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The Influence of Five Rootstocks on the Fruit Quality of Three Orange Cultivars

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ABSTRACT

The physical and chemical fruit qualities of 3 orange cultivars (Hamlin, Washington Navel, and Valencia) grown on 5 different rootstocks (Sour Orange, Cleopatra Mandarin, Rough Lemon, Troyer Citrange and Rangpur Lime) were determined over 2 growing seasons (1977 and 1978). Orange fruits from trees grown on Rough Lemon rootstock were large in weight and volume, but relatively low in TSS, acidity, and ascorbic acid. Fruits from trees grown on Sour Orange and Cleopatra Mandarin, had similar fruit characters, they were relatively small in size and weight but contained high amounts of TSS, acidity, and ascorbic acid. Troyer Citrange and Rangpur Lime took intermediate trend, and were usually inconsistent in their effect on the orange fruit quality.

INTRODUCTION

Citrus rootstocks are known to influence the vigour, productivity, fruit quality, and longevity of the scion cultivars. Hodgson (7), and Minessy (9), reported that fruit characters such as size, weight, rind thickness, juice content, TSS, acidity, ascorbic acid, were the principal characters that might be affected by rootstocks.

Oranges in the Socialist People's Libyan Arab Jamahiriya are mostly grown on the Sour orange rootstock. The Faculty of Agriculture at Al-Fateh University has a program of testing some citrus cultivars for their adaptability as rootstocks in Libya, to find possible replacement for the tristiza-susceptible Sour Orange rootstock now being used. This report is based on one of a series of tests on trees planted in February, 1972. Results from some of these tests have already been published (4,5). The purpose of the present study was to evaluate the response of fruit quality of 3 orange cultivars to the various rootstocks used in the experiment.

MATERIALS AND METHODS

Three orange cultivars (Washington Navel, Hamlin, and Valencia) budded on five different rootstocks: Sour Orange *Citrus aurantium* L.; Rough Lemon *Citrus jambhiri* lush; Rangpur Lime *Citrus limonia* Osbeck; Cleopatra Mandarin *C. reshni* Hort. ex. Tan.; and Troyer Citrange *Poncirus trifoliata* (L.) Ref. × *C. sinensis* (L.) Osbeck; were used in this study. Trees were planted in February 1972, in a deep, sandy loam soil, relatively high in calcium carbonate and of a pH around 7.8. The trees lay-out was a randomized block design, with three replicates for each scion/stock combination. and

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every replicate consisted of 4 trees lined in a row. One composite representative sample of 20 fruits per replicate was used for the analysis of fruit quality. The characters of fruit studied, were fruit weight, fruit volume, fruit length, fruit diameter, length/diameter, rind thickness, juice volume per fruit, total soluble solids (TSS), acidity, TSS/acidity, and ascorbic acid (1). This study was carried out over 2 growing seasons (1977 and 1978). Fruits were harvested when they attained at least a ratio of 8:1 for TSS to acidity (3). Harvesting dates were December 12, 1977 and November 20, 1978 for Washington Navel; December 12, 1977 and November 21, 1978 for Hamlin; February 12, 1978 and February 28, 1979 for Valencia. All data were subjected to statistical analysis using Duncan's new multiple range test.

RESULTS AND DISCUSSION

Rootstocks have shown a profound effect on the physical and chemical properties of Hamlin, Navel, and Valencia orange fruits (Tables 1, 2, and 3). The response varied according to the cultivar.

1. Hamlin

Hamlin orange fruits grown on Sour Orange rootstock were found smallest in weight, volume, and rind thickness compared to fruits from trees grown on other rootstock, but they contained high amount of TSS, acidity, and ascorbic acid (Table 1). The largest Hamlin fruits in weight and volume were obtained from trees grown on Rough Lemon rootstock, but the fruits were significantly low in TSS, acidity, and ascorbic acid. The other rootstocks as shown in Table 1, did not show any consistent effect, and could generally be considered intermediate between the Sour Orange and Rough Lemon, as to their effect on the quality of Hamlin orange fruits. The fruit length, fruit diameter, length/diameter, and juice volume of Hamlin orange were not affected by rootstocks (Table 1).

2. Washington Navel

Navel orange grown on Cleopatra mandarin rootstock produced fruits of smallest weight, volume, length, diameter, and juice volume; while fruits from trees grown on Rough Lemon and Rangpur Lime rootstocks were found largest in these fruit characters, but had adversely affected the TSS, acidity, and to a certain extent ascorbic acid (Table 2). Troyer Citrange and Sour Orange were intermediate in their effect.

3. Valencia

The physical and chemical qualities of Valencia orange fruits were generally similar on all rootstocks, except on Rough Lemon. The weight, volume, diameter, and rind thickness of Valencia orange fruits were significantly increased on the Rough Lemon rootstock, but they were less in TSS, and acidity. Fruits from trees grown on Cleopatra Mandarin, and Sour Orange were found highest in TSS and ascorbic acid. The length/diameter was statistically similar for fruits on all rootstocks (Table 3), indicating that the shape of fruits was not influenced by any of the rootstocks.

From the three cultivars used in this study, it was generally observed that the Rough Lemon rootstock had induced the development of larger and heavier fruits, but were low in TSS and acidity. On the contrary, orange fruits grown on Cleopatra Mandarin were found small in size and weight, but contained high amounts of TSS and acidity. Troyer Citrange and Rangpur Lime rootstocks were generally intermediate in their effect on orange fruit weight and volume. Although Rough Lemon

Table 1 Effect of rootstocks on the quality of Hamlin orange fruits

Rootstock	Fruit weight (grm)	Fruit volumes (ml)	Fruit length (cm)	Fruit diameter (cm)	Length/ diameter	Rind thickness (mm)	Juice volume/ fruit (ml)	TSS %	Acidity %	TSS/Acidity	Ascorbic acid (mg/100 ml juice)
Cleopatra Mandarin	177.85ab	194.83abc	6.725a	6.528a	1.032a	4.63b	70.167a	9.917ab	1.003ab	9.938b	56.850ab
Sour Orange	167.70a	180.67a	6.738a	6.650a	1.017a	3.85a	63.330a	11.066c	1.050b	10.577c	59.470b
Rough Lemon	194.13b	219.83c	7.142a	7.095a	1.012a	4.48b	76.760a	9.3670a	0.943a	9.960b	54.667a
Troyer Citrange	178.60ab	191.60ab	6.836a	6.708a	1.022a	4.54b	67.200a	10.180a	1.048a	9.808b	55.380a
Rangpur Lime	185.35b	216.17bc	6.750a	6.706a	1.010a	4.35ab	73.167a	9.850ab	1.006ab	9.725a	57.867ab

[1]Means in a column followed by the same letter are not significantly different at P = 0.05 according to Duncan's multiple range test.

Table 2 Effect of rootstocks on the quality of Washington Navel orange fruits.[1]

Rootstock	Fruit weight (grm)	Fruit volume (ml)	Fruit length (cm)	Fruit diameter (cm)	Length/ diameter	Rind thickness (mm)	Juice volume/ fluid (ml)	TSS %	Acidity %	TSS/ acidity	Ascorbic acid (mg/100 ml juice)
Cleopatra Mandarin	286.96a	297.4a	8.25a	8.1a	1.018ab	5.440a	122.20a	10.34c	0.976b	10.60a	49.80abc
Sour Orange	333.00b	363.5b	8.75b	8.58b	1.018ab	5.733ab	141.50bc	10.23c	0.917ab	11.23ab	52.57bc
Rough Lemon	377.45c	420.83b	9.34c	9.00c	1.037ab	5.967b	156.00cd	9.13a	0.859a	10.79ab	46.68a
Troyer Citrange	328.25b	362.75b	8.89bc	8.51b	1.045b	5.750ab	136.50ab	10.63d	0.911a	11.67b	53.38c
Rangpur Lime	377.98c	410.50b	9.12bc	9.00c	1.013a	5.450a	162.17d	9.87b	0.899a	11.00ab	48.25ab

[1]Means in a column followed by the same letter are not significantly different at P = 0.05 according to Duncan's multiple range test.

Table 3 Effect of rootstocks on the quality of Valencia orange fruits.[1]

Rootstock	Fruit weight (grm)	Fruit volume (ml)	Fruit length (cm)	Fruit diameter (cm)	Length/ diameter	Rind thickness (mm)	Juice volume/ fruit (ml)	TSS %	Acidity %	TSS/ Acidity	Ascorbic acid (mg/100 ml juice)
Cleopatra Mandarin	212.08a	230.75b	7.36a	7.378a	1.020a	4.63a	93.50ab	10.738cd	1.348c	8.058c	52.863b
Sour Orange	208.84a	217.33a	7.56ab	7.268a	1.040a	4.60a	90.05a	11.075d	1.476d	7.523b	54.800b
Rough Lemon	238.75b	258.00d	8.03c	7.682b	1.043a	4.93b	100.67b	9.475a	1.169a	8.188c	48.935a
Troyer Citrange	223.10a	246.25c	7.81bc	7.470a	1.045a	4.70a	96.45ab	10.263bc	1.276a	8.120c	47.895a
Rangpur Lime	222.06a	229.17b	7.98c	7.493a	1.035a	4.63a	96.03ab	9.825ab	1.379c	8.243a	50.100a

[1]Means in a column followed by the same letter are not significantly different at P = 0.05 according to Duncan's multiple range test.

increased the dimensions of fruits, and Sour Orange and Cleopatra Mandarin decreased it, the shape of orange fruits expressed as length/diameter was not influenced by any of the rootstocks. The rind thickness was significantly decreased by the Sour Orange rootstock in Hamlin fruits, and increased by the Rough Lemon in Navel and Valencia orange fruits.

The influence of rootstocks on the physical characteristics of orange fruits was generally in line with reports of other investigators (7,9,12).

The chemical composition of orange fruits was influenced by rootstocks. In the three cultivars tested in this study, the fruits from trees grown on Rough Lemon rootstock, were consistently low in TSS and acidity, and were relatively low in ascorbic acid; while fruits from trees grown on Sour Orange and Cleopatra Mandarin, maintained high amounts of TSS, acidity, and ascorbic acid. The adverse effects of Rough Lemon on the composition of organge fruits were reported by other workers (2,7,10,11,12).

Hodgson (6), in his report on the analysis of Libyan citrus industry in 1964, had strongly recommended the substitution of Sour Orange rootstock with Cleopatra Mandarin. As far as orange fruit quality is concerned, the results of this study are in line with Hodgson's recommendation. Cleopatra Mandarin and Sour Orange showed similar effect on the fruit quality of the three cultivars used. This could be confirmed by similar results obtained by Minessy (9) in Egypt. However, many factors other than fruit quality must be thoroughly studied before final conclusions can be drawn.

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تأثير خمس أصول حمضيات على صفات الجودة لثلاث أصناف من البرتقال

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المستخلص

بدراسة الخواص الطبيعية والكيماوية أثناء موسمى ١٩٧٧ ، ١٩٧٨ م لثلاثة أصناف من البرتقال (هاملن ، أبو سرة ، فالنشيا) مطعمة على خمسة أصول (الشفشى ، الليمون المخرفش ، كليوبترة ، ترويير سترانج ليمون رانجبور) وجد الآتى :

ثمار البرتقال النامية على أصل الليمون المخرفش كانت كبيرة فى الحجم والوزن ولكنها منخفضة فى المواد الذائبة الكلية الحموضة ، وحمض الاسكوبيك (فيتامين ج) .

الثمار النامية على أصول الشفشى وكليوبترة كانت متشابهة فى الصفات حيث كانت صغيرة فى الحجم والوزن ولكنها احتوت على كميات عالية من المواد الذائبة الكلية ، الحموضة ، وحمض الاسكوربيك .

أما الثمار النامية على أصول ترويير سترانج وليمون رانجبور فكانت متوسطة الحجم والوزن ، وفى كثير من الأحيان كان تأثيرها على صفات الجودة الأخرى غير ثابت .