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PERFORMANCE OF 'SHAMOUTI' ORANGE GRAFTED ON SOME CITRUS ROOTSTOCKS IN THE JORDAN VALLEY

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DEDICATION

To my wife and son for their patience.

To my professors who put their best effort in guiding me.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

The influence of four rootstocks; sour orange, 'Volkameriana', 'Cleopatra' mandarin and C. macrophylla on vegetative and reproductive growth, fruit characteristics and fruit ripening of 'Shamouti' orange (Citrus sinensis (L.) Osbeck) trees grown in Deir-Alla at the Jordan Valley in 1991, was studied. 'Shamouti' orange trees on 'Volkameriana' rootstock had earlier bud break and higher leafy to leafless inflorescences ratio than those on sour orange 'Cleopatra' mandarin and C. macrophylla rootstocks. Trees on 'Volkameriana' and 'Cleopatra' mandarin had larger tree canopies than those on sour orange and C. macrophylla. Higher fruit set percent and earlier fruit ripening were obtianed from trees grafted on 'Volkameriana' and C. macrophylla rootstocks. 'Shamouti' fruits from trees on sour orange and 'Cleopatra' mandarin had thicker peel and less juice percent than on the other rootstocks. The undesirable rough peel was noticed for fruits from trees on sour orange and C. macrophylla rootstocks. Fruits from trees on sour orange and 'Cleopatra' mandarin had higher total acidity than those on the other rootstocks. Soluble solids and vitamin C content of fruits from trees on sour orange were mostly higher than on the other rootstocks at different picking dates. 'Shamouti' orange trees on 'Volkameriana' and C. macrophylla yielded more fruits than those on the other rootstocks used.

INTRODUCTION

Citrus is a tropical fruit tree belongs to Rutaceae family which consist of 130 genera (1).

Citrus is a major fruit tree in the Jordan Valley. It is very well adapted to such an area and it will continue to be so in the near future.

Until 1991, the area planted with citrus trees in the Jordan Valley was over 54000 dunum. One third of this area was planted with orange trees, including the cultivars Washington Navel, Valencia and Shamouti(2).

Citrus trees are propagated by grafting the seedling rootstocks with the desirable cultivar. Every citrus cultivar can be budded on practically any member of Citrus and related genera. However, some rootstocks are greatly preferred (1).

Citrus rootstocks are many and have various influences on scion cultivars with respect to vegetative growth, flowering and fruiting (3). According to Samson (1), the most important requirements for a citrus rootstock is high degree of polyemberyony, good union with the main cultivars, ability to grow on various soils, tolerance to virus and fungus diseases, tolerance to nematodes, good nursery performance and tolerance to drought and wind.

Studies on performance of most common Citrus cultivars such as 'Shamouti' orange (*Citrus sinensis* (L.) Osbeck) on various citrus rootstocks under lccal condition in the

Jordan Valley are not available. Thus, this research work was undertaken to investigate the behavior of 'Shamouti' orange grafted on sour orange, 'Cleopatra' mandarin, 'Volkameriana' and Citrus macrophylla (Alemow) in the Jordan valley.

LITERATURE REVIEW

Most commercially-grown citrus trees are budded to seedling rootstocks of cultivar grown for that purpose. Rootstocks are chosen for scion compatibility and on the basis of adaptability to soil and water condition, fruit size, fruit quality, yield, and nematode and disease resistance (3).

1. Rootstock and size of scion cultivar.

Citrus rootstocks exert a vital influence on tree size (4). Variations in citrus tree growth attributed to rootstocks are partially due to differences in root quantity and distribution (5). Saad-Allah et al., (6), indicates that rough lemon rootstock produces the largest tree size, followed by sour orange, while 'Troyer' citrange gave the lowest values in this respect. Hassan (7), reported that trees of 'Washington Navel' orange on rough lemon had the largest size as compared to those on sour orange and 'Troyer' citrange. In addition, sour orange had the deepest root system indicating a relation between depth of rooting and tree size.

'Pera' sweet orange showed the best vegetative growth when grafted on 'Florida' and 'Rugoso da Africa' rough lemon, 'Sunki' tangerine and 'Caipira' sweet orange while 'Limeira' and 'Davis A' trifoliate rootstocks showed the poorest growth (8). Sobrinho et al., (9), showed highest tree vigor for 'Rubi' sweet orange induced by 'Caipira', 'Cleopatra' and 'Rangpur' lime, whereas trees grafted on 'Volkameriana', lemon and 'Morton' citrange were the least vigorous.

2. Rootstock and scion productivity in citrus.

The production of citrus tree may be influenced by rootstock. Cedeno (10), showed that the production of 'Westin' orange trees was clearly influenced by rootstocks. In this respect, the trees grafted on 'Caipira' sweet orange and 'Sunki' mandarin that induce a larger tree vigor, also provided greater production than 'Rangpur' lime, 'Florida' rough lemon and trifoliate orange. However, trees on 'Rangpur' lime were earlier to come into bearing, while those on 'Caipira' sweet orange were delayed in bearing large yield. The trials of Brown (11), indicated that total yields/tree of 'Washington Navel' orange were highest on 'Island' mandarin as compared to trifoliate orange, 'Troyer' citrange and sweet orange. However, in the two other trials, Brown (12), mentioned that 'Washington Navel' orange yield/tree was reduced when trifoliate orange rootstock was used in proportion to tree size. On the other hand, the productivity of 'Dancy' mandarin on 'Volkameriana' were the highest, followed by sour orange, 'Carrizo' citrange and 'Troyer' citrange (13).

According to Bello and Nunez (14), yield of 'Frost Dancy' mandarin on 'Cleopatra' mandarin was higher than 'Kinnow' mandarin on sour orange. However, Grisoni et al., (15) reported that 'Cleopatra' mandarin induced the highest accumulated yield for 'Pineapple' orange SRA, clementines and tangelos.

According to Sobrinho et al., (8) 'Pera' sweet orange gave the highest yields when grafted on 'Florida' and 'Rugoso da Africa' rough lemon, 'Troyer' citrange and 'Rangpur' lime, whereas 'Limeira' trifoliate and 'Citrumelo 4475' gave the lowest yields. In another study, Sobrinho (9) reported that 'Rangpur' lime, 'Troyer' citrange and 'Caipira' sweet orange rootstocks induced highest yield for 'Rupi' sweet orange whereas 'Volkameriana' lemon and 'Morton' citrange induced lowest yield.

Porto and Souza (16) mentioned that 'Valencia' orange gave the highest yield on 'Florida' and 'Africa' rough lemon, 'Volkameriana', 'Sunki' mandarin and '$C1_3$' citrange rootstocks when 36 rootstocks were compared. On the other hand, Reck and Porto (17) mentioned that 'Florida' rough lemon as a rootstock gave highest yield of 'Hamlin' orange.

Alvarenga et al., (18), showed that 'Cravo' and 'Volkameriana' lemon yielded the highest weight and fruit number of 'Valencia' orange.

Koller et al., (19), reported that fruit average weight was not affected by plant spacing in all rootstocks under study. However, trifoliate rootstocks gave always lower production per plant and per unit area in all spaces used. Higher fruit production per unit area was always obtained at shorter plant spacing.

3. Rootstock and citrus fruit quality.

Fruit quality of citrus cultivars such as size, color, sugar content, flavor and peel thickness have been reported to be influenced by the rootstock (4, 20, 21). Brown (12) indicated that fruit quality (sugar level, flavor and peel thickness) of 'Washington Navel' orange was best on trifoliate orange followed by sweet orange. However, fruit from trees on 'Troyer' citrange and mandarin rootstocks were of unacceptable quality in many seasons. On the other hand, data of eleven years indicated that 'Washington Navel' orange on 'Island' mandarin and 'Troyer' citrange rootstocks were of poor quality when compared to trifoliate orange and sweet orange which showed higher soluble solids and acidity, thinner peel and better flavor (11).

Moreover, Jimenez et al., (13), reported that best fruit quality of 'Dancy' mandarin was obtained from trees grafted on 'Troyer' and 'Carrizo' citrange rootstocks followed by C. amblycarpa. However, 'Volkameriana' rootstock brought poor quality fruits.

The study of Sobrinho et al., (9) did not indicate differences in fruit quality of 'Rupi' sweet orange among the eight tested rootstocks. However, the same authors found that 'Cleopatra' tangerine and 'Limeira' trifoliate gave best fruit quality of 'Pera' sweet orange.

Citrus peel is one of the quality parameters. In this respect, Erner et al., (22), reported that peel of 'Shamouti' orange becomes thick and rough when sour orange is used as a rootstock rather than sweet lime.

Influence of rootstock in citrus on fruit quality may occur during storage. In this regard, El-Zeftawi and Peggie, (23), reported that more storage disorders for 'Valencia' oranges seemed to be related to 'Symons' sweet orange rootstock as compared to 'Rangpur' lime or 'Emperor' mandarin rootstocks.

4. Other influences related to citrus rootstocks.

The susceptibility of citrus tree cultivars to some diseases and thier tolerance to salt are influenced by the rootstock. Tristeza virus is a major problem in citrus production as it causes significant damage to citrus trees. In this respect, Atiri,(24), reported that 'Pineapple' orange, 'Campbell Valencia' orange and 'Parso Brown' orange scions on 'Cleopatra' mandarin were free from the virus. In addition, among the four rootstocks 'Cleopatra' mandarin and rough lemon conferred high tolerance. However, Cedero (10), in his studies about Tristeza reported that 'Westin' orange budded on 'Rangpur' lime rootstock was found to be light pitted, while those on trifoliate rootstock had higher levels of stem pitting. On the other hand, susceptibility of 5 citrus rootstocks to nematode populations were examined by Yousif (24). The results indicated that reproduction potenial of Tylenchulus semipenetras was the highest on sour orange and 'Japanese' lemon for the first and second isolates, respectively. In addition, minimal rates of nematode reproduction occurred on 'Troyer' citrange and 'Cleopatra' mandarin for the first isolated and rough lemon and 'Cleopatra' mandarin for the second. However, Zaragoza et al., (26), mentioned that 'Washington Navel' and 'Valencia' orange on mandarin and sweet orange rootstocks were very susceptible to Phytophthora infection. Katana (27), reported that 'Eureka' lemon trees budded on 'Sampson Tangles' were less susceptible to lemon decline disease.

Roots of tolerant kinds of citrus rootstocks such as 'Rangepur' lime, 'Cleopatra' and 'Sunki' mandarins tend to exclude chlorides and thus to render trees on those roots relatively tolerant to chloride salts (28).

According to Abdel-Messih et al., (29), the addition of $CaCl_2$ and NaCl salts to irrigation water at levels of 1000, 2000, 4000 and 6000 ppm reduced growth measurements of 'Washington Navel' orange budded on different rootstocks with varying degrees. For instance, 'Washington Navel' orange on 'Brazillian' sour orange was more vigorous than those on 'Cleopatra' mandarin, rough lemon and sour orange.

In addition, increasing salinity levels in irrigation water increased the concentration of Cl, Na, Ca, P, Fe, Mn and Zn; and depressed K accumulation in the scion leaves. Moreover, final height, trunk diameter, top and root system fresh weight of 'Washington Navel' orange budded on 'Brazillian' sour orange were more vigorous than those on the other three rootstocks.

Relationships between scion-rootstock affinity and degree of successful grafts between them were cleared by several studies. In most cases, grafting the closely related plants was more successful than those unrelated (30). In citrus, the studies of Samaan and Fadel, (31), showed that the most related rootstocks with respect to compatibility to the tested scions of 'Washington Navel' and 'Shamouti' orange were the 'Cleopatra' mandarin and 'Troyer' citrange, whereas the sweet lime rootstock was the least in this respect. However, Sobrinho et al., (8), reported that incompatibility level at the bud union of 'Pera' sweet orange was severe on 'Limeira' trifoliate, absent on 'Rangepur' lime, 'Sunki' tangerine, 'Caipira' sweet orange, 'Orlando' tangelo and 'Citrumelo 4475', and slight on 'Volkameriana', 'Davis A' trifoliate, 'Rugoso da Africa' rough lemon and 'Florida' rough lemon and 'Troyer' citrange.

MATERIALS AND METHODS

1. Location.

Twenty year old citrus orchard, located at Deir-Alla station in the Jordan Valley, that belongs to the Ministry of Agriculture, was used.

2. Plant material.

The orchard consists of six rootstocks: 'Cleopatra' mandarin, sour orange, 'Volkameriana', the 'Alemow' C. macrophylla, 'Keen' sour orange and 'Brazilian' sour orange. These are grafted with 'Shamouti' orange, 'Washington Navel' and 'Valencia' oranges, mandarin, 'Algerian' tangerine, 'Marsh' grapefruit, 'Eureka' and 'Lisbon' lemons. The orchard consists of three blocks. Each block consists of the seven citrus cultivars in addition to the 'Shamouti' orange which are grafted on the previously mentioned rootstocks. The plant spacing is 6m X6m. Orchard layout is shown in figure 1.

3. Experimental work and design.

The orchard is designed to the randomized complete block. Only four of the six rootstocks; 'Cleopatra' mandarin sour orange, 'Volkameriana' and C. macrophylla,

Rootstocks

a) 'Cleopatra' mandarin

b) Sour orange

c) 'Volkameriana'

d) 'Keen' sour orange

e) _C. macrophylla_

f) Brazillian sour orange

Cultivars

1. Shamouti
2. Washington Navel
3. Valencia
4. Mandaline
5. Algerian tangerine
6. Marsh grapefruit
7. Eureka lemon
8. Lisbon lemon

F	1	3	6	5	4	7	2	8
D	7	3	5	8	2	1	6	4
C	7	3	5	8	2	1	6	4
B	1	3	6	5	4	7	2	8
A	4	1	3	7	2	8	5	6
E	3	2	6	8	7	1	4	5

C	5	4	1	7	8	6	2	3
E	8	7	2	4	6	1	3	5
F	1	2	5	4	7	6	3	8
A	1	2	5	4	7	6	3	8
D	2	7	6	1	4	3	5	8
B	2	7	6	1	4	3	5	8

B	8	7	2	4	6	1	3	5
A	2	5	4	7	6	8	1	3
D	2	5	4	7	6	3	1	8
F	2	7	6	1	4	3	5	8
E	2	7	6	1	4	3	5	8
C	7	6	1	5	4	2	8	3

Fig. 1. Layout of citrus orchard in Deir-Alla station in the Jordan Valley. Plant spacing is 6m X 6m.

were used in the study. The four rootstocks were grafted onto the 'Shamouti' ornage. Trees of the 'Shamouti' orange grafted on the four rootstocks were tagged on January 1991.

Twenty uniform one year old shoots from each tree were labeled using plastic tags. Shoot length in mm for each labeled shoot was recorded. The trees were pruned, irrigated and fertilized as practiced by local orchardists in the Jordan Valley.

3.1. Vegetative and reproductive growth.

Data for date of bud break of 'Shamouti' orange grafted onto the four rootstocks started mid-February 1991. When inflorescences of each tree attained full bloom, which happened to be about two to three weeks of bud break, the following measurements were recorded for each labeled shoot:

a) Number of flowers per inflorescence.

b) Number of leafy and leafless inflorescences.

c) During the first half of April 1991, initial fruit setting percentage was recorded.

d) Extension growth of the labeled shoots was recorded in the first half of May so as to calculate the increase in shoot length during the first flush growth.

e) Shoot length for the same 20 shoots was recorded one more time towards the end of the growing season which was in the second half of August in order to estimate extension growth during the second flush growth.

f) Seasonal shoot growth was culculated by collecting the growth of shoot at the first and second growth flush periods.

g) The percent of final fruit set of the labeled shoots was calculated as follows:

Fruit set % = No.of fruits X 100 /No.of flowers

h) Fruit set efficiency percent was calculated by dividing final fruit set percent on initial fruit set percent and multiplying the product by 100.

j) Number of fruit per each tree at mid-November (yield).

3.2. Fruit physical and chemical properties.

When fruits started to show change in peel color from green to light green and finally to yellowish green at about the seventeenth of November, 'Shamouti' fruits from the four rootstocks were picked at random around tree periphery. Each sample consisted of four fruits and the following parameters were studied.

3.2.1. Peel color.

Differences in changes in peel color were studied through establishing the following index:

Peel color	Index (score)
Light green	5
Yellow green	10
Green yellow	15
Orange green	20
Yellow with small green side	25
Orange with small green side	30
Orange yellow	35
Yellow orange	40

3.2.2. Peel texture.

Peel texture of 'Shamouti' orange fruits was divided into two categories: smooth or rough. This was accomplished by feeling them by fingers.

3.2.3. Fruit weight, volume and specific gravity.

For every 'Shamouti' tree, ten fruits were taken at random around tree periphery (The sample used for measuring average fruit weight and volume was ten fruits to reduce error). These were weighed to the nearest gram and divided by ten to get average fruit weight. The volume of each sample was measured by using the water displacement method, which was divided by ten to get average fruit volume. Fruit specific gravity was calculated by dividing fruit weight by the volume.

3.2.4. Peel thickness.

Peel thickness of the fruit included the flavedo, the outer layer of the fruit known as the exocarp, and the albedo (mesocarp), was measured through a longitudinal section to the fruit starting at stem end and ending by the blossom end. Three measurements for fruit thickness were taken using Vernier calibre, one from the blossom end, the other near the stem end and the third one at the middle of the fruit. The average of the three measurement was calculated as well as the average of the sample which consisted of four fruits.

3.2.5. Fruit shape.

The shape of the fruit was presented as the ratio between the distance between the stem end and the blossom end of the fruit (which known as Y axis or length) and its middle which is perpendicular to Y axis (known as X axis or width). The measurements were taken for every sample which consisted of four fruits, and the average of the four was calculated.

3.2.6. Fruit juice percent.

For every sample (four fruits), fruit juice was expressed using a citrus citromatic. The juice was filtered through gauze, and then the weight of the juice was measured. The measured weight was divided by the weight of the whole fruits of the sample to get the percent of juice in the fruit (weight / weight).

3.2.7. Juice pH.

Juice obtained in item 3.2.6. was used to measure pH using a PH meter (model Corning 125). Twenty ml from each juice sample were taken and divided into two subsamples. Each subsample was 10 ml and the pH was read. However, average of the two subsamples was recorded.

3.2.8. Juice soluble solids content.

Soluble solids content of the juice expressed in item 3.2.6 was determined using a hand refractometer (model Baush and Lomb 33-45-58) which has been already cleaned. Two measurements were taken for each juice sample by using few drops of juice on the platform of the refractometer. The average soluble solids content of the two measurements was recorded.

3.2.9. Juice acidity.

Total acidity was determined and calculated as the volume in ml of 0.1 N NaOH required to titrate 100 ml of juice to the phenolphthalein end point (pH 8.1) and expressed as the percent of total acid as citric acid.

This was accomplished by taken 10 grams of the juice from each sample, five to six drops of phenolphthalein were added to the juice, then the juice was titrated with 0.1 N NaOH. When juice color showed a pale pink, the volume of 0.1 N NaOH was recorded. In the same way 10 grams of water (blank)was titrated with 0.1 N NaOH. The percent of total acids was calculated as follows:

Total acids %

(as citric acid) = V x N x 64 x 100/ Wt x 1000

where:

Wt = weight of sample in grams.

V = mls of NaOH used in titration of the sample-mls of NaOH consumed by the blank.

N = normality of NaOH.

3.2.10. Vitamin C content of the juice.

The most commonly used procedure for ascorbic acid (AA) determination is the oxidation-reduction titration procedure (indophenol titration method)(32).

A 0.05 % solution of 2,6-dichlorophenolindophenol (DCPIP) was prepared by dissolving 250 mg of 2,6- dichloro-phenolindophenol - sodium salt in 500 ml of water. One hundred mg $NaHCO_3$ were added to the solution, which was filtered through fluted filter paper into a glass stoppered bottle and stored in the refrigerator.

An acid stabilizer solution was made by dissolving 15 g of metaphosphoric acid (HPO_3) pellets plus 4 ml of glacial acetic acid in 500 ml distilled water. The solution was filtered rapidly through fluted filter paper into a glass stoppered flask and stored in the refrigerator.

The procedure used included taking 10 ml of juice from every sample that had been filtered and mixed with 10 ml of the phosphoric acid stabilizing solution. Ten ml of the mixture was taken by a pipet into 50 ml Erlenmeyer flask. The mixture was titrated with indolephenol solution until a pink color appeared and persisted for five seconds. The determination was repeated and the average of the two titrations was recorded.

To standardize the indolephenol solution, two ml of the solution containing 2 mg ascorbic acid in 100 ml of the stabilizing solution (HPO_3) were titrated with indolephenol solution until a light distinct rosy pink color persisted for more than five seconds. Similarly, blanks composed of seven ml of the HPO_3 -HAC reagent plus a volume of water equivalent to the volume of DCPIP used for the direct titration was titrated with DCPIP solution.

Calculation of AA mg/100 ml for orange juice: if volume of indolephenol for standerd AA titration =15.7 ml and volume of indolephenol for blank titration = 0.1 ml and volume of indolephenol for 5 ml juice titration = 14.9 ml, volume of indolephenol consumed for AA titration =

15.7 - 0.1 = 15.6

mg of AA in 5 ml juice = 14.9 x 2/15.6 = 1.91

mg of AA /100 ml juice = 1.91 x 100/5 = 38.2

3.2.11. Pulp percent in juice.

For every sample, the juice which had been expressed carefully from the fruits was filtered through gauze, 30 grams of juice were taken from each sample. Pulp was separated from juice using centrifuge model IEC HN-SII at 2000 rpm for five minutes. The pellet (separated pulp) was weighed to the nearest 0.1 gram and the value was divided by 30 multiplying by 100 to get the percent of pulp in the sample.

3.2.12. Fruit ripening in relation to some fruit properties.

Some physical properties of 'Shamouti' orange were studied for a month after the seventeenth of November 1991. Sampling took place in the 24th of November, the second and the 9th of December 1991, where four fruits were taken to study some chemical properties of 'Shamouti' orange during various stages of maturity which included juice PH, acidity, soluble solids content and ascorbic acid (vitamin C) level.

RESULTS AND DISCUSSION

1. Influence of rootstock type on vegetative growth of 'Shamouti' orange.

1.1. Bud break.

Observations recorded on date of bud break indicated that buds of 'Shamouti' orange trees grafted on 'Volkameriana' were first to open (February, 15, 1991). This was followed by trees grafted on suor orange (February, 19, 1991), 'Cleopatra' mandarin (February, 20, 1991) and finaly on C. macrophylla (February, 22, 1991).

The observed differences in the date of bud break at the beginning of the growing season in 'Shamouti' orange trees grafted on various citrus rootstocks is an indication of the influence of the rootstock on scion cultivar. Delayed or early bud break in fruit tree species grafted on various rootstocks is well known (33). For instance, citrus trees on 'Cleopatra' mandarin came late into bearing than on other rootstocks (1). Studies with citrus showed that the five rootstocks started fruiting two seasons earlier when budded to themselves than when unbudded (34). In addition, three peach cultivars on 'Siberian C' rootstock developed more slowely than those on 'Harrow Blood', 'Lovell' and 'Halford' rootstocks (35).

1.2. Shoot growth.

Average shoot length (196 mm) of 'Shamouti' orange trees grafted on 'Volkameriana' in the first flush of growth was significantly longer than those grafted on 'Cleopatra' mandarin (153 mm), while those grafted on sour orange had the smallest shoot length (120 mm) (Table 1). However, 'Shamouti' orange trees on C. macrophylla were on the same level of significance with those on 'Cleopatra' mandarin and sour orange where shoot length of 139, 153 and 120 mm were obtained, respectively.

In the second flush period, growth of 'Shamouti' trees on 'Cleopatra' mandarin gave significantly longer shoots than those on 'Volkameriana', sour orange and C. macrophylla : 86, 42, 37 and 9 mm were obtained, respectively (Table 1).

These results indicate that tree size of 'Shamouti' orange is influenced by the type of rootstock. For instance, seasonal shoot growth of 'Shamouti' orange was significantly longer on 'Volkameriana' (238 mm) and 'Cleopatra' mandarin (238 mm) than on sour orange (157 mm) and C. macrophylla (148 mm). A difference in shoot growth has a dwarfing effect which may lead to closer planting, hence higher production and lower picking cost (1). According to Fallahi and Mousavi, (36), trees of 'Orlando' tangelo had relativly larger tree canopies on 'Carrizo' citrange than on other nine rootstocks used. However,

Table 1. Effect of four citrus rootstocks on shoot growth of 'Shamouti' orange trees for the first and second flush periods, and seasonal shoot growth, 1991.

Rootstock	Average shoot length(mm)		Seasonal shoot growth(mm)
	First flush	Second flush	
'Volkameriana'	196 a *	42 b	238 a
Sour orange	120 c	37 b	157 b
'Cleopatra' mandarin	153 b	86 a	238 a
C. macrophylla	139 bc	9 b	148 b

* Values within the same columns followed by the same letters are not significantly different at P= 0.05 using Duncan's multiple range test.

'Shamouti' orange trees were the the tallest when 'Cleopatra' mandarin was used as a rootstock (14). On the other hand, 'Pera' sweet orange had best vegetative growth on 'Florida' and 'Rugoso da Africa' rough lemons, 'Sunki' tangerine and 'Caipira' sweet orange (8).

2. Influence of rootstock on reproductive growth, fruit weight, fruit volume, specific gravity and yield of 'Shamouti' orange.

Percent of fruit set in 'Shamouti' orange trees grafted on C. macrophylla was significantly higher than those on 'Volkameriana', sour orange and 'Cleopatra' mandarin where 30.1 , 12.9 , 12.8 and 4.1 % were obtained, respectively (Table 2). Highest final fruit set in 'Shamouti' orange trees was obtained by 'Volkameriana' (3.5%) and C. macrophylla (3.3%) rootstocks, while sour orange and 'Cleopatra' mandarin gave the lowest percentage (1.3%) (Table 2). However, the differences in the final fruit set between the four rootstocks are nonsignificant at P= 0.05. 'Shamouti' orange trees grafted on C. macrophylla gave the lowest ratio (0.8) between leafy and leafless inflorescences as compared to the other rootstocks, while those on 'Volkameriana' (3.3) gave the highest leafy to leafless inflorescences ratio. However, the trees on the four rootstocks did not differ significantly with respect to that ratio.

Table 2. Effect of four citrus rootstocks on initial and final fruit set percent, fruit set efficiency and leafy and leafless inflorescence of 'Shamouti' orange trees, 1991.

Rootstock	Initial fruit set(%)	Final fruit set(%)	Fruit set efficiency (%)	Ratio between leafy and leafless inflorescences
'Volkameriana'	12.9 b *	3.5 a	27 a	3.3 a
Sour orange	12.8 b	1.3 a	16 a	1.5 a
'Cleopatra' mandarin	4.1 b	1.3 a	52 a	2.0 a
<u>C. macrophylla</u>	30.1 a	3.3 a	11 a	0.8 a

* values within the same columns followed by the same letters are not significantly different at P = 0.05 using Duncan's multiple range test.

A variation in fruit set efficiency for 'Shamouti' orange trees grafted on the different rootstocks was noticed (Table 2). The highest fruit set efficiency was obtianed from trees grafted on 'Cleopatra' mandarin followed by those on 'Volkameriana' and sour orange and finally C. macrophylla rootstocks where 52, 27 , 16 and 11 % were obtained, respectively. However, the differences in fruit set efficiency between trees grafted on the different rootstocks were not significant at P= 0.05. The increased fruit set efficiency could be related to the high ratio of leafy inflorescences in 'Cleopatra' mandarin (2.0) and 'Volkameriana' (3.3). According to El-Azzouni, (37), fruit set in orange increase in leafy inflorescences than in leafless ones. On the other hand, Saad-Allah et al., (6) showed that 'White Khalily' orange have lower leafy to leafless inflorescence ratio when it was grafted on sour orange than on 'Troyer' citrange and rough lemon.

The results in table (3) show that the average fruit weight for 'Shamouti' orange trees grafted on the four rootstocks were on the same level of significance. However, trees on sour orange rootstock gave lower fruit weight (243 g) than those on 'Volkametiana' (266 g) 'Cleopatra' mandarin (266 g) and C. macrophylla (258 g). In addition, the difference in average fruit volume between 'Shamouti' orange trees grafted on the different rootstocks were not significant.

Specific gravity of 'Shamouti' orange fruits in the

Table 3. Effect of four citrus rootstocks on weight, volume, specific gravity and number of 'Shamouti' orange fruits, 1991.

Rootstock	Average fruit weight(g)	Average fruit volume(cm^3)	fruit No. per tree	Average specific gravity (Kg/L)
'Volkameriana'	266 a *	304 a	209.7 a	0.88 a
Sour orange	241 a	287 a	107.0 ab	0.85 a
'Cleopatra' mandarin	266 a	313 a	47.3 b	0.85 a
C. macrophylla	258 a	297 a	192.0 a	0.84 a

* Values within the same columns followed by the same letters are not significantly different at P = 0.05 using Duncan's multiple range test.

four rootstocks did not show significant differences (Table 3).

Number of fruits per 'Shamouti' orange tree grafted on 'Volkameriana' (209.7) and C. macrophylla (192.0) were significantly higher than those on 'Cleopatra' mandarin (47.3) (Table 3). However, number of fruit for trees grafted on sour orange were intermediate (107.0) and on the same level of significance with the other three rootstocks.

The results in table 3 indicate a striking effect of the rootstock on fruit yield and; characteristics of the scion cultivar with respect to weight and volume were not significantly influenced. According to Bitters and Batchelor, (38), citrus fruits of grapefruit were usually excellent in size and the larger 'Navel' orange fruits are produced on sour orange and smallest on 'Palestine' sweet lime. In addition, largest 'Valencia' oranges were obtained on trifoliate orange , whereas sweet orange rootstock produed the smallest fruits. In addition, effect of rootstock on yield have been reported for various cultivars (4, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,50, 51, 52, 53). Fallahi and Mousavi, (36), reported that Orlando tangelo trees on C. macrophylla were the most precocious and produced the highest yield. On the other hand, Zaragoza et al., (26), reported that 'Washington Navel' and 'Valencia' oranges produced the lowest yield on 'Cleopatra' mandarin.

3. Influence of rootstock on physical and chemical properties of 'Shamouti' orange fruits.

3.1. Peel color change.

Observation on green color changes of the peel revealed that fruits of 'Shamouti' orange trees grafted on 'Volkameriana' were the first to show change which occurred to be Nov. 11, 1991. After that, 'Shamouti' fruits obtained from C. macrophylla, sour orange and 'Volkameriana' gave significantly the same color changes in the peel which occurred to be Nov. 17, 1991,(Table 4). However, 'Shamouti' fruits form 'Cleopatra' mandarin were significantly the last to show peel color change. On the other hand, sampling fruits in Nov. 24, and Dec. 2, 1991, for color change in the peel of 'Shamouti' orange grafted on the four rootstocks did not show significant differences (Table 4). Sampling fruits on Dec. 9, 1991, showed that fruit from trees on 'Cleopatra' mandarin were the last to show peel color change.

The results in table 4 indicate influence of rootstock on peel coloration where 'Shamouti' orange fruits on 'Cleopatra' mandarin were late in this respect. El-Azzouni and El-Barckouki, (54), reported that Jaffa orange grafted on the double rootstock (sweet lemon and sour orange), showed faster peel coloration when compared to the other tested rootstocks. In addition, Qrunfleh et al., (55),

Table 4. Effect of four citrus rootstocks on peel color change of 'Shamouti'orange fruits, 1991.

Rootstock	Sampling date			
	Nov. 17	Nov. 24	Dec. 2	Dec. 9
'Volkameriana'	11.7 a *	16.7 a	31.7 a	38.2 a
Sour orange	10.0 ab	16.7 a	21.7 a	38.3 a
'Cleopatra' mandarin	5.0 b	13.3 a	21.7 a	30.0 b
<u>C. macrophylla</u>	10.0 ab	13.3 a	31.7 a	38.3 a

* Values within the same columns followed by the same letters are not significantly different at P = 0.05 using Duncan's multiple range test.

showed that fruit coloration of 'Marsh' grapefruit, 'Navel' orange, 'Lisbon' lemon and mandarin was influenced by the rootstocks tested (sour orange, 'Cleopatra' mandarin and 'Volkameriana') as well as dipping the fruits in etherel.

3.2. Peel texture, thickness and ratio between length and width of the fruit.

Peel texture of fruits of 'Shamouti' oranges from trees grafted on sour orange and C. macrophylla were rough, while those on 'Volkameriana' and 'Cleopatra' mandarin were smooth.

Peel of 'Shamouti' orange fruits on sour orange (8.9 mm) was significantly thicker than 'Shamouti' fruits from trees grafted on 'Volkameriana' (6.6 mm) and C. macrophylla (6.7 mm) (Table 5). However, peel thickness of fruits on 'Cleopatra' mandarin (8.5 mm) was intermediate and on the same level of significance with those on other rootstocks. This indicates that peel thickness is influenced by rootstock type in citrus. However, Erner et al., (56), reported that 'Shamouti' orange trees grafted on sour orange have a rough and thicker fruit peel than on sweet lime rootstock. In addition, with progressively greater roughness, the fruit becomes longer due to increasing peel roughness accintuated at stem end rather than increasing pulp volume. Tissues of rough peel divided more intensively, and the resulting cells remain smaller and

Table 5. Effect of four citrus rootstocks on peel thickness and ratio between length and width of 'Shamouti' orange fruits, 1991.

Rootstock	Average peel thickness (mm)	Ratio between length and width of the fruit
'Volkameriana'	6.6 b *	1.09 a
Sour orange	8.9 a	1.10 a
'Cleopatra' mandarin	8.5 ab	1.15 a
<u>C. macrophylla</u>	6.7 b	1.14 a

* Values within the same columns followed by the same letters arenot significantly different at P = 0.05 using Duncan's multiple range test.

more compact especially in the external layer. According to Bain, (57), the intensive peel divisions are due to shifts in the hormonal balance of peel tissues. Similar results were obtained by Bitters and Batchelor, (38), where peel thickness of the fruirs of sweet orange, tangerine and grapefruit was influenced by sour orange when used as a rootstock.

The ratio between length and width of the fruit (fruit shpae) did nit differ significantly for 'Shamouti' orange trees grafted on various rootstocks at 5 % level of significance (Table 5). However, fruit from trees on 'Cleopatra' mandarin (1.15) and C. macrophylla had higher length to width ratio than those from trees on sour orange (1.10) and 'Volkaneriana' (1.09), indicating that fruits from trees on the last two rootstocks tended to be more spherical.

3.3. Juice and pulp percent.

'Shamouti' orange fruits from trees grafted on 'Volkameriana' and C. macrophylla gave significantly greatest juice percent (weight/weight) (47.1%) over those on sour orange (38.8%) and 'Cleopatra' mandarin (40.1%) (Table 6). Fallahi and Mousavi, (36), reported diffrences in juice percent of 'Orlando' tangelo fruits from trees grafted on ten rootstocks. In this respect, 'Orlando' tangelo fruits from trees on 'Carrizo' citrange and rough

Table 6. Effect of four citrus rootstocks on fruit juice and juice pulp percent (w/w) of 'Shamouti' orange fruits, 1991.

Rootstock	Average juice percent	Average pulp percent in juice
'Volkameriana'	47.1 a *	7.70 a
Sour orange	38.8 b	10.33 a
'Cleopatra' mandarin	40.1 b	9.47 a
<u>C. macrophylla</u>	47.1 a	8.80 a

* Values within the same columns followed by the same letters are not significantly different at P= 0.05 using Duncan's multiple range test.

lemon contained more juice than those from trees on C. macrophylla, 'Batangas' mandarin and Savage citrange.

'Shamouti' fruits from trees grafted on sour orange gave the highest juice pulp percent (10.33%), followed by those on 'Cleopatra' mandarin (9.47%) and C. macrophylla (8.8 %). However, juice pulp percent for fruits on the four rootstocks did not differ significantly from each other at 5 % level of significance (Table 6).

3.4. Fruit characteristics in relation to juice pH, total acidity, soluble solids, and vitamin C content throughout the harvesting season.

Juice pH of 'Shamouti' orange fruits on the four rootstocks showed a slight increase during the four weeks of harvesting which started Nov. 17 and ended Dec. 9 (Table 7). Although significant differences in juice pH of 'Shamouti' fruits grafted on the four rootstocks were recorded when harvesting took place in Nov. 17, 1991, no differences were obtained in the pH of the juice obtained from the fruits harvested on the other dates (Nov. 24, Dec. 2, Dec. 9) (Table 7).

Even though no significant differences were obtained in juice acidity of 'Shamouti' orange fruits from trees grafted on the four rootstocks, 'Shamouti' orange fruits on sour orange (0.818) and 'Cleopatra' mandarin (0.821) were higher on Nov. 17, 1991, than those from trees on C.

Table 7. Effect of four citrus rootstocks on juice pH of 'Shamouti' orange fruits harvested at four picking dates in 1991.

Rootstock	Picking date			
	Nov.17	Nov.24	Dec.2	Dec.9
	juice pH			
'Volkameriana'	3.77 a *	3.87 a	3.77 a	3.87 a
Sour orange	3.70 ab	3.77 a	3.77 a	3.90 a
'Cleopatra' mandarin	3.60 b	3.80 a	3.80 a	3.83 a
C. macrophylla	3.77 a	3.80 a	3.80 a	3.83 a

* Values within the same columns followed by the same letters are not significantly different at P= 0.05 using Duncan's multiple range test.

macrophylla (0.621) and 'Volkameriana' (0.628) (Table 8). At the second picking date (Nov. 24, 1991) 'Shamouti' fruits on 'Volkameriana' had significntly the lowest acid content (0.513 %) as compared to 'Cleopatra' mandarin (0.693 %) and sour orange (0.651%). In addition, 'Shamouti' fruits on C. macrophylla were intermediate in this respect. At the third picking date 'Shamouti' fruits on 'Volkameriana' had the lowest total acidity, while those on 'Cleopatra' mandarin gave the highest total acidity (Table 8). On Dec. 9, 1991, all 'Shamouti' fruits from the four rootstocks did not differ significantly in juice acidity.

Soluble solids content of 'Shamouti' fruits obtained from trees grafted on the four rootstocks and harvested at the four picking dates did not show specific pattern (Table 9). For example, 'Shamouti' fruits from trees grafted on 'Volkameriana' had soluble solids of 11.77, 11.03, 10.60 and 11.40 when fruits were picked Nov. 17, Nov. 24, Dec. 2 and Dec. 9, respectivily. However, differences in soluble solids content of 'Shamouti' fruits from the four rootstocks on each picking date showed significant differences. For instance, soluble solids content in fruit juice of 'Shamouti' orange trees grafted on sour orange was significantly higher (13.1) than C. macrophylla (11.47) and 'Volkameriana'(11.77) when fruits were harvested Nov. 17, 1991. In addition, fruits from trees on 'Cleopatra' mandarin (12.2) were at the same level of significance

Table 8. Effect of four citrus rootstocks on juice total acids percent of 'Shamouti' orange fruits harvested at four picking dates in 1991.

Rootstock	Picking date			
	Nov.17	Nov.24	Dec.2	Dec.9
	Total acids percent			
'Volkameriana'	0.628 a *	0.513 b	0.563 b	0.559 a
Sour orange	0.818 a	0.651 a	0.636 ab	0.673 a
'Cleopatra' mandarin	0.821 a	0.693 a	0.680 a	0.661 a
<u>C.macrophylla</u>	0.621 a	0.590 ab	0.636 ab	0.649 a

* Values within the same columns followed by the same letters are not significantly different at P = 0.05 using Duncan's multiple range test.

with the other rootstocks (Table 9).

For individual rootstock type, a sharp increase in vitamin C content of 'Shamouti' orange fruits was obtained throughout the harvesting season which started Nov. 17 and ended Dec. 9, 1991, (Table 10). However, differences in 'Shamouti' fruits from the four rootstocks at each picking date were recorded. For instance, on Nov. 17, amount of vitamin C in the juice of 'Shamouti' fruits from trees grafted on sour orange was significantly higher (42.37 mg/ 100 ml) than in fruits from trees on C. macrophylla (37.27). However, vitamin C content of fruits from trees grafted on 'Cleopatra' mandarin (40.2) and 'Volkameriana' (37.63) were intermediate and were on the same level of significance with the other rootstocks.

The results in tables 7. 8. 9 and 10 show that there were differences between 'Shamouti' trees grafted on the different rootstock, regarding juice pH, total acid content, soluble solids and vitamin C content. The effect of rootstock on these quality parameters of the fruit was noticed by many researchers. For instance, Fallahi and Mousavi, (36), showed that fruits of 'Orlando' tangelo from trees on 'Volkameriana' lemon and rough lemon was lower in soluble solids content and total acids than from trees on other rootstocks. On the other hand, Saad-Allah et al., (6), reported that there were no significant diffrences in juice acidity between 'White Khalily' orange grafted on sour orange, rough lemon and 'Troyer' citrange rootstocks.

Table 9. Effect of four citrus rootstocks on juice soluble solids content of 'Shamouti' orange fruits harvested at four picking dates in 1991.

Rootstocks	Picking date			
	Nov.17	Nov.24	Dec.2	Dec.9
	percent of soluble solids			
'Volkameriana'	11.77 b *	11.03 b	10.60 b	11.40 a
Sour orange	13.10 a	12.80 a	13.00 a	12.47 a
'Cleopatra' mandarin	12.20 ab	12.03 ab	11.83 ab	11.80 a
<u>C. macrophylla</u>	11.47 b	11.53 ab	11.70 ab	12.53 a

* Values within the same columns followed by the same letters are not significantly different at P = 0.05 using duncan's multiple range test.

Table 10. Effect of four citrus rootstocks on juice vitamin C content of 'Shamouti' orange fruits harvested at four picking dates in 1991.

Rootstock	Picking date			
	Nov.17	Nov.24	Dec.2	Dec.9
	Vitamin C content (mg/100 ml)			
'Volkamriana'	37.63 ab *	35.17 b	39.03 c	43.20 b
Sour orange	42.37 a	45.83 a	56.93 a	61.10 a
'Cleopatra' mandarin	40.20 ab	45.25 a	49.07 b	47.80 b
<u>C. macrophylla</u>	37.27 b	40.27 ab	46.20 b	49.03 b

* Values within the same columns followed by the same letters are not significantly different at P = 0.05 using Duncan's multiple range test.

According to El-Azzoni and El-Barkouki, (58), 'Jaffa' orange fruits contained highest citric acid and vitamin C when trees were grafted on the combination of sweet lime and sour orange.

4. Influence of rootstock on ripening of 'Shamouti' orange fruits.

Observations recorded for the change in fruit color, fruit juice pH , acidity and soluble solids content for 'Shamouti' orange trees grafted on the four rootstocks (Tables 4, 7, 8, 9) indicated that fruit from trees on 'Cleopatra' mandarin were ripened later than fruits from trees on the other three rootstocks. On the other hand, fruit from trees on 'Volkameriana' were ripened earlier than the other rootstocks. It is knowen that the increasing in juice pH and the decreasing in juice total acidity, in addition to the change in fruit peel color were indicators for citrus fruit ripening. According to Samson, (1), citrus fruits can be harvested when they show certain level of soluble solids content, percent of H_2O, free citric acid in the juice and percent of juice. The present study showed that all of these parameters were influenced by the rootstock.

SUMMARY

This research was carried out to study the performance of 'Shamouti' orange on various citrus rootstocks under local condition in the Jordan Valley. The trees were twenty years old and were grafted on four rootstocks; sour orange, 'Cleopatra' mandarin 'Volkameriana' and C. macrophylla. The experimental design was randomized complate block , with three replications and four treatments. The vegetative and reproductive growth, fruit set, and other fruit properties were evaluated during the growing season started mid-February and ended mid-December.

The results showed that the rootstocks influenced 'Shamouti' orange performance. Trees on 'Volkameriana' and 'Cleopatra' mandarin had longer shoot growth than those on the other rootstocks. Fruit set percent and number of fruits/tree were highest for 'Shamouti' trees grafted on 'Volkameriana' and C. macrophylla than those on sour orange and 'Cleopatra' mandarin.

Fruit characteristics were influenced by rootstock. 'Shamouti' orange fruits from trees on sour orange and 'Cleopatra' mandarin had thicker peel and less juice percent than those on other rootstocks. In addition, fruits from trees on sour orange and C. mocrophylla had rough peel whereas those on 'Cleopatra' mandarin and 'Volkameriana' were smooth.

'Shamouti' fruits from trees on sour orange had the

highest juice soluble solids and vitamin C content at the different picking dates.

Fruit ripening was influenced by rootstock. The change in 'Shamouti' fruit color and the decrease in juice acid content of fruits from trees grafted on 'Volkameriana' and C. macrophylla started earlier than those on sour orange and 'Cleopatra' mandarin.

As a conclusion, citrus orchardist should be aware of the rootstock upon which 'Shamouti' orange is grafted, since reproductive and vegetative growth of the scion cultivar was very much influenced.

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Table 1. Analysis of variance of average shoot growth of 'Shamouti' orange trees for the first and the second flush periods and the seasonal growth, 1991.

Source of variation	df	Mean square: First flush growth	Mean square: Second flush growth	Mean square: Seasonal growth
Rep.	2	114.3	414.7	280.6
Treat.	3	3189.0	3036.7	7468.4
Error	6	137.7	274.0	337.8
Coefficient of variation		7.73%	38.28%	9.42%
F value		23.16	11.08	22.11

Table 2. Analysis of variance of initial and final fruit set percent, ratio between leafy and leafless inflorescences and fruit set efficiency of 'Shamouti' orange trees, 1991.

Source of variation	df	Mean square: Initial fruit set %	Final fruit set %	Ratio leafy to leafless inf.	Fruit set effic.
Rep.	2	34.436	0.591	0.819	471.8
Treat.	3	354.476	4.361	3.309	1014.2
Error	6	59.388	1.471	1.728	
Coefficient of variation		51.49%	51.43%	68.58%	80.18%
F value		5.97	2.97	1.92	2.3

Table 3. Analysis of variance of weight, volume, specific gravity and fruit number of 'Shamouti' orange fruits, 1991.

Source of variation	df	Mean square			
		Fruit weight	Fruit volume	Specific gravity	Fruit No.
Rep.	2	674.1	532.8	9.91	1314.7
Treat.	3	422.33	389.0	8.61	17229.6
Error	6	218.080	287.1	15.38	3978.3
Coefficient of variation		5.72 %	5.58%	4.60%	45.38%
F value		1.9	1.4	0.56	4.33

Table 4. Analysis of variance of peel color change of 'Shamouti' orange fruits, 1991.

Source of variation	df	Mean square			
		Sampling date			
		Nov.17	Nov. 24	Dec. 2	Dec. 9
Rep.	2	8.332	14.58	2.08	6.25
Treat.	3	25.00	18.75	100.00	52.08
Error	6	8.333	22.92	43.75	6.25
Coefficient of variation		31.49%	31.05%	24.80%	6.90%
F value		3.0	0.82	2.28	8.33

Table 5. Analysis of variance of peel thickness and ratio between length and width of 'Shamouti' orange fruits, 1991.

Source of variation	df	Mean square: Average peel thickness	Mean square: Ratio between length and width
Rep.	2	1.92	0.001
Treat.	3	4.17	0.003
Error	6	0.90	0.001
Coefficient of variation		12.38 %	2.85 %
F value		4.62	2.49

Table 6. Analysis of variance of fruit juice percent and juice pulp percent of 'Shamouti' orange fruits, 1991.

Source of variation	df	Mean square	
		Average juice percent	Average pulp percent
Rep.	2	5.958	5.53
Treat.	3	58.903	3.70
Error	6	3.62	2.61
Coefficient of variation		4.4 %	17.18 %
F value		16.27	1.42

Table 7. Analysis of variance of juice pH of 'Shamouti' orange fruits harvested at four picking dates in 1991

Source of variation	df	Mean square Picking date Nov. 17	Nov. 24	Dec. 2	Dec. 9
Rep.	2	0.003	0.006	0.010	0.006
Treat.	3	0.019	0.005	0.002	0.003
Error	6	0.004	0.010	0.006	0.008
Coefficient of variation		1.80 %	2.66 %	1.96 %	2.33 %
F value		4.19	0.51	0.40	0.38

Table 8. Analysis of variance of juice total acids percent of 'Shamouti' orange fruits harvested at four picking dates in 1991.

Source of variation	df	Mean square Nov. 17	Nov. 24	Dec. 2	Dec. 9
Rep.	2	0.009	0.008	0.013	0.021
Treat.	3	0.039	0.018	0.007	0.007
Error	6	0.015	0.004	0.002	0.003
Coefficient of variation		16.96 %	10.39 %	7.16 %	8.56 %
F value		2.53	4.54	3.47	2.42

Table 9. Analysis of variance of juice soluble solids content of 'Shamouti' orange fruits harvested at four picking dates in 1991.

Source of variation	df	Mean square			
		Nov. 17	Nov. 24	Dec. 2	Dec. 9
Rep.	2	0.801	1.178	1.616	1.110
Treat.	3	1.518	1.70	2.890	0.892
Error	6	0.362	0.53	0.649	0.782
Coefficient of variation		4.96 %	6.13 %	6.84 %	7.34 %
F value		4.19	3.22	4.45	1.14

Table 10. Analysis of variance of vitamin C of 'Shamouti' orange fruits harvested at four picking dates in 1991.

Source of variation	df	Mean square			
		Nov. 17	Nov.24	Dec. 2	Dec. 9
Rep.	2	5.06	3.43	10.991	14.93
Treat.	3	17.12	74.29	164.401	174.90
Error	6	5.46	12.69	9.913	22.05
Coefficient of variation		5.93 %	8.56 %	6.59 %	9.34 %
F value		3.13	5.85	16.59	7.93

ملخص

سلوك صنف البرتقال الشموطي المطعم على بعض اصول الحمضيات المختلفة في وادي الاردن

تم دراسة تأثير أربعة من اصول الحمضيات وهي الخشخاش ، الفولكامريانا ، الكليوبترا مندرين والماكروفيلا على النمو الخضري والاثماري بما فيها صفات الثمار ونضجها لصنف البرتقال الشموطي النامي في منطقة دير علا في وادي الاردن ، وتبين من الدراسة أن براعم اشجار البرتقال الشموطي المطعمة على اصل الفولكامريانا تفتحت مبكراً ، وكانت نسبة النورات الورقية الى النورات الغير ورقية فيها اعلى منها من الاشجار على باقي الاصول . كما اظهرت الدراسة أن الاشجار المطعمة على اصلي الفولكامريانا وكليوبترا مندرين كانت أكبر حجماً من الاشجار المطعمة على باقي الاصول كما كانت نسبة عقد الثمار للاشجار المطعمة على اصلي الفولكامريانا وماكروفيلا اعلى منها عما في الاصول الاخرى . لقد كانت ثمار اشجار البرتقال الشموطي المطعمة على الخشخاش والكليوبترا مندرين ذات قشرة سميكة ونسبة عصير اقل مقارنة بالاصول الاخرى . كما لوحظ أن ثمار الاشجار المطعمة على اصلي الخشخاش والماكروفيلا كانت خشنة بالمقارنة مع ثمار الاشجار على الاصول الاخرى .

لقد كانت نسبة الحموضة في ثمار اشجار الشموطي المطعمة على الخشخاش والكليوبترا مندرين اعلى منها في ثمار الشموطي عن الاصول الاخرى بينما كانت اعلى نسبة مواد صلبة ذائبة وفيتامين ج في عصير ثمار اشجار الشموطي المطعمة على اصل الخشخاش وذلك في مختلف مواعيد القطف . كما لوحظ أن اشجار الشموطي على اصلي الفولكامريانا وماكروفيلا اعطت إنتاجاً أكبر كما كانت ثمارها مبكرة في النضج بالمقارنة مع ثمار الاشجار على باقي الاصول .