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EFFECT OF FOLIAR APPLICATION WITH NANO IQ-COMBI AND SEAWEED EXTRACT ON SOME GROWTH PARAMETER OF CITRUS ROOTSTOCK SAPLINGS C-35

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Abstract

A shade house experiment was conducted in a certified citrus nursery belongs to the Directorate of Agriculture and Forests in Al-Hindiya district, province of Karbalaa, during the period from 1-3-2018 to 1-4-2019 to study the effect of foliar spray with Nano IQ-Combi or seaweed extract (SWE) and their interactions on vegetative growth parameters of citrus rootstock C-35 saplings. Beside the control treatment (plants sprayed with distilled water only), both fertilizers were used at three concentrations which were 0.5, 1 or 1.5 g/L for the IQ-Combi and 3, 6 or 9 ml/L for the SWE. Results showed that both types of fertilizers were effective in increasing all the studied plant growth parameters compared to untreated control plants. The 1 g/L of IQ-Combi and 9 ml/L of SWE were the most effective concentrations among all the treatments. IQ-Cobi at 1 g/L resulted in higher values of all studied growth parameters, but did not differ from those resulted from SWE at 9 ml/L. Best results were obtained from the interaction treatment of 1 g/L of IQ-Combi and 9 ml/L of SWE resulting in the highest values of plant height (58.63 cm), stem diameter (1.62 cm), number of branches per plant (2.97 branch plant^{-1}), number of leaves per plant (65.10 leaf plant^{-1}), leaf area (11.80 cm^2), leaf content of total chlorophyll (7.86 mg.100g^{-1}FW) and carbohydrates (36.66 mg.g^{-1}DW) with significant difference from the control which resulted in 23.74 cm, 1.25 cm, 1.11 branch plant^{-1}, 20.16 leaf plant^{-1}, 5.71 cm^2, 5.60 mg.100g^{-1}FW and 24.96 mg.g^{-1}DW, respectively.

Key words: citrus, rootstock, micronutrients, foliar spray, growth parameters.

Introduction

Citrus belongs to the Rutaceae plant family, which is characterized by the presence of many oil glands in most parts of the plant giving them smells of aromatic. This family includes many of the most important species (Citrus) of economic importance (Khafaji *et al*., 1990). The origin of citrus is believed to be the equatorial and subtropical regions between latitudes 40 degrees north and south of the equator (Agha and Daoud, 1991). Citrus fruits are rich in minerals needed to build the human body, such as potassium, iron, calcium, magnesium, sodium, sulfur, phosphorus and an important source of vitamin C and vitamin A, B1, B2, B12 and Niacin and others, 1990).

The C-35 is a hybrid citrus produced by cross fertilization of common orange *Citrus sinensis* (L.) Osb with trifoliate oranges *Poincirus trifoliate* (L.) (Raf) (Casales *et al*., 2003). Studies indicate that the citrus trees grafted on C-35 rootstock give relatively small trees with high production. This hybrid, thus, is favorable for high density orange cultivation, as well as has the compatibility to all grafts except Naval Orange (Roose *et al*., 1989; Castls and Bowman, 2011; Chahal and Gill, 2015). In addition to high vegetative growth indicators of trees grafted to this rootstock, they also show less decline symptoms compared to trees of other types of rootstocks (Stuart *et al*., 2006). This hybrid rootstock was reported to be resistant to gungal root rot diseases caused by *Fusarium solani* and *Phytophthora nicotianae* (Burger, 2001; Benfradj *et al*., 2016). It also showed resistance to *Citrus tristeza* virus CTV (Cales *et al*., 2003) and nematodes (Niles *et al*., 1995).

Although fertilizers are important for plant growth and development, most soil applied fertilizers are facing ineffectiveness and low nutrients availability problem due to environmental factors such as washing, adsorption and sedimentation. It is necessary to reduce nutrient loss in fertilization and to increase crop productivity by adopting new fertilization forms and applications.

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This is possible with the aid of nanotechnology as nanoparticles or coated nanoparticles are highly effective properties to accelerate crop growth due to their unique action in slow nutrient release on plant demand. They control nutrient release and so that regulate plant growth by enhancing activities of targeted sites (Derose *et al*., 2010; Nair *et al*., 2010; Diaz Morales *et al*., 2017).

Several published studies have indicated the role of nanotechnology in stimulating the growth of plants with NMs and NPs made with plants grown in uncultivated farming communities. Several studies have been conducted to evaluate NPs on plants in soilless farming systems, such as pure nutrient solutions and sand. Cue was well adsorbed onto the root surfaces and transported to plant shoot parts of plants grown in sandy growth medium (Dimkpa *et al*., 2013; Wang and others, 2013). Cui *et al*., (2010) conversion from traditional fertilizers into nanoparticles or namely smart fertilizers allows fertilizer to control the speed of nutrients release to suit the pattern of crop absorption. Nanoparticles improve the solubility of soluble nutrients in the soil, reduce adsorption, fixation and increase their uptake (DeRosa *et al*., 2010).

Seaweed extract (SWE) is one of the organic sources used in agricultural production as fertilizer supplements (Verkleij, 1992). More than 15 million tons of fertilizers are used annually in the agricultural field worldwide. SWEs are non-fertilizer complex compounds that stimulate plant growth at low concentrations, consisting macro and micro elements and several groups of plant stimulants such as cytokinins, auxins, vitamins, amino and organic acids and auxin-like compounds (Spinelli *et al*., 2009). Laane, (2014) reported the positive effect of SWE increasing activities of plant enzymes including nitrate reductase, Phosphatase and chelateductase where used sufficiently and giving much better results compared to using commercial traditional fertilizers. For the importance of nano-produced micronutrients and seaweed extracts in new trends of agricultural production, objective of this study was to evaluate the efficacy of IQ-Combi (a nano product) and a commercial seaweed extract in growth and plant content of nutrients of citrus rootstock C-35 saplings.

Materials and Methods

The study was conducted in the nursery of certified citrus production belongs to the Directorate of Horticulture and Forests in Al-Hindiya district/province of Karbala for the period from 1/3/2018 to 1/4/2019. Effect of IQ-Combi (a nano-product) and seaweed extract SWE in growth of citrus rootstock saplings C-35 and their content of nutrients were evaluated in this study. Ingredients contained in the IQ-Combi (Agri-Science nono-products/Turkey) are soluble boron 0.2%, copper as copper sulfate 0.2%, iron as ferrous sulfate 6%, manganese as manganese sulfate 6%, molybdenum 0.2% and zinc as zinc-sulfate 6%. While, the SWE (Agri-Tecno/ Spain) contains pure seaweed extract 16%, organic matter 7%, N 0.1%, phosphorous (P_2O_5) 0.15% and potassium (K_2O) 0.25%.

A total of 144 saplings of C-35 citrus rootstock were selected at age of 3 months to be as homogeneous as possible planted in 5 kg plastic bags.

The saplings were transformed into 10 kg plastic bags filled with river sand soil and maintained in under the shade house a month before starting the experiment. The experiment was factorial with two factors and three replicates based on Randomized Complete Block Design (RCBD). The first factor was the IQ-Combi (IQ-C) at four concentration levels (0, 0.5, 1, 1.5 g L^{-1}) while the second factor was seaweed extracts (SWE) at four concentration levels (0, 3, 6, 9 ml.L^{-1}). The experiment, thus, was 16 treatments in 48 experimental units with 3 replicates and 3 saplings per unit.

Measurements and statistical analysis

At the end of the experiment, data were recorded including plant height cm, main stem diameter cm, number

Table 1: Effect of foliar spray with IQ-Combi (nano fertilizer) and SWE on some plant growth characters of citrus rootstock C-35.

Nano IQ-Combi	Plant height (cm)					Stem diameter (cm)					No. of branches plant^{-1}				
	SWE ml/L														
g/L	0	3	6	9	Average	0	3	6	9	Average	0	3	6	9	Average
0	23.74	30.89	36.34	43.05	33.51	1.25	1.32	1.36	1.45	1.34	1.11	1.44	1.75	2.25	1.63
0.5	28.09	35.18	41.36	46.36	37.74	1.28	1.34	1.38	1.48	1.37	1.12	1.55	1.88	2.49	1.76
1	31.60	41.35	52.40	58.63	45.99	1.29	1.36	1.42	1.62	1.42	1.60	1.84	2.20	2.97	2.15
1.5	41.10	48.13	50.96	53.80	48.49	1.30	1.35	1.40	1.50	1.38	1.50	1.70	2.10	2.60	1.97
Average	31.13	38.88	45.26	50.46		1.28	1.34	1.39	1.51		1.33	1.63	1.98	2.57	
LSD $_{(p\leq 0.05)}$	IQ=2.23; SWE= 2.23; Interaction=4.47					IQ=0.3; SWE=0.3; Interaction= 0.25					IQ=0.311; SWE=0.311; Interaction=0.40				

Values are means of 3 replicates of 3 plants in each replicates.

Table 2: Effect of foliar spray with IQ-Combi (nano fertilizer) and SWE on some plant growth characters of citrus rootstock C-35.

IQ-Combi	No. of leaf.plant^{-1}				
	SWE ml.L^{-1}				
	0	3	6	9	Average
0	20.16	21.16	27.00	31.78	25.02
0.5	35.16	37.44	43.66	54.83	42.77
1	39.00	46.55	60.66	65.10	52.82
1.5	43.40	50.80	52.11	56.38	49.92
Average	34.43	38.98	45.85	51.27	
L.S.D.$_{(P\leq0.05)}$	IQ= 2.30; SWE= 2.30; Interaction= 4.60				
IQ-Combi	**Leaf area cm^2.plant^{-1}**				
0	5.71	7.23	8.06	9.61	7.65
0.5	5.93	7.66	8.30	9.70	7.89
1	6.43	7.90	9.77	11.80	8.97
1.5	6.83	7.96	10.00	10.10	8.54
Average	6.22	7.68	9.03	10.30	
L.S.D.$_{(P\leq0.05)}$	IQ= 1.00; SWE= 1.00; Interaction= 2.00				
IQ-Combi	**Leaf content of Total chlorophyll mg.100g^{-1}FW**				
0	5.60	6.55	6.80	7.10	6.51
0.5	5.80	6.60	6.85	7.20	6.61
1	6.90	6.85	6.99	7.86	7.15
1.5	6.60	6.75	7.00	7.40	6.93
Average	6.22	6.68	6.91	7.39	
L.S.D.$_{(P\leq0.05)}$	IQ= 0.201; SWE= 0.201; Interaction= 0.403				
IQ-Combi	**Leaf content of carbohydrates mg.g^{-1}DW**				
0	16.35	23.53	26.32	30.60	24.20
0.5	21.38	25.53	32.30	33.05	28.19
1	32.02	33.20	33.87	36.66	33.9
1.5	30.12	31.40	29.50	30.61	30.40
Average	24.96	28.41	30.49	32.81	
L.S.D.$_{(P\leq0.05)}$	IQ= 1.80; SWE= 1.80; Interaction= 3.60				

Values are means of 3 replicates of 3 plants in each replicates.

of branches per plant (branch.plant^{-1}, leaf area cm^{-2}plant^{-1}, leaf content of total chlorophyll (mg.100g^{-1}FW) and total carbohydrates (mg.g^{-1}DW). Recorded data were analyzed and analysis of variance ANOVA was performed using GenStat 12th Edition computing program. Means were compared for each measured parameter based on the least significant difference L.S.D. at $P\leq0.05$.

Results

Results showed that different type of treatment and concentration had different effects on vegetative characters and leaf content of nutrients in C-35 Citrus rootstock saplings under study (Table 1 and 2). In case of the vegetative characters, the highest plant height (58.63 cm) was recorded in the interaction treatment of 1.5 g.L^{-1} IQ-Combi and 0 ml.L^{-1}SWE (Table 1) which significantly differed from most individual treatments especially the control which recorded the least plant height (23.74 cm). The same treatment combination as shown in table 1, resulted in significant increase in stem diameter (1.62 cm) and number of branches per plant (2.60 branch plant^{-1}) compared to 1.25 cm and 1.11 branch plant^{-1}, resulted from the control treatment, respectively.

The other studied parameters were also affected by different treatments and combinations or interactions (Table 2). Similarly, the interaction treatment of 1.5 g.L^{-1} IQ-Combi and 0 ml.L^{-1} SWE was the most effective treatment among all the other treatments. Highest increase was recorded by this treatment combination in number of leaves per plant (65.10 leaf. Plant^{-1}) and leaf area (11.80 cm^2) compared to values of same characters resulted from the control that of 20.16 leaf. Plant^{-1} and 5.71 cm^2, respectively. In case leaf content of total chlorophyll and carbohydrates, the 1.5 g.L^{-1} IQ-Combi interacted with 0 ml.L^{-1} SWE resulted in the highest values of both parameters recording 7.86 mg.100g^{-1}FW and36.66 mg.g^{-1}DW compared to 5.60 mg.100g^{-1}FW and16.35 mg.g^{-1}DW resulted from the control, respectively.

Discussion

Findings of our study showed that C-35 rootstock saplings positively responded to the foliar application with nano-nutrients IQ-Combi. This product contains a group of plant micro-nutrients which play important role in synthesis of amino acids, carbohydrates and energy compounds, as well as their action in increasing plant respiration and photosynthesis (Mer *et al.*, 2015). This findings also agreed with results of Adhikary *et al.*, (2010) and Vitti *et al.*, (2014) where they found that foliar spray with micronutrients always increase plant growth all activities in relation with metabolism including photosynthesis, CHO synthesis and activities of involved plant enzymes.

Zinc in plant body is considered to be enzyme stimulator, helps in nucleic acids synthesis and contributes in producing the amino acid Tryptophan which is a main component of Indol acetic acid (a plant auxin) that necessary for cell elongation and growth. This may explain the significant increase of growth parameters in our study agreeing with of previous studies (Chichiricco *et al.*, 2015; Valadkhan *et al.*, 2015). This is consistent with the results obtained by Rezaei and Abbasi, (2014) when spraying plants with nanostructures and normal zinc resulted in higher plant height which was confirmed by results of Farnia and Omidi, (2015) where they found that plant height was more affected by foliar spray than soil application. They also found that foliar spray with copper, zinc and iron gave the highest values for plant height confirming that combined effect of two elements better

than spraying with single nutritional element agreeing with findings of Mamyandi *et al*., (2012).

Abou-Elwafa *et al.,* (2011) found several compounds produced from brown moss including carbohydrates as well as other substances such as fats, fibers, proteins, carbohydrates and amino acids. Spraying with marine algae extracts leads to an increase in vegetative growth indicators because it contains some growth regulators, microelements, amino acids and vitamins (Abd, 2008). Numerous studies and researches pointed to the positive effect of marine algae extracts in many vegetative growth traits and some basic chemical content traits. The significant increase in vegetative growth characteristics due to the effect of seaweed extracts may be attributed to the fact that it contains plant hormone-like substances such as auxins, cytokinins and gibberellins and macro and microelements beside growth-promoting substances such as organic and amino acids and vitamins, which play major role in promoting cell division and elongation. These contents, thus, stimulated and increased efficiency the plant carbonation processes and improved plant vegetative growth in general (Osman *et al*., 2010).

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