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Short Communication

Effect of four rootstocks on fruit quality of sweet orange c.v. 'Shamouti' under Jordan valley conditions

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Abstract: Fruit quality of sweet orange c.v. 'Shamouti' grafted on four rootstocks: sour orange (*Citrus aurantuim*), 'Cleopatra' mandarin (*Citrus reticulata*), volkamer lemon (*Citrus volkameriana*) and macrophylla (*Citrus macrophylla*) were studied in the Jordan Valley during the 2000 season. The results indicated that 'Shamouti' grafted on macrophylla significantly gave the largest fruit weight, length, diameter and the thickest peel, while 'Shamouti' on 'Cleopatra' mandarin gave the least values. The highest juice percentage was observed when 'Shamouti' was grafted on 'Cleopatra' mandarin; however, 'Shamouti' on sour orange was the least. In addition, the highest TSS percentage was for 'Shamouti' on sour orange compared to those on macrophylla. The opposite was for juice pH; 'Shamouti' on macrophylla gave the highest juice pH, while those on volkamer lemon gave the least juice pH.

Keywords: Fruit quality, shamouti, sweet orange, *Citrus sinensis*, rootstocks.

تأثير أربعة أصول في نوعية ثمار البرتقال الحلو صنف "شموطي" تحت ظروف وادي الأردن

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الملخص: تم دراسة مواصفات ثمار البرتقال الحلو صنف "شموطي" مطعما على أربعة أصول هي: خشخاش، كليوباترا مندرين، فولكامريانا، وماكروفيلا تحت ظروف وادي الأردن خلال موسم العام 2000م، وحللت النتائج حسب القطاعات العشوائية الكاملة وبثلاثة مكررات لكل معاملة. وأشارت النتائج إلى أن ثمار الشموطي المطعم على أصل ماكروفيلا أعطت أعلى معدل وزن وطول وقطر للثمار مقارنة بأشجار الشموطي المطعمة على أصل كليوباترا مندرين التي أعطت أقل القراءات. بالإضافة إلى ذلك فإن ثمار الشموطي على أصل كليوباترا مندرين أعطت أعلى نسبة عصير للثمار في حين أعطت على أصل الخشخاش أقل نسبة عصير للثمار. كما وجد أن ثمار الشموطي على أصل الخشاش أعطت أعلى نسبة مواد صلبة ذائبة كلية وأقلها كانت للثمار الناتجة من تطعيم الشموطي على أصل ماكروفيلا. وبالعكس من ذلك فإن عصير الثمار الناتجة من تطعيم الشموطي على أصل ماكروفيلا كان ذو pH مرتفع في حين سجلت ثمار الشموطي على أصل فولكامريانا أدنى pH للعصير.

كلمات مفتاحية: جودة الثمار، شموطي، البرتقال الحلو، *Citrus sinensis*، الأصول.

Introduction

Citrus is one of the major crops in Jordan, in which the area planted is about 6200 hectare (Ministry of Agriculture Statistics, 2004). Most of our citrus trees are grafted on sour orange rootstock, which is known for its resistance to gummosis, and high tolerance to wet calcareous soils (Wutscher, 1979), making it well adapted to surface irrigation used by many farmers in the Jordan Valley.

However, because of the fact that sour orange is susceptible to viral diseases such as 'Tristeza', several rootstocks were introduced and tested for their compatibility, tolerance and

adaptability to avoid the risk of future incidence in citrus orchards in the Jordan Valley.

Citrus rootstocks have been used for a long time, and their effects on the performance and characteristics of scion cultivars have been reported by many researchers. Grapefruits c.v. 'Marsh' and c.v. 'Red blush' grafted on both Palestine sweet lime and volkamer lemon gave the highest production compared to those on sour orange and 'Cleopatra' mandarin (Fallahi et al., 1989; Eonomides et al., 1993). In addition, "citrus rootstocks' effects on fruit volume, weight, rind thickness, juice content and total soluble solids of different citrus varieties were also reported (Mehrotra et al., 2000; Ramin and Alirezanezhad, 2005). Ghnaim (1993) in his study observed differences among rootstocks studied on fruit quality of sweet orange c.v. 'Shamouti' in respect to fruit weight, peel thickness, juice percent, total acidity, vitamin C and total yield. In the same manner, Georgiou and Georgiou (1999) reported that sweet orange c.v. 'Shamouti' fruit quality including fruit size and weight, rind thickness, juice content, Brix and total acids were also affected by rootstock type. Similar effects were noticed for other sweet orange varieties (Wutscher, 1979; Reyes et al., 1984; Salibe and Mischan, 1984; Wutscher and Bistline, 1988, Wheaton et al., 1991 and Wheaton et al., 1995).

This work was carried out to study the fruit quality of sweet orange c.v. 'Shamouti' grafted on four rootstocks under Jordan Valley conditions.

Material and Methods

This study was conducted in Wadi Al-Rayyan in the northern Jordan Valley during the 2000 season. Twelve 20-years old trees of sweet orange c.v. 'Shamouti' (*Citrus sinensis* Osbeck) were chosen uniform in respect to age and size. Trees were grafted on four rootstocks: Sour orange (*Citrus aurantuim* L.), 'Cleopatra' mandarin (*Citrus reticulata* Blanco.), Volkamer lemon (*Citrus volkameriana* L.), and Macrophylla (*Citrus macrophylla* Wester.) and spaced 6 x 6 m. The trees received similar cultural practices as practiced by orchardists in the Jordan Valley in respect to irrigation, fertilization, pest management and weeding. Orchard soil texture was clay, and the pH, EC and $CaCO_3$ were 8.2, 1.0 dS/m and 35.0 %, respectively.

On 15th of January, 25 kg of fully colored 'Shamouti' fruits were randomly picked around tree periphery at shoulder level from each treatment. Fruits were weighed, length and diameter were measured by a digital caliper, and fruits were cut in half. Rind thickness (including Albedo and Flavedo) was measured by a digital caliper. Juice was extracted with an electric citromatic and weighed to calculate the juice percentage (w/w) and filtered, and the seed number per fruit was counted. Total soluble solids were measured using a Fisher® refractometer, and the juice pH was measured using a pH meter (A.O.A.C., 1970).

Collected data was statistically analyzed by ANOVA according to Randomized Complete Block Design with three replicates, and mean separation was calculated according to the Least Significant Differences (LSD) method at the 5% level of significance.

Results and Discussion

The results indicated that 'Shamouti' trees on macrophylla gave the significantly heaviest average fruit weight, 22-24% heavier than those on both volkamer lemon and 'Cleopatra' mandarin (both gave the least fruit weight), and by 11% compared with 'Shamouti' trees on sour orange which gave medium fruit weight (Figure 1). This could be correlated with fruit length

and diameter; trees grafted on macrophylla gave the significantly largest fruit length and diameter, and the least values were for 'Shamouti' trees on 'Cleopatra' mandarin; also, sour orange gave intermediate values (Figure 2). This agrees with the findings of Wutscher (1979), Wutscher and Bistline (1988), Zekri and Al-Jaleel (2004) and Al-Jaleel et al. (2005) who reported that citrus species grafted on lemon rootstocks (volkamer and macrophylla) produced usually larger fruits (except for 'Shamouti' trees on volkamer lemon in this study), while on sour orange rootstock they produced medium to large size fruits, and on 'Cleopatra' mandarin rootstock they produced smaller fruits. However, Ghnaim (1993) found that 'Shamouti' trees on 'Cleopatra' mandarin gave the largest fruit size.

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 (Table 1). This agrees with the results of Wutscher (1979) and Fallahi et al., (1989). On the other hand, trees on 'Cleopatra' mandarin gave the significantly least rind thickness (Figure 2), which does not agree with the results of Ghnaim (1993) who found that 'Shamouti' trees on 'Cleopatra' mandarin gave fruits with thick rinds. Although no significant differences were observed among rootstocks in respect to seed number per fruit, 'Shamouti' trees on sour orange gave the highest seed number, while those on both volkamer lemon and 'Cleopatra' mandarin gave the least seed number (Figure 3).

'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 (Figure 4). However, Ghnaim (1993) reported that 'Shamouti' fruits from trees on both sour orange and 'Cleopatra' mandarin gave less juice percentage compared to both macrophylla and volkamer lemon rootstocks. On the contrary, Wutscher and Bistline (1988) found that sweet orange c.v. 'Hamlin' grafted on sour orange rootstock had the highest fruit juice percentage.

The results showed that rootstocks influenced TSS percentage; 'Shamouti' fruits on sour orange rootstock had the highest TSS percentage while the least TSS percentage was found in 'Shamouti' on macrophylla, which could be due to the production of larger fruit (Figure 4). This agrees with Wutscher (1979), Fallahi et al. (1989), Ghnaim (1993) and Al-Jaleel et al. (2005), who found that citrus trees grafted on sour orange rootstock produced fruits with high total soluble solids (TSS %) while trees on lemon rootstocks produced larger fruits with low total soluble solids.

In addition, '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 (Figure 5).

The nature of scion-rootstock relationship is very complex and the mechanism of how rootstocks influence scion fruit quality is not clear; three approaches can be considered: some of the rootstock effects appear to be related to the nutritional uptake and utilization (increased supply of water and nutrients of certain rootstocks rather than others). This increases tree size and produces larger fruits with lower soluble solids, which was noticed in this study. The second approach of rootstocks influence could be based on the efficiency of a rootstock in absorbing and translocating mineral nutrients and water (e.g. potassium increases fruit size and acidity). The third approach could be related to the inability to produce, conduct or utilize some endogenous growth promoters such as auxins and

gibberellins (Hartmann and Kester, 1987 and Wutscher, 1979).

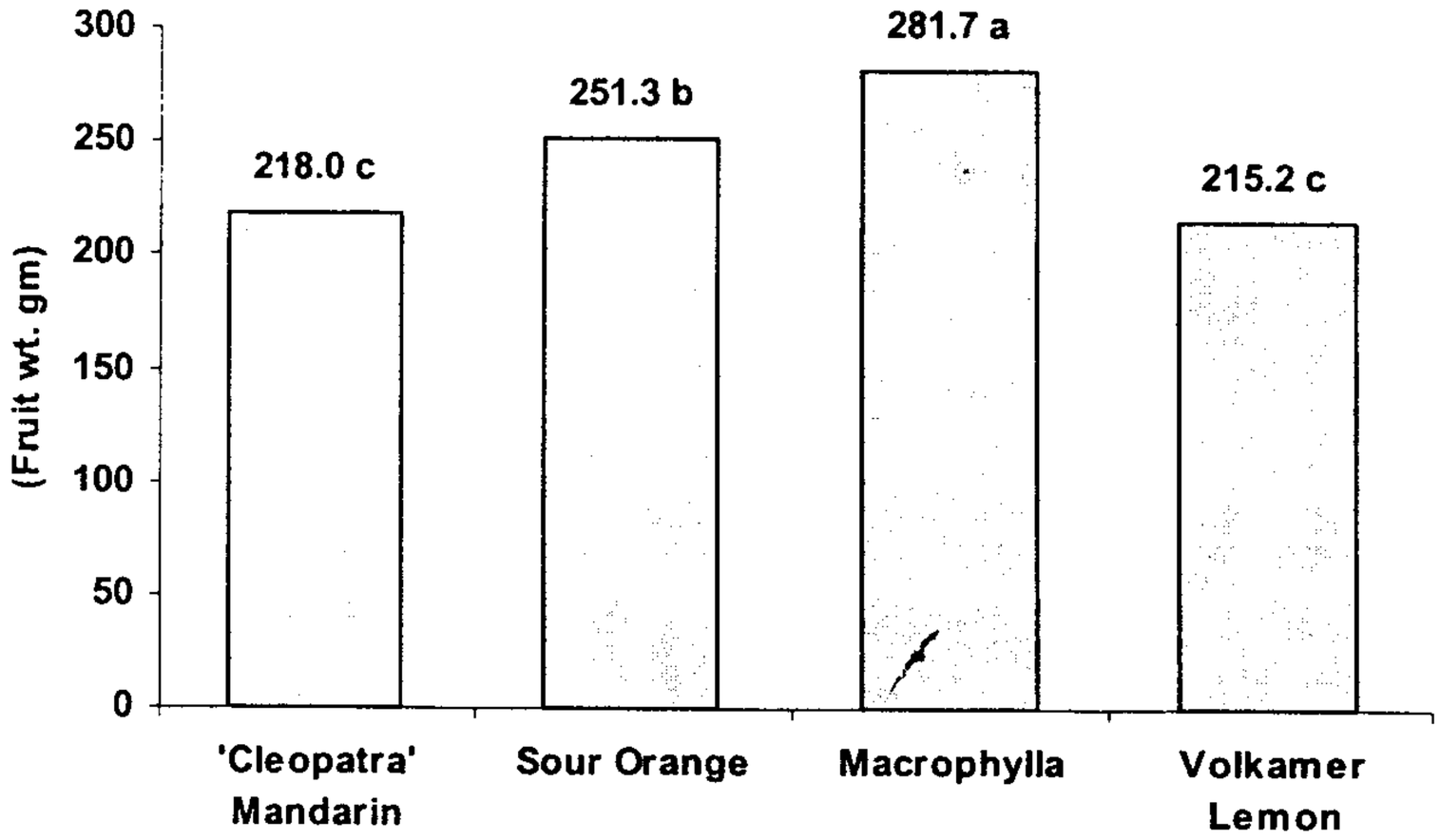

Figure 1. Effect of rootstocks on average fruit weight (gm) of sweet orange c.v. 'Shamouti'.

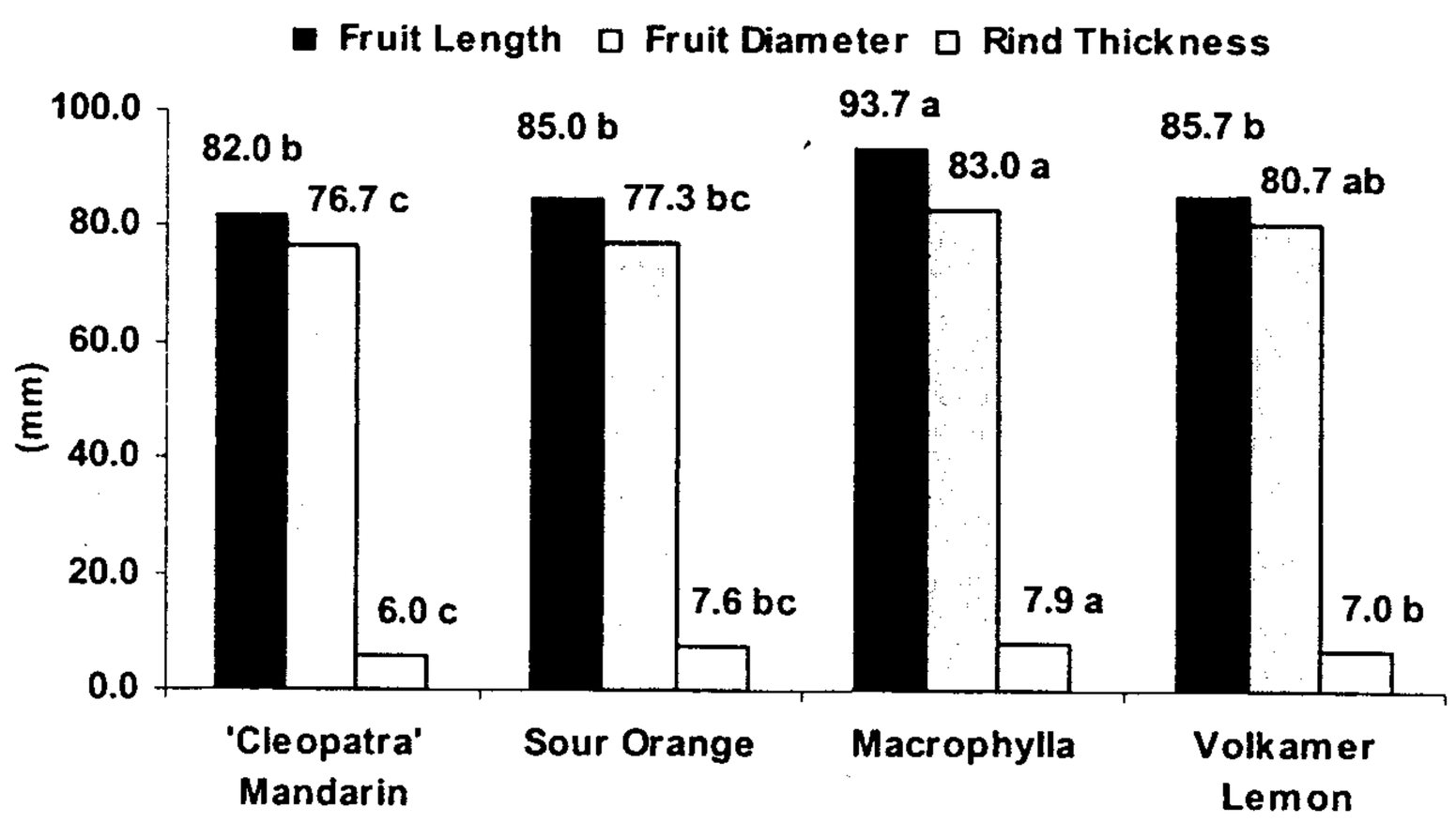

Figure 2. Effect of rootstocks on average fruit length, diameter and rind thickness (mm) of sweet orange c.v. 'Shamouti'.

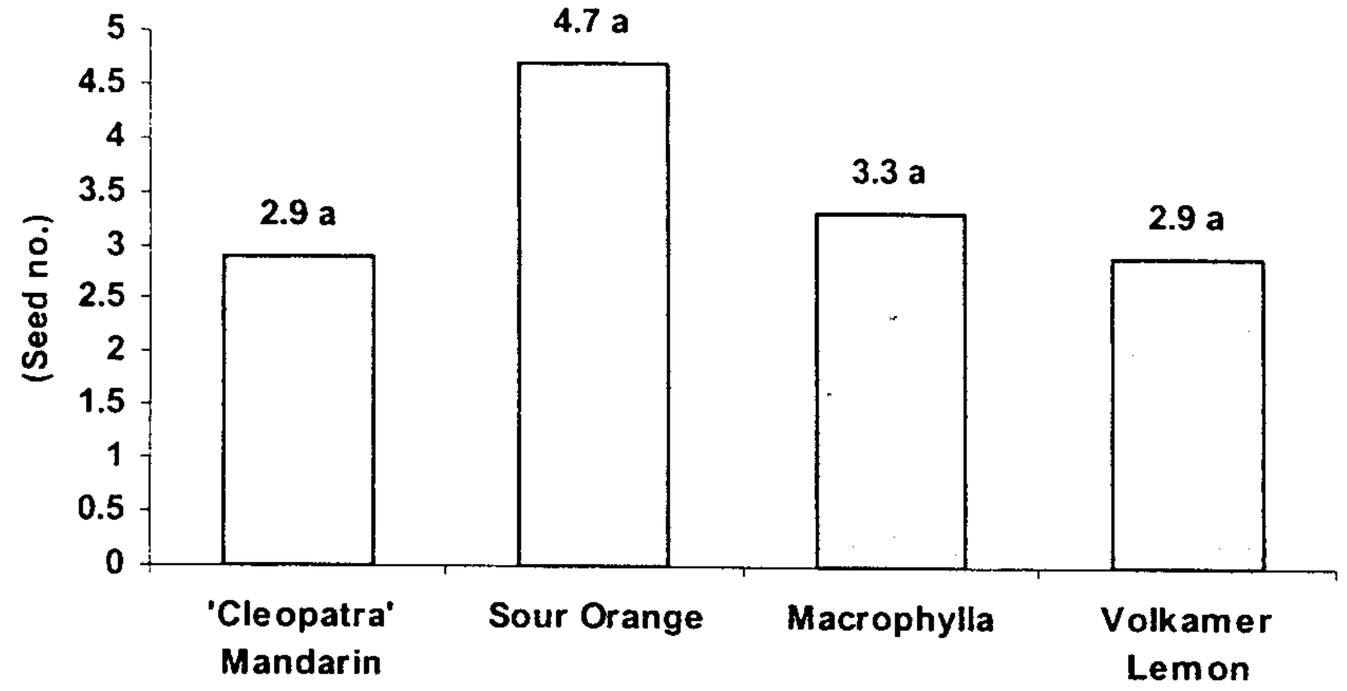

Figure 3. Effect of rootstocks on average seed number per fruit of sweet orange c.v. 'Shamouti'.

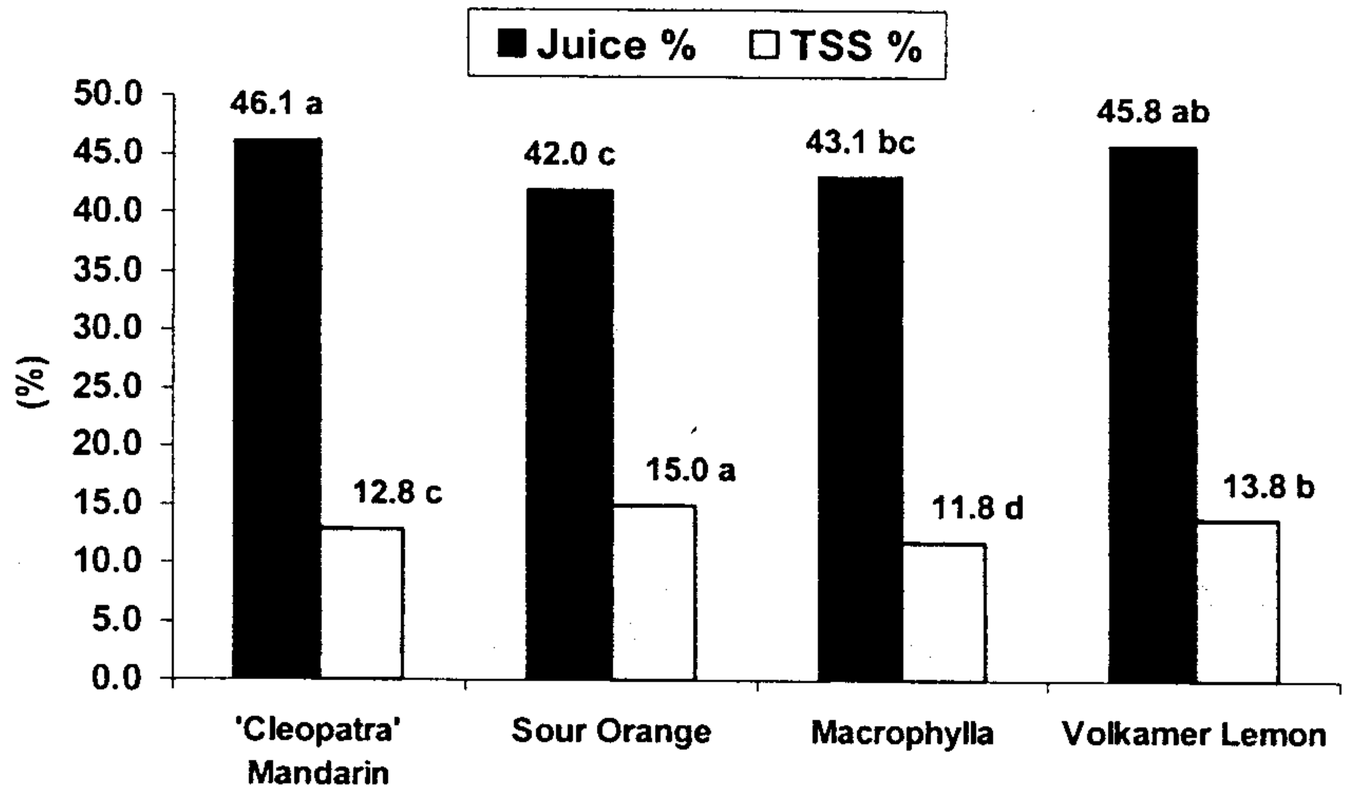

Figure 4. Effect of rootstocks on juice and total soluble solids percentages of sweet orange c.v. 'Shamouti'.

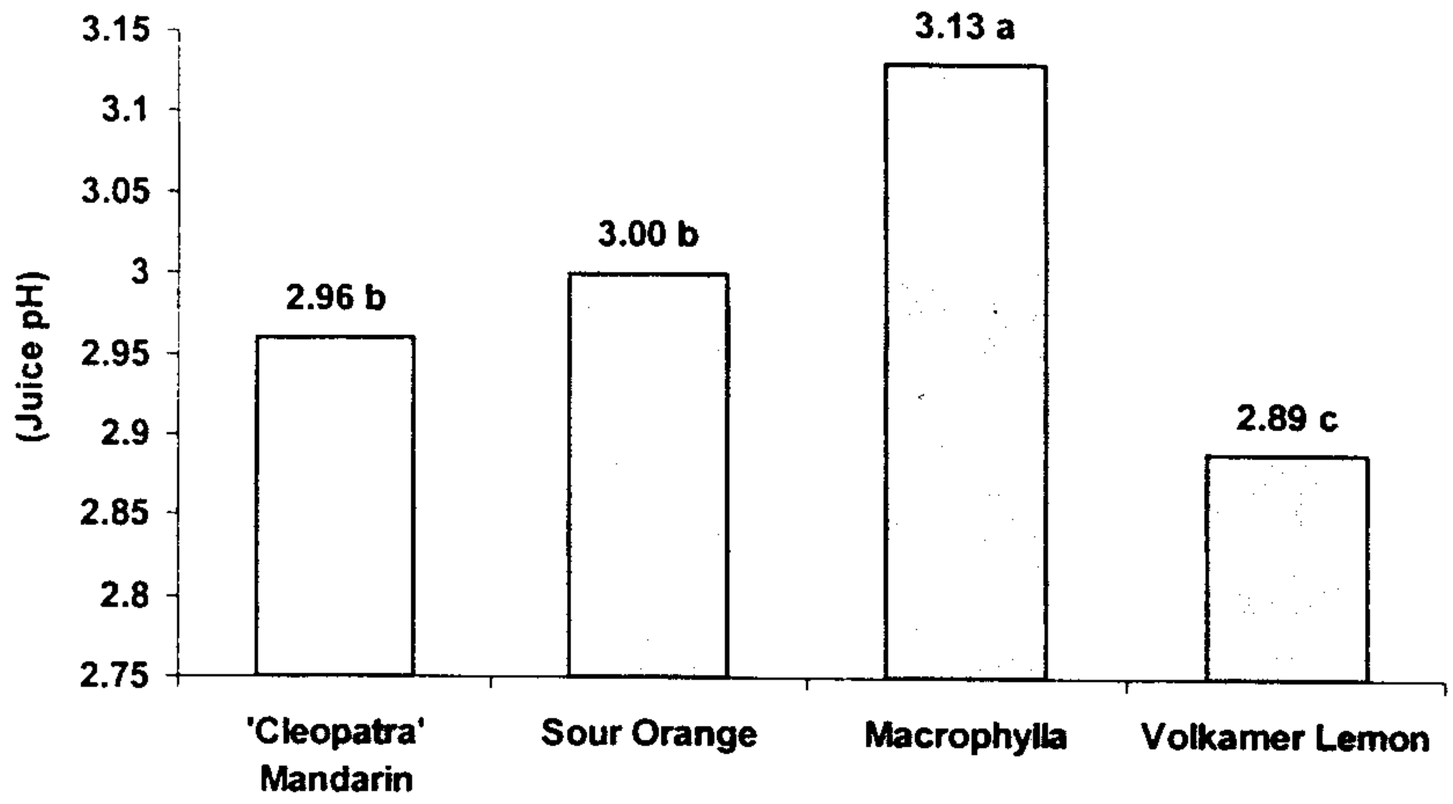

Figure 5. Effect of rootstocks on juice pH of sweet orange c.v. 'Shamouti'.

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