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Effect of fertilizer ratios between N, P, and K on enhancing vegetative growth of Cleopatra mandarin seedlings

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ABSTRACT

This field experimental work was conducted during successive seasons (2021 and 2022) to explore the effect of different fertilizer ratios between nitrogen (N), phosphorus (P) and potassium (K) on the vegetative growth of Cleopatra mandarin rootstock seedlings (*Citrus reshni* L.). The seedlings were subjected to different fertilizer ratios between N, P and K (2:1:1 and 1:1:2) as well as the control (1:1:1) for investigating their effect on some growth parameters of Cleopatra mandarin rootstock seedlings. All fertilizer ratios were applied at the beginning of April and during the experimental seasons using 0.5 g of N, P, and K mixed with ratios different (1:1:1, 2:1:1 and 1:1:2) for every litter of irrigation water. The treatments were distributed as randomized complete block designs with 3 replicates for each treatment. The results obtained during both experimental seasons revealed obviously that all treatments have significantly increased growth parameters as compared to control. Generally, N, P and K with a ratio 2:1:1 particularly were statistically the most effective in this study.

Keywords: Cleopatra mandarin (*Citrus reshni* L.), seedlings, rootstock, citrus, nitrogen (N), phosphorus (P) and potassium (K)

INTRODUCTION

Citrus is one of the most crucial fruit vegetation all over the world. It ranks third role between fruit crops and is most effective preceded by grapes and apples. In Egypt, it's far the maximum crucial fruit crop. 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 is excellent and resembling those produced on sour orange rootstock, however, fruit size is smaller. Cleopatra mandarin is considered as one of the essential 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, calcareous soil. It grows well in sandy and heavy soils as well as its high tolerance to chlorosis and salinity. Cleopatra mandarin seedlings take a longer time as compared to other citrus rootstocks to reach the budding stage due to their slow growth. Moreover, the trees budded on Cleopatra mandarin are slowly grown until they reach the fruiting stage (Llosa *et al.*, 2009; Anjum, 2010; Lacey, 2012; Sharaf *et al.*, 2016; Al-Janabi, 2018 and Mahmoud *et al.*, 2022).

Nutrients including nitrogen (N), phosphorus (P), and potassium (K) are essential for plant growth and fruit production. N is one of the most important nutrients significantly affecting plant growth and at a lesser extent fruit production. This is because N is the main component for the structure of amino acids and hence proteins, as well as nitrogen is the main component of chlorophyll, which influences photosynthesis and plant growth (Marschner, 1995; Ashkevari *et al.*, 2013 and Abo-Eid, 2017).

Nitrogen fertilization is important for the efficient production of fruits including citrus. Nitrogen is subjected to different chemical processes including leaching and denitrification. Both processes result in the reduction of N availability in soil. Adequate nitrogen is a necessary condition for cell division, and whether the nitrogen supply is sufficient or not is directly related to organ differentiation, formation and tree structure formation. Accordingly, it is important to find and suggest the appropriate methods of N fertilization with appropriate efficiency. Nitrogen leaching is especially common in humid areas decreasing the efficiency of N fertilization as well as available soil inorganic N, which is the product of organic N mineralization in soil. Chemical N fertilization, especially at high rates would result in the decreased N efficiency by processes of denitrification and leaching. Denitrification also decreases N availability to plants, especially under saturated conditions as mineral N including ammonium (NH_4)

and nitrate (NO_3) are reduced to gaseous N and emitted to the atmosphere (Dong *et al.*, 2005; Miransari and Mackenzie, 2011; Ashkevari *et al.*, 2013; Abo-Eid, 2017; Zhang *et al.*, 2019).

Phosphorus (P) is also necessary for plant growth and fruit production. It has different functions in plant the most important of which is the role of P in the production of energy. Because of P chemical properties, it behaves differently from N. Phosphorus products are more subjected to precipitation and usually after fertilizing with P about 20% of P is available to plant and the other part would turn into insoluble products although they may become soluble gradually. Accordingly, it is important to use appropriate methods of P fertilization with appropriate efficiency. For example, chemical P can be fertilized around tree roots or it can be fertilized organically to increase its efficiency (Marschner, 1995; Ashkevari *et al.*, 2013; Abo-Eid, 2017).

Potassium (K) is also another necessary nutrient for plant growth and fruit production with some important functions in plant. For example, K can adjust enzyme functioning in plant, control water behavior including the process of plant transpiration, etc. Similar to N, K is also a mobile nutrient and hence is subjected to leaching. It is necessary in high amounts by plants and can be applied by the use of chemical fertilization or organic fertilization (Ashkevari *et al.*, 2010, 2013; Abo-Eid, 2017).

The aim of the present study was prime importance to enhance the Cleopatra mandarin rootstock seedlings' vigor process to shorten the period necessary for budding through the application of different fertilizer ratios between N, P, and K.

MATERIAL AND METHODS

This field experimental work was conducted during successive seasons (2021 and 2022) to explore the effect of different fertilizer ratios between N, P and K on the vegetative growth of Cleopatra mandarin rootstock seedlings (*Citrus reshni* L.) by using different fertilizer ratios between N, P and K (2:1:1 and 1:1:2) as well as the control (1:1:1). In March 2021 and 2022 seasons a 45 seedlings uniform in their growth as much as possible, with their stem diameters ranged between 2-3 mm on the height of 10-15 cm from the soil surface level were chosen. The seedlings were separately subjected to different fertilizer ratios between N, P and K (2:1:1 and 1:1:2) as well as the control (1:1:1). Herein, the randomized complete block design (RCBD) with three replications was employed for arranging the investigated 3 treatments, whereas each replicate was represented by five seedlings, planted in plastic pots with the dimensions of 15 cm diameter x 30 cm height filled with potting media consisted of sand + clay mixture at equal proportion (v:v). In addition, all horticultural field practices were conducted for the seedlings regarding irrigation and removal of all lateral branches (suckering process), weeding and control of insects when needed.

The different fertilizer ratios between N, P, and K were applied in the first week of April among the experimental seasons using 0.5 g of N, P, and K mixed with ratios different (1:1:1, 2:1:1 and 1:1:2) for every litter of irrigation water. The experimental seedlings were grown in a greenhouse at a private orchard at Nobaria region – El Behera Governorate Egypt. All the seedlings of this study received the same horticultural practices except for experimental treatments.

Composition of fertilizers used in the experiment:

The first fertilizer (control), the proportion of the elements the ratio (1:1:1). Ammonium nitrate (163 g), mono-ammonium phosphate (390 g), potassium sulfate (210 g) and inert filler substance (237 g) per every 1000 g containing N (100.6 g), P (101.0 g) and K (100.8 g).

The second fertilizer, the proportion of the elements the ratio (2:1:1) of ammonium nitrate (285 g), Urea (125 g), mono-ammonium phosphate (385 g) and potassium sulfate (205 g) per every 1000 g containing N (197.8 g), P (101.1 g) and K (98.40 g).

The third fertilizer, the proportion of the elements the ratio (1:1:2) of ammonium nitrate (130 g), ammonium sulfate (60 g), mono-ammonium phosphate (392 g) and potassium sulfate (418 g) per every 1000 g containing N (102 g), P (101 g) and K (201 g).

Note that, ammonium nitrate contains 33% N, ammonium sulfate contains 20.5 % N, urea contains 46 % N, mono-ammonium phosphate contains 12 % N and 26% P_2O_5, as well as potassium sulfate, contains 48 % K_2O.

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 roots were washed thoroughly 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 of seedling height, stem thickness, canopy weight, number of leaves and total leaves weight per each seedling were counted for the seedlings per each replicate, then an 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 for the 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 according to (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 of 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 ground 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 experimental design was randomized complete block design (RCBD) with three replications was employed for arranging the investigated 3 treatments, whereas each replicate was represented by five seedlings. The data obtained were statistically analyzed using the analysis of variance method as reported by (Snedecor and Cochran, 1980). The differences between means were differentiated by using Duncan's range test (Duncan, 1955) using computer program COSTAT.

RESULTS

Data in **Table (1),** summarizes mainly that, all different fertilizer ratios between N, P and K (2:1:1 and 1:1:2) as compared to the control (1:1:1) had a great positive effect on vegetative growth parameters of Cleopatra mandarin rootstock seedlings in both seasons.

Concerning, the seedling height in **Table (1)** reached 99.12 cm and 100.52 cm with N2P1K1 , which were over the control by 55.95% & 65.87% in the first and the second seasons, respectively, while the N1P1K2 came in the second rank by reaching 80.44 and 77.78 cm, which were over the control by 26.56% & 28.35% in the first and

the second seasons, respectively, while the control (N1P1K1) recorded 63.56 and 60.60 cm in the first and the second seasons, respectively.

Moreover, the highest values of stem thickness were obtained by N2P1K1 which recorded 10.74 and 11.60 mm, which were over the control by 58.41% & 27.33% in the first and the second seasons, respectively. The second rank was gained by N1P1K2 which reached 9.03 and 10.55 mm, which were over the control by 33.19% & 15.81% in the first and the second seasons, respectively, while the control (N1P1K1) reached 6.78 and 9.11 mm in the first and the second seasons, respectively.

In general, the same trend was obtained with canopy weight, number of leaves per plant and total fresh leaves weight per plant parameters in both seasons.

Table 1. Effect of different fertilizer ratios between N, P and K on some 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				
$N_1 P_1 K_1$ (Control)	Value	63.56 c	6.78 c	28.55 c	53.45 c	7.43 c
$N_2 P_1 K_1$	Value	99.12 a	10.74 a	63.50 a	101.24 a	20.34 a
	±%*	55.95%	58.41%	122.42%	89.41%	173.76%
$N_1 P_1 K_2$	Value	80.44 b	9.03 b	44.98 b	74.23 b	14.33 b
	±%*	26.56%	33.19%	57.55%	38.88%	92.87%
		Second season 2022				
$N_1 P_1 K_1$ (Control)	Value	60.60 c	9.11 c	24.48 c	59.57 c	10.81 c
$N_2 P_1 K_1$	Value	100.52 a	11.60 a	56.82 a	95.45 a	23.59 a
	±%*	65.87%	27.33%	132.11%	60.23%	118.22%
$N_1 P_1 K_2$	Value	77.78 b	10.55 b	39.22 b	78.56 b	16.48 b
	±%*	28.35%	15.81%	60.21%	31.88%	52.45%

*±% = increase or decrease % in relation to the control and it was calculated in cases of significant differences only.
In a column, means followed by a common letter (s) are not significantly different at the 5% level by DMRT

Thus, it could be suggested from the foregoing results in Table (2) that all different fertilizer ratios between N, P and K (2:1:1 and 1:1:2) as compared to the control (1:1:1) had a great statically influence on leaves characteristics in both seasons.

In this concern, leaf area achieved 14.64 and 17.05 cm2 with N2P1K1 , which were over the control by 102.21% & 106.17% in the first and the second seasons, respectively, while the control (N1P1K1) recorded 7.24 and 8.27 cm2 in the first and the second seasons, respectively. The second rank was gained by N1P1K2 ratio, which achieved 10.57 and 12.38 cm2, which were over the control by 45.99% & 49.70% in the first and the second seasons, respectively. Moreover, the trend of leaf fresh weight, leaf length, leaf width and total leaf water content percentage parameters was noticed in leaf area in both seasons. On contrary, the leaf dry weight percentage gained the highest values in both seasons with the control, which reached 11.54 % in the first season and 14.19 % in the second season.

Table 2. Effect of different fertilizer ratios between N, P and K on some 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							
N_1 P_1 K_1 (Control)	Value	0.139 c	4.03 c	2.68 c	7.24 c	88.46 c	11.54 a
N_2 P_1 K_1	Value	0.201 a	5.54 a	3.94 a	14.64 a	90.55 a	9.45 c
	±%*	44.60%	37.47%	47.01%	102.21%	2.09%	-2.09%
N_1 P_1 K_2	Value	0.193 b	4.74 b	3.33 b	10.57 b	89.44 b	10.56 b
	±%*	38.85%	17.62%	24.25%	45.99%	0.98%	-0.98%
Second season 2022							
N_1 P_1 K_1 (Control)	Value	0.181 c	4.20 c	2.94 c	8.27 c	85.81 c	14.19 a
N_2 P_1 K_1	Value	0.247 a	5.99 a	4.25 a	17.05 a	88.30 a	11.70 c
	±%*	36.46%	42.62%	44.56%	106.17%	2.49%	-2.49%
N_1 P_1 K_2	Value	0.210 b	5.07 b	3.64 b	12.38 b	87.19 b	12.81 b
	±%*	16.02%	20.71%	23.81%	49.70%	1.38%	-1.38%

*±% = increase or decrease % in relation to the control and it was calculated in cases of significant differences only. In a column, means followed by a common letter (s) are not significantly different at the 5% level by DMRT

It should be emphasized that all different fertilizer ratios between N, P and K (2:1:1 and 1:1:2) had a major statistical impact in both seasons than the control on the root system of Cleopatra mandarin rootstock seedlings in both seasons **Table (3).**

With regards to, the weight of the total root system of Cleopatra mandarin rootstock seedlings reached to 65.95 and 66.93 g with N2P1K1, which were over the control by 137.74% & 176.91% in the first and the second seasons, respectively, while the control recorded 27.74 and 24.17 g in the first and the second season respectively. In addition, the N1P1K2 came in the second rank with 48.80 and 48.97 g , which were over the control by 75.92% & 102.61% in the first and the second season, respectively. A parallel trend concerning, the rest of the characteristics of the root system in this experiment held as the previous one.

Table 3. Effect of different fertilizer ratios between N, P and K on the 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							
N_1 P_1 K_1 (Control)	Value	27.74 c	1733.49 c	11.78 c	6.73 c	736.09 c	420.55 c
N_2 P_1 K_1	Value	65.95 a	4122.09 a	28.01 a	16.00 a	1750.36 a	1000.02 a
	±%*	137.74%	137.79%	137.78%	137.74%	137.79%	137.79%
N_1 P_1 K_2	Value	48.80 b	3049.84 b	20.72 b	11.84 b	1295.05 b	739.89 b
	±%*	75.92%	75.94%	75.89%	75.93%	75.94%	75.93%
Second season 2022							
N_1 P_1 K_1 (Control)	Value	24.17 c	1510.51 c	10.26 c	5.86 c	641.41 c	366.45 c
N_2 P_1 K_1	Value	66.93 a	4182.92 a	28.42 a	16.24 a	1776.19 a	1014.78 a
	±%*	176.91%	176.92%	177.00%	177.13%	176.92%	176.92%
N_1 P_1 K_2	Value	48.97 b	3060.76 b	20.79 b	11.88 b	1299.69 b	742.54 b
	±%*	102.61%	102.63%	102.63%	102.73%	102.63%	102.63%

*±% = increase or decrease % in relation to the control and it was calculated in cases of significant differences only. In a column, means followed by a common letter (s) are not significantly different at the 5% level by DMRT

Data presented in Table 4 showed that all different fertilizer ratios between N, P and K (2:1:1 and 1:1:2) as compared to the control (1:1:1) had a major statistical impact on total chlorophyll and chemical leaf composition in both seasons.

With regards to, the total chlorophyll leaf content reached 65.81, and 66.91 with N2P1K1 compared to the control, which was 63.38 and 65.23 in the first and the second season, respectively, while the N1P1K2 came in the second rank by reaching 64.85 and 66.19 in the first and the second seasons, respectively. In addition, leaf nitrogen content reached 2.196 and 2.291 % with N2P1K1, compared to the control, which was 1.846 and 1.928 in the first and the second, respectively, while the N1P1K2 came in the second rank by reaching 1.997 and 2.120 % in the first and the second seasons, respectively. On the contrary, the leaf potassium content reached to 1.917 and 1.827 % with N1P1K2, compared to the control, which was 1.448 and 1.456 in the first and the second seasons, respectively.

Concerning the phosphorous, zinc and manganese, also an analogous trend to leaf nitrogen content was obtained. On the other hand, calcium, magnesium and iron take another direction to leaf nitrogen content. The leaf magnesium content gained 0.489 and 0.483 % with the control in the first and the second seasons, respectively

Table 4. Effect of different fertilizer ratios between N, P and K on Total chlorophyll, nitrogen, potassium, phosphorous, calcium, magnesium, iron, zinc and manganese of Cleopatra mandarin leaves (2021-2022 seasons)

Treatments		Total chlorophyll SPAD	N %	K %	P%	Ca%	Mg %	Fe ppm	Zn ppm	Mn ppm
First season 2021										
$N_1 P_1 K_1$ (Control)	Value	63.38 c	1.846 c	1.448 c	0.241 c	2.050 a	0.489 a	115.65 a	19.96 c	12.59 c
$N_2 P_1 K_1$	Value	65.81 a	2.196 a	1.663 b	0.290 a	1.508 c	0.388 c	86.73 c	32.98 a	19.20 a
	±%*	3.83%	0.35%	0.22%	0.05%	-0.54%	-0.10%	-25.01%	65.23%	52.50%
$N_1 P_1 K_2$	Value	64.85 b	1.997 b	1.917 a	0.258 b	1.771 b	0.434 b	103.40 b	26.63 b	15.17 b
	±%*	2.32%	0.15%	0.47%	0.02%	-0.28%	-0.06%	-10.59%	33.42%	20.49%
Second season 2022										
$N_1 P_1 K_1$ (Control)	Value	65.23 c	1.982 c	1.456 c	0.244 c	2.040 a	0.483 a	112.37 a	20.68 c	12.42 c
$N_2 P_1 K_1$	Value	66.91 a	2.291 a	1.651 b	0.303 a	1.485 c	0.363 c	74.51 c	32.30 a	21.07 a
	±%*	2.58%	0.31%	0.20%	0.06%	-0.56%	-0.12%	-33.69%	56.19%	69.65%
$N_1 P_1 K_2$	Value	66.19 b	2.120 b	1.827 a	0.276 b	1.734 b	0.418 b	93.65 b	26.87 b	17.18 b
	±%*	1.47%	0.14%	0.37%	0.03%	-0.31%	-0.07%	-16.66%	29.93%	38.33%

*±% = increase or decrease % in relation to the control and it was calculated in cases of significant differences only.
In a column, means followed by a common letter (s) are not significantly different at the 5% level by DMRT

DISCUSSION

The present data in **Tables (1 and 2)**, showed that there is a great positive impact on vegetative growth and leaves parameters of Cleopatra mandarin seedlings for all different fertilizer ratios between N, P and K (2:1:1 and 1:1:2) as compared to the control (1:1:1) in both seasons. The significant effects of $N_2P_1K_1$ treatment on the vegetative growth and leaves parameters particularly with the height and diameter of the seedling stem could be stated that, the seedlings require such amount of N for optimum growth and fruit production.

Moreover, Nitrogen is a very important nutrient for plant growth, especially at the vegetative growth stage. Because N is necessary for different plant functioning, including its presence in the structure of amino acid and proteins, as well as nitrogen is the main component of chlorophyll, which influences photosynthesis and plant growth. Citrus trees produce a high volume of green tissue and fruits and hence N fertilization is demanding for the seedlings (Wang *et al.*, 2006, Ashkevari *et al.*, 2013 and Abo-Eid, 2017). The results of the present study are in parallel with those previously found by (Jahromi *et al.*, 2012; Ashkevari *et al.*, 2013; Sujeet *et al.*, 2013; Ramana *et al.*, 2014; Abo-Eid, 2017).

The results listed in **Table 3** emphasized that all different fertilizer ratios between N, P and K (2:1:1 and 1:1:2) had a major statistical impact in both seasons than the control on the root system of Cleopatra mandarin rootstock seedlings in both seasons. With regards to, the weight of the total root system of Cleopatra mandarin rootstock seedlings came in the first rank with $N_2P_1K_1$ in both seasons as compared to the control. In addition, the $N_1P_1K_2$ came in the second rank. A parallel trend concerning, the rest of the characteristics of the root system in this experiment held true as the previous one. This trend of response is confirmed by the earlier findings (Jahromi *et al.*, 2012; Ashkevari *et al.*, 2013; Sujeet *et al.*, 2013; Ramana *et al.*, 2014; Abo-Eid, 2017).

Data presented in **Table (4)** showed that, all different fertilizer ratios between N, P and K (2:1:1 and 1:1:2) as compared to the control (1:1:1) had a major statistical impact on total chlorophyll and chemical leaf composition in both seasons. With regards to, the total chlorophyll leaf content gained the highest values with $N_2P_1K_1$ as compared to the control in both seasons, while the $N_1P_1K_2$ came in the second rank. In addition, leaf nitrogen content achieved the highest values with $N_2P_1K_1$, compared to the control in both seasons, while the $N_1P_1K_2$ came in the second rank. On the contrary, the leaf potassium content gained the highest ualues in both seasons with $N_1P_1K_2$, compared to the control.

Concerning the phosphorous, zinc and manganese, also an analogous trend to leaf nitrogen content was obtained. On the other hand, the calcium, magnesium and iron take another direction to leaf nitrogen content. The leaf magnesium content gained the highest rank with the control in the first and the second seasons, respectively
The obtained results are in line with those obtained by (Jahromi *et al.*, 2012; Ashkevari *et al.*, 2013; Sujeet *et al.*, 2013; Ramana *et al.*, 2014 and Abo-Eid, 2017).

CONCLUSION

Conclusively, it could be mentioned based on the obtained results that all treatments of Cleopatra mandarin rootstock seedlings increased significantly growth parameters as compared to the control. Generally, N, P and K with a ratio 2:1:1 particularly were statistically the most effective in this study. Such enhancement of seedlings growth enabled them to reach the grafting stage in a rather shorter time which is highly recommended by nurserymen and thus reduces the cost of production. Thus, we recommend applying the treatment of N, P and K with 2:1:1 ratio to the rootstocks of Cleopatra mandarin seedlings by using 0.5 gram per every liter of irrigation water throughout the growth season.

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تأثير النسب السمادية بين الازوت، الفسفور والبوتاسيوم على تحسين النمو الخضري لشتلات اليوسفي كليوباترا

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تم إجراء هذه التجربة خلال المواسم المتتالية (2021، 2022) لاستكشاف تأثير النسب السمادية المختلفة بين النتروجين والفوسفور والبوتاسيوم على النمو الخضري لشتلات أصل اليوسفي كليوباترا .(*Citrus reshni* L) خضعت الشتلات لنسب سماد مختلفة بين الأزوت، الفسفور والبوتاسيوم (2: 1: 1، 1: 1: 2) وكذلك الكنترول (1: 1: 1) لمعرفة تأثيرها على بعض صفات النمو. تم تطبيق جميع النسب السمادية في أبريل. تم توزيع المعاملات على شكل قطاعات كاملة العشوائية مع 3 مكررات لكل معاملة. وقد أظهرت النتائج التي تم الحصول عليها خلال الموسمين التجريبيين بشكل واضح أن جميع المعاملات قد أدت إلى زيادة معنوية في صفات النمو مقارنة بالكنترول. وبشكل عام، كان الازوت، والفسفور والبوتاسيوم بنسبة 2: 1: 1 بشكل واضح هي الأكثر فعالية من الناحية الإحصائية في هذه الدراسة.

الكلمات المفتاحية: يوسفي كليوباترا، شتلات، أصول، موالح، الأزوت ، الفسفور، البوتاسيوم