



Influences of Rootstocks on Fruit Quality of 'Henderson' Grapefruit

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Abstract

In this study, the effects of some important citrus rootstocks such as local sour orange (*Citrus aurantium* L. var. "Yerli"), Carrizo and Troyer citranges (*Citrus sinensis* Osb. x *Poncirus trifoliata* Raf. var. "Troyer" and "Carrizo"), Swingle citrumelo (*Citrus paradisi* Macf. x *Poncirus trifoliata* Raf.), Volkameriana (*Citrus volkameriana* Tan. and Pasq.) on fruit quality of Henderson grapefruit were investigated. The experiment was conducted in 2013 at the Department of Horticulture, Faculty of Agriculture, University of Cukurova on the trees planted as 8 x 8 m in 1997. Fruit weight, diameter, index, rind thickness, juice content, total soluble solids, titratable citric acid, and TSS/TA ratio were determined in order to see the effects of various rootstocks. The smallest fruit size was obtained from the scion on Troyer citrange whereas fruit sizes of scion on the other rootstocks were in the same subset. Rootstock significantly affected total acid content and the highest total acid content of fruits was found with Troyer citrange and Swingle citrumelo. Also, there was a significant rootstock effect on total soluble solids, highest for fruits from the trees on Troyer citrange.

Keywords: Citrus, rootstocks, Henderson, grapefruit, fruit quality.

Özet

Bu araştırmada, Yerli turuncu (*Citrus aurantium* L. var. "Yerli"), Carrizo and Troyer sitranjları (*Citrus sinensis* Osb. x *Poncirus trifoliata* Raf. var. "Troyer" and "Carrizo"), Swingle sitrumelo (*Citrus paradisi* Macf. x *Poncirus trifoliata* Raf.), Volkameriana (*Citrus volkameriana* Tan. and Pasq.) gibi bazı önemli turuncgil anaçlarının Henderson altıntopunun meyve kalitesi üzerine etkileri incelenmiştir. Çalışma 2013 yılında Çukurova Üniversitesi Ziraat Fakültesi Bahçe Bitkileri Bölümünde 1997 yılında 8 x 8 m aralıklarla dikilmiş parselde yürütülmüştür. Değişik anaçların etkilerini görmek için meyve ağırlığı, meyve çapı, indeks, kabuk kalınlığı, meyve suyu, suda çözünebilir kuru madde miktarı, titre edilebilir asit miktarı ve suda çözünebilir kuru madde /asit oranı incelenmiştir. En küçük meyve boyutu Troyer sitranji anacı üzerine aşıllı ağaçlardan elde edilirken diğer anaçlar üzerine aşıllı olanların meyve boyutu aynı alt grupta bulunmuştur. Anaçlar toplam asit içeriğini önemli derecede etkilemiş ve en yüksek asit miktarı içeren meyveler Troyer sitranji ve swingle sitrumelo anaçları üzerine aşıllı olanlarda bulunmuştur. Ayrıca, toplam çözünebilir kuru madde üzerine de önemli bir anaç etkisi vardır ve en yüksek miktar Troyer sitranji üzerine aşıllı ağaçların meyvelerinden elde edilmiştir.

Anahtar Kelimeler: Turuncgil, anaç, Henderson, Altıntop, Meyve kalitesi

Introduction

Citrus is produced commercially in Mediterranean climates. Turkey has very suitable ecological conditions and potential for citrus growing. Turkey produces more than 3.5 million tons of citrus fruits annually, and holds 9th place in the world citrus production (FAO, 2014). The major citrus producing regions are located along Turkey's southern Mediterranean and Aegean coastal plains. The east Mediterranean Region produces

67.39 % of Turkey's total citrus fruit and 99.74% of the grapefruit. Currently, 65% of Turkey's fresh fruit exportation is citrus fruits. In recent years, there has been a large increase in the exportation of citrus fruits, especially grapefruit (Yildirim et al 2010). Henderson is similar to Star Ruby in characteristics. But, Henderson is more productive and it bears homogeneous fruits (Tuzcu, 1990).

Rootstocks play an important role in the rapid development of citrus in the world. The necessity of using rootstocks for citrus fruits is to have a profitable production against some limiting

factors such as climate, bad soil conditions, diseases and etc. (Yildirim et al. 2010). Besides these factors, the rootstock used can alter the scion and resulting yield and quality attributes of the fruit (Incesu et al.,2013). Also, use of the citrus rootstocks provides a large amount of choices to the growers to increase fruit quality and yield, obtain early fruiting, uniform cropping, avoidance of juvenility, control of the tree size and have the opportunity for high density planting etc. These factors give a lot of economic important advantages (Tuzcu et al. 2005). Choosing a rootstock is an important decision and local climatic and soil conditions are important factors in rootstock selection. Although any citrus variety can be used as a rootstock, some of them are better suited to specific conditions than the others (Davies and Albrigo, 1994; Lawrence and Bridges, 1974).

Sour orange, which is still the main rootstock used in citrus growing in Mediterranean Region and in the world, is used as a rootstock for all citrus cultivars in Turkey (about 95%), especially in the entire Mediterranean and southern part of the Aegean Regions (Yildirim et al. 2010). This rootstock is well adapted to calcareous and other soil types and is used widely in the Mediterranean basin (Özsan, 1979). Although the sour orange has many excellent horticultural advantages, it has a very important disadvantage for its susceptibility to *Citrus tristeza virus* (CTV). This problem has severely reduced the use of this rootstock in many places especially Western Mediterranean. Following these problems researchers and citrus growers have harnessed efforts to look for alternative rootstocks. Selection of a suitable rootstock, its adaptability to the soil conditions and the interactive effects with the scion cultivar has to be carefully considered (Shafieizargar et al. 2012). Studies describing positive rootstock effects over fruit quality for citrus fruits have been conducted in several regions (Ferguson and Chao, 2000; Shafieizargar et al. 2012).

This study was aimed to determine the best rootstock or rootstocks for 'Henderson' grapefruit variety in Mediterranean Region of Turkey and to determine the rootstocks that may replace sour orange which is widely used in Turkey but sensitive to Tristeza.

Materials and Methods

This research was conducted in 2013 vegetation period under Adana conditions. Henderson grapefruit variety was grafted on the rootstocks local sour orange (*Citrus aurantium* L. var. "Yerli"), Carrizo and Troyer citranges (*Citrus sinensis* Osb. x *Poncirus trifoliata* Raf. var.

"Troyer" and "Carrizo"), Swingle citrumelo (*Citrus paradisi* Macf. x *Poncirus trifoliata* Raf.), Volkameriana (*Citrus volkameriana* Tan. and Pasq.). The grafted trees were planted in 1997 with 8 x 8 m spacing at the Research Station of Çukurova University, Agricultural Faculty Citrus Experiment Station, Adana (Latitude, 35° 23N; Longitude, 36° 50E, altitude 27 m). In the experimental area, the soil was a clay-loam (57% clay, 21% silt, 22% sand and contain 12% CaCO₃) and the soil pH was in the range of 7.29 to 7.37 at a depth of 0 - 90 cm. The salt content of the soil was 0.22 EC (mmhos/cm). The area has a mean maximum and minimum temperature ranging from 26 and 14.5°C and an average annual rainfall of 465 mm. The trees were irrigated weekly from May to October using drip irrigation. Nitrogen (N) was applied at a rate of 1.5 kg N / tree (2/3 in mid-February and 1/3 in mid-May) and phosphorus (P) was applied at a rate of 1 kg P/tree (December) and potassium (K) at a rate of 1 kg K/tree (January). Pest populations were controlled with recommended pest management program. Each year, random samples of 25 fruits from each tree were collected for fruit quality analysis at optimum harvest time (at the end of November or at the beginning of December). The fruit samples were weighed, and fruit diameter at the equator was measured with a digital caliper and also rind thickness was measured after cutting in half with a digital caliper (Mitutoyo CD-15CPX). The fruits were weighed and juiced using a standard juicer; then juice was weighed, and expressed as a percentage of the total fruit weight. Total soluble solids content (TSS) was determined with a portable refractometer (FG-103/113) using a few drops of juice. The total acidity (TA) of the juice was determined by titrating 5 ml of the juice sample with 0.1 N sodium hydroxide (NaOH) using phenolphthalein as the indicator.

Completely randomized experimental design was used with six replicates for each combination. Data were subjected to ANOVA and analyzed using SAS statistical procedures. Mean comparisons were performed using Fisher's LSD test to examine if differences between rootstocks were significant at $P < 0.05$.

Results

Rootstocks had significant effects ($P < 0.05$) on fruit weight (Table 1). The lightest fruits were obtained from the trees on Troyer citrange. The other rootstocks showed the highest fruit weight and gave similar values. Growing in the same region, the biggest fruits were found in Kütdiken lemon trees grafted on Yuzu, Volkameriana and Taiwanica, whereas the smallest fruits were

obtained from the trees on Benecke trifoliolate orange and *Troyer citrange* (Tuzcu et al. 1992). Even Jimenez et al. (1987) indicated that citranges had the smallest fruits. Ochoa et al. (1998) indicated that 'Washington' navel fruits on *Citrus taiwanica* were heavier than those on *Troyer citrange* and sour orange. In contrast, Georgiou and Georgiou (1993) reported higher fruit weight of 'Shamouti' orange on Carrizo citrange than on sour orange, *Troyer citrange* or *Citrus taiwanica*.

The effects of rootstocks on fruit diameter and index were not statistically significant and all of the rootstocks gave similar values (Table 1). Fruit diameter and index ranged between 81.34 and 87.07 mm and 1.08-1.14, respectively.

Rootstock had no significant effect on rind thickness and fruit juice (Table 1). Trees on all of the rootstocks produced similar rind thickness and fruit juice.

Table 1. Effects of rootstocks on the fruit characteristics of 'Henderson' grapefruit

Rootstocks	Fruit weight (g)	Fruit diameter (mm)	Fruit Index	Rind thickness (mm)	Juice content (%)	TSS (%)	TA (%)	TSS/TA
Sour orange	292.67 a ^x	87.07	1.14	7.27	47.88	10.07 c	2.28 bc	4.41
Carrizo citrange	283.33 a	84.87	1.11	7.31	49.38	11.90 ab	2.46 ab	4.83
Troyer citrange	231.00 b	81.34	1.12	7.14	47.64	12.33 a	2.52 a	4.90
Swingle citrumelo	271.17 a	84.45	1.08	6.77	48.25	10.90 bc	2.51 a	4.36
Volkameriana	266.00 a	85.22	1.12	7.31	46.91	10.00 c	2.15 c	4.36
Significant ^y	*	ns	ns	ns	ns	*	*	ns
LSD	34.47	-	-	-	-	0.246	0.224	-

^y: Level of Significance; ns: not significance, ** P<0.01; * P<0.05;

^x Means with the same letter in a column are not statistically significant different from each other according to the Fisher's LSD at P≤0.05

Significant rootstock effects (P<0.05) on TSS and TA of the grapefruits determined (Table 1). *Troyer citrange* yielded the highest fruit TSS content, followed by Carrizo citrange and Swingle citrumelo, respectively. The lowest was from those on Volkameriana and Sour orange. The TA was highest from Henderson on *Troyer citrange* and Swingle citrumelo and followed by Carrizo citrange; the lowest was from those on Volkameriana and followed by Sour orange (Table 1). These results are in agreement with previous works, where fruits with the highest acid content and TSS are on trifoliolate orange and citranges (Bevington and Cullis, 1990; McCollum et al., 2002; Stover, 2004). The lowest total acid content of fruits on Volkameriana was reported by various authors (Stover, 2004; Ramin and Alirezanezhad, 2005).

TSS/TA ratio, which is generally defined as the fruit maturity index in citriculture, was not affected by rootstocks (Table 1) and TSS/TA ratio ranged between 4.36 and 4.90.

According to our results, Carrizo and *Troyer citrange*s have been determined as the promising rootstocks for 'Henderson' grapefruit fruit quality.

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