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STUDIES OF DIFFERENT CITRUS ROOTSTOCKS ON GROWTH, YIELD AND FRUIT QUALITY OF VALENCIA ORANGE

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ABSTRACT

The present study was carried out during seasons of 2012 and 2013, to evaluate Valencia orange (C. Sinensis L. Osbeck) trees budded on four citrus rootstocks , i.e. Cleopatra mandarin, Sour orange' Rangpur lime and Volkamer lemon. The experimental trees were grown in a newly reclaimed sandy soil at the orchard of EL-Kassasin Horticulture Research Station, Ismailia Governorate Egypt. The considered parameters were mostly of significant responses among Valencia orange cv. and the four studied rootstocks. This study presented that the superiority of Volkamer lemon rootstock for Valencia orange trees, as compared with the other tested rootstocks. On the contrary, Rangpur lime rootstock seemed to be the worst one for Valencia orange trees under the experimental conditions.

Keywords: Citrus rootstocks (Cleopatra mandarin, Sour orange, Rangpur lime and Volkamer lemon) -Valencia orange Vegetative growth - Yield -Fruit quality.

INTRODUCTION

It is well known that rootstock greatly affect numerous growth and fruiting parameters of the borne cultivar. In this respect the change in canopy diameter and plant height for Persian lime, was more vigorous in trees on C. Volkameriana than those on Cleopatra mandarin (Valbuena, 1996). Also, Abo El-Komsan (1998) found that Rough lemon and Sour orange rootstocks were the best compatible for Ruby, Marsh and Thompson grapefruit cultivars. Iriarte-Martel *et al*., (1999); Ibrahim, (2000) and Ibrahim,(2005) mentioned that the greatest tree height and canopy volumes of Balady mandarin and Valencia orange were obtained with Cleopatra mandarin and C.volkarneriana rootstocks.

Abd alla *et al*., (1978) showed that fruits of Washington Navel orange trees on Sour orange had the highest juice vitamin C. than those on Rough lemon and baladi lime . Baldry *et al,* (1982) found that fruits of Valencia orange trees on C.volkameriana had lower ascorbic acid content .Monteverde *et. al.,* (1988) found that C. volkameriana induced the best mean fruit weight for Valencia orange. Monteverde (1989) reported that the smallest fruits of Valencia orange were produced on Cleopatra mandarin rootstock, and gave a higher juice percentage on Cleopatra mandarin and C.voikarneriana. Whereas, the T. S. S. / acid ratio of Valencia orange was higher on C. voikameriana, Sour orange, Cleopatra mandarin and Carrizo citrange. Gregoriau and Economides (1994) noticed that the yields of Valencia orange trees on Rough lemon and C. Voikarnerirna rootstocks were significantly higher than those of trees on the other rootstocks. They added that rootstock had no clear effects on fruit quality. Tuzcu *et al.,* (1999) noted that the highest yields of Washington Navel orange were obtained from trees on Carizzo citrange and C. volkarneriana, while both the citranges gave positive effected of fruit quality. C. voikarneriana, Sour orange and C. junos showed all negative effect on fruit quality. In Moro blood orange, the best yields were obtained from trees on C. voikarneriana, while the best fruit quality was obtained from trees on the citranges. Sour orange and C. junos gave negative effects in both yield and fruit quality of Moro blood orange.

The present study dealt with the effect of four citrus rootstocks i.e. CM. SO., R.L. and V.L. on growth, compatibility %, flowering pbit, yield and fruit quality of the Valencia orange cv. through 2012 & 2013 seasons.

MATERIALS AND METHODS

The present study was carried out in Kassasin Horticulture Research Station, Ismailia Governorate, Egypt during 2012 and 2013 seasons. Eight-years-old Valencia orange (V.O.) (Citrus sinensis L. Osbeck) trees, budded on 4 citrus rootstocks namely Cleopatra mandarin (CM.) (Citrus reticulata, Blanco); Sour orange (SO.) (Citrus aurantiurn Lime.); Rangpur lime (R.L) (Citrus lirnonia, Osbeck) and Volkamer lemon (V.L.) (Citrus voikarneriana, Tan & Pesq). Trees were planted in September 2005, at 5 m apart and they received the same traditional horticulture practices including, and pest control. However, the present experiment comprises V.O. Cv. and 4 rootstocks where each combination was replicated three times with 3 trees for each replicate. Thus, 36 trees of V.O cv. budded on 4 different rootstock were experimented in a complete randomized block design.

Table (1): Soil and irrigation water analyses of the experimental orchard:

A. Soil mechanical analysis, $CaCo_3$%, organic matter, EC (mmhos /cm) and pH.

Soil depth (cm)	Soil mechanical analysis			Soil texture	$CaCo_3$ %	Organic matter %	EC Mmhos/cm	PH
	Sand %	Clay %	Silt %					
0-30cm	83	14	3	Sand	2	0.16	0.42	7.9
30-60cm	90	9	1	Sand	1.7	0.13	0.39	8.6
60-90cm	94	5	1	Sand	1.6	0.07	0.37	8.9

B. Soil soluble ions, m.meq/L.

oil depth (cm)	Cations (meq/L)				Anions (meq.L)			
	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	So_4^{+}	Cr	HCO_3^{-}	CO_3^{+}
0-30 cm	0.6	0.7	0.41	0.18	0.98	0.75	0.24	0
30-60cm	0.8	0.5	1.09	0.11	0.82	0.80	0.40	0
60-90 cm	0.7	0.3	0.87	0 12	1.00	0.60	0.90	0

C. Soil macro and micronutrients content:

Soil depth (cm)	(meq.L)					
	N	P	K	Fe	Zn	Mn
0-30cm	54	4	80	1.4	0.11	0.61
3O-60cm	29	2	88	1.6	0.03	0.54
60-90cm	18	3	112	1.5	0.02	0.60

D. Chemical analysis of the irrigation water.

pH	E.C m.mohs / Cm	Salinity PP^{++}	Cations (m.eq/L)				Anions (meq/L)			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	So_4^{+}	Cr	HCO_3^{-}	CO_3^{+}
7.5	1.12	716.8	3.2	1	1.32	0.22	0.27	0.82	0.21	0.0

Morphological characteristics:

Tree vigor measurements: In February and November of two seasons, the following measurements were carried out: Tree height (m); canopy diameter (m) (average in- row and cross - row diameter); canopy circumference (m), tree canopy volume (m3) (calculated according to the equation reported by Morse and Robertson (1987).

Canopy volume: 0.5236 x HD2, Where H= tree height (m) and D = canopy diameter (m). Trunk circumference was measured at 5 cm above and below the bud union and used to calculate the scion\ rootstock circumference ratio (Compatibility %).

Scion fresh weight and scion dry weight: In Feb. of the 1st growing season and Nov. in the 2nd growing one, three trees from each scion I rootstock combination, were utilized. Horizontal spread (in meters) of scion canopy and root system of the studied rootstocks were measured in 8 directions and the average was considered as a diameter of tree canopy projection area. Root system horizontally spread from the trunk of the studied trees was measured in 8 directions and the average was considered as a diameter of a circle in which the roots were spread. Thereafter, the ratio between scion canopies

Vegetative growth flushes: The current growth cycles which developed on the studied trees throughout the season were counted every year to compare the intensity of vegetative growth between spring (March - May), summer (June - August) and autumn (September-November) flushes.

Flowering period, yield and fruit quality:

Flowering: In both seasons, dates of beginning, full and ending of blooming for each tree were recorded. Average number of flowers /shoot was counted (using 12 shoots at the different four sides of each tree).

Yield: Yield as fruit number and weight per tree was recorded at the harvest commercial time in both seasons (the third week of January in the first season (2012), and the fourth week of January in the second one (2013).

Fruit quality: A sample of 25 fruits of each individual tree was taken randomly at harvest time to determine the physical and chemical properties as follows:

Fruit physical properties:

1. Fruit weight (g).
2. Pulp weight (g).
3. Fruit height and diameter (cm) using a veneer caliper.

4. Fruit shape index: as height/ diameter ratio.
5. Peel thickens (mm) using a veneer caliper.
6. Juice volume (m1 per fruit).

Fruit chemical properties:

1- Total soluble solids percentage (T.S.S. %) was determined by using Karl Zeiss hand refractmeter.
2- Total acidity percentage was determined in fruit juice as percentage of citric acid by titration with standard 0.01 N sodium hydroxyl solutions and phenolphthalein 1% as indicator according to A.O.A.C (1984).
3- Total soluble solids / acid ratio:
4- Ascorbic acid (Vitamin C) content: was determined by using 2,6 - dichlorophenol indophenol and 2% oxalic acid. Ascorbic acid was calculated as milligrams per 100 ml of juice (A.O.A.C .1984).

Statistical analysis:

The obtained results were statistically analyses using analysis of variance and Duncan's multiple range tested was used to differentiate means Snedecor and Cochran (1980).

RASULTS AND DISCUSSIONS

Effect of different citrus rootstocks on some morphological characteristics of scion:

1. Tree height:

Table (2) reveals that in 1st season Volkamer lemon (V.L.) rootstock induced the tallest trees (2.O1& 2.26 m) in Feb. and Nov. respectively, followed by those on Rangpur lime (R.L.) rootstock (1 .93 & 2. 15 m) . Whereas, the shortest trees were produced by both Sour orange (S.O.) rootstock (1.84 & 2.07 m), and Cleopatera mandarin (CM.) rootstock (1.83 & 2.01 m) in Feb. and Nov. respectively.

Concerning, the second on, similar data had obtained scions rootstocks had recorded the tallest trees in Feb. and Nov., respectively. Whereas, S.O. and C.M. rootstocks had induced the shortest trees of V.O. trees in Feb. and Nov., respectively. In this respect, the data showed tree height was almost tallest in Feb. than those obtained from Feb. during the both seasons.

2. Canopy diameter:

The highest canopy diameter of V.O. trees was recorded on V.L. rootstock in Feb. and Nov. in the First season, respectively, followed by those on R.L. rootstock. Whereas, the smallest canopy diameter was shown on S.O. rootstock in Feb. and Nov., respectively, during both seasons under study.

In the second season, the greatest canopy diameter of V.O. trees was recorded on V.L. rootstock in Feb. and Nov. respectively, followed by those on R.L. rootstock. Whereas , the smallest canopy diameter was shown on S.O. rootstock in Feb. and Nov., respectively.

3. **Canopy circumference:**

The data showed that the highest canopy circumferences of V.O. trees were shown on V.L. (6.96 & 6.86 m), and R.L. (6.43 & 6.58 m) rootstocks in

Feb. and Nov., respectively, whereas the lowest canopy circumference was found on S.O. (5.66 & 5.80 m), and CM. (5.92 & 6.03 m) rootstocks in Feb. and Nov. in the first season.

In the second season, the highest canopy circumference of V.O. trees was recorded on V.L. and R.L. rootstocks in Feb. and Nov., respectively. Whereas, the lowest canopy circumference was noticed on S.O. and CM. rootstocks in Feb. and Nov. in the second season.

4. Canopy volume (m3):

Results cleared that, V.L. rootstock induced the significantly largest canopy volume of V.O. trees (4.86 &6. 3 m^3) in Feb. and Nov., respectively in the first season as compared with other tested rootstocks . Whereas, the smallest canopy volume were produced on both CM. (3.64 & 4.77m^3) and S. 0. (3.36 & 4.59 m^3) rootstock in Feb. and Nov., respectively in the first season, in the second season, the highest canopy volume was recorded by V.L. (6. 88 &7. 85m^3) rootstocks. Whereas, the lowest canopy volume was resulted by SO. (S.O5 &6.23 m^3) and CM. (5.25 &5.90 m^3) rootstocks.

5. Scion / rootstock compatibility percent:

In the first season, V.O. trees had significantly higher compatibility percentage on both V.L. (94.32 & 95.79 %) and SO. (93.74 & 94.362%) rootstocks in Feb. and Nov., respectively compared with those budded on CM. which gave the lowest significant compatibility percentage (88.75 & 89.10 %) in Feb. and Nov., respectively.

In the second season, V.L rootstock showed the highest compatibility percentage (96.18 & 96.73%) in Feb. and Nov., respectively without significant difference than SO. (94.68 & 95.33 %) in Nov. only. While, the lowest compatibility percentage was recorded by both .C.M. (91.26& 92.59%) and R.L. (92.90 &93.47 %) rootstocks in Feb. and Nov.

Table (2): Effect of different citrus rootstocks on some morphological characteristics (Tree height, Canopy diameter, Canopy circumference Campy Volume and compatibility (%) of Valencia orange tree in 2012 and 2013 seasons.

Rootstocks characteristics	Tree height (m)				Canopy diameter (m)				Canopy circumference (rn)				Canopy Volume (m3)				compatibility (%)*			
	2012		2013		2012		2013		2012		2013		2012		2013		2012		2013	
	Feb.	Nov.	Feb.	Nov.	Feb.	Nov.	Feb.	Nov.	Feb.	Nov.	Feb.	Nov.	Feb.	Nov.	Feb.	Nov.	Feb.	Nov.	Feb.	Nov.
C.M.	1.83 A	2.01 A	2.15 A	2.23 A	1.95 AB	2.13 AB	2.16 A	2.29 A	5.9 2A	6.03 AB	6.13 A	6.56 B	3.64 AB	4.77 A	5.2 5A	5.90 A	88.7 5A	89.10 A	91.2 6A	92.59 A
S.O.	1.84 A	2.07 AB	2.11 A	2.29 AB	1.87 A	2.06 A	2.14 A	2.28 AB	5.6 6A	5.80 A	5.89 A	6.06 A	2.36 A	4.59 A	S.O 5A	6.23 A	93.7 4B	94.62 BC	94.6 8B	95.33 BC
R.L.	1.93 AB	2.15 BC	2.25 BC	2.38 BC	2.04 BC	2.19 B	2.24 AB	2.36 A	6.4 8B	6.58 BC	6.66 B	6.78 C	4.21 B	5.37 B	5.9 1B	6.94 B	91.2 5AB	92.70 B	92.9 0A	93.47 AB
V.L	2.01 B	2.26 C	2.32 C	2.44 C	2.15 C	3.31 C	2.38 B	2.48 B	6.6 9C	6.86 C	6.98 C	7.12 D	4.86 C	6.13 B	6.8 8C	7.85 C	94.3 2B	95.79 C	96.1 8C	9673. C

The obtained findings are in agreement with those reported by Valbuena (1996) showed that C. Volkmeriana was generally considered the best rootstocks for Valencia orange in terms of tree height, canopy volume and cropping Canopy area (m^2): As shown in table (2) the canopy area of V.O. trees was significantly the highest on V.L. rootstock (3.62 & 4.83 m^2) in the first and second seasons without significant differences than R.L.

rootstock (3.26 m^2) in the first seasons only . The smallest canopy area of V. O. trees was recorded on SO. rootstock (2.74 & 4.08 m^2) in the first and second seasons, respectively.

6. Root system spread area (m^2):

Data revealed that V.L. rootstock recorded the significantly highest root spread area (6.96 & 7.98 m^2) in the first and second seasons , respectively. But CM. rootstock recorded the lowest roots spread area (4.78 & 6.02 m^2) in the two seasons without significant differences than R.L. (5. 10 & 6.60 m^2) rootstock in the first season only . While, SO. rootstock came in-between (6.O & 7.22 m^2) in the two seasons.

Canopy / root system area ratio:

Concerning canopy / roots area ratio for V.0. trees, it is obvious that R.L. rootstock induced the highest canopy/roots area ratio (63 . 92 & 66.21%) in the first season , and C.M. rootstock recorded the greatest ratio (62.34 & 68.94 %) in the second one without significantly differences between them in the two studied seasons . While the lowest canopy / roots area ratio recorded by SO. rootstock (45 . 59 & 56. 5 %) in the first and second seasons, respectively without significant differences than V.L. rootstock (52.O1&60.53%) in both seasons.

Scion fresh weight (kg):

Results indicated that V.O. trees on V.L. rootstock showed the significantly highest scion fresh weight (19.67 kg) without significant differences than R.L. rootstock (9.33 kg) as compared with other tested rootstocks. Whereas, CM. rootstock produced the significantly lowest scion fresh weight (15. 01 kg) as compared with other tested rootstocks.

Scion dry weight (kg):

V.L. rootstock induced the significantly highest scion dry weight (11 .45 kg) as compared with other tested rootstock except R.L. rootstock (11 .07 kg) whereas CM. rootstock produced the significantly lowest scion dry weight (9.22 kg) compared with other tested rootstocks.

The obtained findings are in agreement with those reported by Valbuena (1996) that C.Volkameriana was generally considered the best rootstock for Valencia orange in terms of tree growth and cropping.

Table (3): Mutual effect between Valencia orange scion and rootstocks on canopy area, root system area, canopy area/root system area ratio, scion fresh weight and scion dry weight in 2012 and 2013 season.

Characteristics Rootstocks	Canopy area(m2)		Root system area(m^2)		Canopy area/root system area ratio		Scion fresh weight (kg)	Scion dry weight (kg)
	FEB.2012	NOV.2013	FEB.2012	NOV.2013	FEB.2012	NOV.2013	FEB.2012	NOV.2013
C.M	2.98AB	4.15A	4.78A	6.02A	62.34 DC	68.94B	1S.O0 A	9.22A
S.O	2.74A	4.08A	6.01B	7.22C	45.59A	56.51A	17.16 B	10.84B
R.L	3.26BC	4.37A	5.10A	6.60B	63.92C	66.21B	19.33 CD	1 1.07CD
V.L	3.62C	3.62C	6.96C	7.981C	52.01A	60.53AB	19.67 D	11.45D

Means having the same letter (s) in a column are no significant at 5 % level

C. M. = Cleopatera mandarin, S.O. = Sour orange, R. L. Rangpurlime , V.L. Volkamer

Vegetative growth Flushes:

Data in table (4) Clear the effect of four citrus rootstocks on the number of shoots/tree in different vegetative growth flushes of Valencia orange trees in 2011 and 2012 seasons. The tested citrus rootstocks and growth flushes significantly affected shoots number per tree in the two experimental seasons. Concerning the first one, it is obvious that the highest shoots number per tree (89.67) was recorded on V.L. rootstock followed by those on R.L. (89.22) without significant difference between them. The lowest shoots number per tree (73.11 & 7S.O5) was gained on CM. and S O. Rootstocks, respectively without significant difference between them and regardless of grow flush.

As for the effect of growth flush, one can noticed that the highest shoots number per tree (140.67) was recorded for spring flush, whereas the significantly lowest number (4S.O9) was detected for autumn flush. While summer flush shoots number per tree (59. 54) came in between regardless of rootstock.

The interaction between the used rootstocks and growth flushes was significant in most cases during the first season and it could be noticed that R.L. rootstock with spring flush (154.67) achieved the significantly highest shoots number per tree, opposite to SO. Rootstock in autumn flush.

Regarding the effect of rootstocks in the second season, it is clear that the significantly highest shoot number per tree was found on R.L. (97.77) and V.L. (96.99) rootstocks. Whereas the significantly lowest number (82.89 & 83.91) was gained on both C.M and SO. rootstocks, respectively. As for the growth flush effect, data indicated that the significantly highest shoots number per tree (151.83) was recorded for spring flush, whereas the significantly lowest number was shown by both summer flush and autumn flush (59.47& 59.88), respectively.

The interaction between the used rootstocks and growth flushes was significant in most cases during the second season. The highest significant shoots number per tree was achieved by R.L. rootstock in spring flush while the significantly lowest number was recorded by SO. rootstock in summer flush.

The obtained findings are in line with those reported by Abo-El Komsan, (1998) who studied on some citrus cvs budded on different, citrus rootstocks and found that number of shoots was generally formed in the spring flush compared to these in summer and autumn.

Table (4): Effect of different citrus rootstock on number of shoots / tree in different vegetative growth flushes of Valencia orange trees in 2012 and 2013 seasons.

Growth flush	Season 2012				Season 2013			
rootstocks	Spring	Summer	Autumn	Means	Spring	Summer	Autumn	Means
C.M	125.5de	49.17ab	44.67a	73.11A	138.33b	5l.17a	59.17a	82.89A
S.O	140.5ef	4633ab	38.33a	7S.O5A	143.17b	48.00a	60.57a	83.91A
R.L	15467g	6133 b	51.67ab	89.22BC	168.5b	63.7a	61.l0a	97.77C
V.L	142.0f	8l:33c	45.67a	89.67C	157.3b	7S.O0a	58.67a	96.99BC
Means	140.67C	59.54B	4S.O9A	-	151.83B	59.47A	59.88A	-

Effect of different citrus rootstocks on blooming characteristics Date of beginning bloom:

Data in table (5) show clearly that, Sour orange V.L rootstock considered as a control in such study, the budding V.O. trees on-other tested rootstocks had delayed the dates of beginning bloom than the control. Meanwhile, V.L rootstock delayed such date for V.O. trees by 6 & 4 days in the 1 st and 2nd season, respectively. Whereas, R.L. achieved, 5 & 4 days delay. C.M. rootstock resulted 1& 2 days delay than the control in the 1 st and 2nd season, respectively.

Date of full bloom:

Data clearly indicated that R.L rootstock delayed the data of full bloom in V.O. trees by 5 day in the 1st season but it advanced such date by one day in the 2nd one. V.L. rootstock, however, delayed the full bloom date by 4 days in the 1st reason only, whereas C.M. rootstock delayed such date by one day in the second season only. The two latter rootstocks had no effect on blooming dates in the other season.

Date of ending bloom:

As shown in table (5) the data presented that both R.L and V.L. rootstocks delayed the date of ending bloom of V.O. trees in both seasons than the control (S.O rootstock) such delay were 5 & 3 days and 6 & 2 days in the 1st and 2nd seasons , respectively. On the other hand, CM. rootstock took another trend , where it delayed the date of ending bloom by one day in the 1st season, but it advanced such sate by one day in the 2nd one.

Duration of bloom:

V.O. trees which budded on S.O rootstock exhibit blooming period of 20 & 19 days (from 2/4 & 30/3 to 21/4 & 17/4 in the 1st and 2nd seasons , respectively). Both of CM. and V.L. rootstocks advanced such period in the 2nd season only by 2 and 3 days, respectively and they were without effect in the 1 st one. On the other hand, R.L. rootstock, delayed the full bloom period by one day in the 1st season, but it advanced such period by 2 days in the 2nd one variations in dates of the beginning and end of bloom as well as blooming duration in different citrus species and cultivars were reported by Minessy *et. al.,* (1965), who mentioned that different citrus varieties and species differ in beginning, end and duration of bloom.

Table (5):Effect of different citrus rootstocks on blooming characteristics of Valencia orange trees in 2012 and 2013 seasons.

Rootstocks	Date of beginning bloom				Date of full bloom				Date of ending bloom				Duration of bloom /day			
	Date		Delayer* advance than control in days		Date		Delayer* advance than control in days		Date		Delayer* advance than control in days		Date		Delayer* advance than control in days	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
C.M	1/4	28/3	-1	-2	10/4	4/4	0	-1	20/4	18/4	-1	+1	20	21	0	+2
S.O	2/4	30/3	0	0	10/4	5/4	0	0	21/4	17/4	0	0	20	19	0	0
R.L	28/3	26/3	-5	-5	5/4	6/4	-5	+1	16/4	14/4	-5	-3	19	21	-1	+2
V.L	27/ 3	26/3	-6	-6	6/4	5/4	-4	0	15/4	15/4	-6	-2	20	22	0	+3

Means having the same letter (s) in a column are not significant at 5 % level

C. M. = Cleopatera mandarin, S.O = Sour orange R. L = Rangpur lime, V.L = Volkamer lemon * control SO.

Effect of different citrus rootstocks on yield and fruit quality of scion:

Data in table (6) show clearly that the effect of some citrus rootstocks on the yield per tree (Kg) and some physical characteristics of Valencia orange fruits.

Yield (kg/tree):

It is evident from these results that average tree yield for V.O. trees was considerably higher on V.L. rootstock (26.23 & 30.18kg) compared with those on C.M. rootstock (7. 75 & 21.67 kg) in the first and the second seasons, respectively. In addition, tree yield of V. O. on R.L. rootstock (24.75 & 29. 18 kg) was significantly higher compared with those on S.O. rootstock (19.25 & 24. 50 kg) in both two seasons, respectively.

The obtained results are in harmony with those found by Tuzcu et al., (1994) on Washington Navel orange since they found that the highest yields were obtained from trees on C. Voikarneriana.

Fruit weight (gm):

The significantly highest V.O. fruit weight was recorded on R.L. rootstock (261.6 & 251.03 gm) in the first and the second season, respectively. Whereas, the significantly lowest value was shown on C.M. (214.3 & 213.01 gm) in two seasons, respectively.

Pulp weight (gm):

Sour orange rootstock induced the significantly lowest pulp weight (127.9 & 140.7 gm) compared with other rootstocks in the two seasons. Whereas, V.O. fruits on R.L. rootstock recorded the significantly highest pulp weight in the first season only (164.08gm), and without significant difference than V.L (15 1.68 gm) and C.M. (150.5 gm) rootstocks in the second season only.

Fruit height (cm):

The greatest fruit height was recorded by V.L. (7.83 & 8.03 cm) and the lowest value was detected on C.M. (6.61 & 6.89 cm) rootstocks in the first and the second seasons, respectively.

Fruit diameter (cm):

The greatest fruit diameter of V.O. fruits was recorded by those on V.L. rootstock (8.01 & 7.86 cm) in the first and second seasons, respectively. Whereas, the lowest diameter was shown by S.O. rootstock (7.43 &7.54 cm) without significant difference than those on R.L rootstock (7.53 cm) in the second season only.

The obtained findings are in agreement with those reported by Sharawy (1992) on Ruby Red grapefruit cultivar budded on different citrus rootstocks.

Fruit shape index:

It is shown from the obtained results that V.O. fruits specially on R.L. and V.L. rootstocks differ in their shape from season to another. Such difference may be due to the environmental and nutritional factors rather than rootstock effect.

Table (6):

Peel thickness (mm):

The significantly highest and lowest peel thickness were recorded by V.L. (4.3 & 4. 1 5 mm) and SO. (3 .7 & 3.65 mm) rootstocks in the first and the second seasons, respectively.

The obtained data are in agreement with those of Monteverde (1989), who reported that fruit peel thickness of Satsuma, Valencia, orange, Parent Navel orange and grapefruit was greatest on C. Volkameriana compared than those on others tested rootstocks.

Juice volume (ml fruit):

Fruit juice volume was significantly higher on R.L. rootstock, (114.63 & 115.75 ml) and significantly lowers on S.O. rootstock (98.50 &102.5 ml) in the first and second seasons, respectively.

Chemical properties of fruits:

Total soluble solids % (T. S.S. %):

As shown in table (7), the significantly highest T. S. S. percentage of V.O. juice were obtained on S.O. rootstock (10.62 & 10.83 %) in both seasons respectively, but the lowest one were recorded on R.L. rootstock (9.20 & 9.65 %) in the first and the second seasons , respectively.

These results are in agreement with those obtained by Monteverde (1989); who found that T.S.S. percentage of fruits from Genoa EETA lemon, Valencia orange were highest on Sour orange.

Total acidity:

Valencia orange fruit juice acidity percentage was - significantly higher on V.L. rootstock (0.08 & 1.06 %) in the first and the second seasons, respectively. Whereas, the lowest significant juice acidity percentage were recorded by S.O (0.99 & 1 .01 %) and R.L. (1.0 & 0.99 %) rootstocks in the first and the second seasons, respectively.

T.S.S. acid ratio:

T.S.S. acid ratio in fruit juice was highly significant in those on S.O. rootstock (10.73 & 10.72 %) in the first and the second seasons, respectively. Whereas, the lowest values were recorded by those on V.L. rootstock (9.08 & 9.27 %) in the first and the second seasons, respectively. These results are in agreement with those found by Monteverde (1989), who reported that, the T.S.S/ acid ratio of Valencia orange was high on C. Volkameriana, Sour orange and Cleopatera mandorin.

Ascorbic acid content (mg/100 ml juice):

Valencia orange fruit Ascorbic acid content was significantly the highest from trees budded on S.O rootstock (40.63 & 39.85). While the lowest content was recorded by R.L. rootstock (34.08 & 36.63). The difference between Ascorbic acid content for V.O. fruit on CM. and V.L. rootstocks was insignificant. Such results are in agreement with those obtained by Abd-alla et al., (1978), who found that Ascorbic acid content was highest in fruits juice of Washington Navel orange trees on Sour orange rootstock. Most results are in harmony with that found by Baldry el al., (1982), who stated that ascorbic acid content was lowest in fruit juice of Valencia orange tree on C. Volkarnarian rootstocks.

Table (7): Effect of different citrus rootstocks on some fruit chemical properties of Valencia orange trees in 2012 and 2013 seasons.

Rootstocks	T.S.S%		Acidity %		T.S./ Acid Ratio		Ascorbic acid content (mg/100 ml) juice	
	2012	2013	2012	2013	2012	2013	2012	2013
C.M	9.63A	9.96A	1.02A	1.04BC	9.44B	9.68 A	35.72AB	37.50AB
S.O	10.62B	10.83B	0.99A	1.01A	10.73C	10.72B	40.63C	39.85B
R.L	9.20A	9.65A	1.01A	0.99A	9.11A	9.75AB	34.08A	36.63A
V.L	9.81AB	9.83A	1.08B	1.06C	9.08A	9.27 A	36.15B	37.09A

Mcans having same letter (s) in a column are not significant at 5 % level.
C. M. = Cleopatera mandarin, S.O. Sour orange, R. L. Rangpur Lime ,
V.L.= Volkamer lemon

In conclusion, one can say that, louver rootstock is the best and promising rootstock for Valencia orange trees under Ismailia Governorate conditions because it proved that tree on V.L. produced the tallest tree height, best tree volume, root system and yield than obtained from the other rootstocks.

REFERENCES

Abd alla, K.M. ;M.A. Meligi and H.M. Kouka (1978). Influence of different rootstocks on yield and fruit properties of regenerated Washington Navel orange trees. Research Bulletin Mn Shams University , Faculty Agriculture. (No. 895): pp28.

Abo El-Komsan, E.G., (1998). Evaluation of some grapefruit cultivars budded on different Citrus rootstocks grown in Middle Egypt. Ph.D. Thesis, Fac. Agric., Cairo Univ., Cairo, Egypt. pp 242 (1984) .

A.O.A.C., (1984): Association of Official Agricultural Chemists, official and tentative, Methods of Analysis, Washington. D.C., pp. 43-428.

Baldry, J.; J. Dougan; A. Shaked and A. Bor-Akiva (1982). Chemical analysis and taste panel evaluation of the fruit quality of Valencia late oranges on two rootstocks. Journal of Horticultural Science 57(2):233-237. Dhd, H,S. and G.S. Randhowa (1963).Effect of gibberelic acid, germination and pollentube growth in citrus Indian Horst-Sc(20)186-190.

Gimeno, V. Simon, I. Nieves, M. Martinez, V. Camara-Zapata, J. M. Garcia, A. L. Garcia-Sanchez, F(2012):The physiological and nutritional responses to an excess of boron by Verna lemon trees that were grafted on four contrasting rootstocks. Trees: Structure and Function; 26 (5):1513-1526. 63 ref.

Gregoriou, C. and C.V. Economides (1994). Growth, yield and fruit quality of nuclear Frost Valencia orange on fifteen rootstocks in Cyprus. Acta Horticulture No. 365 : 57 - 68. Hort. Abst. 65.(6) : 5408 1.

Hussain, S.Curk, F. Anjum, M. A. Pailly, O.Tison, G. (2013):Performance evaluation of common Clementine on various citrus rootstocks. Scientific Horticulture; 150:278- 282.19 ref.

Ibrahim, A.M . (2000). Effect of some Citrus rootstocks on Growth of young Ballade mandarin and Valencia orange trees in newly reclaimed soil. M. Sc . Thesis Fac. , Agric . Zagazig Univ., Egypt.

Ibrahim, A.M . (2005): Mutual effects of some Citrus Rootstocks with Valencia Orange and Ballade Mandarin under Ismallia governorates conditions . PHD. Thesis Fac. , Agric . Ain Shams Univ., Egypt .

Iriate -Marte1-J.H.; L.C. Donadio and J.O. Figeiredo (1999). Effect of eleven rootstocks on fruit quality and plant development of Tahiti lime. Reviste Brasileira De Fruticulturea- 2 1 (2), 23 5-23 8(c.f. CAB Abst., 2000). 4. Minessy, F.A.; F.M. kat and A.M. Rokba (1965) . Genetically studies on some citrus hybrids . Res. Bull No l2.pp. 32. Fac, of Agric., Alexandria Univ., Egypt.

Legua, P. Bellver, R. Forner, J. Forner-Giner, M. A.(2011):Plant growth, yield and fruit quality of 'Lane Late' navel orange on four citrus rootstocks. Spanish Journal of Agricultural Research; 9(1):271-279. 27 ref.

Minessy, F.A.; F.M. kat and A.M. Rokba (1965) . Genetically studies on some citrus hybrids . Res. Bull .No 12.pp. 32. Fac, of Agric., Alexandria Univ., Egypt .

Monteverde, E.E., (1989): Evaluation of Valencia orange on ten rootstocks in high altitude valleys in Carabobo-Yaracuy. I. Yields, growth and efficiency. FONAJAP Divulga, 7 (31) 6-9 . [of Hort. Abst. 62 (1) : 703].

Monteverde, E.E.; F.J. Reyes; G. Laborem and J.R. Ruiz (1988). Citrus rootstocks in Venezuela ; behavior of Valencia orange on ten rootstocks. Sixth international citrus congress, Middle-East, Tel Aviv, Israel, 6-1 1 March 1988. Volume 1, Rehovot, Israel; Balaban Publishers 47 - 55, [c.f. Hort. Abst. 60 (9); 7673].

Morse, J.G. and C.A. Robertson (1987). Calculating canopy area of Citrus trees and surface area of fruits. Florida Entomology. 70-168 .J. Amer. Soc. Hort. Sci, 115 (1) : 6-8.

Sharawy A.M.A. (1992). A comparative study for some citrus species and varieties grown in Egypt and Sudan. The effect of environmental Factors on the quality of fruits and yield . M. Sc. thesis in Pomology, Cairo Univ., Egypt.

Snedecor, G.W. and W.G. Cochran (1980). Statistical Method. 7th Ed. Iowa State Univ., Press, Amer. Iowa, U.S.A. pp.

Toplu, C. Uygur, V. Kaplankran, M. Demirkeser, T. H. Yldz, E (2012) :Effect of citrus rootstocks on leaf mineral composition of 'okitsu', 'clausellina', and 'silverhill' mandarin cultivars. Journal of Plant Nutrition. 35(9):1329-1340. 37 ref.

Tuzcu-O; B.Yiklirim; S. Duzenoglu and I. Bahceci (1999). Effects of different rootstocks on yield and fruit quality of Washington Navel and Moro blood oranges. Turkish Journal Agriculture and Forestry. 23: 2, 2.1.3-222, (cf. CABAbst.,1999) /v Valbuena, H. (1996). Evaluation of Volkamer lemon (Citrus volkameriana Pasg.) and Cleopatra mandarin (Citrus-teshai Hort) as rootstocks for Persian lime (Citrus latfolia Tarn.) in the middle region of the Guasare river valley, Sierra de Perija, Zulia state, Venezuela. Revista de la Faculltad de Agronomia Univ. del Zulia 13 (2) 139-151[c.f. Hort. Abst. 67 (7):637].

Valbuena, H. (1996). Evaluation of Volkamer lemon (*Citrus volkameriana* Pasg.) and Cleopatra mandarin (*Citrus-teshai* Hort) as rootstocks for Persian lime (*Citrus latifolia* Tarn.) in the middle region of the Guasare river valley, Sierra de Perija, Zulia state, Venezuela. Revista de la Faculltad de Agronomia,Univ. del Zulia 13 (2) 139-151[c.f. Hort. Abst. 67 (7):637].

دراسات على أصول الموالح مختلفة وتأثيرها على النمو والمحصول وجودة الثمار للبرتقال الفالنشيا

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أجريت هذه الدراسة خلال موسمي 2013/2012 لتقييم أشجار البرتقال الفالنشيا المطعومة على أربعة أصول موالح هي اليوسفي كليوباترا والنارنج والليمون الرانجبور والليمون الفولكامريانا، والمنزرعة في ارض رملية حديثة الاستصلاح بمزرعة بمحطة بحوث البساتين بالقصاصين بمحافظة الإسماعيلية جمهورية مصر العربية، اظهرت النتائج تفوق أصل الليمون الفولكامريانا كأصل للبرتقال الفالنشيا تحت ظروف محافظة الإسماعيلية مقارنة بالأصول الأخرى وعلى العكس من ذلك كان أصل الليمون الرانجبور اقل ملائمة البرتقال الفالنشيا تحت ظروف هذه التجربة.

Table (6): Effect of different citrus rootstocks on tree yield and some physical characteristics of Valencia orange fruits in 2012 and 2013 seasons.

Character Rootstocks	Yield I tree (Kg)		Fruit Weight (gm)		Pulp weight (gm)		Fruit height (cm)		Fruit diameter (cm)		Fruit shape index		Peel thickness (mm)		Juice volume/fruit (ml)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
C.M	17.73A	21.67A	214.3A	213.01A	141.6B	150.5AB	6.61A	6.89A	7.72B	7.61AB	0.85A	0.9A	3.9B	3.81B	107.11B	105.0B
S.O	1925B	24.50B	219.7A	219.86B	127.9A	140.7A	7.62CD	7.86AB	7.43A	7.54A	1.02D	1.04BC	3.7A	3.65A	98.50A	102.5A
R.L	2475C	29.18CD	261.6C	251.03D	164.8D	159.53B	7.54BC	7.93B	7.96C	7.53A	0.95B	1.05CD	4.1C	3.96C	114.63D	115.75D
V.L	26.23D	30.l8D	245.5B	246.71C	149.6C	151.68B	7.83D	8.03B	8.01D	7.86C	0.97BC	1.02DB	4.3D	4.15D	111.08C	111.5C