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Effect of spraying some growth regulators on the vegetative growth of Cleopatra mandarin seedlings

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ABSTRACT

This study was conducted over two successive seasons (2021 and 2022) to investigate the effect of some plant growth regulators on the vegetative growth of Cleopatra mandarin rootstock seedlings (*Citrus reshni* L.). Thus, trials were conducted to evaluate the effect of foliar application of gibberellic acid (GA_3) or kinetin (Kn) as a means to promote their vegetative growth. Thus, the seedlings were subjected to spraying in April, June, August and October with GA_3 (50, 100, 150 and 200 ppm) or kinetin (50, 75 and 100 ppm) as well as (control), to investigate their impact on some growth parameters. Data obtained during both experimental seasons revealed obviously that all GA_3 and kinetin treatments increased significantly growth parameters as compared to control. However, concentrated solutions particularly GA_3 at 200 ppm or kinetin at 100 ppm were statistically the most effective in this concern by significantly increasing seedlings height and stem diameter, in particular, in comparison to the control.

Keywords: Cleopatra mandarin (*Citrus reshni* L.), Seedlings, Rootstock, Citrus, Gibberellic acid and Kinetin

INTRODUCTION

Citrus is one of the most important fruit crops worldwide. It ranks third among fruit crops and preceded only by grapes and apples. It is considered one of the most important fruit crops in Egypt. Cleopatra mandarin (*Citrus reshni* L.) has been established as a rootstock over many years. Tree vigor and fruit quality of sweet orange and mandarin cultivars on Cleopatra mandarin rootstock are very good and equal to those produced on sour orange rootstock, but fruit size is smaller. However, its growth in the nursery is very slow and the time required for seedlings to reach a suitable size for budding takes a long time. Cleopatra mandarin is considered one of the important species of citrus root-stocks, and studies have begun on it as a substitute for the sour orange rootstock in many countries. Cleopatra mandarin is more tolerant than sour orange for Tristeza, gummosis, exocortis, phytophthora foot rot, cold and calcareous soil. It grows well in sandy and heavy soils as well as its high tolerance to chlorosis and salinity. The trees budded on Cleopatra mandarin are slowly grown until they reach the fruiting stage (Anjum, 2010; Lacey, 2012; Sharaf *et al.,* 2016; Al-Janabi, 2018, Mahmoud *et al.,* 2022; Mahmoud *et al.,* 2023).

Gibberellic acid (GA_3) plays important roles in many essential plant growth and development processes, including seed germination, stem elongation, leaf expansion, shoot length and root length (Baskin & Baskin, 2014; Pallaoro *et al.,* 2016; Ma *et al.,* 2018; Cornea-Cipcigan *et al.,* 2020; Mahmoud *et al.,* 2022).

Kinetin (Kn) is considered the most known cytokinin, where its physiological efficacy is represented by stimulating cell division and expansion, uptake, transport and assimilation of nutrients, increasing the effectiveness and activity of the apical meristem, promoting chloroplast development, delaying leaf senescence, hormonal regulation of plant morphogenesis and other influences (El-Badawy and Abd-El-Aal, 2013; Al-Janabi, 2018; Al-Isaw and Al-Janabi, 2021).

The major objective of this study was to explore shortening the period to reach a suitable size for budding and to enhance the growth Cleopatra mandarin rootstock seedlings vigor process by testing the effect of foliar application of GA_3 or Kinetin (Kn) at different concentrations for each one.

MATERIAL AND METHODS

This study was conducted over two successive seasons (2021 and 2022) to investigate the effect of some growth regulators on the vegetative growth of Cleopatra mandarin rootstock seedlings (*Citrus reshni* L.) by spraying gibberellic acid (GA_3) at (50, 100, 150 and 200 ppm) or kinetin (Kn) at (50, 75 and 100 ppm) as well as (control). At the end of March 2021 and 2022 years, 72 seedlings were selected for their uniformity in growth as much as possible,

with stem diameters ranging between 2-3 mm on the height of 10-15 cm from the soil surface level. The uniform seedlings were then separately subjected to sprays of GA_3 (50, 100, 150 and 200 ppm) or kinetin (50, 75 and 100 ppm) as well as the (control). Herein, the experiment was designed as a randomized complete block design (RCBD) with three replicates. Thus, the total number of seedlings for the experiment equal 72 seedlings (8 treatments X 3 replicates X 3 seedlings), grown in plastic pots with the dimensions of 15 cm diameter x 30 cm height filled with potting media consisting of sand + clay mixture at equal proportion (v:v). In addition, all field operations were conducted for the seedlings regarding irrigation and removal of all lateral branches (suckering process), weeding and control of insects when needed. The foliar spraying process with GA_3 or kinetin (Kn) was applied in the first week of April, June, August and October with the addition of a wetting agent (Triton B) to the spraying solution at a concentration of 0.1% by using a backpack sprayer, with the capacity of 20 litres until the drip point. The experimental seedlings were planted in a greenhouse at a private orchard in Nobaria region – El Behera Governorate Egypt. All the seedlings of this study received the same horticultural practices except for experimental treatments.

The tested treatments were evaluated through the following parameters:

At the end of each experimental season, the seedlings were carefully taken out from their pots and were thoroughly washed with tap water to free them from any residues attached. Then the following growth parameters were recorded as follows:

Average plant height, stem thickness, canopy weight, number of leaves and total leaves weight

In November during 2021 and 2022 years, respectively, the average seedling height, stem thickness, canopy weight, number of leaves and total leaves weight per each seedling were counted for the seedlings per each replicate, and then the average plant height per every investigated treatment was estimated (as an average of its three replicates).

Leaf area (cm^2)

In August during 2021 and 2022 years, respectively, ten fully expanded leaves were taken from each seedling. Leaf area was calculated by measuring the maximum length and maximum width of a leaf as follows: Leaf area = 2/3 x length x width according to (Chou, 1966).

Leaf total chlorophyll

In August during 2021 and 2022 years, respectively, the leaf total chlorophyll was recorded in fresh leaves per each seedling using a portable chlorophyll metter SPAD 502 (Yadava, 1986).

The total leaf water content and dry matter content

The total leaf water content (%) was determined according to the following equation (water content (%) $=\frac{\text{Leaf fresh weight- Leaf dry weight}}{\text{Leaf fresh weight}} X100$), while the dry matter percentage = 100- The total leaf water content.

Root system parameters

In November during 2021 and 2022 years, respectively the average weight, total length of fibrous roots and root system distribution were determined.

Leaf chemical composition

In August during 2021 & 2022 years, respectively, five dried leaves were finely grinded and digested using the micro-kjeldahl method. The percentage of nitrogen content was determined according to (Naguib, 1969). Phosphorus percentage was determined according to (AOAC, 1985). Potassium percentage was determined according to (Browen and Lilliand, 1964). Moreover, Calcium, Magnesium, Iron, Manganese and Zinc were determined using Atomic absorption spectrophotometer (Perkin. Elmar – 3300) (Chapman and Pratt, 1961).

Statistical analysis

The experiment was designed as a randomized complete block design (RCBD) with three replicates. Thus, the total number of seedlings for this experiment equals 72 seedlings (8 treatments X 3 replicates X 3 seedlings). The data obtained were statistically analyzed using the analysis of variance method as reported by (Snedecor & Cochran, 1980). The differences between means were differentiated by using Duncan's range test (Duncan, 1955) using the computer program COSTAT.

RESULTS

Data obtained in Table 1 clearly show that all gibberellic acid (GA_3) and kinetin (Kn) concentrations had a great positive effect on vegetative growth parameters of Cleopatra mandarin rootstock seedlings in both seasons.

As for the seedling height data in Table (1), they reached 132.20 cm and 122.23 cm with 200 ppm of GA_3 in the first and second seasons, respectively, while the Kn at 100 ppm came in second place by reaching 120.68 and 110.93 cm in the first and second seasons, respectively, compared to the control, which was 52.90 and 56.23 cm in the first and second seasons, respectively.

In addition, stem diameter gained 11.75 and 11.47 mm with GA_3 at 200 ppm and Kn at 100 ppm, respectively, in the first season, while in the second season, stem diameter gained 12.78 and 12.36 mm with GA_3 at 200 ppm and Kn at 100 ppm, as compared to the control, which were 6.30 and 8.67 mm in the first and second seasons, respectively.

An analogous trend was obtained with canopy weight, number of leaves per plant and total fresh leaves weight per plant parameters in both seasons.

Table 1. Gibberellic acid and kinetin foliar application treatments impact on vegetative growth parameters of Cleopatra mandarin rootstock seedlings (2021-2022 seasons).

Treatments	Seedling height (cm)	Stem diameter mm	Canopy weight (g)	Number of leaves per plant	Total fresh leaves weight per plant (g)
First season 2021					
Control	52.90 f	6.30 f	13.78 h	46.60 h	5.73 g
GA_3 at 50 ppm	69.76 e	7.62 e	32.50 g	57.52 g	11.10 f
GA_3 at 100 ppm	93.56 d	10.36 c	56.78 d	92.90 d	19.42 c
GA_3 at 150 ppm	109.87 c	11.26 b	66.76 c	107.12 c	22.60 b
GA_3 at 200 ppm	132.20 a	11.75 a	81.31 a	121.37 a	26.22 a
Kn at 50 ppm	73.95 e	8.24 d	41.29 f	64.44 f	13.08 e
Kn at 75 ppm	89.08 d	10.01 c	49.85 e	80.29 e	16.70 d
Kn at 100 ppm	120.68 b	11.47 a	76.58 b	112.61 b	23.87 b
Second season 2022					
Control	56.23 h	8.67 f	18.73 h	51.93 h	6.18 g
GA_3 at 50 ppm	69.38 g	9.57 e	27.85 g	67.63 g	13.46 f
GA_3 at 100 ppm	92.98 d	11.39 c	48.47 d	90.92 d	20.91 c
GA_3 at 150 ppm	105.64 c	12.05 b	58.59 c	100.00 c	24.40 b
GA_3 at 200 ppm	122.23 a	12.78 a	73.57 a	116.34 a	28.97 a
Kn at 50 ppm	74.10 f	9.98 d	33.87 f	73.47 f	14.77 e
Kn at 75 ppm	84.71 e	11.05 c	43.35 e	83.83 e	18.69 d
Kn at 100 ppm	110.93 b	12.36 a	61.65 b	105.02 b	25.73 b

Control= 0 ppm Gibberellic acid or Kinetin, GA_3 = Gibberellic acid and Kn = Kinetin
In a column, means followed by a common letter (s) are not significantly different at the 5% level by DMRT

The data in Table 2 show that, all gibberellic acid (GA_3) and kinetin (Kn) concentrations had a great statistical influence on leaf characteristics in both seasons.

Regarding leaf area, GA_3 at 200 ppm achieved 20.51 and 22.18 cm^2 in the first and second seasons, respectively, compared to the control, which was 6.18 and 6.95 cm^2 in the first and second seasons, respectively.

Moreover, leaf fresh weight, leaf length, leaf width and total leaf water content percentage parameters had the same trend for leaf area in both seasons. On the contrary, the leaf dry weight percentage gained the highest values in both seasons with the control, which reached 11.84% in the first season and 14.78% in the second season.

Tabulated data in Table 3 illustrated that all gibberellic acid (GA_3) and kinetin (Kn) concentrations had a significant impact on the root systems of Cleopatra mandarin rootstock seedlings in both seasons.

Generally, the total root system weight of Cleopatra mandarin rootstock seedlings reached 84.37 and 84.23 g with GA_3 at 200 compared to the control, which was 17.52 and 19.74 g in the first and second seasons, respectively. In addition, the Kn at 100 ppm came in second place with 80.09 and 79.12 g in the first and second seasons respectively.

Moreover, total root system length, root weight g per 1 liter of soil, root weight g per 1 kg of soil, root length g per 1 liter of soil and root length g per 1 kg of soil had the same trend to total root system weight in both seasons.

Table 2. Gibberellic acid and kinetin foliar application treatments impact on leaves parameters of Cleopatra mandarin rootstock seedlings (2021-2022 seasons).

Treatments	Leaf fresh weight (g)	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Total water content (%)	Dry weight (%)
First season 2021						
Control	0.123 f	3.76 f	2.45 h	6.18 h	11.84 a	88.16 f
GA_3 at 50 ppm	0.193 e	4.14 e	2.99 g	8.30 g	11.19 b	88.81 e
GA_3 at 100 ppm	0.209 c	5.34 c	3.83 d	13.70 d	9.77 e	90.23 d
GA_3 at 150 ppm	0.211 b	5.93 b	4.02 c	15.99 c	9.10 f	90.90 c
GA_3 at 200 ppm	0.216 a	6.63 a	4.62 a	20.51 a	8.29 h	91.71 a
Kn at 50 ppm	0.203 d	4.47 d	3.13 f	9.38 f	10.81 c	89.19 e
Kn at 75 ppm	0.208 c	5.07 c	3.50 e	11.90 e	10.10 d	89.90 d
Kn at 100 ppm	0.212 b	6.32 a	4.42 b	18.71 b	8.87 g	91.13 b
Second season 2022						
Control	0.119 f	4.03 f	2.58 h	6.95 h	14.78 a	85.22 f
GA_3 at 50 ppm	0.199 e	4.67 e	3.31 g	10.36 g	13.52 b	86.48 e
GA_3 at 100 ppm	0.230 c	5.50 c	4.11 d	15.14 d	11.97 e	88.03 d
GA_3 at 150 ppm	0.244 b	6.34 b	4.47 c	18.97 c	11.06 f	88.94 c
GA_3 at 200 ppm	0.249 a	6.84 a	4.84 a	22.18 a	10.36 h	89.64 a
Kn at 50 ppm	0.201 e	4.87 d	3.51 f	11.47 f	13.21 c	86.79 e
Kn at 75 ppm	0.223 d	5.23 c	3.93 e	13.77 e	12.41 d	87.59 d
Kn at 100 ppm	0.245 b	6.59 a	4.65 b	20.55 b	10.58 g	89.42 b

Control= 0 ppm Gibberellic acid or Kinetin, GA_3 = Gibberellic acid and Kn = Kinetin
In a column, means followed by a common letter (s) are not significantly different at the 5% level by DMRT

Table 3. Gibberellic acid and kinetin foliar application treatments impact on root system of Cleopatra mandarin rootstock seedlings (2021-2022 seasons).

Treatments	Total root system weight (g)	Total root system length (cm)	Root weight g per 1L soil	Root weight g per 1kg soil	Root length (cm) per 1L soil	Root length (cm) per 1kg soil
First season 2021						
Control	17.52 h	1095.17 h	7.44 h	4.25 h	465.04 h	265.69 h
GA_3 at 50 ppm	33.70 g	2106.19 g	14.31 g	8.18 g	894.35 g	510.96 g
GA_3 at 100 ppm	61.04 d	3814.88 d	25.92 d	14.81 d	1619.91 d	925.49 d
GA_3 at 150 ppm	72.15 c	4509.08 c	30.63 c	17.50 c	1914.68 c	1093.90 c
GA_3 at 200 ppm	84.37 a	5273.19 a	35.83 a	20.47 a	2239.15 a	1279.28 a
Kn at 50 ppm	38.56 f	2410.22 f	16.38 f	9.36 f	1023.45 f	584.72 f
Kn at 75 ppm	52.56 e	3284.69 e	22.32 e	12.75 e	1394.77 e	796.87 e
Kn at 100 ppm	80.09 b	5005.93 b	34.01 b	19.43 b	2125.66 b	1214.44 b
Second season 2022						
Control	19.74 h	1233.68 h	8.38 h	4.79 h	523.85 h	299.29 h
GA_3 at 50 ppm	31.82 g	1988.67 g	13.51 g	7.72 g	844.44 g	482.45 g
GA_3 at 100 ppm	60.83 d	3801.93 d	25.83 d	14.76 d	1614.41 d	922.35 d
GA_3 at 150 ppm	72.81 c	4550.64 c	30.92 c	17.66 c	1932.33 c	1103.99 c
GA_3 at 200 ppm	84.23 a	5264.33 a	35.77 a	20.43 a	2235.38 a	1277.13 a
Kn at 50 ppm	38.78 f	2423.89 f	16.47 f	9.41 f	1029.25 f	588.04 f
Kn at 75 ppm	57.22 e	3576.11 e	24.30 e	13.88 e	1518.52 e	867.57 e
Kn at 100 ppm	79.12 b	4944.88 b	33.60 b	19.19 b	2099.74 b	1199.63 b

Control= 0 ppm Gibberellic acid or Kinetin, GA_3 = Gibberellic acid and Kn = Kinetin
In a column, means followed by a common letter (s) are not significantly different at the 5% level by DMRT

Results in Table (4) reflected that all gibberellic acid (GA_3) and kinetin (Kn) concentrations had a pronounced and significant impact on total chlorophyll and chemical leaf composition in both seasons compared with the control.

Generally, the total chlorophyll leaf content reached 66.81, 66.34, and 66.16 with GA_3 at 200, Kn at 100 and GA_3 at 150 ppm in the first season and 67.88, 67.55 and 67.21 with GA_3 at 200, Kn at 100 and GA_3 at 150 ppm in the second season compared to the control, which was 63.06 and 65.07 in the first and the second, respectively. In addition, leaf nitrogen content reached 2.46 and 2.52 % with 200 ppm of GA_3, compared to the control, which was

1.73 and 1.93 in the first and second seasons, respectively. Potassium, phosphorous, zinc and manganese follow the same trend to leaf nitrogen content. A contradictory trend was obvious clearly with the calcium, magnesium, iron to leaf nitrogen content. Leaf magnesium content gained 0.326 and 0.324 % with 200 ppm of GA_3, compared to the control, which was 0.506 and 0.494 % in the first and second seasons, respectively.

Table 4. Gibberellic acid and kinetin foliar application treatments impact on Total chlorophyll, nitrogen, potassium, phosphorous, calcium, magnesium, iron, zinc and manganese of Cleopatra mandarin rootstock leaves (2021-2022 seasons).

Treatments	Total chlorophyll SPAD	N %	K %	P%	Ca%	Mg %	Fe ppm	Zn ppm	Mn ppm
First season 2021									
Control	63.06 d	1.73 h	1.40 h	0.232 h	2.14 a	0.506 a	118.99 a	18.39 h	12.12 h
GA_3 at 50 ppm	64.23 c	1.89 g	1.55 g	0.247 g	1.94 b	0.467 b	112.83 b	21.78 g	13.18 g
GA_3 at 100 ppm	65.61 b	2.15 d	1.81 d	0.281 d	1.57 e	0.403 e	91.51 e	31.81 d	17.39 d
GA_3 at 150 ppm	66.16 a	2.27 c	1.95 c	0.298 c	1.47 f	0.375 f	79.30 f	34.37 c	20.78 c
GA_3 at 200 ppm	66.81 a	2.46 a	2.07 a	0.329 a	1.34 h	0.326 h	62.45 h	38.37 a	22.98 a
Kn at 50 ppm	64.67 c	1.96 f	1.58 f	0.254 f	1.84 c	0.457 c	107.71 c	23.91 f	14.33 f
Kn at 75 ppm	65.25 b	2.07 e	1.76 e	0.268 e	1.72 d	0.422 d	97.89 d	27.93 e	16.24 e
Kn at 100 ppm	66.34 a	2.38 b	2.02 b	0.312 b	1.41 g	0.348 g	71.34 g	37.01 b	22.33 b
Second season 2022									
Control	65.07 c	1.93 h	1.40 h	0.235 h	2.14 a	0.494 a	118.09 a	18.37 h	12.10 h
GA_3 at 50 ppm	65.70 c	2.04 g	1.50 g	0.257 g	1.97 b	0.459 b	105.87 b	22.34 g	14.32 g
GA_3 at 100 ppm	66.70 b	2.22 d	1.70 d	0.292 d	1.57 e	0.385 e	80.74 e	29.54 d	19.76 d
GA_3 at 150 ppm	67.21 a	2.35 c	1.91 c	0.316 c	1.41 f	0.350 f	71.34 f	34.51 c	22.25 c
GA_3 at 200 ppm	67.88 a	2.52 a	2.03 a	0.336 a	1.34 h	0.324 h	63.15 h	38.26 a	23.67 a
Kn at 50 ppm	65.85 c	2.09 f	1.55 f	0.265 f	1.84 c	0.446 c	102.50 c	23.80 f	16.40 f
Kn at 75 ppm	66.46 b	2.16 e	1.68 e	0.280 e	1.69 d	0.406 d	87.41 d	28.85 e	18.89 e
Kn at 100 ppm	67.55 a	2.40 b	1.96 b	0.328 b	1.39 g	0.334 g	68.26 g	35.96 b	22.89 b

Control= 0 ppm Gibberellic acid or Kinetin, GA_3 = Gibberellic acid and Kn = Kinetin
In a column, means followed by a common letter (s) are not significantly different at the 5% level by DMRT

DISCUSSION

Data obtained in Tables (1 and 2) clearly show that all gibberellic acid (GA_3) and kinetin (Kn) concentrations had a great positive effect on vegetative growth and leave parameters of Cleopatra mandarin rootstock seedlings in both seasons.

As for, the seedling vegetative growth and leaves data in Table (1) revealed that GA_3 at 200 ppm gained the first rank in both seasons, while the Kn at 100 ppm came in the second rank as compared to the control. This came true in both seasons.

In this respect, our results are in agreement with those obtained by other researchers (El-Badawy & Abd-El-Aal, 2013; Mahmoud *et al.,* 2015; Turgutoglu *et al.,* 2015; Sharaf *et al.,* 2016; Dilip *et al.,* 2017; Al-Janabi, 2018; Al-Isaw & Al-Janabi, 2021 and Mahmoud *et al.,* 2022).

Moreover, The positive role of GA_3 on such properties might be due to the mode of action for gibberellins, which depends on their binding to a carrier protein in the first place, which allows it to be inserted into the cell, after binding to a specific receptor, it passes into the cell nucleus and changes the synthesis of genetic material (RNA). Thus, its increases cell division and elongation, photosynthesis, chlorophyll content, and carbohydrate biosynthesis.

In addition, kinetin is considered the most known cytokinin, where its physiological efficacy is represented by stimulating cell division and expansion, uptake, transport and assimilation of nutrients, increasing the effectiveness and activity of apical meristem, promoting chloroplast development, delaying leaf senescence, hormonal regulation of plant morphogenesis and other influences (El-Badawy & Abd-El-Aal, 2013; Pallaoro *et al.,* 2016; Al-Janabi, 2018; Ma *et al.,* 2018; Cornea-Cipcigan *et al.,* 2020; Al-Isaw & Al-Janabi, 2021, Attia, 2022; Mahmoud *et al.,* 2022).

Tabulated data in Table (3) illustrated that all gibberellic acid (GA_3) and kinetin (Kn) concentrations had a significant impact on the root system of Cleopatra mandarin rootstock seedlings in both seasons.

Generally, the total root system parameters of Cleopatra mandarin rootstock seedlings gained the highest values with 200 ppm of GA_3 compared to the control, In addition, the Kn at 100 ppm came in the second rank after GA_3 at 200 ppm. This came true in both seasons.

In this respect, our results are in agreement with those obtained by other researchers (El-Badawy & Abd-El-Aal, 2013; Mahmoud *et al.,* 2015; Turgutoglu *et al.,* 2015; Sharaf *et al.,* 2016; Dilip *et al.,* 2017; Al-Janabi, 2018 and Al-Isaw & Al-Janabi, 2021).

Results in Table (4) reflected that all gibberellic acid (GA_3) and kinetin (Kn) concentrations had a pronounced and significant impact on total chlorophyll and chemical leaf composition in both seasons compared with the control.

Generally, the total chlorophyll, nitrogen, phosphorous, potassium, zinc and manganese leaf content reached the highest values with GA_3 at 200, while Kn came in the second rank as compared to the control, which was in the last rank.

The contradicting trend was obvious with the calcium, magnesium and iron to leaf nitrogen content. Leaf calcium, magnesium and iron content gained the first rank with the control treatment in both seasons.

These results are in general agreement with the earlier findings of (Abd El-momein *et al.,* 2007; Panigrahi & Srivastava, 2011; Mahmoud, 2012; El-Badawy & Abd-El-Aal, 2013; Mahmoud *et al.,* 2015; Sharaf *et al.,* 2016; Dilip *et al.,* 2017; Al-Janabi, 2018; Al-Isaw & Al-Janabi, 2021).

CONCLUSION

The results demonstrated that application of some plant growth regulators to Cleopatra seedlings might be a useful way of enhancing their growth and reducing the time and cost of seedlings production. Consequently, based on the present study, it was concluded that treatment of Cleopatra mandarin rootstock seedlings with gibberellic acid at 200 ppm or kinetin at 100 ppm, applied in the first week of April, June, August and October, significantly enhanced seedlings growth and led to faster and vigorous vegetative growth of Cleopatra mandarin seedlings. The best values for seedling height and stem diameter were obtained by the application of gibberellic acid at 200 ppm followed by kinetin at 100 ppm. Such achievement always teaches the seedlings the grafting stage faster than the comparison treatment.

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تأثير الرش ببعض منظمات النمو على النمو الخضري لشتلات اليوسفي كليوباترا

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أجريت هذه الدراسة في موسمين متتاليين (2021، 2022) لبحث تأثير بعض منظمات النمو على النمو الخضري لشتلات أصل اليوسفي كليوباترا (*Citrus reshni L*). وهكذا، أجريت التجربة لتقييم تأثير الرش الورقي بحمض الجبرلين او الكينيتين كوسيلة لتحسين النمو الخضري. وهكذا، تم رش الشتلات في أبريل ويونيو وأغسطس وأكتوبر باستخدام حمض الجبرلين (50، 100، 150 و200 جزء في المليون) أو الكينيتين (50، 75، 100 جزء في المليون) وكذلك (الكنترول)، للتحقق من تأثيرها على بعض دلائل النمو. وقد أظهرت النتائج التي تم الحصول عليها خلال الموسمين التجريبيين أن جميع معاملات حمض الجبرلين او الكينيتين أدت إلى زيادة معنوية في صفات النمو مقارنة بالكنترول. ومع ذلك، كانت المعاملات المستخدمة خاصة حمض الجبرلين عند 200 جزء في المليون أو الكينتين عند 100 جزء في المليون هي الأكثر فاعلية إحصائيًا في هذا الصدد من خلال زيادة ارتفاع الشتلات وقطر الساق بشكل كبير، على وجه الخصوص، مقارنةً بالكنترول.

الكلمات المفتاحية: يوسفي كليوباترا، شتلات، أصول، موالح، حمض الجبرلين، الكينيتين