Effect of Fertilization with Seaweed Extract and High K-P Mixture on Leaf Nutritional Content in Citrus Rootstock C-35

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Abstract

The experiment was conducted in the citrus production nursery/Al-Hindiya District/province of Karbala, Iraqi for the period 10/4 -to 10/12/2021. The study aimed to evaluate citrus rootstock C-35 saplings response to four fertilization levels of SWE (0.0, 0.5, 1.0, 1.5 g. L^{-1}) and/or high K-P mixture (0.0, 0.5, 1.5, 2.5 g.$plant^{-1}$) and their interaction effects. Both fertilizers were monthly applied (six times) except for July and August. The treatments were distributed as Randomized Complete Block Design (RCBD) factorial experiment with three replications. The results showed that leaf content of nutrients (nitrogen, phosphorous, potassium, iron, zinc, and boron) was significantly higher when SWE was used at 1.5 and 1.0 g.L^{-1} and High potassium-phosphorus fertilizer at 2.5 g.$plant^{-1}$. The interaction of 1.5 g.L^{-1} SWE and 2.5 g.$plant^{-1}$ K-P fertilizer caused a significant increase in most parameters tested in C-35 citrus rootstock seedlings leaves.

Key Words: Citrus Fruits, Roots, SWE, Compound Fertilizer.

DOI Number: 10.14704/nq.2022.20.2.NQ22268 **NeuroQuantology 2022; 20(2):168-172**

Introduction

Citrus can be propagated by sexual propagation through seeds to produce new varieties to obtain proper rootstock, or asexual propagation (which is the most common) through grafting for the desired species to take advantage of its characteristics (Alexander and Lewis, 2008; and Albrecht et al., 2018). The rootstock choice is very important in citrus production since it is affecting the productivity and quality of the fruits (Zhu et al., 2020). The rootstock can physiologically affect the growth and production of the grafts (Khan, 2007). It is a necessary element in citrus production because rootstock can make grafts tolerant to difficult conditions, diseases, and pests (Bowmar and Joubert, 2020). One of these rootstocks is the C-35 rootstock, which is a cross-breeding hybrid (Khojah et al., 2020, Dambier et al., 2011). C-35 rootstock belongs to the group of Citranges. It is gained from the cross-breeding between *Citrus Sinensis* × *Poncirus trifoliata*. C-35 can resist the Tristeza virus, which is one of the diseases that destroy many citrus trees. Therefore, the use of C-35 rootstock is an effective tool to combat this virus leading to an increase in its demand to replace bitter orange *Citrus aurantium*, which is still the most widely grown rootstock (Chiancone, et al., 2014).

The slow growth of citrus is leading to the use of some ways to accelerate the growth of seedlings and bring them to an appropriate size. One of these ways is the addition of plant stimuli such as seaweed extracts (Depascal et al., 2017).

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Received: 15 January 2022 **Accepted:** 04 February 2022

The products extracted from seaweed are widely used as stimulants in horticultural productions due to its unique content of many growth regulators such as cytokinins, auxins, and gibberellins (Thirumaran and Arumugam, 2009). In addition, SWE contains some essential nutrients such as phosphorus, potassium, calcium, and micro-nutrients. These elements are necessary in plant growth and development (Begum et al., 2018). Using fertilizers containing (N-P-K) is one of the important agricultural operations that are carried out on fruit trees for its impact on vegetative growth and nutrition, especially at the beginning of the growth (Oberza and Morgan, 2011).
Given the importance of fertilizer in improving the plant's nutritional status, this study was conducted to evaluate C-35 rootstock under the fertilization of seaweed extract as well as high potassium and phosphorous compound fertilizer. In addition, the interaction between both fertilizers was determined.

Materials and Methods

The experiment was conducted in the nursery of citrus production which belongs to Al-Hindiya District/ Karbala Governorate /Iraqi Ministry of Agriculture for the 2021 growing season, to determine the effect of seaweed extract (Acadian) as well as high potassium and phosphorous fertilizer mixture on seedlings of C-35 rootstock. As 144 seedlings of the rootstock at 6 months old were selected and placed in the half-shade cover net for a month before the treatment. Acadian seaweed extract was used as main factor, it is organic fertilizer and a bio-stimulant (Table 2), where it was sprayed on the vegetative system at four levels (0, 0.5, 1 and 1.5 g. L^{-1}). The high-potassium-phosphorous fertilizer mixture was used as the second factor. It is a fertilizer containing the three elements (N P K) necessary for plant nutrition (Table3). This fertilizer was produced by the Kufa Agricultural Fertilizer Factory/College of Agriculture/University of Kufa. The fertilizer was added to the seedling roots at levels of 0, 0.5, 1.5, 2.5 $gm.sapling^{-1}$. The experimental units were distributed as factorial based on Randomized Complete Block Design (R. C. B. D) with two factors and three replications (Al-Rawi and Khalaf Allah, 2000). Each replicate contains 16 unit, and each experimental unit has three seedlings, to be 144 saplings distributed randomly.

Table 1. Some chemical and physical characteristics of the soil

Soil particles	**Unit**	**Amount**
Clay	g.kg soil-1	82
sand	g.kg soil-2	113
Clay	g.kg soil-3	805
Texture		sandy loam
soil properties		Amount
EC	decimens. m-1	1.59
pH		7.4
available nitrogen	%	0.09
available phosphorus	%	0.003
available potassium	%	0.08
available calcium	%	1400
Organic matter	g.kg-1	2.58

Table 2. Seaweed Extract (Acadian) contents

Component	**Min. ratio**
NPK and metals (ash)	45%
Alginic acid	10%
Mannitol	4%
Amino acids	4%
pure seaweed (substances that occur naturally in plant growth)	50%

Table 3. The components of the compound fertilizer high potassium and phosphorus (K-Humate)

Components	N	P	K	Ca	Sulfate	Humic acids	Fulvic acids	Organic acids
percentage %	12.32	22.32	17.9	10.636	1.84	6.75	2.835	9.45

Measurements and Data Analysis

The measurements included estimation of nitrogen content in leaves (%) using Microkjeldohl device (Page et al., 1982), leaf content (%) of phosphorous using ascorbic acid and ammonium molybdate with aid of Spector photometer at a wavelength of 620 nm (Al-Sahhaf, 1986), and leaf content (%) of potassium (Hornck and Hanson, 2019) using a flame-photometer. As for leaf content of iron and zinc (mg. kg-1) where leaf samples were digested with nitric and perchloric acids, and the estimation was done using an atomic absorption spectro photometer (Al-Musili, 2018). similarly leaf content of Boron (mg. kg-1) was also determined (Pratt, 1961). The data were analyzed and analysis of variance ANOVA table was performed using GenStat, 2012 computing program set. Means were compared among treatments according the least significant difference LSD at 5% probability level ($P \leq 0.05$).

eISSN 1303-5150

Results and Discussion

The results (Tables 4 and 5) showed that the seedlings treated with seaweed extract had significantly increased content of nutrients. The saplings treated with 1.5 g.L^{-1} SWE recorded the highest leaf content phosphorous, potassium, iron, boron and zinc compared to the control and other SWE concentrations, while highest nitrogen content was in the 1 g.L^{-1} SWE. In case of High K-P fertilizer, results also showed that the higher concentration 2.5 g.plant^{-1} resulted in the highest values all the parameters under study.

The interaction of 1.5 g.L^{-1} SWE and 2.5 g.plant^{-1} High K-P mixture resulted in the highest leaf content of phosphorous (0.69%), iron (63.62 mg.Kg^{-1}), and zinc (35.48 mg.Kg^{-1}). While, SWE 1g.L^{-1} interaction with High K-P mixture at 2.5g.plant-1 recorded the highest leaf content of nitrogen and potassium, 4.04% and 3.73% respectively. Whereas, the highest leaf content of boron (48.51 mg. Kg^{-1}) was in the interaction treatment of 1.5 g.L^{-1} SWE and 1.5 g.plant^{-1} High K-P mixture.

The increase in citrus saplings leaf nutrients may be attributed to the SWE containing the necessary nutrients, especially nitrogen, phosphorous, and potassium (Singh, 2003). In addition, SWE contains high cytokinin-like compounds, which lead to increasing total leaf content of chlorophyll, and thus increase the efficiency of the photosynthesis which is positively reflected in increasing the nutrient content (Mancuso et al., 2006).

Table 4. The effect of foliar application of seaweed extract and the addition of high-potassium-phosphorous fertilizers and the interaction between them on the content of N, P, and K elements in the leaves

SWE g/L (A)	**Leaf content of N (%)**					**Leaf content of P (%)**					**Leaf content of K (%)**				
	High K-P fertilizer mixture (g.sapling^{-1})														
	0	**0.5**	**1.5**	**2.5**	**Average**	**0**	**0.5**	**1.5**	**2.5**	**Average**	**0**	**0.5**	**1.5**	**2.5**	**Average**
0	1.56	2.77	2.84	3.54	2.68	0.12	0.18	0.23	0.42	0.24	1.09	1.58	2.17	2.33	1.79
0.5	2.57	3.18	3.59	3.84	3.29	0.19	0.38	0.51	0.58	0.42	1.80	2.11	2.45	2.55	2.23
1	3.33	3.74	3.85	4.04	3.74	0.26	0.50	0.62	0.64	0.50	2.22	2.58	3.04	3.73	2.89
1.5	3.43	3.75	3.79	3.86	3.71	0.47	0.54	0.67	0.69	0.59	2.27	3.35	3.65	3.61	3.22
Average	2.72	3.36	3.52	3.82		0.26	0.40	0.51	0.58		1.84	2.40	2.83	3.05	
LSD (p<0.05)	**SWE g/L=0.27 NPK=0.27 Interaction=0.55**					**SWE g/L= 0.034 NPK=0.034 Interaction=** 0.069					**SWE g/L= 0.26 NPK=0.26 Interaction = 0.52**				

Table 5. The effect of foliar application with seaweed extract and the addition of high potassium and phosphorous fertilizers and the interaction between them on the content of Fe, Zn, and B elements in leaves

SWE g/L	**Leaf content of Fe (mg.Kg^{-1})**					**Leaf content of Zn (mg.Kg^{-1})**					**Leaf content of B (mg.Kg^{-1})**				
	High K-P fertilizer mixture (g.sapling^{-1})														
	0	**0.5**	**1.5**	**2.5**	**Average**	**0**	**0.5**	**1.5**	**2.5**	**Average**	**0**	**0.5**	**1.5**	**2.5**	**Average**
0	34.51	40.07	42.94	45.60	40.78	24.32	25.81	27.29	28.86	26.57	19.80	21.87	28.47	33.63	25.94
0.5	42.39	47.91	56.29	58.49	51.27	26.23	29.07	29.64	30.38	28.83	25.58	30.32	36.10	42.80	33.70
1	50.69	53.53	54.65	58.11	54.24	27.92	30.87	31.81	33.33	30.98	26.71	34.91	42.24	46.83	37.67
1.5	53.03	57.06	60.15	63.62	58.47	29.67	33.01	34.92	35.48	33.27	35.57	45.24	48.51	47.90	44.30
Avarage	45.15	49.64	53.51	56.45		27.03	29.69	30.91	32.01		26.91	33.08	38.83	42.79	
LSD (p<0.05)	**SWE g/L= 1.899 NPK=1.899 Interaction=3.799**					**SWE g/L= 0.54 NPK= 0.54 Interaction=1.09**					**SWE g/L=** 0.93 **NPK=0.93 Interaction= 1.86**				

The results agreed with the findings of AL-Rawi (2021) when treating lemon saplings with seaweed extract, which increased the leaf nutrients. Also, the study was consistent with the results of Al-Kuraiti (2020) as spraying SWE on fig saplings significant increased plant content rate of macro and micro elements. The high potassium-phosphorous fertilizer resulted in a significant increase in the proportions of the leaf elements under study. This may be explained by roots absorbing the fertilizer which contains the major elements. Therefore, increasing the nutrient concentrations occurs in the seedling leaves (Osman et al., 2010), especially nitrogen, potassium, and potassium. Thus, the efficiency of photosynthesis increases, and that increases the absorption of nitrogen as ammonium (Hagagg, 2018). Findings of this study came in agreement with previous studies for the importance of Phosphorous and Potassium fertilizers in growth and yield of citrus (Al-Jalihawi, 2019; Tariq et al., 2018; Attaha and AL-Mubark 2014).

Conclusion

The citrus C-35 rootstock saplings responded positively in all the studied parameters to spraying with Acadian SWE as well as to ground application with high potassium-phosphorous fertilizer. SWE especially at higher concentrations was better in increasing leaf content of nutrients under study. Combination of 1.5 $g.L^{-1}$ SWE and 2.5$g.plant^{-1}$ high potassium-phosphorous fertilizers showed superiority in most of the nutrients of the leaves.

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