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EVALUATION OF TWO CITRUS ROOTSTOCKS UNDER KAFR EL- SHEIKH CONDITIONS:

a -EVALUATING VOLKAMER LEMON "*C. Volkameriana*" AS ROOTSTOCK FOR VALENCIA ORANGE CULTIVAR UNDER KAFER EL-SHEIKH CONDITIONS.

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ABSTRACT

This study was carried out during 2001 and 2002 seasons on 8 - years old Valencia orange trees budded on Volkamer lemon and Sour orange rootstocks to evaluate vegetative and root growth, Yield, Fruit quality, leaf and root mineral contents and ability of both rootstocks to tolerate salinity as well as ability to transport some heavy metals.

The obtained results showed that, Volkamer lemon rootstocks enhanced tree size, tree height, shoot length, number of leaves per shoot, trunk cross-sectional area "TCSAcm^2" and leaf area than those on Sour orange rootstock.

Also trees on Volkamer lemon rootstock produced the highest values of root growth i.e. root length, root density and root dry weight at different depths (30, 60 and 90cm) and distances (50, 100 and 150cm) from tree trunk comparing with those on Sour orange rootstock and both seedling stocks.

Valencia orange trees on Volkamer lemon rootstock had lower Na and Cl ions in their leaves and roots and higher levels of proline, carbohydrate and chlorophyll a,b and its total value than those recorded for leaves on Sour orange rootstock.

Fruit set was higher on Volkamer lemon than of that on Sour orange rootstock, meanwhile fruit drop was higher in May, June, July than on Sour orange rootstock.

Valencia orange on Volkamer lemon maximized fruit yield with higher values of fruit length, diameter, volume, weight and juice volume, T.S.S, Acidity, T.S.S/acid ratio and vitamin C than those on Sour orange rootstock.

Valencia Leaf N, P, K, Ca, Mg, Fe, Mn, Zn and Cu contents were higher on Volkamer lemon rootstock. On the contrary leaf Na and Cl values were higher on Sour orange comparing with those of Volkamer lemon rootstock.

Beside, root N, P, K, Fe, Mn, Zn and Cu contents were higher on Volkamer lemon rootstock, but root Ca, Mg, Na and Cl values were only higher on Sour orange rootstock comparing with Volkamer lemon roots.

Valencia orange trees on Sour orange rootstock had higher Pb, Cd, Se, Ni and Cr, in their leaves, roots, fruit peel and fruit juice than those on Volkamer lemon rootstock. Therefore, Volkamer lemon as rootstock for Valencia orange seemed to be a good substitute comparing with Sour orange rootstock under the conditions of this experiment.

INTRODUCTION

Rootstock is one of the most important factors affecting citrus production. Sour orange is the most commonly used rootstock in Egypt inspite of it's susceptibility to tristeza, gummossis and other virus disease.

A chosen rootstock has different effects on vegetative growth of scion trees (Monteverde *et al.*, 1990: Martinez *et al.* 1994 and El-Sayed 1999)

these variations also included flowering, fruit set, fruit drop and yield (Kitate *et al.* 1973 & Inoue, 1989), fruit quality (Saad-Allah *et al.* 1985: Mehrotra *et al.*, 1999 & Meligy *et al.* 1999) and leaf mineral content (El-Azab *et al.*, 1978: El-Barkouky *et al.*, 1984: Kaplankiran and Tuzcu, 1994 and Azab, 1995). Rootstock's root system has a great influence on vegetative growth and production of citrus varieties. This effect can be attributed to 1) resistant to diseases, 2) tolerant to drought, salinity and alkaline soil and 3) absorption of mineral nutrients from a given soil (Allurwar & Parihar, 1992 and Dawood 1996).

So, this study aimed to evaluate and compare Volkamer lemon as rootstock for Valencia orange under Kafer El-Sheikh conditions and to answer this question: is Volkamer lemon can be used as a good substitute for Sour orange rootstock under the same conditions?

MATERIALS AND METHODS

The present study was carried out at the experimental farm of Sakha Agriculture Research Station, Kafer El - Sheikh Governorate during 2001 and 2002 seasons, on 8 - years old Valencia orange trees budded on two citrus rootstocks, i.e., Volkamer lemon (*C. Volkameriana*) and Sour orange (*C. aurantium*). In addition three seedling trees of both stocks were also included in comparison.The trees were grown in clay soil and spaced 5x5 meters in a complete randomized block design with three trees plot replicated three times for a total of nine trees per rootstock. Mechanical and chemical analysis of the experimental soil is shown in Table (a)

Table (a) Mechanical and chemical analysis of experiment field soil.

Mechanical				Chemical			Available ppm			DTPA extractable ppm.				
Sand %	Silt %	Clay %	Structure	pH	EC	O.m %	N	P	K	Fe	Zn	Pb	Ni	Cd
9.65	32.15	58.20	clay	7.97	3.35	1.90	18.53	7.78	73.47	20.09	9.97	0.48	0.74	0.19

In both seasons of study all trees received the following fertilizer, 300 gm/tree ammonium sulphate in March, 450 gm/tree ammonium sulphate in June, 200 gm/tree ammonium nitrite and 200 gm/tree potassium sulphate in August, all trees irrigated at intervals of 10- 15 days in summer and 15 - 18 days in winter.

In this study four branches of 2 inches in diameter were selected and tagged on each tree. The vegetative growth parameters were measured in terms of tree height, shoot length, number of leaves per shoot, trunk cross-sectional area "TCSA cm^2" and leaf area. Canopy volume was calculated according to the formula: 0.5238x tree height x diameter square (Turell, 1946).

During September of both seasons, root samples were taken from four directions at distances of 50, 100 and 150 cm., from tree trunk. Samples were obtained by a method described by Ellis & Bomes (1971) using an auger of 10 cm in diameter and 30 cm length. The auger was driven into the soil to a depth of 30, 60 and 90 cm each from the soil surface. The soil

samples were washed through 1.0 cm mesh to separate roots from soil. Root length cm/auger, root density as number of roots/auger and root dry weight gm/auger were measured according to Newman (1966). These measurements will help for evaluating root density and distribution under Kafer El- Sheikh soil conditions.

The number of flowers on tagged branches on each tree was counted through the blooming season, then fruit set was calculated as a percentage to initial number of flowers. Numbers of dropping fruits were also counted during the period from May 10th to July 30th in both seasons to determine the percentage of dropped fruits.

At harvest time, in March yield as weight Kg/tree, Kg/cm^2 TSCA and Kg/m^3 of tree canopy were determined in both seasons. Fruit quality was determined as: fruit length, fruit diameter, fruit volume, fruit weight, rind thickness, juice volume, T.S.S, acidity, T.S.S/acid ratio and ascorbic acid in 100 ml juice according to (A. O. A. C. 1970).

Fresh leaf samples were taken from each replicate for chlorophyll determination according to Moran (1982). Total carbohydrates were determined in 0.5 g fine powder leaf sample according to Dubois *et al.* (1956). Leaf proline content was determined according to Bates *et al.* (1973).

In September of both 2001 and 2002 sample of 50 leaves as well as samples from feeder roots were washed and oven dried at 65-70 C° to constant weight. The dried leaves and roots were grounded and digested with sulphoric acid and hydrogen peroxide according to (Evenhuis & DeWaard 1980). Total nitrogen was determined by microkjeldahl Gumming method (A.O.A.C. 1970). Phosphorus was determined by colorimeter, potassium by using Flame photometer according to (Chapman & Pratt 1978) Ca, Na and Mg by the versenate method (Johanson & Ulrich 1959). Fe, Zn, Mn and Cu were determined using parking Elemar atomic absorption spectrophotoemeter. Chloride was determined by silver nitrate methods according to Brown & Jackson (1955).

Lead, cadmium, selenium, nickel and chromium were determined in leaves, roots, fruit peel " ppm" and fruit juice " ppm/100 g juice" using atomic absorption spectrophotoemeter, according to Black (1965) and Brigs & Crock (1986). All data were statistically analyzed according Snedecor & Cochran (1967).

RESULTS AND DISCUSSION

1-Vegetative growth:

Data presented in Table (1) show that tree size and growth vigour were significantly affected by tested rootstocks. Valencia orange on Volkamer lemon rootstock produced the largest tree size and the highest height comparing with those recorded on Sour orange. Meanwhile, Sour orange seedlings gave the lowest values in this respect. Moreover trunk cross sectional area (TCSA) of Valencia orange on Volkamer lemon rootstock was higher than that recorded on Sour orange rootstock with significant differences between them in both seasons. Also, average leaves number per shoot and leaf area were also significantly enhanced by Volkamer lemon

rootstock in both seasons. Moreover, average shoot length gave the longest values on Volkamer lemon rootstock followed by those on Sour orange rootstock with significant differences between them in the first season. Meanwhile in the second season Valencia orange on Volkamer lemon and Sour orange had approximately the same values (Table1). These results are in agreement with those obtained by Monteverde *et al.* (1990), Martinez *et al.* (1994) and El-Sayed (1999) who reported that, *C. Volkameriana* was generally the best rootstock for most vegetative growth of Valencia orange trees.

Table (1): Vegetative growth parameters of valenica orange trees budded on Volkamer lemon and Sour orange and corresponding values of both seedling rootstocks during 2001and2002 seasons.

Rootstock	Tree hieght M	Canopy Volume M^3/tree	TCS A* cm^2	Average shoot lenght	Leaves number per shoot	Leaf area cm^2
2001 Season						
Valencia orange/C. Volkameriana	3.40	11.84	71.8	31.9	20.7	21.2
Valencia orange/Sour orange	2.77	9.02	50.7	29.5	18.2	18.4
C. Volkameriana/Seedling rootstock	2.88	6.60	47.3	33.4	20.0	19.8
Sour orange/Seedling rootstock	2.65	5.37	41.7	34.2	19.8	19.4
L.S.D 5%	0.07	0.49	8.9	1.8	1.4	1.3
2002 Season						
Valencia orange/C. Volkameriana	3.66	14.48	92.3	28.7	19.1	20.5
Valencia orange/Sour orange	3.00	12.26	68.4	28.6	17.6	17.5
C. Volkameriana/Seedling rootstock	3.18	8.14	48.7	34.2	18.8	20.3
Sour orange/Seedling rootstock	3.00	7.04	43.5	36.6	19.2	19.7
L.S.D 5%	0.05	0.80	3.0	1.9	1.1	0.7

*** trunk cross sectional area**

2-Root System growth:

Concerning Valencia orange scion variety, the longest values of fibrous root length, at 50, 100 and 150 cm from tree trunk always belonged to Volkamer lemon rootstock and the differences were significant when compared with Sour orange rootstock. Also, the results indicated that, fibrous root length was less when the distance from tree trunk was increased from 50 to 150 cm. This relationship was also true with increasing soil depth from 30 to 90 cm (Table 2).

Similar results were reported by Hassan (1984), Saad-Alla *et al.* (1985 a,b) and Allurwar & Parihar (1992) who supported the obtained results herein that Volkamer lemon had a better root distribution than Sour orange as rootstock for Valencia orange scion.

The results in Table (3) indicated that the highest values of root density was found on Volkamer lemon rootstock comparing with those recorded on Sour orange rootstock with significant differences between them in both seasons. These results were true at different soil depths (30, 60 and 90 cm) and at different distances (50, 100 and 150 cm) from tree trunk. So, Volkamer lemon produced the highest root density than that of Sour orange rootstock (Table 3).

These results agree with those obtained by Dawood (1996) and El-Sayed (1999) which said that Volkamer lemon had a better root density than Sour orange as rootstock for Valencia orange.

Table (2): Fibrous root length (cm) of Sour orange and Volkamer lemon rootstocks as affected Valencia orange scion and corresponding values of both seedling rootstocks during 2001and2002 seasons.

Rootstock	2001 Season			2002 Season		
	30cm depth	60cm depth	90cm depth	30cm depth	60cm depth	90cm depth
50 cm from tree trunk						
Valencia orange/C. Volkameriana	6.5	7.0	3.3	11.3	10.0	5.1
Valencia orange/Sour orange	5.2	5.3	2.5	7.0	8.1	2.2
C. Volkameriana/Seedling rootstock	24.7	13.5	8.1	22.7	13.9	9.3
Sour orange/Seedling rootstock	12.8	9.3	5.5	12.5	10.5	6.5
L.S.D 5 %	1.06	0.70	0.23	2.01	2.47	0.40
100 cm from tree trunk						
Valencia orange/C. Volkameriana	10.1	7.7	2.4	11.5	10.0	3.3
Valencia orange/Sour orange	3.7	5.4	1.0	5.1	8.5	1.5
C. Volkameriana/Seedling rootstock	16.4	6.8	4.2	16.4	7.2	4.6
Sour orange/Seedling rootstock	8.6	4.7	2.3	8.5	5.4	2.5
L.S.D 5 %	1.20	0.56	0.43	1.31	1.45	0.58
150 cm from tree trunk						
Valencia orange/C. Volkameriana	9.2	7.5	2.2	10.4	10.3	3.9
Valencia orange/Sour orange	4.8	4.6	1.4	7.3	6.8	3.1
C. Volkameriana/Seedling rootstock	12.7	4.5	1.6	10.9	5.1	2.8
Sour orange/Seedling rootstock	6.7	3.3	1.1	7.8	3.8	1.9
L.S.D 5 %	0.63	0.35	0.74	1.99	1.45	0.48

Auger soil sample = 2356 cm3

Table (3): Fibrous root density (number of roots/auger *) of Sour orange and Volkamer lemon rootstocks as affected Valencia orange scion and corresponding values of both seedling rootstocks during 2001and2002 seasons.

Rootstock	2001 Season			2002 Season		
	30cm depth	60cm depth	90cm depth	30cm depth	60cm depth	90cm depth
50 cm from tree trunk						
Valencia orange/C. Volkameriana	11.62	12.46	5.79	15.94	17.09	7.27
Valencia orange/Sour orange	4.84	4.59	1.19	6.61	7.01	2.01
C. Volkameriana/Seedling rootstock	43.39	23.69	14.16	43.25	23.66	13.51
Sour orange/Seedling rootstock	11.89	8.02	4.97	11.82	9.00	5.84
L.S.D 5 %	1.33	1.51	1.61	2.24	3.24	2.09
100 cm from tree trunk						
Valencia orange/C. Volkameriana	17.94	13.48	5.89	24.61	14.92	4.66
Valencia orange/Sour orange	3.06	5.60	1.92	4.07	6.59	1.46
C. Volkameriana/Seedling rootstock	28.85	11.88	7.29	27.72	10.78	6.46
Sour orange/Seedling rootstock	6.99	4.17	2.05	6.81	4.13	2.30
L.S.D 5 %	1.67	1.42	1.10	2.41	2.99	0.20
150 cm from tree trunk						
Valencia orange/C. Volkameriana	16.22	13.25	3.90	21.92	17.24	5.35
Valencia orange/Sour orange	4.43	3.91	1.35	5.99	4.95	1.93
C. Volkameriana/Seedling rootstock	22.36	7.93	2.83	22.66	7.95	2.85
Sour orange/Seedling rootstock	6.19	2.79	0.99	6.33	2.84	1.10
L.S.D 5 %	1.28	1.87	0.26	2.33	1.11	0.19

*Auger soil sample = 2356 cm^3

Also, data presented in Table (4) show the fibrous root dry weight of Volkamer lemon and Sour orange rootstocks at 50, 100 and 150 cm from tree trunk at different soil depths (30, 60 and 90 cm) was affected by Valencia orange cultivars. It is clear in both seasons that Volkamer lemon rootstock gave the highest values of root dry weight than those on Sour orange rootstock without significant differences between them. This result was true at different soil depths and distances from tree trunk in both seasons (Table 4).

These results agree with those obtained by Saad-Alla *et al.* (1985b), Allurwar & Parihar (1992) and El-Sayed (1999) and supported the obtained results that Volkamer lemon had a root system characterized by better root growth and distribution than Sour orange rootstock.

Table (4): Fibrous root dry weight (gm/auger*) of Sour orange and Volkamer lemon rootstocks as affected Valencia orange scion and corresponding values of both seedling rootstocks during 2001and2002 seasons.

Rootstock	2001 Season			2002 Season		
	30cm depth	60cm depth	90cm depth	30cm depth	60cm depth	90cm depth
50 cm from tree trunk						
Valencia orange/C. Volkameriana	1.06	0.72	0.23	1.45	1.56	0.72
Valencia orange/Sour orange	1.06	0.69	0.22	1.46	1.57	0.67
C. Volkameriana/Seedling rootstock	3.95	2.15	1.29	3.94	2.16	1.29
Sour orange/Seedling rootstock	2.24	1.51	0.94	2.25	1.53	0.93
L.S.D 5 %	0.06	0.13	0.02	0.03	0.05	0.07
100 cm from tree trunk						
Valencia orange/C. Volkameriana	1.35	0.90	0.17	2.25	1.52	0.48
Valencia orange/Sour orange	1.36	0.91	0.17	0.99	1.51	0.48
C. Volkameriana/Seedling rootstock	2.62	1.08	0.66	2.53	1.10	0.66
Sour orange/Seedling rootstock	1.51	0.97	0.39	1.52	0.78	0.38
L.S.D 5 %	0.02	0.03	0.02	0.07	0.05	0.04
150 cm from tree trunk						
Valencia orange/C. Volkameriana	1.06	1.09	0.37	2.03	1.65	0.16
Valencia orange/Sour orange	1.06	1.09	0.36	2.04	1.66	0.16
C. Volkameriana/Seedling rootstock	2.03	0.72	0.26	2.10	0.76	0.26
Sour orange/Seedling rootstock	1.17	0.53	0.19	1.21	0.58	0.20
L.S.D 5 %	0.09	0.11	0.01	0.20	0.07	0.01

*Auger soil sample = 2356 cm^3

3- Fruit set, fruit drop, yield and yield efficiency:

As shown in Table (5) the results indicated that, fruit set percentage on Volkamer lemon rootstock was higher than that recorded on Sour orange rootstock, however the differences between them were not significant in both seasons. On the other hand, Volkamer lemon seedlings recorded highly significant values of fruit set % than those of Sour orange ones in both seasons (Table 5). Similar results were obtained by Kitat *et al.* (1973) and Inoue (1989).

Also, the results indicated that, at May of the first season fruit drop of Valencia orange was significantly higher on Sour orange than on Volkamer lemon. But in the second season, Valencia orange budded on both rootstocks

Volkamer lemon and Sour orange had approximately the same values of May fruit drop.

It is clear that, fruit drop percentages in June, July on Volkamer lemon were lower than those recorded on Sour orange rootstock, and the differences were significant in both seasons (Table 5). Similar conclusions were obtained by Kitate *et al.* (1973) and Inoue (1989).

Concerning yield as kg/tree listed in Table (5) data showed that, Valencia orange budded on Volkamer lemon had significantly higher fruit yield than on Sour orange rootstock. This result was true in both seasons. On the other hand, the yield of Valencia orange was lower in the second season when compared with the first one. Conclusively Valencia orange trees produced more yield on Volkamer lemon than on Sour orange rootstock. These results agree with those obtained by Saad-Allah *et al.* (1985), Mehrotra *et al.* (1999) and Meligy *et al.* (1999).

Moreover, yield efficiency as Kg/Cm^2 trunk cross - sectional area (TCSA),or Kg/m^3 of tree canopy volume on Volkamer lemon rootstock was significantly higher when compared with that on Sour orange rootstock in both seasons. These results are in accordance with those obtained by Mehrotra *et al.* (1999) on several fruit species, which means that Volkamer lemon rootstock has a higher yield capacity than Sour orange rootstock under the conditions of this experiment.

Table (5): Fruit set, fruit drop and yield as well as yield efficiency of valenica orange trees budded on Volkamer lemon and Sour orange and corresponding values of both seedling rootstocks during 2001and2002 seasons.

Rootstock	Fruit Set %	Fruit drop			Yield Kg/tree	Yield efficiency	
		May %	June %	July %		Kg/cm^2 TCSA	Kg/m^3 canopy volume
2001 Season							
Valencia orange/C. Volkameriana	27.9	24.5	20.4	20.4	65.6	0.91	5.54
Valencia orange/Sour orange	26.5	27.7	22.3	20.5	45.2	0.89	5.01
C. Volkameriana/Seedling rootstock	36.0	21.5	20.0	20.3	24.8	0.52	3.75
Sour orange/Seedling rootstock	26.9	29.6	25.0	26.6	23.5	0.56	4.37
L.S.D 5%	2.74	2.57	N.S	2.71	4.79	0.02	0.13
2002 Season							
Valencia orange/C. Volkameriana	30.2	26.3	24.4	17.7	60.3	0.65	4.05
Valencia orange/Sour orange	27.2	26.8	23.3	18.8	43.5	0.63	3.54
C. Volkameriana/Seedling rootstock	33.1	20.4	19.3	19.0	23.9	0.49	2.93
Sour orange/Seedling rootstock	24.2	27.3	23.2	24.1	23.4	0.53	3.32
L.S.D 5%	3.81	1.36	2.06	1.84	3.21	0.02	0.30

N.S Not significant.

4- Fruit quality:

It is clear from table (6) that the tested rootstocks had a significant effect on most fruit parameters in this study, i,e. fruit length, diameter, friut volume, weight and juice volume showed the highest values in fruit parameters taken from the trees budded on Volkamer lemon comparing with those on Sour orange rootstock. On the other hand, rind thickness gave similar values for fruits either on Volkamer lemon or Sour orange rootstock.

Total soluble solids, Acidity, Vitamin C and T.S.S/acid ratio were generally higher in the fruit juice taken from the budded trees on Volkamer lemon rootstock than those on Sour orange.These findings are in accordance with those obtained by El-Azab *et al.* (1978), El-Barkouky *et al.* (1984), Saad-Allah *et al.* (1985), Mehrotra *et al.* (1999)and Meligy *et al.* (1999).So, Volkamer lemon as rootstock for Valencia orange produced higher yield with higher acidity in fruit juice,when compared with Sour orange rootstock in both season.

It could be concluded that most physical and chemical fruit characters on Volkamer lemon are not less quality than those recorded for Valencia fruits on Sour orange rootstock except for higher juice acidity of the fruit on Volkamer lemon rootstock..

Table (6): Fruit quality of Valenica orange trees budded on Volkamer lemon and Sour orange and corresponding values of both seedling rootstocks during 2001and2002 seasons.

Rootstock	Fruit length, Cm	Fruit diameter, cm	Fruit volume , cm^3	Fruit weight, g	Rind thickness, mm	Juice volume cm3/fruit	T.S.S %	Acidity %	T.S.S/acid ratio	Vitamin Cmg/100 ml juice
Season 2001										
Valencia orange/C. Volkameriana	10.6	8.3	282.7	193.70	5.3	95.0	10.9	1.29	8.45	44.22
Valencia orange/Sour orange	9.0	7.6	257.0	173.00	4.8	86.7	10.8	1.28	8.43	42.52
C. Volkamenana/Seedling rootstock	6.8	6.5	126.8	116.88	4.2	44.6	8.60	4.68	1.83	38.00
Sour orange/Seedling rootstock	5.6	4.5	154.8	145.98	5.2	56.0	9.24	5.46	1.69	31.40
L.S.D 5%	0.05	0.91	3.86	5.26	N.S	4.09	1.17	0.05	0.62	4 18
Season 2002										
Valencia orange/C. Volkameriana	10.4	8.2	277.2	189.95	5.4	93.1	10.12	1.23	8.21	43.36
Valencia orange/Sour orange	8.8	7.4	253 5	170.63	4.2	80.0	10.10	1.15	8.08	39 24
C. Volkamenana/Seedling rootstock	6.8	6.6	127.1	116.53	5.3	44.1	8.30	4.86	1.70	35.60
Sour orange/Seedling rootstock	5.7	4 6	154.8	141.56	6.3	54.9	9.13	5.33	1.71	30.00
L.S.D 5%	0.42	1.52	5.86	7.24	N.S	1.89	0.92	0.59	1.61	4.33

N.S Not significant.

5-Root and leaf Na and Cl contents:

Data in table (7) revealed that roots of Sour orange seedlings had higher contents of Na and Cl when compared with Volkamer lemon seedlings but the differences were not significant between all tested rootstocks in both seasons. Regarding the Valencia orange scion effect on the root Na anc Cl of the two tested rootstocks, Na and Cl concentrations present in roots followed their concentration in their seedling roots in both seasons.

Leaf Na and Cl contents of Valencia orange were significantly higher on Sour orange as compared with those on Volkamer lemon in both seasons. Beside, leaves of Sour orange seedlings had higher content of Na and Cl than that on Volkamer lemon without significant differences between them in both seasons.These results agree with the findings of El-Hammady *et al.* (1995) they reported that, Volkamer lemon seedlings contained the lowest concentration of Na and Cl in their leaves. The obtained results explain the

ability of Volkamer lemon to avoid high absorption of Na and Cl ions from the saline soil, so this ability may make it more tolerant in saline and alkaline soil than Sour orange rootstock.

6 - Some leaf organic substances:

Concerning, leaf chlorophyll a, b and its total contents data showed that, leaves from Valencia orange budded on Volkamer lemon or Sour orange rootstock had approximately similar values of chlorophyll without significant differences between them in both seasons. Meanwhile, Volkamer lemon and Sour orange seedlings had higher values of chlorophyll when compared with Valencia orange on the same rootstocks in both seasons and the differences were significant in most cases (Table 7). This result leads to suggest that no significant effect of rootstock on leaf chlorophyll of scion.

As shown in Table (7) total carbohydrate % was higher in leaves of Valencia orange on Volkamer lemon than that on Sour orange rootstock in both seasons without significant differences in both seasons. Similar results were reported by Azab (1995) and El-Sayed (1999).

The results also indicated that, leaf proline content always was higher on Volkamer lemon rootstock when compared with that on Sour orange rootstock with significant differences between them in both seasons. These results agree with those reported by El-Sayed (1999).

Finely, it could be concluded that Valencia orange tree on Volkamer lemon rootstock had higher proline level and total carbohydrate in addition to lower values of Na and Cl ions than these on Sour orange rootstock. These results mean that Volkamer lemon rootstock could tolerant saline and alkaline stresses under Kafer El-Sheikh conditions more than Sour orange rootstock.

Table (7): Root and leaf contents of Na and Cl, and some organic substances in leaf of valenica orange trees budded on Volkamer lemon and Sour orange and corresponding values of both seedling rootstocks during 2001and2002 seasons.

Rootstock	Root		Leaf		Chlorophyll			Total carbo-hydrate	Proline
	Na %	Cl %	Na %	Cl %	a	b	total		
Season 2001									
Valencia orange/C. Volkamenana	0.210	0.155	0.088	0.030	37.84	17.51	55.35	12.36	0.32
Valencia orange/Sour orange	0.230	0.179	0.483	0.043	37.52	17.36	54.88	11.86	0.27
C. Volkameriana/Seedling rootstock	0.223	0.148	0.152	0.206	50.48	48.90	69.38	14.90	0.63
Sour orange/Seedling rootstock	0.240	0.162	0.161	0.220	49.78	19.04	68.82	17.00	0.52
L.S.D 5%	N.S	N.S	0.213	0.023	3.90	N.S	3.69	2.44	0.05
Season 2002									
Valencia orange/C. Volkamenana	0.205	0.151	0.061	0.040	36.24	18.60	54.94	12.44	0.49
Valencia orange/Sour orange	0.232	0.169	0.421	0.050	36.39	18.70	49.99	10.50	0.37
C. Volkameriana/Seedling rootstock	0.222	0.163	0.152	0.204	51.87	20.92	71.56	15.23	0.67
Sour orange/Seedling rootstock	0.239	0.179	0.162	0.217	48.92	20.82	68.24	17.43	0.55
L.S.D 5%	N.S	N.S	0.042	0.030	1.37	N.S	4.46	4.09	0.05

N.S Not significant.

7-Leaf and root mineral content:

Data in Table (8) revealed that, N, P and K contents in leaves of Valencia orange on Volkamer lemon was higher in both seasons than those determined on Sour orange rootstock without significant differences. This result was true in both seasons. Also it was clear that leaf Ca and Mg contents were higher on the tree leaves budded on Volkamer lemon as

compared with those on Sour orange in both seasons. However, the difference was significant in Mg% in both seasons.

Table (8): Leaf mineral content of valenica orange trees budded on Volkamer lemon and Sour orange and corresponding values of both seedling rootstocks during 2001and2002 seasons.

Rootstock	N %	P %	K %	Ca %	Mg %	Fe ppm	Mn ppm	Zn ppm	Cu ppm
Season 2001									
Valencia orange/C. Volkameriana	2.45	0.181	1.33	3.93	0.41	87.7	41.5	41.5	14.1
Valencia orange/Sour orange	2.40	0.162	1.16	3.89	0.36	69.7	31.3	34.2	13.2
C. Volkameriana/Seedling rootstock	2.47	0.202	1.33	3.56	0.57	134.8	44.6	55.4	12.8
Sour orange/Seedling rootstock	2.56	0.194	1.37	3.52	0.48	125.1	34.5	45.0	13.0
L.S.D 5%	N.S	N.S	N.S	0.22	0.03	8.2	5.6	4.3	N.S
Season 2002									
Valencia orange/C. Volkameriana	2.49	0.190	1.41	3.96	0.46	91.5	45.0	45.0	14.0
Valencia orange/Sour orange	2.47	0.180	1.08	3.94	0.41	72.0	31.2	31.0	13.0
C. Volkameriana/Seedling rootstock	2.42	0.203	1.36	3.55	0.65	132.0	45.5	56.6	12.8
Sour orange/Seedling rootstock	2.51	0.196	1.32	3.58	0.56	123.0	35.6	45.5	13.5
L.S.D 5%	N.S	N.S	N.S	0.15	0.07	6.1	5.6	7.6	N.S

N.S Not significant.

Generally, leaves of Sour orange seedlings had higher content of N,P,K, Ca and Mg when compared with those of Volkamer lemon seedlings without significant differences between them in both seasons.

The result also indicated that, Fe, Mn, Zn and Cu levels in leaves of Valencia orange tree were higher when budded on Volkamer lemon rootstock than those on Sour orange. The differences were significant between them in both seasons, except Cu level in both seasons. In other words, it is clear that. leaves from Valencia orange budded on Sour orange had less Fe, Mn and Zn concentrations than on Volkamer lemon rootstock. This reduction may explain the vigorous effect of Volkamer lemons rootstock. Similar results were reported by Labanauska & Bitters 1974, Saad-Allah *et al.* (1985), Kaplankiran & Tuzcu (1994), Azab (1995) and El-Sayed (1999). Concerning root mineral content, roots of Volkamer lemon had high values of N, P, K, Ca, Fe and Cu, and lower Mg, and Mn when compared with those recorded for Sour orange rootstock. However, the differences were not significant in most cases in both seasons(Table 9). These results are in line with those obtained by Saad-Alla *et al.* (1985a), Azab (1995) and Dawood (1996).

Table (9): Root mineral content of Sour orange and Volkamer lemon rootstocks as affected by Valencia orange scion and corresponding values of both seedling rootstocks during 2001and2002 seasons.

Rootstock	N %	P %	K %	Ca %	Mg%	Fe ppm	Mm ppm	Zn ppm	Cu ppm
Season 2001									
Valencia orange/C. Volkameriana	1.72	0.18	1.15	1.55	0.25	86	25	25.3	7.5
Valencia orange/Sour orange	1.68	0.14	0.95	1.46	0.27	85	25.8	29	6.6
C. Volkameriana/Seedling rootstock	1.34	0.18	0.88	1.49	0.24	224	70	68	11
Sour orange/Seedling rootstock	1.45	0.19	0.91	1.45	0.27	184	91	87	17
L.S.D 5%	0.20	NS	0.10	0.06	NS	10.03	4.1	4.3	2.6
Season 2002									
Valencia orange/C. Volkameriana	1.73	0.17	1.08	1.52	0.25	78	25	27	6
Valencia orange/Sour orange	1.66	0.15	0.87	1.44	0.26	79	26	26	5
C. Volkameriana/Seedling rootstock	1.35	0.18	0.86	1.48	0.24	225	71	69	11
Sour orange/Seedling rootstock	1.44	0.20	0.46	1.46	0.26	185	92	88	18
L.S.D 5%	0.19	NS	0.08	NS	NS	6.7	6.6	5	1.8

N.S Not significant.

8-The concentrations of some heavy metals:

Data in Table (10) showed that, Pb, Cd, Se, Ni and Cr contents in the leaves, roots, fruit peel and fruit juice of Valencia orange budded on Volkamer lemon rootstock were lower than those on Sour orange rootstock with significant differences between them in most cases. This result was true in both seasons.

Table (10): Concentrations of some heavy metals in leaf, root, fruit peel and fruit juice of Valencia orange budded on Volkamer lemon and Sour orange and corresponding values of both seedling rootstocks during 2001and2002 seasons.

Rootstock		Season 2001				
		Pb ppm	Cd ppm	Se ppm	Ni ppm	Cr ppm
Season 2001						
Leaf	Valencia orange/C. Volkameriana	2.01	1.83	3.88	5.46	6.00
	Valencia orange/Sour orange	2.47	2.35	4.00	5.58	5.39
	C. Volkameriana/Seedling rootstock	2.96	2.11	2.38	1.78	1.46
	Sour orange/Seedling rootstock	2.18	2.73	3.66	2.94	2.09
	L.S.D 5%	0.64	0.33	0.47	0.56	1.41
Root	Valencia orange/C. Volkameriana	2.95	3.33	4.51	5.74	4.86
	Valencia orange/Sour orange	2.73	3.66	4.68	5.91	6.01
	C. Volkameriana/Seedling rootstock	5.19	4.33	8.99	4.98	7.41
	Sour orange/Seedling rootstock	5.02	5.62	11.65	5.50	7.63
	L.S.D 5%	0.31	0.61	0.54	0.37	0.49
Fruit Peel	Valencia orange/C. Volkameriana	0.022	0.013	0.031	0.020	0.035
	Valencia orange/Sour orange	0.024	0.019	0.037	0.021	0.044
	C. Volkameriana/Seedling rootstock	0.017	0.018	0.019	0.015	0.047
	Sour orange/Seedling rootstock	0.025	0.031	0.027	0.022	0.061
	L.S.D 5%	0.003	0.010	0.005	0.003	0.003
Fruit Juice	Valencia orange/C. Volkameriana	0.0019	0.0012	0.0018	0.0054	0.0042
	Valencia orange/Sour orange	0.0032	0.0018	0.0021	0.0061	0.0051
	C. Volkameriana/Seedling rootstock	0.0023	0.0013	0.0017	0.0022	0.0033
	Sour orange/Seedling rootstock	0.0035	0.0021	0.0022	0.0059	0.0065
	L.S.D 5%	0.0003	0.0002	0.0002	0.0002	0.0004
Season 2002						
Leaf	Valencia orange/C. Volkameriana	2.16	2.81	4.21	6.05	5.94
	Valencia orange/Sour orange	2.23	4.68	4.36	6.81	6.44
	C. Volkameriana/Seedling rootstock	2.74	2.19	2.55	1.82	1.56
	Sour orange/Seedling rootstock	2.28	2.78	3.78	2.05	2.40
	L.S.D 5%	0.12	0.56	0.27	1.34	0.30
Root	Valencia orange/C. Volkameriana	3.02	3.76	4.45	5.79	5.14
	Valencia orange/Sour orange	3.33	4.34	4.83	6.13	6.54
	C. Volkameriana/Seedling rootstock	8.36	4.38	9.08	4.17	7.74
	Sour orange/Seedling rootstock	5.89	5.67	11.77	5.61	7.90
	L.S.D 5%	0.43	0.47	0.96	N.S	0.65
Fruit peel	Valencia orange/C. Volkameriana	0.023	0.015	0.033	0.019	0.037
	Valencia orange/Sour orange	0.026	0.020	0.036	0.020	0.043
	C. Volkameriana/Seedling rootstock	0.015	0.017	0.019	0.013	0.045
	Sour orange/Seedling rootstock	0.021	0.032	0.026	0.021	0.059
	L.S.D 5%	0.006	0.005	0.011	N.S	0.009
Fruit Juice	Valencia orange/C. Volkameriana	0.0018	0.0010	0.0019	0.0053	0 0044
	Valencia orange/Sour orange	0.0030	0.0017	0.0020	0.0058	0 0053
	C. Volkameriana/Seedling rootstock	0.0024	0.0010	0.0016	0.0021	0.0031
	Sour orange/Seedling rootstock	0.0032	0.0019	0.0024	0.0058	0.0066
	L.S.D 5%	N.S	N.S	N.S	0.001	0.001

N.S Not significant.

The concentrations of different heavy metals were always higher in roots followed by leaves and fruit peel then came fruit juice, on both rootstocks.

Conclusively, Volkamer lemon rootstock might have absorbed and transported less amount of most heavy metals when compared with Sour orange rootstock.

The concentration of heavy metals are within the normal level in the four tested sampled parts and their values were much less than those considered toxic limits for citrus as reported by Salama & Khalifa (1993) of Cd (1-2.4 ppm), Cr (10 ppm), Ni (55 ppm), Pb (2-14 ppm) and Se (2 ppm) in the leaves. Also, this concentrations of heavy metals in fruit juice are too lower to cause any harmful effects for human health.

CONCLUSION

It could be concluded from this study that Valencia orange on Volkamer lemon produced the highest values of most vegetative and root growth parameters. Also, gave the highest yield as Kg/tree or yield efficiency compared with some characters of Sour orange rootstock. Valencia orange fruits on Volkamer lemon seemed to have physical and chemical characters are not less in quality than those produced on Sour orange rootstock, except for higher acidity of fruit juice.

Moreover,Valencia orange tree on Volkamer lemon rootstock had lower Na and Cl ions in their leaves and roots but had higher values of chlorophyll, proline and total carbohydrate. Thus, Volkamer lemon rootstock is recommended for Valencia orange cultivars exhibited higher ability for growth and yield than on Sour orange under saline and alkaline soil at Kafer El-Sheikh. This conclusion assure the successful replacement of Volkamer lemon as a rootstock for Valencia orange which seemed to be a good substitute for Sour orange rootstock under the conditions of this experiment.

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أ- تقييم الليمون الفولكاماريانا كأصل لصنف البرتقال الفالينشيا تحت ظروف كفرالشيخ

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أجريت هذه الدراسة على أشجار برتقال فالينشيا عمرها ٨ سنوات مطعومة على أصل الفولكاماريانا والنارنج وذلك لتقييم النمو وجودة الثمار ومحتوى الأوراق من المعادن وقدرة الأصل على تحمل الملوحة علاوة على امتصاص ونقل بعض المعادن الثقيلة وأوضحت النتائج أن: -

١ - الأشجار المطعومة على أصل الفولكاماريانا كانت أكبر حجما وأعلى ارتفاعا. وكذا طول الفرع وعدد الأوراق على الفرع ومساحة الورقة ومساحة مقطع الساق عن الأشجار المطعومة على أصل النارنج.

٢ - أصل الفولكاماريانا أعطى أعلى قيم لنمو الجذور مثل طول الجذور وكثافتها ووزنها الجاف وذلك على ثلاثة أعماق مختلفة)٣٠ ، ٦٠ ، ٩٠ سم من سطح التربةوعلى مسافات مختلفة)٥٠ ، ١٠٠ ، ١٥٠ سم(من جذع أشجار الفالينشيا المطعومة على أى من الأصلين المختبرين عند المقارنة بأصل النارنج وكانت النتائج مؤكدة إحصائيا.

٣ - زادت نسبة العقد في الأزهار المتكونة على الأشجار المطعومة على أصل الفولكاماريانا بينما زادت نسبة تساقط الثمار في شهور مايو ويونيو ويوليو في الأشجار المطعومة على أصل النارج.

٤ - أشجار الفالينشيا المطعومة على أصل الفولكاماريانا أعطت أعلى محصول)كجم/شجرة) وكذلك أعطت أعلى كفاءة بالنسبة للأشجار وذلك عند قياس المحصول)كجم/سم^2 من مساحة مقطع الجذع وكجم/م^3 من حجم الشجرة(وأحسن صفات جودة للثمار متمثلة في طول وقطر ووزن وحجم الثمرة وكذلك المواد الصلبة الذائبة الكلية و الحموضة ونسبة المواد الصلبة إلى الحموضة وفيتامين ج.

٥ - أشجار البرتقال الفالينشيا المطعوم على أصل الفولكاماريانا احتوت جذورها وأوراقها على أقل محتوى من الصوديوم والكلور وذلك عند المقارنة بالأشجار المطعومه على أصل النارنج بالإضافة إلى ذلك فإن مستوى البرولين والكربوهيدرات وكلوروفيل أ ، ب والمجموع الكلى للكلوروفيل سجل أعلى مستوى له في أوراق الأشجار المطعومة على أصل الفولكاماريانا عن تلك المطعومه على أصل النارنج.

٦ - أشجار الفالينشيا المطعومة على أصل الفولكاماريانا أعطت أوراق محتواها من النيتروجين والفوسفور والبوتاسيوم والكالسيوم والماغنسيوم والحديد والمنجنيز والزنك والنحاس مرتفع عند المقارنة بالأشجار المطعومة على أصل النارنج. بينما وجد أن البوتاسيوم والصوديوم والكلور كان مرتفعا في أوراق الأشجار المطعومة على أصل النارنج عن الأشجار المطعومة على أصل الفولكاماريانا.

٧ - إحتوت جذور أصل الفولكاماريانا على أعلى مستوى من النيتروجين والفوسفور والبوتاسيوم والحديد والمنجنيز والزنك والنحاس بينما وجد أن تركيز الكالسيوم والماغنسيوم والصوديوم والكلور كان مرتفعا في جذور أصل النارنج بالمقارنة بأصل الفولكاماريانا وكانت النتائج مؤكدة إحصائيا على أي من الأصلين موضع الدراسة.

٨ - بالإضافة إلى ذلك الأشجار المطعومة على أصل النارنج احتوت على تركيزات أعلى من الرصاص و الكادميوم والسيلينيوم والنيكل والكروم في الأوراق والجذور وقشرة الثمرة وعصير الثمرة عن مثيلاتها من الأعضاء النباتية على الأشجار المطعومة على أصل الفولكاماريانا.

وقد خلصت الدراسة إلى أنه يمكن إحلال أصل الفولكاماريانا محل أصل النارنج لتطعيم البرتقال الفالنشيا عليه بنجاح تحت ظروف محافظة كفرالشيخ وإن إحتاج ذلك إلى مزيد من الدراسة قبل التوصية فى أماكن أخرى.