	6.367 b	8.470 B
1.0	0	2.667 ab	2.925 Ef	3.327 De	3.467 cde	4.177 cde	4.850 Cd	5.267 def	6.833 F
	150	2.692 ab	2.993 cdef	3.783 Bc	4.033 abcde	4.200 cde	5.408 Bc	6.100 bc	7.700 cde
	300	2.668 ab	3.168 abc	3.800 Bc	4.233 abcde	5.043 ab	5.983 B	6.200 bc	8.190 bc
	450	2.508 ab	3.317 A	4.400 A	4.967 a	5.677 a	6.693 A	7.133 a	9.680 A
2.0	0	2.825 a	2.993 cdef	3.887 Bc	3.743 bcde	5.160 ab	5.567 B	5.833 bcd	7.383 def
	150	2.633 ab	3.098 bcde	4.128 Ab	4.510 ab	5.217 ab	5.825 B	6.133 bc	8.223 bc
	300	2.517 ab	3.250 Ab	4.417 A	4.710 ab	5.360 ab	5.867 B	6.233 bc	8.497 B
	450	2.525 ab	3.317 A	4.350 A	4.950 a	5.393 Ab	5.900 B	6.300 b	8.667 B

Values are means of 3 replications (4 plant each). Means followed by the same letter(s) within a column are not significantly different accodring Duncan's multiple range tests ($P \leq 0.05$)

Results showed that the growth indicators of key lemon saplings differed according to the type of fertilizer treated, as well as by the concentration used for each fertilizer (Table 2). It is clear from the results that the mineral NPK at concentration 2.0$g.L^{-1}$ and Nano-NPK at 450$mg.L^{-1}$ led to the highest values of the growth indicators under study including the total leaf area/plant, the dry weight of the vegetative group and the root group, and the absolute growth rate compared to the other concentrations within a fertilizer with significant difference from the control treatment. Generally, the highest values for all growth indicators under study were recorded in the interference treatment of 2.0$g.L^{-1}$ mineral NPK and 450$mg.L^{-1}$ Nano-NPK.

The increase in stem diameter was associated with an increase in the levels of mineral and nanoparticle NPK fertilizers or their interactions. This may be due to the role played by the N, P and K nutrients in plant growth. Nitrogen works to meet the plant's need for compounds necessary in the processes of cell division and elongation, so that the growth of different tissue cells in the plant body increases, including an increase in the activity and division of the cambium tissue and thus an increase in the thickness of the main and branch legs (Al-Rikaby, 2014).

Spraying the seedlings with NPK nanoparticles and the synergistic effect of the three elements increased the seedlings leaf content of total carbohydrates and as a result of the dry weight gain of the vegetative and root system (Qureshi *et al*., 2018).

The fertilizer nanoparticles and their large surface area lead to an increase in their solubility in various solvents, including water, which increases the penetration of these particles into the surface of the contact papers leading to an increase in a larger area for diffusion and various metabolic reactions in plants and an increase in the rate of photosynthesis causing an increase in the production of dry matter in the plant General (Ali, 2015).

Table 2 : Effect of fertilization with mineral and Nano NPK on growth parameters of key lemon saplings grown in 10 kg plastic pots

Treatments		Total leaf area/plant cm	Shoot dry weight g/plant	Root dry weight g/plant	Absolute growth rate
Mineral NPK Soil treatment	**Nano-NPK Foliar spray**				
0	0	929 K	5.04 i	2.820 I	0.0179
	150	1915 I	7.12 h	5.710 Gh	0.0277
	300	3243 G	12.61 ef	6.690 F	0.0533
	450	4199 E	14.37 de	8.867 D	0.0615
0.5	0	1505 J	6.71 hi	5.060 H	0.0257
	150	2014 I	9.60 g	5.910 Fg	0.0392
	300	3784 F	11.30 fg	7.610 E	0.0471
	450	4611 D	15.42 cd	9.447 D	0.0664
1.0	0	1965 I	7.57 h	6.540 Fg	0.0297
	150	2421 H	11.39 fg	7.990 E	0.0476
	300	4366 De	13.53 e	9.447 D	0.0576
	450	6135 B	21.46 b	13.430 B	0.0946
2.0	0	2366 H	10.52 g	7.523 E	0.0436
	150	3214 G	11.36 fg	9.380 D	0.0475
	300	5238 C	16.72 c	11.110 C	0.0725
	450	7581 A	32.51 a	15.750 A	0.1463

Values are means of 3 replications. Means followed by the same letter(s) within a column are not significantly different accodring Duncan's multiple range tests ($P \leq 0.05$)

Here, it can be said that the rate of absolute growth may explain the efficiency of the plant in carrying out the biological processes, which is affected by any factor that negatively affects the activity of roots and their efficiency in absorbing nutrients. Thus, the growth of plants in general is evident from its association with increasing the dry weight of the roots, as the many and long roots produced more weight that reflected on the rate of absolute growth. And considering that the rate of absolute growth of plants is an indication of the efficiency of the plant's completion of metabolic and biological processes taking place in the plant, the increase in operations with increasing concentrations used for fertilizer NPK in the two methods (ground and spray on the vegetative system) that confirmed the rate of absolute growth and the indicators under study. These indicators clearly indicate that the citrus saplings become ready for grafting as rootstocks in relatively shorter period of time compared to the saplings in the case of non-fertilization with NPK, taking into account the type of citrus used as rootstock.

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