Dirasat, Agricultural Sciences, Volume **33**, No. **2**, 2006

Effect of Four Rootstocks on Fruit Quality of 'Washington Navel' Sweet Orange under Jordan Valley Condition

Hani D. Ghnaim and Jalal A. Al-Muhtaseb *

ABSTRACT

Fruit quality of 'Washington Navel' sweet orange grafted on four rootstocks: sour orange (*Citrus aurantium)*, 'Cleopatra' mandarin (*Citrus reticulata*), *Citrus volkameriana* and *Citrus Macrophylla* was evaluated under Jordan Valley condition during the season of 2000. Fruits of 'Washington Navel' orange trees grafted on *C. macrophylla* increased average fruit weight compared with those on 'Cleopatra' mandarin. Also, fruits of trees grafted on *C. macrophylla* significantly gave the highest fruit length, diameter and the thickest rind, and the least values were on 'Cleopatra' mandarin and sour orange. Fruit juice percentage was increased when trees were grafted on *C. volkameriana* compared with those on *C. macrophylla* which gave the least juice percentage. The highest fruit TSS percentage was for fruits of tree grafted on sour orange while the least was for those grafted on both *C. volkameriana* and *C. macrophylla*.

KEYWORDS: Fruit quality, Washington Navel, sweet orange, (Citrus sinensis), rootstocks.

1. INTRODUCTION

Citrus is a major crop all over the world as well as in Jordan in which the area planted is about 6200 hectare (Ministry of Agriculture Statistics, 2002). In Jordan, most citrus trees are grafted on sour orange, which is known for its resistance to gummosis, and high tolerance to wet calcareous soils (Wutscher, 1979), making it well adapted to surface irrigation system used by many farmers in the Jordan Valley.

Citrus rootstocks have been used for a long time and their effects on the performance and characteristics citrus scion cultivars have been reported by many researchers and they differ in their effects on production and tree size. 'Marsh' and 'Red blush' grapefruit grafted on Palestine sweet lime and *C. volkameriana* gave the highest production compared to those grafted on sour orange and 'Cleopatra' mandarin. Also, Citrus rootstocks affect fruit volume and weight, rind thickness, juice content and total soluble solids (Economides *et al.*, 1993; Fallahi, *et al.* 1989; Mehrotra *et al.*, 2000 and Ramin and Alirezanezhad, 2005). Similar effects of Citrus rootstocks were observed for 'Washington navel' and 'Valencia' oranges and 'Minneola' tangelo (Roose *et al.*, 1989). Sweet orange varieties with respect to tree size and vigor, yield and fruit quality (juice %, total soluble solids, titratable acidity, fruit weight, size, length and diameter) were influenced by rootstock type (Ghnaim, 1993; Reyes *et al.*, 1984; Salibe and Mischan, 1984; Wheaton *et al.*, 1991; Wheaton *et al.*, 1995; Wutscher, 1979 and Wutscher and Bistline, 1988). The fact that sour orange is susceptible to viral diseases such as 'Tristeza', and to avoid the risk of incidence in the future in citrus orchards in the Jordan Valley, several rootstocks had been introduced and tested for their compatibility, tolerance and adaptability.

This study was carried out to evaluate fruit characteristics of 'Washington Navel' sweet orange grafted on four Citrus rootstocks grown in the Jordan Valley.

2. MATERIAL AND METHODS

This study was conducted in Wadi Al-Rayyan northern Jordan Valley during the season of 2000. Twelve 20-year old 'Washington Navel' sweet orange (*Citrus sinensis* Osbeck) grafted on four rootstocks: Sour orange (*Citrus aurantium* L.), 'Cleopatra' mandarin (*Citrus reticulata* Blanco), Volkamer lemon (*Citrus volkameriana* L.*)* and

* National Center for Agricultural Research and Technology Transfer (NCARTT). Received on 27/9/2005 and Accepted for Publication on 9/4/2006.

Table 1. Effect of four rootstocks on average fruit weight, length, diameter seed number and rind thickness of 'Washington Navel' sweet orange.

Treatments	F.wt. (gm)	F L (mm)	F D (mm)	F. Seed no.	R. TH (mm)
'Cleopatra' Mandarin	*187.6 d	75.7 c	73.3 c	2.7 a	4.2 b
Sour Orange	198.7 c	74.7 c	75.6 bc	1.3 a	5.0 b
C. Macrophylla	233.9 a	86.3 a	81.7 a	2.1 a	6.2 a
C. Volkameriana	214.9 b	82.3 b	77.0 b	1.1 a	4.7 b

* Mean separation within columns by LSD test, values that don't share the same letter are significantly different at the 5 % level.

Table 2. Effect of four rootstocks on juice and total soluble solids percentages and juice pH of 'Washington Navel' sweet orange.

Treatments	Juice %	TSS %	Juice pH
'Cleopatra' Mandarin	47.5 a	12.0 b	3.68 b
Sour Orange	46.2 ab	12.8 a	3.85 a
C. Macrophylla	43.7 b	11.0 c	3.88 a
C. Volkameriana	48.5 a	10.5 c	3.85 a

* Mean separation within columns by LSD test, values that don't share the same letter are significantly different at the 5 % level.

Macrophylla (*Citrus macrophylla* Wester.) and spaced 6x6 m. The trees received uniform standard cultural practices as practiced by orchardists in the Jordan Valley. The experiment was designed according to the Randomized Complete Block Design with three replicates and one tree on each rootstock per replicate.

Rootstock effect on 'Washington Navel' sweet orange was evaluated in relation to fruit characteristics including fruit weight, length and diameter (measured by a digital caliper), seed number, rind thickness (including Albedo and Flavedo), juice percentage (w/w), total soluble solids (measured by a refractometer) and juice pH (measured by a pH tester). To perform this, 5 kg of fully colored fruits were randomly collected at shoulder's level from each replicate on different rootstock and analyzed.

Recorded data were statistically analyzed by ANOVA and mean separation was calculated according to LSD at the 5% level of significance.

3. RESULTS AND DISCUSSION

The results indicated that trees grafted on *C. macrophylla* significantly gave the heaviest average fruit weight (233.9 gm), while those grafted on 'Cleopatra' mandarin gave the least fruit weight (187.6 gm). With respect to fruit length and diameter, 'Washington Navel' fruits from *C. macrophylla* significantly gave the longest fruit (86.3 mm) and diameter (81.7 mm), while the least values were recorded for those grafted on 'Cleopatra' mandarin (75.7, 73.3 mm) and Sour orange (74.7, 75.6 mm) (Table 1).

Although no significant differences for seed number were observed among the four rootstocks, 'Washington Navel' fruits from both 'Cleopatra' mandarin and *C. macrophylla* gave the highest number, while those from *C. volkameriana* and Sour orange gave the least seed number per fruit (Table 1). In addition, 'Washington Navel' fruits from *C. macrophylla* significantly gave the thickest rind (6.2 mm) followed by those from both Sour orange and *C. volkameriana* (5.0 and 4.7 mm, respectively); and 'Cleopatra' mandarin (4.2 mm) (Table 1).

Despite the little differences recorded for juice percentage; 'Washington Navel' fruits from *C. volkameriana* gave the highest juice percentage (48.5 %) while those from *C. macrophylla* gave the least juice percentage (43.7 %). The highest fruit TSS percentage was for fruits from Sour orange (12.8 %), while the least was for those from both *C. volkameriana* and *C.*

macrophylla (10.5 and 11.0 %, respectively). The highest juice pH was recorded for *C. macrophylla*, sour orange and *C. volkameriana* which were significant over those from 'Cleopatra' mandarin (Table 2).

According to several researches, citrus trees grafted on sour orange rootstock can be expected to produce medium-sized to large fruit with high Total Soluble Solids (TSS %) and high juice acidity (Ghnaim, 1993; Ramin and Alirezanezhad, 2005; Wutscher, 1979 and Zekri and Al-Jaleel, 2004) which was observed in the results of this study except for juice acidity. However, other researchers found different sweet orange scion-rootstocks interactions; 'Hamlin' sweet orange grafted on sour orange gave the highest fruit juice percentage (Wutscher and Bistline, 1988), while 'Shamouti' trees grafted on sour orange gave fruits with thick rind and the least juice content (Ghnaim, 1993).

On the other hand, Citrus trees grafted on lemon rootstocks are usually expected to produce larger fruits with poor fruit quality; thick rinds, low total soluble solids and low juice acidity (Ghnaim, 1993; Reyes *et al.*, 1984; Ramin and Alirezanezhad, 2005; Wutscher and Bistline, 1988 and Zekri and Al-Jaleel, 2004) which are in general agreement with the results of this study, although 'Washington Navel' trees grafted on *C. volkameriana* gave the highest juice percentage.

In addition, Citrus trees grafted on 'Cleopatra' mandarin rootstock would be expected to produce small fruits with high total soluble solids and juice acidity tend to be higher than the other rootstocks (Wutscher, 1979) which are in general agreement with the results of this study.

REFERENCES

Econoimdes, C.V and Gregrious, C. 1993. Growth, Yield and Fruit Quality of Nucellar Frost 'Marsh' Grapefruit on Fifteen Rootstocks in Cyprus. *J. Amer. Soc. Hort. Sci.*, 118 (3): 326-329.

Fallahi, E., Moon, J.W. and Rodney, D.R. 1989. Yield and Quality of 'Red Blush' Grapefruit on Twelve Rootstocks. *J. Amer. Soc. Hort. Sci.*, 114 (2): 187-190.

Ghnaim, H. 1993. *Performance of 'Shamouti' Orange Grafted on some Citrus Rootstocks in Jordan Valley*. MSc. Thesis, Univ of Jordan, 65.

Mehrotra, N.K., Kumar, H., Vij, V. K. and Aulakh, P.S. 2000. Performance of Jaffa Cultivar of Sweet Orange (Citrus Sinensis (L.) Osbeck) on Different Rootstocks. *J. of Research-Punjab Agricultural University*, 37(1 and 2): 56-60 (Abstract).

Ministry of Agriculture, 2002. Annual Statistical Report.

Ramin, A. and Alirezanezhad, A. 2005. Effects of Citrus Rootstocks on Fruit Yield and Quality of Ruby Red and Marsh Grapefruit. *Fruits*, 60 (5): 311-317.

Reyes, F.J., Monteverde, E. and Espinoza, M. 1984. Preliminary Results of "Valencia'' Orange on Several Rootstocks in Venezuela. *Proc. Int. Soc. Citriculture*, 1: 34-35.

Roose, M.L., Cole, D.A. and R.S. Atkupper, 1989. Yield and Tree Size of Four Citrus Cultivars on 21 Rootstocks in California. *J. Amer. Soc. Hort. Sci.*, 114 (4): 678-684.

Salibe, A.A., and Mischan, M.M. 1984. Effect of Ten Rootstocks on Tree Size, Early Bearing and Fruit Quality of Satsuma Mandarin Trees. *Proc. Int. Soc. Citriculture*, 1: 55-57.

Wheaton, T.A., Castle, W.S., Whitney, J.D. and Tucker, D.P.H. 1991. Performance of Citrus Scion Cultivars and Rootstocks in a High-density Planting. *Hort Science*, 26 (7): 837-840 (Abstract).

Wheaton, T.A., Whitney, J.D., Castle, W.S., Muraro, R.P., Browning, H.W. and Tucker, D.P.H. 1995. Citrus Scion and Rootstock, Topping Height, and Tree Spacing Affect Tree Size, Yield, Fruit Quality, and Economic Return. *J. Amer. Soc Hort. Sci.*, 120 (5) (Abstract).

Wutscher, H. K. 1979. Citrus Rootstocks. *Horticultural Reviews*, 1: 237-269.

Wutscher, H.K. and Bistline, F.W. 1988. Performance of 'Hamlin' Orange on 30 Citrus Rootstocks in Southern Florida. *J. Amer. Soc Hort. Sci.*, 113: 493-497.

Zekri, M. and Al-Jaleel, A. 2004. Evaluation of Rootstocks for Valencia and Navel Orange Trees in Saudi Arabia. *Fruits*, 59: 91-100.

تأثير أربعة أصول على نوعية ثمار صنف البرتقال "أبو صرة" تحت ظروف وادي الأردن

هاني غنيم وجلال المحتسب*

ملخص

تم تقييم مواصفات ثمار صنف البرتقال "أبو صرة" المطعم على أربعة أصول هي: الخشخاش، كليوباترا مندرين، ونوعين من الليمون هما فولكامريانا وماكروفيلا في منطقة وادي الأردن خلال الموسم 2000م.

أظهرت النتائج زيادة في وزن ثمار البرتقال "أبو صرة" المطعم على الأصل ماكروفيلا مقارنة بتلك المطعمة على الأصل كليوباترا مندرين. وسجلت ثمار "أبو صرة" المطعم على الأصل ماكروفيلا معنويا أعلى معدل لكل من طول الثمرة وقطرها وسماكة قشرتها، بينما سجلت تلك المطعمة على الأصل كليوباترا مندرين معنويا أدنى القيم. ولوحظ زيادة نسبة عصير ثمار البرتقال "أبو صرة" المطعمة على الأصل فولكامريانا مقارنة بثمار الأشجار المطعمة على الأصل ماكروفيلا التي سجلت معنويا اقل نسبة عصير في ثمارها.

وبالنسبة لمعدل نسبة المواد الصلبة الذائبة فقد تميزت ثمار الأشجار المطعمة على اصل الخشخاش وسجلت أعلى نسبة مقارنة بثمار الأشجار المطعمة على الأصلين فولكامريانا وماكروفيلا، بينما لوحظ ارتفاع رقم حموضة عصير ثمار الأشجار المطعمة على الأصل ماكروفيلا والخشخاش وبفروق معنوية عن بقية المعاملات.

الكلمات الدالة: نوعية الثمار، برتقال، أبو صرة، Citrus sinensis، أصول.

* المركز الوطني للبحوث الزراعية ونقل التكنولوجيا (نكارت). تاريخ استلام البحث 2005/9/27، وتاريخ قبوله 2006/4/9.