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EFFECT OF ADDITION OF ORGANIC FERTILIZER AND ROOTSTOCK IN LEMON TRANSPLANTS EXPOSED TO WATER STRESS

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ABSTRACT

This experiment was carried out in lath house at University of Baghdad / college of Agricultural Engineering Sciences /Department of Horticulture and Landscape design during the two season 2019 and 2020 .The experience was conducted according to Split-split plots Within Design (RCBD) By three factors, the first factor was two-irrigation Intervals (every 3, 6 days), the second factor was three of rootstock (Volcamariana, Swingle Stromelo and sour orange) and the third factor organic fertilizer, was three concentrations, which is (0, 2.5 and 5 ml. L^{-1}/plant). results showed that irrigation Intervals had a significant effect It has given (every 6 days) increase in Proline and Transpiration rate and the effectiveness of the enzyme peroxidase in the leaves,The citrus rootstock have exceed with each other in the mentioned characteristics, while the organic fertilizer increased leaf water potential (less negative), the leaf area, percentage dry weight of leaves and the activity of the peroxidase enzyme in the leaves.
***Keywords*:** Water stress, organic fertilizer, citrus rootstock, lemon

Introduction

The genus Citrus belongs of the family Rutaceae. Citrus is the most important fruit tree crop in the world, lemon is classified as *Citrus lemon* (L.) Lemon is the third most important Citrus species after orange and mandarin (Rafiq *et al*., 2018), with its production totaling over 4 200 000 tonns in 2007, with 750 000 tonns for 2007/2008 Spain being the third main lemon producing country in the world, Several studies highlighted lemon as an important health-promoting fruit rich in phenolic compounds as well as vitamins, minerals, dietary fiber, essential oils and carotenoids. Lemon fruit has a strong commercial value for the fresh products market and food industry (González-Molina *et al*., 2010).

Rootstock choice is one of the most important aspects in orchard management because scion cultivars respond differently to growth, fruit quality and nutrients accumulation when grown on diverse rootstocks. Plant nutrient concentrations in scion cultivar may differ even though they are grown in the same conditions (Bergmann, 1992). Citrus rootstocks affect many external and internal fruit characteristics including size, shape, peel thickness, juice content, total soluble solids and phytonutrient composition (Perez-Perez *et al*., 2005; Gil-Izquierdo *et al*., 2005; Campeanu *et al*., 2009) and too Rootstocks directly affect the ability of plants to uptake the water and nutrients from the soil (Smith *et al*., 2004; Shirgure *et al*., 2000; Toplu *et al*., 2012).

Organic fertilizers are effective in promoting environmental sustainability and plant growth after long-term use, the abundant organic matter and soluble nutrients in the liquid organic fertilizers could maintain soil sustainability and plant health (Hou *et al*., 2017; Dordas *et al*., 2017).Humic substances represent the organic material mainly widespread in nature, have positive effects on plant physiology by improving soil structure and fertility and by influencing nutrient uptake and root architecture and plant growth. (Ji *et al*., 2017; Trevisan *et al*., 2010) the special compounds in liquid organic fertilizers, such as chitin, humic and fulvic acids, and other biopolymers, can be biostimulants to plants (Canellas *et al*., 2015; Tang 2013). In addition, the integration of watering and fertilization patterns could improve the nutrient use efficiency and decrease the risk of nutrient loss (Toonsiri *et al*., 2016; Ceretta *et al*., 2010)

The phenomenon of drought is one of the most important problems facing the agricultural sector, as the lack of water determines agricultural production and distributes it in the world, Water stressing or droughting can be intensified by gradually lengthening the drought period, Drought stress develops when tree water loss exceeds the rate of water uptake for a sustained period, and Stress can occur whenever the rate of water loss from the leaves by transpiration exceeds the rate of water absorbed by the root system. Although citrus species are well adapted to conditions of moderate drought stress, optimizing water management can provide significant benefit to the citrus grower. Drought stress influences many components of citrus growth and development, with effects differing by stage of growth and severity of stress, severe moisture deficits result in familiar symptoms of wilting, abscission of many leaves, poor fruit quality, and small fruit size (Pirzad *et al*., 2011).

The lack of rainfall in Iraq during the past two decades, the high temperatures and the increase in evaporation, led to a decrease in the water level in the Tigris and Euphrates rivers, which led to the death of many orchards and agricultural fields. To reduce this phenomenon, modern irrigation methods must be followed, as well as the use of all available means that increase the ability of plants to adapt to

face the shortage of irrigation water without harming the plant, as indicated by many sources. Water stress leads to great damage to the plant, and adding some organic compounds to the plant would increase the plant's tolerance to drought on the one hand, and on the other hand, to see the ability of the assets to withstand a certain level of drought for local lemon seedlings.

Materials and Method

This experiment was carried out in lath house of the research station B of University of Baghdad/college of Agricultural Engineering Sciences/Department of Horticulture and Landscape design during the two season 2019 and 2020, study to the effect of the rootstocks, organic fertilizer and Irrigation Intervals on the growth of seedlings of the local lemon variety. The first factor involved exposing the plants to two Irrigation Intervals which is irrigation each 3 days and is symbolized by (A1) and irrigation every 6 days and is symbolized by (A2), which was calculated by adding irrigation water to the total weight of the pots with their contents at the field capacity depending on the weight method of the pots from each treatment, completing the water deficiency and estimating the decrease in moisture content, the equation:

total weight of the pot at the field capacity = the weight of the dry soil in the oven + the typical weight of the water to reach the field capacity + the weight of the empty pot + the weight of the filter + the weight of the fertilizer + the weight of the seedling according to the stages of growth, the total weight at the field capacity = 13.404 kg + 2480 ml 0.700 + gm + 0.400 gm + 5 gm + 9800 kg) = 25690 kg, and this weight is maintained at each irrigation Intervals for every 3 or 6 days and completed to this number and compensated for the moisture deficiency occurring in each period. The weight of the plant during the growth stages must also be taken into consideration and compensate for the calculations. As for the second factor, It use three citrus rootstock, which are of Volkameriana and is symbolized by C1, Swingle Citrumelo, is symbolized by C2 and Sour orange which is symbolized by C3. As for the third factor , it used Organic fertilizer (Fulvigrow) (Table 2) adding a ground six times between one addition and another for 15 days, which are (1/3, 15/3, 1/4, 15/4, 1/5 and 15/5) in three concentrations, which are comparison treatment (adding water Only) and its symbolized by F0, 2.5 ml. L^{-1}/plant its symbolized by F1 and 5 ml. L^{-1}/plant its symbolized by F2. Seedlings were brought at the age of 3 years and then transferred from plastic pots of 10 kg capacity to plastic containers perforated from the bottom of 20 kg capacity. The experiment was carried out using split-split plots within the design of the RCBD with three factors, as the first factor included irrigation with two Intervals (main plots), the second factor included rootstock three types (secondary plots) and the third factor included organic fertilizer in three concentrations (the sub-secondary plots), which includes 18 treatments and three repetitions, with two seedlings for each experimental unit, and the number of seedlings is 108 seedlings. The results will be analyzed using the Genstat program and the averages will be compared using the least significant difference at a 5% probability level.

Table 1 : Physical and chemical characteristics of the soil:

Character	Values	Unit
EC	4.2	$ds.m^{-1}$
PH	7.3	-
O.M.	0.7	%
Ca	6.0	mg. Kg^{-1} soil
Mg	4.0	
Na	10.8	
K	1.3	
HCO_3	0.8	
Cl	24.0	
$CaCo_3$	19.4	%
N	2.2	mg. Kg^{-1} soil
P	4.3	
K	36.7	
Sand	67.2	gm. Kg^{-1}
Clay	24.8	
Silt	8	
PW at field capacity	20.34	
PW for soil	1.76	
Bulk density	0.91	
Texture	Sandy mixture	

1-Leaf water potential (bar) Measured in mid-August, I used the Dye meathead, (Methylene blue), (Knipling,1967).

2- Leaf area (cm^2 and $leaf^{-1}$)

3- Percentage dry weight of leaves (%)

4- Rate of transpiration(mg cm. Hr) It measured according to the method (Chogtu, 2003).

5- Leaf content of Proline (micromol proline, gm fresh weight^{-1}) Follow the method of Bates *et al.* (1973)

6- Estimate the total activity of peroxidase enzyme (POD) : according to the method described (Nezih, 1985)

Results and Discussion

Leaf water potential (bar)

The results of Table (2) showed that irrigation Intervals had a significant effect on leaf water potential, as the irrigation Intervals every 3 days a significant exceeded (less negative) compared to the irrigation Intervals every 6 days for the two seasons in respectively. The type of rootstock also has a significant effect, as it exceeded the rootstock of Volkameriana for the two seasons in respectively. Organic fertilizer has a significant effect on this characteristic, as it exceeds at a concentration of 5 ml. L, compared to a treatment without addition for the two seasons in respectively.

Leaf area (cm^2 and $leaf^{-1}$)

The results in Table (3) confirm significant differences in the increase in the leaf area, as the irrigation Intervals every 3 days achieved a significant exceeded, compared to the irrigation Intervals every 6 days for the two seasons in respectively. Also, the type of rootstock has an impact, as the rootstock of the Volkameriana gave the highest rate in the first season, as for the second season, the rootstock of the stromelo was exceeded. The organic fertilizer has a significant effect in this characteristic, as the concentration of

5 gm. L^{-1} exceeds the treatment without adding fertilizer for the two seasons in respectively.

Percentage dry weight of leaves (%)

Notes through a Table (4) that the irrigation Intervals had a significant effect on percentage dry weight of leaves, as the irrigation Intervals achieved the highest rate every 3 days for the two seasons respectively. Also, the type of rootstock; had a significant effect, as the rootstock of the Volkameriana exceeded for the two seasons in respectively. Organic fertilizer has a significant effect on this characteristic, as it exceeds a concentration of 5 ml. L, compared to a treatment without addition for the two seasons respectively.

Transpiration rate (mg cm^{-2} h^{-1})

The results of Table (5) showed that the irrigation Intervals had a significant effect on the transpiration rate, as the irrigation Intervals every 6 days achieved the highest rate compared to the irrigation period every 3 days and for the two seasons respectively Also, the type of rootstock; had a significant effect, as the rootstock of the sour orange exceeded for the two seasons in respectively. As for organic fertilizer, it gave a significant effect, as it was exceeded to the comparison treatment without adding, measured at a concentration of 5 ml. For the two seasons respectively.

Estimation of proline content of leaves (m mol g^{-1} fresh weight)

The results of Table (6) showed that the irrigation Intervals had a significant effect on the leaves content of Proline, as the irrigation period every 6 days achieved the highest rate compared to the irrigation Intervals every 3 days and for the two seasons respectively, and that the type of rootstock had a significant effect, as it exceeded of Stromelo in the first season, while the second season was exceeded. The rootstock of Volkameriana. As for organic fertilizer, it gave a significant effect, as it was exceeded to the comparison treatment without adding, measured at a concentration of 5 ml. For the two seasons respectively.

Assessment of peroxidase activity (POD) (unit. gm^{-1})

The results of Table (**7**) showed that the irrigation Intervals had a significant effect on the Assessment of peroxidase activity, as the 6 day irrigation Intervals achieved the highest rate compared to the 3day irrigation Intervals for the two seasons respectively. Also, the type of rootstock has a significant effect, as the rootstock of sour orange is exceeded to the two seasons respectively. Organic fertilizer has a significant effect for this characteristic, as it was exceeded to the treatment with a concentration of 2.5 ml. L, compared to a treatment without addition for the two seasons respectively.

Table 2 : Effect of rootstock type and Organic fertilizer and irrigation Intervals on the leaf water potential (bar) for lemon seedlings for the growing seasons 2019 and 2020

		Season2019				season 2020			
Irrigation intervals	**Rootstocks**	**Organic fertilizer (ml.L^{-1})**			**A x C**	**Organic fertilizer (ml.L^{-1})**			**A x C**
		F0	**F1**	**F2**		**F0**	**F1**	**F2**	
A1	C1	-4.01	-2.67	-1.82	-2.83	-3.64	-2.43	-1.82	-2.63
	C2	-4.62	-3.89	-2.67	-3.72	-4.01	-3.64	-2.43	-3.36
	C3	-5.47	-4.01	-3.16	-4.21	-5.10	-3.64	-3.28	-4.01
A2	C1	-6.44	-5.47	-4.49	-5.47	-6.08	-5.47	-4.25	-5.26
	C2	-9.24	-7.29	-6.08	-7.53	-9.12	-7.29	-5.71	-7.37
	C3	-9.36	-7.90	-5.47	-7.57	-9.12	-7.66	-5.47	-7.41
LSD			0.63		0.54		0.79		0.63
F		-6.52	-5.20	-3.95	A	-6.18	-5.02	-3.83	A
LSD			0.18				0.27		
A x F	A1	-4.70	-3.52	-2.55	-3.59	-4.25	-3.24	-2.51	-3.33
	A2	-8.35	-6.89	-5.35	-6.86	-8.10	-6.80	-5.14	-6.68
LSD			0.40		0.53		0.56		0.73
					-6.86				C
C X F	C1	-5.22	-4.07	-3.16	-4.15	-4.86	-3.95	-3.04	-3.95
	C2	-6.93	-5.59	-4.37	-5.63	-6.56	-5.47	-4.07	-5.37
	C3	-7.41	-5.95	-4.31	-5.89	-7.11	-5.65	-4.37	-5.71
LSD			0.46		0.41		0.55		0.43

Table 3 : Effect of rootstock type and Organic fertilizer and irrigation Intervals on leaf area (cm^2 and $leaf^{-1}$) for lemon seedlings for the growing seasons 2019 and 2020.

		Season 2019				season 2020			
irrigation intervals	Rootstocks	organic fertilizer ($ml.L^{-1}$)			A x C	organic fertilizer ($ml.L^{-1}$)			A x C
		F0	F1	F2		F0	F1	F2	
A1	C1	30.07	31.28	34.81	32.05	35.57	41.27	44.30	40.38
	C2	28.54	31.13	32.71	30.79	37.53	42.62	41.21	40.46
	C3	29.96	31.43	31.33	30.90	35.46	38.93	41.83	38.74
A2	C1	25.62	27.56	29.51	27.56	30.62	31.55	33.51	31.90
	C2	24.93	27.40	27.02	26.45	31.93	32.40	32.52	32.28
	C3	24.45	29.21	29.10	27.59	31.45	32.71	31.60	31.92
LSD		1.62			0.69	2.24			1.69
F		27.26	29.67	30.74	A	33.76	36.58	37.49	A
LSD		0.76				0.82			
A x F	A1	29.52	31.28	32.95	31.25	36.19	40.94	42.45	39.86
	A2	25.00	28.06	28.54	27.20	31.33	32.22	32.54	32.03
LSD		0.97			0.86	0.99			0.58
					C				C
C X F	C1	27.85	29.42	32.16	29.81	33.09	36.41	38.91	36.14
	C2	26.73	29.26	29.86	28.62	34.73	37.51	36.86	36.37
	C3	27.21	30.32	30.21	29.25	33.46	35.82	36.71	35.33
LSD		1.13			0.43	1.76			1.46

Table 4 : Effect of rootstock type and Organic fertilizer and irrigation Intervals on percentage dry weight of leaves (%)for lemon seedlings for the growing seasons 2019 and 2020

		Season2019				season 2020			
Irrigation intervals	Rootstocks	organic fertilizer ($ml.L^{-1}$)			A x C	organic fertilizer ($ml.L^{-1}$)			A x C
		F0	F1	F2		F0	F1	F2	
A1	C1	32.99	35.82	36.27	35.03	36.91	38.26	39.14	38.11
	C2	34.05	35.38	35.50	34.98	36.26	38.02	38.00	37.43
	C3	34.47	35.33	35.08	34.96	37.20	39.00	37.50	37.90
A2	C1	30.38	31.50	32.59	31.49	32.50	33.00	34.00	33.17
	C2	29.82	29.42	31.30	30.18	31.50	32.50	33.50	32.50
	C3	27.99	31.29	32.50	30.59	29.50	33.00	33.50	32.00
LSD		2.17			1.77	1.14			0.51
F		31.62	33.12	33.87	A	33.98	35.63	35.94	A
LSD		0.73				0.53			
A x F	A1	33.84	35.51	35.62	34.99	36.79	38.43	38.21	37.81
	A2	29.39	30.74	32.13	30.75	31.17	32.83	33.67	32.56
LSD		0.85			0.31	0.69			0.62
					C				C
C x F	C1	31.68	33.66	34.43	33.26	34.71	35.63	36.57	35.64
	C2	31.94	32.40	33.40	32.58	33.88	35.26	35.75	34.96
	C3	31.23	33.31	33.79	32.78	33.35	36.00	35.50	34.95
LSD		1.75			1.53	0.80			0.33

Table 5 : Effect of rootstock type and Organic fertilizer and irrigation Intervals on Transpiration rate (mg $cm^{-2}h^{-1}$) for lemon seedlings for the growing seasons 2019 and 2020

		Season2019				season 2020			
irrigation intervals	rootstocks	organic fertilizer (ml.L^{-1})			A x C	organic fertilizer (ml.L^{-1})			A x C
		F0	F1	F2		F0	F1	F2	
A1	C1	0.120	0.112	0.097	0.110	0.154	0.137	0.130	0.140
	C2	0.114	0.105	0.092	0.104	0.163	0.142	0.133	0.146
	C3	0.127	0.104	0.094	0.108	0.165	0.159	0.156	0.160
A2	C1	0.132	0.115	0.104	0.117	0.178	0.174	0.154	0.168
	C2	0.134	0.124	0.114	0.124	0.176	0.161	0.154	0.164
	C3	0.144	0.119	0.105	0.123	0.191	0.176	0.161	0.176
LSD		0.006			0.003	0.007			0.005
F		0.128	0.113	0.101	A	0.171	0.158	0.148	A
LSD		0.002				0.002			
A x F	A1	0.120	0.107	0.094	0.107	0.161	0.146	0.140	0.152
	A2	0.136	0.119	0.108	0.121	0.182	0.170	0.156	0.183
LSD		0.003			0.003	0.003			0.003
					C				C
C X F	C1	0.126	0.114	0.100	0.11**3**	0.166	0.155	0.142	0.154
	C2	0.124	0.115	0.103	0.114	0.169	0.151	0.144	0.155
	C3	0.135	0.112	0.100	0.11**5**	0.178	0.167	0.158	0.168
LSD		0.004			0.002	0.005			0.004

Table 6 : Effect of rootstock type and Organic fertilizer and irrigation Intervals on Estimation of proline content of leaves (m mol g^{-1} fresh weight)for lemon seedlings for the growing seasons 2019 and 2020

		Season2019				season 2020			
irrigation intervals	rootstocks	organic fertilizer (ml.L^{-1})			A x C	organic fertilizer (ml.L^{-1})			A x C
		F0	F1	F2		F0	F1	F2	
A1	C1	4.81	3.91	3.71	4.14	5.55	5.36	4.68	5.19
	C2	5.06	4.73	4.17	4.65	5.64	4.76	4.55	4.98
	C3	5.24	4.54	4.25	4.67	5.54	5.74	4.74	5.34
A2	C1	6.33	5.16	5.11	5.53	6.27	5.70	4.56	5.51
	C2	5.98	5.03	5.16	5.39	5.88	5.38	4.41	5.22
	C3	5.26	5.02	4.57	4.95	5.85	5.49	4.59	5.31
LSD		0.41			0.20	0.19			0.12
F		5.44	4.73	4.49	A	5.78	5.40	4.58	A
LSD		0.18				0.08			
A x F	46.00	5.03	4.39	4.04	4.49	5.57	5.28	4.65	5.17
	A2	5.85	5.07	4.94	5.29	6.00	5.52	4.52	5.34
LSD		0.21			0.06	0.10			0.08
					C				C
C X F	C1	5.57	4.53	4.41	4.83	5.91	5.53	4.62	5.35
	C2	5.52	4.88	4.66	5.02	5.76	5.07	4.48	5.10
	C3	5.25	4.78	4.41	4.81	5.69	5.61	4.66	5.32
LSD		0.30			0.17	0.14			0.10

Table 7 : Effect of rootstock type and Organic fertilizer and irrigation Intervals Assessment of peroxidase activity (POD) (Unit. gm^{-1}) for lemon seedlings for the growing seasons 2019 and 2020

		Season2019				season 2020			
irrigation intervals	rootstocks	organic fertilizer ($ml.L^{-1}$)			A x C	organic fertilizer ($ml.L^{-1}$)			A x C
		F0	F1	F2		F0	F1	F2	
A1	C1	40.00	93.30	86.70	73.30	58.00	93.50	77.50	76.33
	C2	66.70	93.30	100.00	86.70	71.00	87.00	100.00	86.00
	C3	93.30	120.00	126.70	113.30	110.50	128.00	107.50	115.33
A2	C1	86.70	146.70	93.30	108.90	126.00	150.00	139.50	138.50
	C2	113.30	126.70	80.00	106.70	128.00	147.00	128.00	134.33
	C3	113.30	166.70	153.30	144.40	147.00	179.50	185.50	170.67
LSD		24.53			9.78	11.21			6.93
F		85.60	124.40	106.70	A	106.75	130.83	123.00	A
LSD		11.54				4.75			
A x F	46.00	66.70	102.20	104.40	91.10	79.83	102.83	95.00	92.56
	A2	104.40	146.70	108.90	120.00	133.67	158.83	151.00	147.83
LSD		13.99			9.20	5.51			1.24
					C				C
C X F	C1	63.30	120.00	90.00	91.10	92.00	121.75	108.50	107.42
	C2	90.00	110.00	90.00	96.70	99.50	117.00	114.00	110.17
	C3	103.30	143.30	140.00	128.90	128.75	153.75	146.50	143.00
LSD		17.50			7.64	8.52			5.99

It turned out from the above that is for organic fertilizer A significant impact on its content Physiological characteristics According to the results of the above tables، may be due to the role of organic fertilizr Increasing soil Portability to water retain and improve the physical, chemical and biological properties of the soil As well as improving root growth And therefore Increase water absorption (Awad *et al*., 1993; Maksoud *et al*., 2012), It also increases photosynthesis and carbohydrates formation and proteins That is basis structure Enzymes and therefore It reduces the amino acids Decaying Including proline, Since organic fertilizer improves the absorption of elements, including potassium It regulates the movement of opening and closing the stomata and thus has the effect of increasing the relative water content of the cells and thus increasing the stomata area (Kava *et al*., 2005). the activity of the peroxidase enzyme has also increased in Leaves when adding organic fertilizers may be due to the increase in physiological, chemical and biological processes in plant cells and protein formation that leads to increased enzyme concentrations It is in cells (Dantas *et al*., 2007). As for the role of the rootstock, the contrast returns between the rootstock of citrus for the characteristics of the above tables is due to the reasons for genetic traits return to effect rootstock on the scion due to the effect of the rootstock on the scion, Dubey and Sharma (2016) reported that there was a significant effect for the rootstock type used in grafting on citrus lemon on all growth characteristic.

As for the effect of water stress on these characteristics, this may be due to the low water content of the soil, and thus the amount of water absorbed by the root system becomes not enough to replace the transpired water. Plant cells are exposed to the water deficit represented by the decreasing in water content in the leaves (EL-Hafid *et al*., 1998 and Haghighatnia, 2010) The decrease in the stomatal area may be due to a reduction in the leaf content of chlorophyll, and this is due to reduce of absorption of CO_2 and the closing of the stomata due to the accumulation of absicic acid (ABA) in the chloroplasts, as a result of which a decrease in the rate of photosynthesis occurs (Gupta, 2011) or it may be due to an increase in the proline content. In plants, as a result of exposure to long irrigation internal, the plant's inability to photosynthesize protein, so the amount of amino acids inside the plant increases, including proline acid, which is one of the defenses to reduce the harmful effect of drought (Amini and Ehsanpour, 2005).

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