

EFFECT OF ROOTSTOCK AND INTERSTOCK ON GROWTH, YIELD AND FRUITY QUALITY OF SOME ORANGE VARIETIES B. FRUIT QUALITY

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ABSTRACT: *This experiment was designed as long term study, started in 2008 till 2014 with the idea of using sour orange as interstock on volkamer lemon rootstock (SO/VL) for budding four orange varieties, namely, Olinda valencia ,Spring navel, Parent navel, and Fukumoto navel oranges. The purpose was to avoid some disadvantages of volkamer lemon on physical and chemical fruit quality with the hope of maintaining tree growth and its productivity with good properties acceptable for local and foreign market. The obtained results showed that, Fruit of Olinda valencia, Spring navel, Parent navel and Fukumoto navel oranges budded on the interstock were similar to those produced on sour orange in their physical fruit characters in terms of length, diameter, shape, volume, juice volume, rind thickness and segments number. Moreover, chemical fruit properties of orange scions on the interstock were also similar to those on sour orange rootstock in its higher TSS, lower acidity and higher TSS/acid ratio than those on volkamer lemon rootstock. Therefore, it is recommended to use sour orange as interstock when volkamer lemon is the given rootstock in orchard soil . Using sour orange as interstock on volkamer lemon proved to be useful in improving most fruit quality properties of the four orange varieties budded on it in this study.*

Key words: *Rootstock, Interstock, Budwood, Volkamer lemon, Sour orange Fukumoto navel, Parent navel, Olinda valencia, Spring navel, Fruit quality.*

INTRODUCTION

Citrus rootstocks play an important role in growth and productivity of citrus in different area in the world. The effect of fruit quality has been studied on many citrus producing areas. Volkamer lemon as a rootstock have excellent effect on scions in terms of tree growth and yield, because it gave high yield and for its resistance of some Virus diseases, but it is considered poor in its fruit properties, so it was necessary to find a way to avoid these disadvantages.

In this respect, Fallahi *et al* 1989 and Dawood 2002 conducted that, yield of grapefruit and Washington navel orange were higher from trees on volkamer lemon and rangpur lime than those on swingle citrumelo, cleopatra mandarin and sour orange. Also, Gregoriou 2002 reported that Volkamer lemon has been reported to significantly increase yield of clementine mandarin compared with sour orange. In this

respect, Al-Jaleel and Zekri 2003 revealed that, parent Washington navel on volkamer lemon, macrophylla and Rough lemon were the most productive as compared with trees on sour orange and cleopatra mandarin. This result was also concluded by Zayan *et al* 2004 who reported that yield as number of fruits/tree and weight (kg/tree) of Washington navel orange was higher on volkamer lemon and rangpur lime than those on troyer citrange, sour orange and cleopatra mandarin. Also, scions on volkamer lemon produced larger and heavier fruits with thicker peel thickness, but juice quality like TSS, acid and TSS/acid ratio are undesired than that on sour orange. In this respect, Former-Giner *et al* 2003 showed that, fruits from Navelina orange trees on volkamer lemon showed the largest, heaviest and thickest rind as compared with cleopatra mandarin and other rootstocks. Also, Al-Jaleel and Zekri 2003 revealed that,

Parent Washington navel trees on volkamer lemon, macrophylla and rangpur lime gave the highest values of fruit size and peel thickness, whereas trees on sour orange gave the highest values of total soluble solids. Similar results were obtained by Perez-Zamora 2004 who states that volkamer lemon and macrophylla presented the lowest quality of SSC and SSC /acidity. Moreover, Zayan *et al* 2004 concluded that, volkamer lemon and rangpur lime as rootstock for Washington navel orange produced higher yield with good physical fruit characters in terms of length, diameter, volume and weight, whereas produced fruit with lower SSC. Therefore, it was obvious that volkamer lemon rootstock resulted in vigorous, very productive trees; however internal fruit quality of scions varieties especially Washington navel orange could be very poor.

The purpose of this long term study is to avoid or get rid of disadvantages of volkamer lemon on physical and chemical fruit properties, hoping to maintain tree growth and its productivity.

MATERIALS AND METHODS

This experiment is designed as long term study, started in 2008 with the idea of using double budding for volkamer lemon (VL) rootstock by using sour orange (SO) as interstock (SO/VL) for budding four orange varieties. In 2008 budwood for sour orange (SO) (*Citrus aurantium*) were budded on one year volkamer lemon (VL) (*Citrus Volkameriana*) seedlings as interstock .Six months later, (VL), (SO) and (SO/VL) rootstocks were prepared at the same age and budded in 2009 with four orange varieties, namely Olinda valencia, spring

navel, parent navel, and Fukumoto navel orange varieties. The experiments included twelve treatments were arranged in a randomized complete block design, each treatment replicated 3 times and 3 plots for a total 9 tree per rootstock.

Thus, 108 trees (12x9) were planted in 2010 in a private orchard at El- Bustan region , El- Beheira Governorate, Egypt planted at 5x5 meter apart. The soil is sandy and the mechanical and chemical analysis were done as shown in Table (1). All agricultural practices were done as usual in the orchard.

In 2013 and 2014 seasons ,samples and field data were recorded on the trees of the following treatments:

- 1- Olinda valencia orange on sour orange (SO).
- 2- Olinda valencia orange on volkamer lemon (VL).
- 3- Olinda valencia orange on interstock (SO/VL).
- 4- Spring navel orange on sour orange (SO).
- 5- Spring navel orange on volkamer lemon (VL).
- 6- Spring navel orange on interstock (SO/VL).
- 7- Parent navel orange on sour orange (SO).
- 8- Parent navel orange on volkamer lemon (VL).
- 9- Parent navel orange on interstock (SO/VL).
- 10- Fukumoto navel orange on sour orange (SO).
- 11- Fukumoto navel orange on volkamer lemon (VL).
- 12- Fukumoto navel orange on interstock (SO/VL).

Table (1). Mechanical and chemical analysis of experimental soil.

Mechanical			Chemical		Cations (meq/l)				Anions (meq/l)		
Sand %	Silt %	Clay %	pH	Ec dS/m ⁻¹	Na ⁺	Ca ⁺⁺	Mg ⁺⁺	CO ₃ ⁻	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻⁻
77.85	6.50	15.65	8.82	0.64	2.53	1.45	0.60	-	2.23	2.10	0.25

Effect of rootstock and interstock on growth, yield and fruit quality

Fruit quality in 2013 and 2014 seasons was recorded as follows :

To determine fruit quality, 10 fruits were taken at random from each tree at harvest time of both seasons, then fruit length and diameter (cm), were measured and fruit shape was calculated, fruit weight (gm), fruit volume (cm³), rind thickness (mm), segment number/fruit, juice % / fruit were determined. Also, total soluble solids was determined by hand refractometer, total acidity as citric acid was determined according to (A.O.A.C., 1990), then TSS/acid ratio was estimated. Ascorbic acid as mg/100 ml juice was determined by using 2, 6 dichlorophenol indophenol according to Jacobs (1951).

Statistical analysis:

Statistical analysis was done as analysis of variance according to Snedecor and Cochran (1990), and the least significant differences (L.S.D. at 5% level) was used to compare the mean values.

RESULTS AND DISCUSSION

1. Fruit quality:

1.1. Physical fruit quality:

Data in Table (2) show the effect of rootstock type, scions and their combined on fruit length, fruit diameter and fruit shape in both seasons. The results in Table (2) reveal that, scions on three stocks had similar fruit length and fruit diameter without significant differences among them, except fruit length parameter on sour orange and fruit diameter seemed to be variable on interstock in the first season only. Also, fruit shape values was similar among three stocks and the differences were found on trees budded on volkamer lemon rootstock in both seasons. Generally, the three stocks gave similar fruit length, diameter and shape without significant differences among them in most cases.

Table (2). Effect of rootstock and interstock on fruit length, fruit diameter and fruit shape of some orange varieties in 2013 and 2014 seasons.

Treatments		Rootstocks and interstock											
R	V	Fruit length (cm)				Fruit diameter (cm)				Fruit shape			
		VL	SO	SO/VL	Mean	VL	SO	SO/VL	mean	VL	SO	SO/VL	Mean
2013													
Olinda valencia		7.26	7.37	8.05	7.56	7.46	7.22	7.59	7.43	0.97	1.02	1.06	1.01
Spring navel		8.04	7.81	7.76	7.82	8.01	8.01	7.87	7.96	1.00	0.98	0.99	0.99
Parent navel		8.75	5.90	7.93	7.53	8.56	8.15	7.45	8.05	1.02	0.73	1.06	0.94
Fukumoto navel		7.15	7.83	7.91	7.63	7.53	8.11	7.56	7.73	0.95	0.97	1.05	0.99
Mean		7.80	7.23	7.91		7.89	7.87	7.62		0.99	0.93	1.04	
L.S.D. at 5%		V = 0.21 R = 0.16 VxR = 0.32				V = 0.20 R = 0.17 VxR = 0.34				V = 0.04 R = 0.03 VxR = 0.10			
2014													
Olinda valencia		7.20	7.37	7.98	7.52	7.33	7.18	7.67	7.39	0.98	1.03	1.04	1.02
Spring navel		8.15	7.97	8.07	8.06	7.98	7.90	7.87	7.92	1.02	1.01	1.03	1.02
Parent navel		9.35	9.30	7.97	8.87	8.65	8.37	7.45	8.16	1.08	1.11	1.07	1.09
Fukumoto navel		7.67	8.72	7.99	8.13	7.51	7.90	7.53	7.65	1.02	1.10	1.06	1.06
Mean		8.09	8.34	8.00		7.87	7.84	7.63		1.03	1.06	1.05	
L.S.D. at 5%		V = 0.67 R = 0.52 VxR = 1.04				V = 0.51 R = 0.43 VxR = 0.69				V = 0.05 R = 0.05 VxR = 0.09			

SO = Sour orange, VL = Volkamer lemon, V = Variety, R = Rootstock, SO/VL = Interstock

Parent navel orange gave the highest values of fruit length, fruit diameter and fruit shape followed by Spring navel orange as compared with the other orange varieties in both seasons.

The effect of combined treatments between rootstock type and scions, showed that Parent navel orange budded on volkamer lemon rootstock was superior in fruit length, and diameter compared to other combination in both seasons.

This results came in contrary with results obtained by Former-Giner *et al* 2003 who reported that, volkamer lemon produced the larger fruits of Navelina orange than that recorded on sour orange and other tested rootstocks. In this respect, Al-Jaleel *et al* 2005 revealed that, the largest fruit size were obtained from Eureka lemon trees on volkamer lemon and macrophylla, whereas

the smallest fruits were found on trees on Amblycarpa and Cleopatra mandarin.

Data in Table (3) cleared that fruit weight and fruit volume were greater from fruits on volkamer lemon and sour orange rootstocks than those recorded on the interstock in both seasons. As for rind thickness, it is clear that, rind thickness was thicker in fruits from trees on volkamer lemon rootstock, whereas it was thinner in fruits from trees on sour orange and interstock in both seasons, respectively. The obtained results are in agreement with those found by Economides and Gregoriou 1993 and Gregoriou 2000 .In this respect AL-Jaleel and Zekri 2003 on Washington navel orange trees budded on volkamer lemon gave fruit with thicker peel.

Parent and Spring navel oranges gave the highest values of fruit weight, fruit volume and thicker fruit as compared with the other orange varieties in both seasons.

Table (3). Effect of rootstock and interstock on fruit weight, fruit volume and rind thickness of some orange varieties in 2013 and 2014 seasons.

Treatments		Rootstocks and interstock											
R \ V	Fruit weight (g)				Fruit volume (cm ³)				Rind thickness (cm)				
	VL	SO	SO/VL	Mean	VL	SO	SO/VL	mean	VL	SO	SO/VL	Mean	
2013													
Olinda valencia	203.36	190.36	214.19	202.64	194.87	165.12	195.19	185.06	0.49	0.38	0.39	0.42	
Spring navel	238.10	242.60	244.62	241.77	218.72	246.67	221.44	228.94	0.52	0.48	0.46	0.49	
Parent navel	331.27	290.95	222.04	281.42	326.25	370.00	223.50	306.58	0.52	0.50	0.47	0.50	
Fukumoto navel	223.70	261.93	239.58	241.74	208.00	258.67	212.00	226.22	0.50	0.49	0.43	0.47	
Mean	249.11	246.46	230.11		236.96	260.12	213.03		0.51	0.46	0.44		
L.S.D. at 5%	V= 16.87 R= 12.21 VxR= 24.42				V= 22.31 R= 13.34 VxR= 26.07				V= 0.03 R= 0.03 VxR= 0.06				
2014													
Olinda valencia	222.78	198.22	228.33	216.44	185.33	156.11	177.04	172.79	0.49	0.38	0.36	0.41	
Spring navel	260.77	260.22	244.66	255.22	257.33	220.00	225.00	234.11	0.56	0.38	0.46	0.47	
Parent navel	347.57	347.42	227.79	307.57	276.50	270.00	223.50	256.67	0.50	0.51	0.43	0.48	
Fukumoto navel	211.98	275.52	239.58	242.36	209.67	217.00	212.00	212.89	0.53	0.50	0.43	0.49	
Mean	279.83	270.35	235.09		232.18	215.78	209.39		0.52	0.44	0.42		
L.S.D. at 5%	V=40.34 R= 23.11 VxR= 80.06				V= 21.59 R= 17.58 VxR= 35.16				V= 0.07 R= 0.04 VxR= 0.08				

SO = Sour orange, VL = Volkamer lemon, V = Variety, R= Rootstock, SO/VL = Interstock

Effect of rootstock and interstock on growth, yield and fruit quality

The effect of interaction between rootstock type and scions, data in Table (3) showed that, Parent navel orange budded on volkamer lemon and sour orange rootstocks had the highest values of fruit weight and fruit volume compared to other treatments in both seasons. These results are in agreement with those obtained by Zayan *et al* 2004.

The results about fruit volume and weight which were greater from fruits on volkamer lemon rootstock than those recorded on sour orange rootstock are in line with those obtained by Dawood 2001 and 2002 who reported that, heavier fruit weight was obtained from valencia and Washington navel orange trees budded on volkamer lemon rootstock as compared with trees on sour orange rootstock.

Data presented in Table (4) revealed that, segments number per fruit was affected by rootstocks in both seasons. Trees

budded on volkamer lemon gave fruits with more number of segments followed by those on sour orange and interstock in both seasons. The differences were significant between interstock and the two other rootstocks in both seasons. Concerning juice % / fruit, it was more in fruits from trees budded on volkamer lemon rootstock when compared with sour orange and interstock without significant differences among rootstock types in both seasons. As regard vitamin C, it is clear that, vitamin C was higher in juice fruit from trees budded on volkamer lemon and sour orange rootstocks than those recorded on interstock in the first season, but in the second one, vitamin C was higher in fruit juice from trees budded on volkamer lemon and interstock than those recorded on sour orange (Table 4). Similar results were obtained by Mohamed (2011) and Hikal (2014).

Table (4). Effect of rootstock and interstock on segments, juice and vitamin C of some orange varieties in 2013 and 2014 seasons.

Treatments		Rootstocks and interstock											
V	R	Segments number/fruit				Juice % /fruit				Vitamin C mg/100 ml juice			
		VL	SO	SO/VL	mean	VL	SO	SO/VL	mean	VL	SO	SO/VL	Mean
2013													
Olinda valencia		11.67	10.89	13.45	12.00	48.67	44.02	23.53	38.74	50.65	31.73	30.90	37.76
Spring navel		13.22	12.89	11.00	12.37	31.68	25.27	32.56	29.84	44.04	29.36	23.23	32.21
Parent navel		15.25	14.50	11.44	13.73	19.67	16.57	31.06	22.43	39.62	23.72	40.37	34.57
Fukumoto navel		12.89	12.50	11.78	12.39	32.90	25.88	33.05	30.61	32.18	33.27	26.15	30.53
Mean		13.26	12.70	11.92		33.23	27.94	30.05		29.52	29.52	21.16	
L.S.D. at 5%		V = ns R= 1.24 VxR= 2.48				V = 3.91 R= 2.68 VxR= 5.37				V = 3.06 R= 2.03 VxR= 7.98			
2014													
Olinda valencia		12.00	10.89	13.44	12.10	43.16	38.74	27.99	36.63	45.90	21.35	28.46	31.90
Spring navel		13.22	13.61	11.00	12.60	28.38	29.86	29.07	29.10	40.83	24.88	21.02	28.91
Parent navel		15.25	14.50	8.24	12.60	23.05	22.66	31.35	25.69	34.49	21.94	37.96	31.46
Fukumoto navel		12.44	12.50	11.78	11.24	33.43	30.58	33.17	32.39	28.54	27.50	25.00	27.01
Mean		13.22	12.88	11.12		32.00	30.46	30.40		37.44	23.92	28.11	
L.S.D. at 5%		V = ns R= 1.56 VxR= 3.12				V = 7.19 R= 3.68 VxR= 7.36				V = 3.66 R= 2.88 VxR= 5.76			

SO = Sour orange, VL = Volkamer lemon, V = Variety, R= Rootstock, SO/VL = Interstock

Segments number per fruit of Olinda valencia, Spring navel, Parent navel and Fukumoto navel oranges did not show any significant differences among them in both seasons. Juice volume/fruit was higher in Fukumoto navel orange fruit than that on the other varieties, without significant differences in most cases. Moreover, vitamin C was higher in Olinda valencia orange and Parent navel orange than other varieties. The obtained results agree with those found by Fallahi *et al* 1991 and Al-Jaleel and Zekri 2003.

Generally, Tables 2,3, 4 showed that, orange varieties budded on interstock were equal to those budded on sour orange for good physical fruit characters in terms of length, diameter, shape, volume, juice %, rind thickness and segments number. However, all these parameters seemed to be better than those found on volkamer lemon rootstock. Similar results were reported by Davies and Albrigo 1994, Dawood 2002, Al-Jaleel and Zekri 2003 and Zayan *et al* 2004.

1.2. Chemical fruit quality:

Data in Table (5) showed that, fruit juice from trees budded on interstock and sour orange rootstock gave higher values of TSS than that recorded on volkamer lemon rootstock in both seasons. The differences were significant in both seasons. On the other hand, data showed that fruits juice from trees on volkamer lemon rootstock recorded higher values of total acidity than that on interstock and sour orange rootstock, respectively and the differences were significant in both seasons. As for TSS/acid ratio, the maximum values were recorded in fruits from trees on sour orange rootstock, and the minimum was recorded on those on volkamer lemon rootstock in both seasons. TSS/acid ratio in fruits harvested from trees budded on interstock was intermediate between sour orange and volkamer lemon rootstocks (Table 5). These results agree with those obtained by Economides and Gregoriou 1993 and Ennab 2003. In this respect, Perez-Zamora 2004 reveals that, lemon on volkamer lemon and macrophylla obtained a lowest quality of SSC and acidity.

Table (5). Effect of rootstock and interstock on total soluble solids (TSS), acidity and TSS/acid ratio of some orange varieties in 2013 and 2014 seasons.

Treatments R V	Rootstocks and interstock											
	TSS %				Acidity %				TSS/acid ratio			
	VL	SO	SO/VL	Mean	VL	SO	SO/VL	Mean	VL	SO	SO/VL	Mean
2013												
Olinda valencia	7.83	9.10	8.97	8.63	2.17	1.44	1.73	1.78	3.63	6.36	4.77	4.92
Spring navel	9.87	10.93	19.83	13.5	2.23	1.25	1.53	1.67	4.45	8.80	7.13	6.79
Parent navel	10.97	11.30	11.00	11.09	1.66	0.93	1.12	1.24	6.79	12.17	9.82	9.59
Fukumoto navel	9.20	10.30	11.89	10.46	1.45	1.14	1.15	1.25	6.37	9.02	8.81	8.07
Mean	9.47	10.41	12.92		1.88	1.19	1.38		5.32	9.09	7.63	
L.S.D. at 5%	V = 0.72 R= 0.42 VxR= 0.83				V= 0.23 R= 0.17 VxR= 0.34				V = 1.89 R= 0.96 VxR= 1.25			
2014												
Olinda valencia	8.07	9.53	11.00	8.67	1.70	1.34	1.49	1.58	4.22	7.17	5.80	5.73
Spring navel	10.30	11.47	11.47	10.92	1.48	0.99	1.22	1.30	6.10	11.60	9.02	8.91
Parent navel	11.07	11.60	10.33	11.38	1.32	0.91	0.96	1.12	7.56	12.74	11.94	10.75
Fukumoto navel	9.43	10.67	10.30	10.14	1.61	1.13	1.15	1.20	7.23	9.34	9.15	8.57
Mean	9.72	10.82	10.30		1.61	1.09	1.21		6.28	10.21	8.89	
L.S.D. at 5%	V = 0.62 R= 0.43 VxR= 1.47				V= 0.24 R= 0.11 VxR= 0.22				V = 1.51 R= 0.49 VxR= 1.77			

SO = Sour orange, VL = Volkamer lemon, V = Variety, R= Rootstock, SO/VL = Interstock

Effect of rootstock and interstock on growth, yield and fruit quality

Generally, chemical fruit properties of orange scions on interstock showed equal trend to those on sour orange rootstock for higher TSS, low acidity and higher TSS/acid ratio than those on Volkamer lemon rootstock. Similar results were reported by Davies and Albrigo 1994; they reported that *C. volkameriana* produced relatively poor fruit quality with less SSC characterized by higher acidity and coarse peel.

The obtained results in this study supported the idea of intermediate stock such as sour orange on Volkamer lemon rootstock and experimentally led to improve most chemical and physical fruit properties of the scions budded on them. Therefore, using sour orange as interstock for most orange varieties on Volkamer lemon is recommended to maintain high productivity with proper fruit quality, especially in the new reclaimed soils in Egypt.

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تأثير الاصل و الاصل الوسطى على النمو و المحصول وصفات الجودة لثمار بعض اصناف البرتقال ب- التأثير على الخصائص الطبيعية و الكيميائية للثمار

سمية أحمد السيد

قسم الموالح - معهد بحوث البساتين - مركز البحوث الزراعية بالجيزة - مصر

الملخص العربي

اجرى هذا البحث خلال موسمي 2013-2014 بمزرعه خاصه بمنطقه البستان بمحافظة البحيره بهدف دراسته تأثير ااصلى الفولكا ماريانا و النارج و النارج كاصل وسطى بين اصل الفولكاماريانا و الصنف المطعم عليه على اربعة اصناف من البرتقال (البرتقال الصيفى اوليندا - البرتقال ابو سره اسبرينج - البرتقال ابوسره بيرينت - البرتقال ابو سره فوكوموتو) وذلك على الخصائص الطبيعيه و الكيميائيه للصنف المطعم و قد اظهرت النتائج التالى :

1- اظهرت النتائج عدم وجود فروق معنويه بين الاصول الثلاثه بالنسبه لطول و قطر وشكل الثمره فى معظم الحالات فى كلا الموسمين فيما عدا الاصناف على اصل الفولكاماريانا الذى اظهر اختلاف معنوى فى شكل الثمره فى الموسمين ، كما سجل صنف البرتقال ابوسره بيرينت أعلى القيم يليه ابوسره اسبرينج على الاصول الثلاثه مقارنة بالاصناف الأخرى والفروق كانت معنويه بين الاصناف فى كلا الموسمين .

2- سجلت أعلى القيم لوزن و حجم الثمره و سمك القشره على ثمار الاصناف المطعومه على أصل الفولكاماريا مقارنة بثمار الاصناف المطعومه على أصل النارج والاصل الوسطى فى كلا الموسمين ، وكانت قشره ثمار الاصناف على اصل الفولكاماريانا اكثر سمكا مقارنة بقشره ثمار الاصناف المطعومه على كل من اصل النارج و الاصل الوسطى التى كانت اقل سمكا.

3- اظهرت النتائج أن أصناف البرتقال المطعومه على الاصل الوسطى كانت مماثله للاصناف المطعومه على أصل النارج من حيث الصفات لطبيعيه للثمار مثل الطول و القطر وشكل الثمار و حجم الثمره و النسبه المئويه للعصير و سمك القشره بينما كانت اقل من تلك التى و جدت على أصل الفولكاماريانا فى معظم الحالات فى كلا الموسمين

4- كما اوضحت النتائج انخفاض الحموضه و ارتفاع TSS وارتفاع نسبة TSS/Acidity فى ثمار الأصناف على كل من الاصل الوسطى و أصل النارج مقارنة بأصل الفولكاماريانا

من النتائج السابقه يتضح ان استخدام الاصل الوسطى حسن من الصفات الطبيعيه والكيميائيه لثمار الاصناف المطعومه عليه حتى وصلت الى مستوى القيم المتحصل عليها من الاصناف المطعومه على أصل النارج فقط بدون أصل وسطى مقارنة بالاصناف المطعومه على أصل الفولكاماريانا ، لذا تتصح الدراسه باستخدام النارج كأصل وسطى عند استخدام أصل الفولكا ماريانا كأصل للتطعيم عليه وذلك لتفادى بعض العيوب المتعلقة بالصفات الطبيعيه و الكيميائيه للثمار .

Effect of rootstock and interstock on growth, yield and fruit quality