

## **EVALUATION OF GROWTH AND FRUITING OF VALENCIA ORANGE TREES ON DIFFERENT CITRUS ROOTSTOCKS.**

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### **ABSTRACT**

This investigation was carried out on Valencia orange (*Citrus sinensis* L. Osbeck) trees budded on three citrus rootstocks in a private orchard at El-Bostan, El-Behiera Governorate during two successive seasons of 2005 and 2006. The considered rootstocks were: Volkamer lemon (*Citrus volkameriana*, Tan & Pasq.), Rangpur lime (*Citrus limonia* Osbeck) and Sour orange (*Citrus aurantium* linn.).

The data revealed that Valencia orange grafted on Volkamer lemon produced the highest trees with more canopy diameter, volume, trunk circumference of rootstock and scion than those obtained from trees budded on Rangpur lime or Sour orange. Furthermore, trees grafted on Volkamer lemon gave a longer shoots with more number of leaves per shoot and leaf area than those obtained from Rangpur lime or Sour orange rootstocks.

Valencia orange trees budded on Volkamer lemon gave higher yield and fruit weight than trees budded on Rangpur lime or Sour orange. Whereas, trees budded on Sour orange presented a lower yield with higher SSC and total acidity than those obtained from Valencia orange fruits budded on Rangpur lime or Volkamer lemon. Whereas, Rangpur lime produced fruits with higher Vitamin C in fruit juice than the other rootstocks.

### **INTRODUCTION**

Citrus is the most important fruit crop in Egypt, since, it ranks the first among all other fruits. The area under citrus orchards reached 364798 feddan and the total area of fruitful orchards is 332758 feddan with an annual production about 3030244 tons. Orange trees ranking the top among the cultivated citrus species and varieties. So, it occupied about 60.4 % from the total fruitful area in Egypt, the total area reached 224404 feddan with an annual production about 1940422 tons. While, Valencia orange orchard reached 43066 feddan and the total area of fruitful orchard is 51517 feddan with an annual production about 500974 tons, according to Ministry of Agric. (2005).

Valencia is the most important late-season sweet orange in the world. Since, trees are similar in appearance to most other sweet orange cultivars . Fruit usually matures from February to October in the northern hemisphere and July to September in the southern hemisphere. Valencia fruit is medium size, with excellent fruit quality, (Davis & Albirgo, 1998).

Citrus tree is not grown on its own roots, but grown as budded plants. However, all rootstocks are non suitable for one reason to the other. Since, the suitable rootstock at one time, may fail in the future. So, most of Egyptian citrus cultivars are grafted on Sour orange rootstocks in the past, but now there are new citrus rootstocks such as Volkamer lemon and Rangpur lime. In this respect, Castel, (1987) reported that Volkamer lemon is lemon hybrid which as a rootstock produces large, vigorous trees yielding large quantities of moderate to poor quality fruit like rough lemon, and seeds of Volkamer

lemon are highly nucellar, and germinate well seedlings of more growth vigor with straight trunk.

Also, Davis & Albirgo (1998) considered that Rangpur lime is the most important rootstock in Brazil because of its tolerance to Citrus Tristeza Virus (CTV) and drought. Yet, trees on to Rangpur lime characterized by vigorous and healthy growth productive and yielded fruits of high quality, medium to large size with low to moderate juice quality (Chohan and Kumar, 1983). Thus, sour orange has been probably continues to be the most widely planted rootstock in the world. However, susceptibility of sweet orange on Sour orange to Citrus Tristeza Virus (CTV) has greatly decreased its use for new plantings in Australia, Argentina, Brazil, Spain, South Africa and most of Florida (Gregoriou & Economides, 1993).

So, this study aimed to evaluate the growth, yield and fruit quality of Valencia orange budded on Volkamer lemon, Rangpur lime and Sour orange to find the suitable one under the newly reclaimed soils.

## **MATERIALS AND METHODS**

This investigation was carried out on Valencia orange (*Citrus sinensis* L. Osbeck) trees budded on three citrus rootstocks in a private orchard at El-Bostan, El-Behiera Governorate during two successive seasons of 2005 and 2006. The considered rootstocks were: Volkamer lemon (*Citrus volkameriana*, Tan & Pasq.), Rangpur lime (*Citrus limonia* Osbeck) and Sour orange (*Citrus aurantium* linn.).

During the seasons of study the following determinations were under taken :

### **A- Vegetative growth measurements :**

In the study seasons, the following morphological characteristics were carried out during September from each season :

- 1- Tree height (m).
- 2- Canopy circumference (m).
- 3- Canopy diameter (m).
- 4- Canopy volume ( m<sup>3</sup> ): it was calculated according to the following equation presented from Morse and Robertson (1987) .  
$$\text{Canopy volume} = 0.5236 \times HD^2$$

where : H= Tree height ( m ) and D = canopy diameter (m)
- 5- Trunk circumference ( Cm ): it was measured at 10 cm above and below the bud union and the ratio of scion / stock was calculated to show compatibility % .
- 6- Shoot length ( cm ) .
- 7- Number of leaves per shoot .
- 8- Leaf area (cm<sup>2</sup>): it was calculated according to the following equation presented by Chou (1966):

$$\text{Leaf area (cm}^2\text{)} = 2/3 \times \text{length (cm)} \times \text{width(cm)} .$$

### **B- Yield :**

Harvest time was estimated when SSC/acid ratio ranged about 11:1 %. Since, Yield per tree in kg was estimated as number of fruits per tree X average fruit weight at the harvest time.

Samples of 20 fruits from each replicate were taken randomly and transported immediately to the Laboratory of Pomology Dept., Fac. Agric., Mansoura university to determine physical and chemical characteristics :

- 1- Average fruit weight (g).
- 2- Average peel weight (g).
- 3- Average pulp weight (g).
- 4- Average peel thickness (cm).
- 5- Number of seeds per fruit.
- 6- Juice volume (ml): it was estimated for 100gm pulp .
- 7- Soluble solids content (SSC): it was expressed by using carlzeiss hand refractometer.
- 8- Titratable acidity % : it was determined in fruit juice according to A.O.A.C. (1980).
- 9- Soluble solids/acid ratio.
- 10- Ascorbic acid ( Vitamin C ): it was determined by using 2,6-dichlorophenol indophenol and calculated as mg / 100 ml juice according to A.O.A.C. (1980).

**E- Statistical analysis :**

The obtained data of this study were statistically analyzed according to the technique of analysis of variance (ANOVA) for experiment in completely randomized block design according to Snedecor & Cochran, (1980).

## **RESULTS AND DISCUSSION**

**\* Effect of rootstocks on tree vigour and vegetative growth.**

**1- Tree vigour .**

**A- Tree height (m).**

Data from Table (1) show the effect of Volkamer lemon, Sour orange and Rangpur lime on tree height of Valencia orange. The data revealed that Volkamer lemon gave taller trees than those obtained on Rangpur lime or Sour orange. In this respect, the height of Valencia orange trees which grafted on Volkamer lemon was significantly taller than the other tested rootstocks. The height of Valencia orange trees on Volkamer lemon was about 3.4 m as mean of two seasons. Also, the height of Valencia orange trees on Rangpur lime was taller than budded on Sour orange. The height of Valencia orange trees which budded on Sour orange was the shortest than those budded on Rangpur lime or Volkamer lemon. Since , the average tree height was about 3.0 m and 2.7 m for trees budded on Rangpur lime and Sour orange as a mean of two seasons. Similarly, Salem *et al.* (1994) mentioned that, tree height, canopy volume and leaf area of Valencia orange trees grown under sandy soil condition were greater on *C. volkameriana* than on sour orange. Furthermore, Zekri & Al-Jaleel (2004) reported that Valencia and Navel orange on *C. macrophylla*, Volkamer lemon and rough lemon rootstocks were more vigorous than other rootstocks.

**Table (1): Effect of some rootstocks on Tree height ,Canopy diameter and volume of Valencia orange.**

Rootstocks	Tree height ( m )		Canopy diameter ( m )		Canopy volume ( m3 )	
	2005	2006	2005	2006	2005	2006
<b>Volkamer lemon</b>	3.0 a	3.7a	2.24a	3.50a	7.84a	23.52a
<b>Rangpur lime</b>	2.7 b	3.3b	2.02b	3.22b	5.68b	17.74b
<b>Sour orange</b>	2.4c	3.0c	1.76c	2.91c	3.85c	13.22c
<b>L.S.D at 5 %</b>	0.14	0.15	0.121	0.151	0.788	1.642

**B- Canopy diameter and volume .**

With regard to canopy diameter and volume data from Table (1) show that, Valencia orange on Volkamer lemon gave a higher significantly canopy diameter and volume than those obtained from trees grafted on Rangpur lime or Sour orange. Whereas, Valencia orange on Sour orange gave a lower significant canopy diameter and volume during both seasons under the study. Valencia orange trees on Volkamer lemon increased both tree height and canopy diameter than the other rootstocks used. Yet, trees on Sour orange presented a lower tree height and canopy diameter. Our data go on line with those reported by Monteverde (1989) which found that, crown volume of Valencia orange was greatest on *C. volkameriana* followed by those on Cleopatra mandarin, and the least on Rangpur lime. Whereas, Roose *et al.* (1989) found that trees of Olinda Valencia and Washington navel oranges on Rangpur lime had smaller canopy volume compared to those on Cleopatra mandarin. Furthermore, Fallahi & Rodney (1992) presented that, Fairchild mandarin trees on Volkamer lemon had significantly larger canopies than those on tested rootstocks.

**C- Trunk circumference (Stock and Scion) and Scion / Stock ratio.**

Trunk circumference of rootstock and scion was increased as season advanced. The values in the second season were higher than in the first one. Also, the data from Table (2) show that, the trunk circumference of trees budded on Volkamer lemon was higher than those on Rangpur lime or Sour orange rootstocks. In this respect, Trunk circumference of Volkamer lemon rootstock was significantly higher than Rangpur lime or Sour orange. Thus, Sour orange presented a lower significant values.

Regarding to the effect of rootstocks on trunk circumference of Valencia orange scion, data from Table (2) presented that, the tested rootstocks gave a similar effect to those obtained from trunk circumference of the scion during both seasons under the study. Trees grafted on Volkamer lemon almost significantly higher than those obtained from Rangpur lime and Sour orange.

**Table(2): Effect of some rootstocks on Trunk Circumference of Rootstock, Trunk Circumference of scion and Scion/Stock ratio of Valencia orange.**

Rootstocks	Trunk Circumf. of Rootstock (cm)		Trunk Circumf. of scion ( cm )		Scion / stock ratio	
	2005	2006	2005	2006	2005	2006
<b>Volkamer lemon</b>	36.4a	50.0a	37.0a	53.0a	1.0a	1.1a
<b>Rangpur lime</b>	34.0 b	46.9b	34.2ab	47.1b	1.0a	1.0a
<b>Sour orange</b>	31.6c	43.5c	32.4b	44.4b	1.0a	1.0a
<b>L.S.D at 5 %</b>	1.29	3.06	3.01	5.39	N.S	N.S

Concerning the effect of scion/stock ratio which can be used as index for compatibility, data from Table (2) reveal that, no significant effect was obtained from the ratio between scion : stock during the both seasons of the study. It could be concluded that the ratio of scion / stock was nearly equal in the upper and lower position and round the union zone. This may be due to that Valencia orange scion were more adapted on the tested rootstocks. However, this scion tended to higher compatibility between rootstocks. The obtained results agree with those reported by Abo El-Komans (1998) who found that Rough lemon and sour orange rootstocks were the best combination for Ruby Marsh and Thomson grapefruit cultivars. Whereas, Ibrahim (1999) reported that the compatibility percentage was affected significantly by rootstocks for Valencia orange. The compatibility percentage exhibited on Sour orange rootstock was the higher followed by those on Cleopatra mandarin rootstock. The lowest compatibility percentage of Valencia orange trees was recorded on Volkamer lemon rootstock in the last two seasons. Compatibility percentage of Valencia orange trees on Rangpur lime rootstock came in between. Therefore, the most favorable scion/stock combination were on both Sour orange and Cleopatra mandarin rootstocks.

**2- Vegetative growth.**

Data from Table (3) presented the effect of rootstocks on shoot length, number of leaves and leaf area of Valencia orange trees. From this Table it is clear that shoot length was increased as season advanced. The values in the second season were almost higher than in the first one. Whereas, the effect of rootstocks on shoot length of Valencia orange was not pronounced during the second season of the study. Yet, Volkamer lemon or Rangpur lime produced longer shoots than obtained from trees budded on Sour orange.

Regarding to number of leaves, the data reveal that both Volkamer lemon or Rangpur lime presented a higher number of leaves per shoot of Valencia orange than those obtained from Sour orange. The number of leaves was about 19.2 under Volkamer lemon but was about (17.6) for Sour orange as a mean of two seasons.

**Table (3): Effect of some rootstocks on Leaf number and Leaf area of Valencia orange.**

Rootstocks	Shoot length (cm)		No. of Leaves		Leaf area (cm <sup>2</sup> )	
	2005	2006	2005	2006	2005	2006
Volkamer lemon	29.8a	33.0a	18.8a	19.5a	50.7a	55.2a
Rangpur lime	28.3a	31.9a	18.2ab	18.9a	48.9a	53.0ab
Sour orange	26.1b	30.4a	17.0b	18.1a	45.9b	50.8b
L.S.D at 5 %	1.98	N.S	1.22	N.S	1.93	3.71

With regard to the effect on leaf area data from Table (3) show that, leaf area of Valencia orange trees was significantly affected with the tested rootstocks. In this respect, leaf area of Valencia orange budded on Volkamer lemon or Rangpur lime was significantly higher than those obtained from Sour orange. Our data go in line with those found by Abd El-Rahman (1994) which found that the number of spring shoots of Navel orange was much higher than that obtained from summer and autumn growth flushes on C.

*volkameriana* as compared with those on Sour orange, Cleopatra mandarin and other rootstocks. He also, reported that leaf area of Navel orange trees of spring, summer and autumn growth cycles were the highest on *C. volkameriana* rootstock. Whereas, the lowest leaf area was on both Cleopatra mandarin and Troyer citrange stocks. Furthermore, Ibrahim (1999) found that, Valencia orange trees gave a higher leaf number per shoot on Volkamer lemon rootstock followed by Rangpur lime. The same author mentioned that leaf area of Valencia orange trees was significantly higher on Volkamer lemon rootstock in the first season and Cleopatra mandarin rootstock in the second and third one. The least leaf area was recorded for those on Sour orange rootstock.

**\* Effect of rootstocks on yield and fruit quality :**

**1- Number of fruits per tree :**

Table (4) presented that the effect of Volkamer lemon, Rangpur lime and Sour orange rootstocks on number of fruits per tree. In this respect, differences in number of fruits of Valencia orange per tree was unpronounced during both seasons. Yet, Valencia orange budded on Volkamer lemon gave a somewhat increment in number of fruits per tree than those obtained from trees on Rangpur lime or Sour orange, but the differences in number of fruits under these rootstocks were unpronounced. Similarly, Zekri (2000) found that trees on Volkamer lemon produced the most number of fruit per tree and the highest yield in terms of boxes per hectare.

**2- Fruit weight :**

Data from Table (4) reveal that, the average fruit weight of Valencia orange was affected by Volkamer lemon, Rangpur lime and Sour orange rootstocks. In this respect, Valencia orange which budded on Volkamer lemon produced a higher fruit weight than those obtained from trees budded on Rangpur lime or Sour orange. Whereas, average fruit weight of Valencia orange which presented for Rangpur lime or Sour orange were unpronounced. Yet, trees budded on Rangpur lime gave a higher fruit weight than those obtained from trees budded on sour orange rootstock which presented a lower fruit weight. Likewise, Georgiou (2002) showed that Volkamer lemon induced the largest fruit diameter, whereas the other rootstocks gave fruit size similar to that of sour orange. Also, Zekri and Al-Jaleel (2004) mentioned that the largest fruit sizes were obtained from Valencia and Navel orange trees on *Citrus macrophylla* mandarin, Volkamer lemon, and Rough lemon, whereas, the smallest fruits were found on trees budded on Cleopatra mandarin and sour orange. Furthermore, Muhtaseb *et al.* (2006) indicated that Salustiana trees grafted on *C. macrophylla* gave the highest fruit weight (213.5 gm) but no significant difference with *C. volkameriana* and Sour orange rootstocks.

**3- Yield per tree :**

It is clear from Table (4) that Valencia orange budded on Volkamer lemon rootstock presented a higher significant yield per tree than the other rootstocks used, this may be due to the effect of these rootstocks on producing a higher number of fruits per tree and a higher fruit weight than the other rootstocks used. Whereas, yield per tree of Valencia orange grafted on Rangpur lime or Sour orange rootstocks were lower than those obtained from

Volkamer lemon. This may be due to that the number of fruits and fruit weight under these rootstocks were almost lower than which budded on Volkamer lemon. Yet, the differences in yield of Valencia orange trees which budded on Rangpur lime or Sour orange were significant. Thus, the obtained yield from trees budded on Sour orange was almost lower than those obtained for Rangpur lime or Volkamer lemon. Since, this rootstock presented lower number of fruits per tree and lower fruit weight. Similar result was reported by Saleh & El-Shamaa (1997) which found that Valencia orange trees on Volkamer lemon produced the highest yield followed by sour orange. These result are partially in agreement with Monteverde (1989) and Saleh & El-Shamaa (1995) who stated that the yield was highest in trees on Volkamer lemon rootstock. Also, Al-Jaleel & Zekri, (2003) found that Parent Washington navel on Volkamer lemon (VL), *Citrus macrophylla* (CM) and rough lemon (RL) were the most productive. Furthermore, Georgiou (2004) mentioned that Valencia orange trees on rough lemon, Volkamer lemon and Estes rough lemon had the highest cumulative yield which were not significantly different from those of trees on Rangpur lime, Red rough lemon, Palestine sweet lime and Cleopatra mandarin. Also, Zekri and Al-Jaleel (2004) found that Valencia and Navel orange trees on Volkamer lemon, *C. macrophylla* and rough lemon were most productive. While, trees on sour orange, Carrizo citrange, *C. taiwanica* and Amblycarpa were intermediate in fruit production. Furthermore, Al-Jaleel, *et. al.* (2005) found that lemon trees on *C. macrophylla* and Volkamer lemon were most productive. Whereas, trees on sour orange were the least productive.

**Table (4): Effect of some rootstocks on number of Fruit / tree, Fruit weight and tree yield of Valencia orange.**

Rootstocks	No. of Fruits / tree		Fruit weight ( g )		Tree yield ( kg )	
	2005	2006	2005	2006	2005	2006
Volkamer lemon	270.0a	353.3a	212.7a	233.7a	57.4a	82.6a
Rangpur lime	265.5a	350.8a	195.3b	198.4b	51.8b	70.1b
Sour orange	257.0a	340.5a	187.0c	187.8b	48.0b	65.6b
L.S.D at 5 %	N.S	N.S	6.81	16.71	5.28	5.25

**4- Pulp and Peel weight :**

Data from Table (5) reveal that, Valencia orange fruits budded on Volkamer lemon gave a higher significant pulp and peel weight than those obtained from Valencia orange fruits budded on Rangpur lime or Sour orange. Yet, the effect of Rangpur lime or Sour orange rootstocks on pulp weight of Valencia orange fruits was unpronounced. Since, no significant effect of pulp weight was obtained from trees budded on Rangpur lime or Sour orange rootstocks. On the other hand, the data reveal that, Valencia orange obtained from trees budded on Rangpur lime had a higher peel weight than those obtained from Sour orange rootstock. So, the weight of fruit peel which presented from trees budded on Sour orange was almost lower than other rootstocks.

**Table (5) : Effect of some rootstocks on Pulp, Peel weight and Peel thickness of Valencia orange.**

Rootstocks	Pulp weight ( g )		Peel weight (g)		Peel thickness (cm)	
	2005	2006	2005	2006	2005	2006
<b>Volkamer lemon</b>	164.1a	176.7a	48.6a	57.0a	0.45a	0.50a
<b>Rangpur lime</b>	150.7b	148.8b	44.7b	49.6b	0.42a	0.48a
<b>Sour orange</b>	145.5b	151.3b	41.5b	36.5c	0.42a	0.40b
<b>L.S.D at 5 %</b>	5.64	13.57	3.57	4.14	N.S	0.04

#### 5- Peel thickness :

Concerning the effect of rootstocks on peel thickness of Valencia orange fruits, data from Table (5) presented the effect of various rootstocks on peel thickness were unpronounced in the first season. Whereas, peel thickness of fruits from trees budded on Volkamer lemon or Rangpur lime were significantly higher than those obtained from trees budded on Sour orange especially on the second season. Generally, the data show that Volkamer lemon gave thicker fruit peel than those obtained from fruits budded on Rangpur lime or Sour orange which gave a thinner one. Our result in harmony with those reported by Saleh & El-Shamaa (1997) which found that peel thickness was relatively small where it increased significantly in Valencia orange fruits on Volkamer lemon rootstock and tended decreased with relatively equal values in fruit on sour orange and Troyer citrange. Also, Muhtaseb & Ghnaim (2006) indicated that rind thickness of Shamouti on macrophylla and sour orange was significantly thicker, followed by Shamouti on Volkamer lemon, which could be related to the production of larger fruits. Similar results were presented by Fallahi *et al.* (1989).

#### 6- Number of seeds / fruit :

Data from Table (6) show that, the number of seeds/fruit of Valencia orange was affected significantly with rootstocks. In this respect, Valencia orange grafted on Sour orange presented a higher significantly number of seed/fruit than the other rootstocks. Since, these trees gave about 5.5 seeds/fruit as a mean of two seasons. On the other hand, Valencia orange budded on Rangpur lime gave a lower number of seeds/fruit. So, it produced about 3.4 seeds/fruit as a mean of two seasons. Thus, Valencia orange trees on Volkamer lemon gave a somewhat increment of number of seed/fruit than those obtained from Rangpur lime but, almost lower than obtained from fruits of trees budded on Sour orange. Similar results was obtained by Muhtaseb *et al.* (2006) which showed that Hamlin grafted on *C. macrophylla* gave the lowest seed number (2.2 seeds), while trees grafted on Cleopatra mandarin, Sour orange and *C. volkameriana*, gave high fruit seed number. On the other hand, Muhtaseb & Ghnaim (2006) indicated that no significant differences were observed among rootstocks in respect to seed number per fruit, Shamouti trees on sour orange gave a higher number of seeds, while those on both Volkamer lemon and Cleopatra mandarin gave the least values.

#### 7- Juice volume :

It is clear from Table (6) that Valencia orange grafted on both Volkamer lemon or Rangpur lime produced fruits with higher significant values of juice volume than those obtained from fruit trees budded on Sour orange. Since, Valencia orange fruits which obtained from trees budded on



Sour orange gave a lower significant values on pulp juice volume than those obtained on the other trees which budded on Volkamer lemon and Rangpur lime during the both seasons. Our result in harmony with those noticed by Georgiou (2004) which found that Valencia orange trees grafted on Troyer, Carrizo and Yuma citrange, Nasnaran and Cleopatra mandarin produced fruit with similar juice content to that of sour orange. However, Swingle Citrumelo and Morton citrange significantly increased fruit juice content, whereas Volkamer lemon, Palestine sweet lime, Rangpur lime and rough lemon type rootstocks, significantly decreased. Furthermore, Muhtaseb & Ghnaim (2006) indicated that Shamouti fruits from trees on Cleopatra mandarin had higher juice percentage followed by Shamouti on Volkamer lemon, while trees on sour orange gave the least juice percentage.

**Table (6): Effect of some rootstocks on number of seed per fruit, Juice volume and Vitamin C content of Valencia orange.**

Rootstocks	No. of seed per fruit		Juice volume (cm <sup>3</sup> / 100g pulp )		Vitamin C content (mg / 100 gm juice)	
	2005	2006	2005	2006	2005	2006
Volkamer lemon	4.8a	3.7b	61.8a	63.7a	55.0c	58.5b
Rangpur lime	3.0b	3.7b	59.6a	61.3a	68.7a	67.5a
Sour orange	5.1a	5.9a	55.9b	56.3b	61.5b	61.0b
L.S.D at 5 %	0.89	0.83	3.35	4.49	2.35	4.40

#### 8- Vitamin C content :

Data from Table (6) presented that, fruits obtained from Valencia orange which budded on Rangpur lime gave a higher significant values of vitamin C than obtained from the other rootstocks. Since, the average content of vitamin C in the fruit juice ranged about (68.1 mg/100gm) juice as a mean of two seasons under the study. Whereas, fruits obtained from trees budded on Volkamer lemon gave a lower content of vitamin C in fruit juice than those obtained on Sour orange rootstock. Since, trees on Sour orange produced fruits with higher vitamin C content than those obtained under Volkamer lemon. Our findings were in harmony with those reported by Saleh & El-Shamaa (1997) reveal that Vitamin C content was significantly lower in Valencia orange fruits on Volkamer lemon rootstock. Whereas, fruits on troyer citrange gave the highest values followed by sour orange. Also, Tayeh, Enshrah *et al.* (2003) found that Washington Navel orange trees had the highest vitamin C content when budded on sour orange followed by rough lemon and baladi lime.

#### 9- Soluble solid content ( SSC ) .

From Table (7) it is clear that, Valencia orange trees budded on Sour orange produced fruits with higher significant SSC than those obtained from trees budded on Rangpur lime or Volkamer lemon. Since, the content of SSC produced from fruits budded on Volkamer lemon or Rangpur lime was unpronounced during the both seasons under the study. Yet, it was almost lower than those obtained from trees budded on Sour orange. Similarly, Forner-Giner *et al.* (2003) presented that the soluble solids content were higher on the 02034 rootstock and lower on Volkamer lemon rootstock. Also, Muhtaseb & Ghnaim (2006) indicated that Shamouti fruits on sour orange

rootstock gave a highest SSC while the least SSC percentage was found in Shamouti on macrophylla, which could be due to the production of larger fruit. Moreover, Muhtaseb *et al.* (2006) showed that sweet orange cultivars grafted on Sour orange gave the highest total soluble solids percentage followed by those grafted on Cleopatra mandarin. For Salustiana trees grafted on *C. volkameriana* gave the lowest fruit SSC (10.8 %).

**Table (7): Effect of some rootstocks on SSC, Acidity and SSC / acid ratio of Valencia orange.**

Rootstocks	S.S.C %		Acidity %		S.S.C / Acid %	
	2005	2006	2005	2006	2005	2006
<b>Volkamer lemon</b>	9.7c	10.4b	0.915c	0.914b	10.6a	11.4a
<b>Rangpur lime</b>	10.2b	10.0c	1.032b	1.004b	9.9b	10.2b
<b>Sour orange</b>	12.5a	12.5a	1.387a	1.334a	9.0c	9.4c
<b>L.S.D at 5 %</b>	0.40	0.31	0.065	0.12	0.58	0.67

**10- Total acidity .**

Data from Table (7) show that, fruits obtained from trees budded on Sour orange gave a higher total acidity than those obtained from trees budded on Rangpur lime or Volkamer lemon. Since, Valencia orange trees budded on Volkamer lemon produced fruits with lower total acidity than produced from both rootstocks during two seasons under the study. These findings were in line to those reported by Georgiou (2002) which found that fruit from Clementine mandarin trees on Troyer citrange and Volkamer lemon had the highest and lowest acid content, respectively. Also, Georgiou (2004) mentioned that Troyer citrange gave the highest acid content, followed by sour orange. Also, Muhtaseb & Ghnaim (2006) presented that Shamouti fruits on macrophylla gave the highest juice PH. Meanwhile, Shamouti on Volkamer lemon gave the least juice PH, while both sour orange and Cleopatra mandarin gave intermediate juice PH.

**11- SSC / Acid ratio .**

It is obvious from Table (7) that SSC/acid ratio was greatly affected by rootstocks. In this respect, fruits produced from trees budded on Volkamer lemon gave a higher significant values of SSC/acid ratio in pulp juice fruit than those obtained from fruits from trees budded on Rangpur lime or Sour orange. Since, fruits obtained from trees budded on Sour orange gave a lower significant values of SSC/acid ratio in pulp juice fruits. Thus, fruits produced from Valencia orange trees budded on Rangpur lime gave a higher SSC/acid ratio than those obtained from Sour orange rootstock. The increment in SSC/acid ratio in fruit juice of Valencia orange budded on Volkamer lemon may be due to the reduction in total acidity than the other fruits obtained from trees budded on Rangpur lime or Sour orange. Whereas, the reduction in SSC/acid ratio in pulp juice fruits from trees budded on Sour orange may be due to their effect for increasing the content of total acidity under Sour orange rootstock than the other rootstocks used. Similarly, Salem *et al.* (1994) found that SSC/acid ratio was not significantly affected by Volkamer rootstock. Also, Saleh & El-Shamaa (1997) reveal that SSC/acid ratio tended to increase with sour orange rootstock followed by Troyer citrange and Volkamer lemon. Furthermore, Georgiou (2004) found that

Valencia orange trees grafted on most of the rootstocks gave fruits with significantly higher SSC/acid ratio than that on sour orange.

From this study it is clear that grafting Valencia orange on Volkamer lemon gave higher growth vigour and increased yield /tree since it presented a higher fruit weight and increasing the values of fruit juice than Rangpur lime or Sour orange rootstocks.

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### تقييم نمو وإثمار أشجار البرتقال الصيفي على أصول مختلفة من الموالح .

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أجريت هذه الدراسة على أشجار برتقال صيفي عمرها ٦ سنوات مطعومة على أصول (الفولكاماريانا وليمون الرانجبور والنارنج) وذلك في مزرعة خاصة بمنطقة البستان التابعة لمحافظة البحيرة خلال موسمي ٢٠٠٥ ، ٢٠٠٦ . ولقد أوضحت النتائج أن أشجار البرتقال الصيفي المطعومة على الفولكاماريانا أعطت زيادة في طول الأشجار وكذا قطر وحجم النمو الخضري و محيط الجذع عند منطقة الطعم والأصل وذلك بالمقارنة بالأشجار المطعومة على أصلي الرانجبور أو النارنج . علاوة على زيادة نمو الأفرع وكذا عدد الأوراق والمساحة الورقية بالمقارنة بتلك الأشجار المطعومة على أصلي الرانجبور والنارنج .

علاوة على ما سبق فإن أشجار البرتقال الصيفي المطعومة على أصل الفولكاماريانا أعطت زيادة واضحة ومؤكدته في المحصول وكذا وزن الثمار بالمقارنة بالأشجار المطعومة على أصلي الرانجبور والنارنج . بينما أعطت أشجار البرتقال الصيفي المطعومة على أصل النارنج محصولاً أقل وانخفاض في متوسط وزن الثمار مع زيادة نسبة المواد الصلبة الذاتية والحموضة بالمقارنة بالأشجار المطعومة على أصلي الرانجبور والفولكاماريانا . في حين أعطت الأشجار المطعومة على أصل الرانجبور ثماراً ذات محتوى عال من فيتامين C بالمقارنة بتلك المطعومة على كلا من النارنج والفولكاماريانا .