Plant Archives Vol. 21, Supplement 1, 2021 pp. 1266-1273 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
doi link : https://doi.org/10.51470/PLANTARCHIVES.2021.v21.S1.200

RESPONSE OF FOUR CITRUS ROOTSTOCKS IRRIGATED BY MAGNETIC WATER AND SPRAYING WITH THE AMINO ACID TRYPTOPHAN

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ABSTRACT

The current study was conducted in a wooden shadow in Najaf Agriculture Directorate during 2019 – 2020 season to study the effect of some spraying of tryptophan and irrigating with magnetic water on four citrus rootstocks. The experiment was included three main factors and designed using RCBD with three replicates. The first factor was the four citrus rootstocks (Narang, Swenkl stromelo, Benzher and Folga mariana), the second factor was irrigation water (Tap water, Magnetic water treated with 1500 chaos) and the third factor was spraying with amino acid tryptophan. Results showed that citrus rootstocks were varied in vegetative growth traits when Benzher and Swenkl stromelo recorded high height and a biggest diameter of stem. The absolute growth rate was improved in citrus rootstocks in terms of plant height, leafs number and stem diameter in summer and autumn months. The highest chlorophyll content was recorded in *Folga mariana* and *Swenkl stromelo* leafs, while the Benzher was exceled other rootstocks in terms of leafs content of indole acetic acid (IAA). The response of citrus rootstocks to the irrigation with magnetic water was varied, for instance, Swenkl stromelo showed significant plant height when it irrigated with tap water recording 112.53cm and a bigger diameter of stem (813.10mm). Whereas, Benzher irrigated with magnetic water recorded 10.707mm of stem diameter. Swenkl stromelo showed a biggest leaf area (3.627cm^2.plant^{-1}) when irrigated with tap water, and for the Narang rootstock, it achieved a largest thickness of bark (3.856mm) when irrigated with magnetic water. Leaf content of chlorophyll was affected by irrigation water as irrigated Swenkl stromelo with magnetic water recorded the highest concentration of chlorophyll. While irrigating Swenkl stromelo with tap water and Benzher with magnetic water gave a highest content of IAA. Tryptophan concentrations showed significant effect on vegetative traits of citrus rootstocks, when achieving high plant height (109.60cm) after spraying Swenkl stromelo with 100mg.L^{-1}, while bigger diameter achieved (11.040mm) when Benzher rootstock was not treated (control). The large leaf area was recorded in control treatment in Folga mariana and spraying 100mg.L^{-1} of tryptophan in Benzher (3325 and 3212cm2.plant^{-1} respectively). The largest thickness in bark (3.900mm) was recorded in Benzher that spraying with 50mg.L^{-1} tryptophan. The highest concentration of chlorophyll was recorded in Folga mariana with no spraying and in Swenkl stromelo when spraying with 50mg.L^{-1}. IAA concentration in leafs of Swenkl stromelo and Benzher was increased when spraying with 100mg.L tryptophan.

***Keywords*:** Citrus rootstocks, tryptophan, magnetic water, vegetative traits.

Introduction

Citrus is an important fruit tree due to the nutritional and economic value of its fruits, as they are rich in salts that necessary for building human body such as potassium, calcium, magnesium, sodium, sulfur and phosphorous. In addition, it is considered significant source of vitamins C, A, B1 and B2 (Ibrahem, 2015). The productivity of citrus ranked second after grapes globally, and the statistics of the Agricultural Statistics Directorate in Iraq mentioned that the productivity of citrus amounted 98976 ton in 2017. The common method of multiplying citrus is by grafting on seed roots (Khan, 2007), and these rootstocks have an important role in the quality and quantity of yield as well as in the shape and size of the growing tree (Agusti, 2003). Magnetic power has been used recently to improve the properties of irrigation water, as it has important role in breaking salt molecules and making the water more amenable to dissolving salts by reducing surface tension (Al-Gothary, 2006), the water stays magnetized for 12 hours, so it is recommended to use it during this period of time (Mahgoob, 2002). The technique of spraying nutrients, growth regulators and other compounds including amino acids has appeared in the last three decades on a large scale with the aim of improving plant growth and increasing its productivity (Al-Sahaf, 1989b). Amino acids are an essential source in preparing plants with nitrogen which has a role in building chlorophyll and increasing the efficiency of photosynthesis and helps in the production of nucleic acids (DNA, RNA), proteins and other compounds that increase plant activity and growth by increasing division and elongating of cells (Kurepin *et al*., 2013). Moreover, amino acids have a role in building plant hormones, enzymes and vitamins (Abd El-Aziz and Balbaa, 2007), for instance, tryptophan is considered the starting point for building the auxin IAA which increases vegetative growth. This study was conducted due to the lack of research on the use of magnetized water and spraying tryptophan and their role in the growth of citrus seedlings until it become ready for grafting.

Materials and Methods

This research was conducted in Najaf Agriculture Directorate during 2019–2020 season. The experiment was included three main factors, the first factor was the four citrus rootstocks (Narang, Swenkl stromelo, Benzher and Folga mariana), the second factor was irrigation water (Tap water, Magnetic water treated with 1500 chaos) and the third factor was spraying with three concentrations of amino acid tryptophan [0(water only), 50 and 100mg.L-^{1}]. Randomized complete block design (RCBD) was used with three riplicates as rootstocks presented the main plots, type of irrigation water presented the sub plots and tryptophan concentrations presented sub-sub plots and each treatment contained 5 seedlings. Data were analyzed using Genstat and means were compared using the least significant difference (L.S.D.) at 5% level of significance (P>0.05) (Al-Rawi and Khalf, 2000). Three seedlings of each treatment were selected and the measuring of vegetative traits was done for the monthly increasing of plant height and stem diameter at grafting point (15cm above soil surface) then in the end of the experiment, leaf area was measured according to Dvorinic, (1965) method which depends on the relationship between leaf area and its dry weight. The absolute growth rate was calculated according to three indicators including the increasing in plant height, leafs number in plant and plant diameter during the season (Hunt, 1978).

The thickness of bark was measured using vernire and leafs content of chlorophyll was estimated following the procedure of Ranganna, (1977) after extracting it from fresh leaf tissue by acetone and using spectrophotometer at 645 and 663 nanometer. Leafs content of total carbohydrates was estimated from dry sample of leafs according to Duboies *et al*. (1956) that modified by Joslyn, (1970) using UV-Visible spectrophotometer at 490 nanometer by adding H_2SO_4 and phenol to the sample then color became orange. IAA hormone was estimated following Unyayar *et al*., (1996) which described in Ergun *et al*. (2002).

Results and Discussion

The effect of magnetic water and spraying of tryptophan on vegetative and root growth and some chemical traits of the four citrus rootstocks.

(i) Plant height (cm):

Results of Table 1 showed that the four citrus rootstocks were significantly varied when Benzher and Swenkl stromelo recorded a highest plant height (101.58 and 101.34cm respectively) compare to 91.72cm in the Narang rootstock. This difference is expected due to the differences in genetic structure. The type of irrigation water had significant effect on plant height when irrigation with tap water gave a high average of plant height and recorded 99.26cm compare to 98.03 in magnetic water. Tryptophan concentrations also had significant effect on plant height trait as spraying seedlings with 100mg.L^{-1} of tryptophan was increased plant height and recorded 99.71cm compare to 97.67cm in control. Spraying of tryptophan was caused increasing in plant height due to its role in increasing IAA that encourages cell division and elongation (Taiz and Zeiger, 2010). The interaction between the type of rootstock and the type of water had significant effect when irrigated Swenkl stromelo with tap water which led to increase plant height (112.53cm) in the end of the experiment compare irrigated Narang rootstock with magnetic water which decrease the average of height (90.00cm). While, Benzher and Folga mariana rootstocks showed a highest plant height when irrigated with magnetic water compare to tap water. The different responses of different rootstocks when irrigated with magnetic water may relate to genetic structure of these rootstocks. The interaction between tryptophan concentrations and irrigation water type had significant effect when irrigated plants with magnetic water and spraying seedlings with 100mg.L^{-1} of tryptophan gave 100.57cm plant height compare to 96.49cm in irrigated with magnetic water and spraying with 50mg.L^{-1} of tryptophan. The interaction between tryptophan concentrations and citrus rootstocks had also significant effect on plant height when spraying Swenkl stromelo with 100mg.L^{-1} of tryptophan was increased plant height and recorded 109.60cm compare to spraying Narang rootstock at control treatment which decreased the average of plant height to 91.33cm. The interaction of these three factors had significant effect on plant height as irrigated Swenkl stromelo with tap water and spraying with 100mg.L^{-1} , 50mg.L^{-1} of tryptophan was increased the average of plant height (116.40cm) compare to the same rootstock irrigated with magnetic water which decreased plant height to 81.33cm.

(ii) Seedlings diameter at grafting point (m.plant^{-1})

Table 2 results showed that citrus rootstocks were significantly differed when Swenkl stromelo gave the highest value of stem diameter 10.249m.plant^{-1} compare to Narang which gave the lowest value of stem diameter 8.778m.plant^{-1}. These differences between citrus rootstocks were expected due to difference in genetic structure and growth activity. Magnetic water and tryptophan concentration were not significant on this trait. The interaction between rootstock type and water type was significant when Swenkl stromelo irrigated with tap water and Benzher with magnetic water increased the average of stem diameter and gave 10.813 and 10.707m.plant^{-1} respectively compare to Narang rootstock irrigated with magnetic water which decreased stem diameter recording 8.667m.plant^{-1}. These results are compatible with rootstocks behavior toward magnetic water, as Benzher recorded an increasing and the Narang decreasing in vegetative traits when both rootstocks were irrigated with magnetic water. The interaction of water type with tryptophan concentrations was significant when magnetic water and 100mg.L^{-1} concentration of tryptophan treatments gave the highest average of stem diameter in seedlings recording 10.003m.plant^{-1} compare to magnetic water with 50mg.L^{-1} concentration of tryptophan treatments which recorded 9.481m.plant^{-1}. Results indicated the positive effect of the above factors and increased stem diameter by increasing cell division and the role of tryptophan in formation of IAA. The interaction of rootstocks with tryptophan concentrations was significant when spraying Benzher with tryptophan was increased stem diameter recording 11.040m.plant^{-1} compare to 8.517m.plant^{-1} in Narang. The interaction of the three factors had significant effect and increasing seedlings stem diameter as Swenkl stromelo sprayed with 50mg.L^{-1} and Benzher irrigated with magnetic water recorded 11.040 and 11.200m.plant^{-1} respectively compare to irrigated Narang rootstock with magnetic water recording 8.00m.plant^{-1}.

(iii) Leaf area of plant ($cm^2.plant^{-1}$)

Results of Table 3 showed that rootstocks were not significantly differing in leaf area trait and magnetic water did not affect leaf area, while spraying tryptophan was increased leaf area of each plant but it not significant. The interaction of rootstock type and water type was significant when irrigated Swenkl stromelo with tap water which gave a highest average of leaf area for each plant recording $3.627cm^2.plant^{-1}$ in comparison with same rootstock irrigated with magnetic water which decreased leaf area to $2.484cm^2.plant^{-1}$. The interaction between water type and tryptophan concentrations was significant when irrigated with tap water with no spraying of tryptophan and irrigated with tap water with spraying of $100mg.L^{-1}$ concentration of tryptophan gave a high leaf area 3.247 and $3.189cm^2.plant^{-1}$ respectively compare to magnetic water and the control of spraying tryptophan which decreased the average of leaf area to $2.786cm^2.plant^{-1}$ as the main factor of decreasing leaf area is the magnetic water. Interaction between tryptophan concentrations with rootstocks was also significant when Folga mariana at control treatment and spraying Benzher with $100mg.L^{-1}$ concentration of tryptophan gave an increasing in the average of leaf area for each plant amounted 3.212 and $3.325cm^2.plant^{-1}$ respectively in comparison with Narang rootstock with control treatment of tryptophan which decreased the average of leaf area to $2.611cm^2.plant^{-1}$. Results showed that the interaction between the three factors was significant when Benzher irrigated with magnetic water and sprayed with $50mg.L^{-1}$ concentration of tryptophan and irrigated Swenkl stromelo with tap water with spraying $100mg.L^{-1}$ concentration of tryptophan was gave 3.559 and $3.662cm^2.plant^{-1}$ of leaf area respectively compare to $2.275cm^2.plant^{-1}$ when irrigated Swenkl stromelo with magnetic water and spraying $50mg.L^{-1}$ concentration of tryptophan.

(iv) The thickness of bark in grafting point (mm).

Results of Table 4 showed that the used rootstocks were significantly differing in bark thickness trait as the Benzher rootstock gave thick bark 3.728mm compare to low thickness bark 3.106mm in Folga mariana. The use of magnetic water to irrigate citrus rootstocks was also had significant effect on the thickness of bark which recorded 3.564mm compare to tap water treatment which gave only 3.206mm. Tryptophan concentrations did not have significant effect on the thickness of bark, while the interaction between rootstock and water type was significantly effect this trait when irrigated Nanarg with magnetic water gave the largest thick bark amounted 3.856mm compare to 2.756mm in Folga mariana irrigated with tap water. The interaction between water type and tryptophan concentrations was significantly affected bark thickness when irrigated with magnetic water with $100mg.L^{-1}$ concentration of tryptophan gave high value of bark thickness amounted 4.058mm, while irrigated with tap water and same concentration of tryptophan gave the lowest value recording 2.750mm. Results showed that the interaction between rootstocks and tryptophan concentrations was significantly affect bark thickness when spraying Benzher with$50mg.L^{-1}$ concentration of tryptophan gave high value of bark thickness amounted 3.900mm compare to lowest value 2.283mm in Folga mariana sprayed with the same concentration of tryptophan. While the interaction between the three factors was also significant when Swenkl stromelo irrigated with magnetic water and sprayed with $100mg.L^{-1}$ concentration of tryptophan recorded 4.800mm compare to 1.467mm in Narang rootstock when irrigated with tap water and not spraying tryptophan. The importance of increasing bark thickness in grafting area is due to its role in produce callus cells.

(v) Absolute growth rate.

It can be noticed from Table 5 that plant height was rapidly affected by temperature especially minimum temperature as all studied rootstocks had an increasing in this trait when temperature increased and when winter started the average of plant height decreased then in spring seedlings began to regain its growth gradually. These results are expected as citrus is tropical fruit and subtropical and needs relatively high temperatures for its growth and fruiting (Ibrahem, 2015). The average of increasing of plant height in Narang was generally lower than other rootstocks despite its rapid use as rootstock in Iraq (Al-Kafagy *et al*., 1990). The average of increasing of leafs number also affected positively when temperature increase during summer and autumn and negatively in winter for all citrus rootstocks but Narange was more affected when temperature decreased and the number of leafs recorded 1.68 leaf. month compare to 2.62 leaf .month in Swenkl stromelo during winter months despite some of its leafs were fallen in the beginning of winter. During spring season, all citrus rootstocks started to regain its growth except Narang. The highest average of leafs number monthly was recorded 11.27leaf.month in Benzher in August-October. Al-Kafagy *et al*. (1990) mentioned that the cultivation of Benzher located in hot areas and the low temperatures affected negatively the growth of this rootstock, in addition to infect seedlings by diseases. The monthly increasing of stem diameter is important for citrus breeders as it determine the use of rootstock for grafting. Table 5 showed that the stem diameter started to increase in spring, while in winter stem diameter was decreased to 0.147mm.month in comparison with Benzher and Folga mariana which recorded 0.188 and 0.182mm.month respectively.

(vi) Leafs content of chlorophyll ($mg.100g\ fresh\ weight^{-1}$)

Table 6 showed that rootstocks did not significantly effect on leafs content of chlorophyll, magnetic water and tryptophan concentrations also did not effect this trait despite the reduction of chlorophyll when spraying with tryptophan. The interaction between rootstocks and water type was significant when irrigated Swenkl stromelo with magnetic water was increased chlorophyll concentration in leafs to $84.1mg.100g^{-1}$ compare to $70.0mg.100g^{-1}$ in the same rootstock irrigated with tap water. The interaction between water type and tryptophan concentrations was significant when irrigated seedlings with tap water and spraying $50mg.L^{-1}$ of tryptophan and magnetic water with $100mg.L^{-1}$ tryptophan was increased chlorophyll level in leafs to 83.1 and $82.3mg.100g^{-1}$ respectively in comparison with magnetic water treatment with spraying $50mg.L^{-1}$ and tap water at control treatment which recorded the lowest chlorophyll content in leafs amounted 69.4 and $69.5mg.100g^{-1}$. The interaction between rootstocks and tryptophan concentrations was significant as the Folga mariana at control treatment and Swenkl stromelo with spraying $50mg.L^{-1}$ recorded the highest concentration of chlorophyll in leafs amounted 82.1 and $83.1mg.100g^{-1}$ respectively compare to Narang rootstock sprayed with $50mg.L^{-1}$ and Benzher at control which

decreased chlorophyll concentration to 70.3 and 70.7mg.100g^{-1}. Finally, the interaction between rootstocks, water type and tryptophan concentrations was also significant when irrigated Swenkl stromelo with magnetic water and no spraying of tryptophan and irrigated Folga mariana with tap water at control treatment of tryptophan was increased chlorophyll content in leafs amounted 92.5 and 90.7mg. 100g^{-1} respectively compare to Narang irrigated with magnetic water and sprayed with 50mg.L^{-1} of tryptophan which recorded just 56.3mg.100g^{-1}.

(vii) Leafs content of carbohydrates (mg.g-1dry weight)

Results of Table 7 indicated that rootstocks were not significantly differ between each other in leafs content of carbohydrates and magnetic water also did not effect this trait. Tryptophan concentrations had significant effect on carbohydrates content in leafs when 50mg.L^{-1} concentration was increased this content to 49.76mg.g^{-1} in comparison with control treatment which decreased leafs content of carbohydrates amounted 42.25mg.g^{-1}. The interaction between rootstocks and water type was not significant, while the interaction between water type and tryptophan concentrations had significant effect on leafs content of carbohydrates when irrigated seedlings with tap water and spraying 50mg.L^{-1} of tryptophan and magnetic water with spraying 100mg.L^{-1} was increased leafs content of carbohydrates and recorded 52.27 and 55.16mg.g^{-1} respectively compare to irrigated with tap water and not spraying tryptophan which decreased carbohydrates content to 39.81mg.g^{-1}. The interaction between rootstock and tryptophan concentrations had no significant effect, the interaction between the three factors had no significant effect on leafs content of carbohydrates too.

(viii) Leafs content of IAA (Mg.g^{-1}).

Table 8 showed that citrus rootstocks were significantly differ between each other when Benzher recorded the highest value of IAA 3.931Mg.g^{-1} compare to lowest value 3.577Mg.g^{-1} recorded in Narang rootstock. Magnetic water and tryptophan concentrations were not significant on this trait.

The interaction between rootstock and water type was significant when irrigated Swenkl stromelo with tap water and Benzher with magnetic water recorded the highest average of IAA amounted 4.131Mg.g^{-1} respectively in comparison with Narang irrigated with tap water and decreased the average of IAA to 3.477Mg.g^{-1}. The interaction between rootstocks and tryptophan concentrations was also significant when Swenkl stromelo and Benzher rootstocks were sprayed with 100mg.L^{-1} a high percentage of IAA amounted 4.100 and 4.263Mg.g^{-1} respectively compare to the low percentage 3.407Mg.g^{-1} in Narang treated with the same concentration of tryptophan. The interaction between water type and tryptophan concentrations was significant when magnetic water treatment and spraying with 100mg.L^{-1} concentration of tryptophan a high value of IAA amounted 4.013Mg.g^{-1} compare to low value recorded when sprayed 50mg.L^{-1} recorded 3.553Mg.g^{-1}. The interaction between the three factors was significant when Swenkl stromelo and Benzher rootstocks were irrigated with magnetic water and sprayed with 100mg.L^{-1} a high percentage of IAA amounted 4.243 and 4.427Mg.g^{-1} respectively compare to Swenkl stromelo irrigated with tap water and sprayed with 50mg.L^{-1} which decreased the average of IAA to 2.937Mg.g^{-1}. The increasing in some vegetative traits that recorded when spraying tryptophan may occur due to its responsibility in formation IAA as there were four biological pathways to make IAA three of them depends on tryptophan and its role in the growth and development of plant (Kobayashi *et al*., 1995; Mano and Nemoto, 2012) and this reflected significantly on a number of traits such as plant height, leaf area and chlorophyll amount which is in agreement with the findings of Salwa *et al*., (2014) who mentioned an increasing in plant height and fresh and dry weight of *Thymus vulgarris* plant when spraying 0, 50 and 100mg.L^{-1} of tryptophan.

Table 1 : The effect of magnetic water and spraying of tryptophan and their interaction on plant height (cm) in the four citrus rootstocks.

The interaction between rootstock x water type	Tryptophan concentrations mg.L^{-1}			Water type	Rootstocks
	100	50	0		
90.00	97.00	87.33	85.67	M	Narang
93.44	88.00	95.33	97.00	N	
90.16	102.80	86.33	81.33	M	Swenkl stromelo
112.53	116.40	116.40	104.80	N	
105.87	97.60	105.60	114.40	M	Benzher
97.30	96.07	94.23	101.60	N	
106.09	104.87	106.70	106.70	M	Folga mariana
93.74	94.97	89.47	96.80	N	
1.331	4.016			L.S.D 0.05	
Rootstock effect	99.71	98.54	97.67	Tryptophan effect	
	1.663			L.S.D 0.05	
91.72	92.50	91.33	91.33	Narang	Interaction between rootstock x tryptophan concentration
101.34	109.60	101.37	93.07	Swenkl stromelo	
101.58	96.83	99.92	108.00	Benzher	
99.92	99.92	98.08	101.75	Folga mariana	
1.011	2.828			L.S.D 0.05	
Water type effect					
98.03	100.57	96.49	97.02	M	Interaction between water type x tryptophan concentration
99.26	98.86	98.86	100.05	N	
0.755	2.020			L.S.D 0.05	

Table 2 : The effect of magnetic water and spraying of tryptophan and their interaction on the diameter of seedling stem (m.plant^{-1}) in the four citrus rootstocks.

Interaction between rootstock x water type	Tryptophan concentration mg.L^{-1}			Water type	Rootstocks
	100	50	0		
8.667	9.333	8.667	8.000	M	Narang
8.889	8.433	9.200	9.033	N	
9.311	9.600	9.200	9.133	M	Swenkl stromelo
10.813	10.840	11.200	10.400	N	
10.707	10.960	10.120	11.040	M	Benzher
9.791	9.533	8.800	11.040	N	
10.108	10.120	9.937	10.267	M	Folga mariana
9.814	10.120	10.047	9.277	N	
0.4369	0.7773			L.S.D 0.05	
Rootstock effect	9.867	9.646	9.774	Tryptophan effect	
	N.S			L.S.D 0.05	
8.778	8.883	8.933	8.517	Narang	Interaction between rootstock x tryptophan concentration
10.249	10.220	10.200	9.767	Swenkl stromelo	
10.249	10.247	9.460	11.040	Benzher	
9.961	10.120	9.992	9.772	Folga mariana	
0.3469	0.5577			L.S.D 0.05	
Water type effect					
9.698	10.003	9.481	9.610	M	Interaction between water type x tryptophan concentration
9.827	9.732	9.812	9.938	N	
N.S	0.2905			L.S.D 0.05	

Table 3 : The effect of magnetic water and spraying of tryptophan and their interaction on leaf area (cm^2.plant^{-1}) in the four citrus rootstocks.

Interaction between rootstock x water type	Tryptophan concentrations mg.L^{-1}			Water type	Rootstocks
	100	50	0		
2777	2781	3204	2347	M	Narang
2909	3121	2730	2875	N	
2484	2828	2275	2348	M	Swenkl stromelo
3627	3559	3419	3902	N	
3282	2871	3662	3311	M	Benzher
2953	3553	2611	2695	N	
3124	3040	3194	3137	M	Folga mariana
2885	2523	2619	3514	N	
345.5	566.1			L.S.D 0.05	
Rootstock effect	3035	2964	3016	Tryptophan effect	
		N.S		L.S.D 0.05	
2843	2951	2967	2611	Narang	Interaction between rootstock x tryptophan concentration
3055	3193	2847	3125	Swenkl stromelo	
3117	3212	3137	3003	Benzher	
3004	2781	2907	3325	Folga mariana	
N.S	370.6			L.S.D 0.05	
Water type effect					
2917	2880	3084	2786	M	Interaction between water type x tryptophan concentration
3093	3189	2845	3247	N	
N.S	307.4			L.S.D 0.05	

Table 4 : The effect of magnetic water and spraying of tryptophan and their interaction on bark thickness (mm) in the four citrus rootstocks.

Interaction between rootstock x water type	Tryptophan concentrations mg.L^{-1}			Water type	Rootstocks
	100	50	0		
3.856	3.867	3.667	4.033	M	Narang
2.756	2.867	3.933	1.467	N	
3.244	4.800	2.200	2.733	M	Swenkl stromelo
3.556	1.733	4.567	4.367	N	
3.778	3.233	3.400	4.700	M	Benzher
3.678	4.000	4.400	2.633	N	
3.378	4.333	1.600	4.200	M	Folga mariana
2.833	2.400	2.967	3.133	N	
0.4092	0.5828				L.S.D 0.05
Rootstock effect	3.404	3.342	3.408	Tryptophan effect	
	N.S			L.S.D 0.05	
3.306	3.367	3.800	2.750	Narang	Inteaction between rootstock x tryptophan concentrations
3.400	3.267	3.383	3.550	Swenkl stromelo	
3.728	3.617	3.900	3.667	Benzher	
3.106	3.367	2.283	3.667	Folga mariana	
0.2749	0.3887			L.S.D 0.05	
Water type effect					
3.564	4.058	2.717	3.917	M	Interaction between water type x tryptophan concentrations
3.206	2.750	3.967	2.900	N	
0.2505	0.3160			L.S.D 0.05	

Table 5 : The absolute growth rate in terms of plant height leafs number and stem diameter during year seasons in the four citrus rootstocks.

March - May	November - February	August - October	May - July	Rootstock type
A) Plant height (cm.month)				
3.89	2.33	6.05	6.06	Narang
5.03	2.36	6.66	7.07	Swenkl stromelo
4.95	2.56	7.18	7.31	Benzher
4.91	2.52	7.53	5..52	Folga mariana
B) Leafs number (leaf. month)				
4.89	1.68	9.59	5.94	Narang
6.36	2.62	10.96	5.67	Swenkl stromelo
6.07	2.15	11.27	3.81	Benzher
6.15	2.04	10.76	6.13	Folga mariana
C) Stem diameter (mm.month)				
0.413	0.147	0.665	0.639	Narang
0.492	0.167	0.696	0.739	Swenkl stromelo
0.533	0.188	0.772	0.739	Benzher
0.536	0.182	0.752	0.707	Folga mariana

Table 6 : The effect of magnetic water and spraying of tryptophan and their interaction on leafs content of chlorophyll (mg.100g fresh weight^{-1}) in the four citrus rootstocks.

Interaction between rootstock x water type	Tryptophan concentrations mg.L^{-1}			Water type	Rootstocks
	100	50	0		
75.3	85.5	56.3	84.2	M	Narang
71.8	72.3	84.4	58.7	N	
84.1	81.6	78.4	92.5	M	Swenkl stromelo
70.0	63.3	85.7	61.0	N	
73.8	73.0	74.8	73.6	M	Benzher
76.6	76.8	85.2	67.8	N	
77.7	89.2	68.3	75.6	M	Folga mariana
79.0	69.4	76.9	90.7	N	
9.50	14.64			L.S.D 0.05	
Rootstock effect	76.4	76.3	75.5	Tryptophan effect	
	N.S			L.S.D 0.05	
73.6	78.9	70.3	71.5	Narang	Interaction between rootstocks X tryptophan concentrations
77.1	72.4	82.1	76.7	Swenkl stromelo	
75.2	74.9	80.0	70.7	Benzher	
78.3	79.3	72.6	83.1	Folga mariana	
N.S	11.07			L.S.D 0.05	
Water type effect					
77.7	82.3	69.4	81.5	M	Interaction between water type x tryptophan concentrations
74.4	70.4	83.1	69.5	N	
N.S	6.97			L.S.D 0.05	

Table 7 : The effect of magnetic water and spraying of tryptophan and their interaction on leafs content of carbohydrates (mg.g^{-1}dry weight^{-1}) in the four citrus rootstocks.

Interaction between rootstocks X water type	Tryptophan concentrations mg.L^{-1}			Water type	Rootstocks
	100	50	0		
46.02	50.77	38.69	48.62	M	Narang
40.77	39.60	43.94	38.79	N	
47.06	49.01	46.90	45.28	M	Swenkl stromelo
49.24	50.02	59.75	37.96	N	
45.62	56.01	36.69	44.15	M	Benzher
46.13	36.73	56.71	44.95	N	
49.72	53.30	55.19	40.67	M	Folga mariana
47.47	44.63	60.24	37.55	N	
N.S	N.S			L.S.D 0.05	
Rootstock effect	47.51	49.76	42.25	Tryptophan effect	
	4.671			L.S.D 0.05	
43.40	45.18	41.31	43.70	Narang	Interaction between rootstock x tryptophan concentrations
48.15	49.51	53.32	41.62	Swenkl stromelo	
45.87	46.37	46.70	44.55	Benzher	
48.60	48.96	57.71	39.11	Folga mariana	
N.S	N.S			L.S.D 0.05	
Water type effect					
47.11	52.27	44.36	44.68	M	Interaction between water type x tryptophan concentrations
45.90	42.74	55.16	39.81	N	
N.S	7.582			L.S.D 0.05	

Table 8 : The effect of magnetic water and spraying of tryptophan and their interaction on leafs content of IAA ($Mg.g^{-1}$dry weight) in the four citrus rootstocks.

Interaction between rootstock x water type	Tryptophan concentration $mg.L^{-1}$			Water type	Rootstocks
	100	50	0		
3.678	3.527	3.673	3.833	M	Narang
3.477	3.287	3.583	3.560	N	
3.681	4.427	2.937	3.680	M	Swenkl stromelo
4.131	4.100	4.060	4.233	N	
4.048	4.243	3.770	4.130	M	Benzher
3.813	3.957	4.130	3.353	N	
3.829	3.853	3.833	3.800	M	Folga mariana
3.543	3.150	3.957	3.523	N	
0.2266	0.4081			L.S.D 0.05	
Rootstock effect	3.818	3.743	3.764	Tryptophan effect	
	N.S			L.S.D 0.05	
3.577	3.407	3.628	3.697	Narang	Interaction between rootstocks x tryptophan concentration
3.906	4.263	3.498	3.957	Swenkl stromelo	
3.931	4.100	3.950	3.742	Benzher	
3.686	3.502	3.895	3.662	Folga mariana	
0.1189	0.2676			L.S.D 0.05	
Water type effect					
3.809	4.013	3.553	3.861	M	Interaction between water type x tryptophan concentration
3.741	3.623	3.933	3.668	N	
N.S	0.2203			L.S.D 0.05	

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