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Different Interstock Lengths Effects on 'Star Ruby' Grapefruit and 'Kütdiken' Lemon for Some Plant Nutrient Elements

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Abstract

This study was conducted to determine the effects of different varieties and the lengths of interstock on leaf nutrient concentrations of Kütdiken lemon (KL) and Star Ruby grapefruit (SR). SR with different lengths (5, 10, 20 and 40 cm) was used as interstock for KL and Minneola tanjelo (MT) with same lengths was used as interstock for SR. Sour orange (SO) was used as rootstock for both species. KL and SR scions grafted on SO were used as control treatments. Leaf nutrient element concentrations [phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), manganese (Mn), iron (Fe), zinc (Zn), copper (Cu)] were determined in season 2010. The results indicated that the different lengths of interstock had no obvious effects on the contents of microelement but had noted significant effects in the contents of Mn in KL leaves. (Mn) was the highest on KL/SR-20 cm/SO and the lowest on KL/SR-10 cm/SO. Differences among interstock length were important for P and Ca content of Star Ruby and the highest P content were found SR/SO (control), SR/MT-10 cm/SO and SR/MT-40 cm/SO trees. The content of Ca was determined as the highest in the leaves of SR/SO (control), SR/MT-20 cm/SO, SR/MT-40 cm/SO and SR/MT-5 cm/SO. The KL/SO (control) trees have given the highest K content followed by KL/SR-10 cm/SO, whereas the lowest K content was obtained in the leaves of KL/SR-5 cm/SO.

Keywords: Interstock, citrus, grapefruit, lemon, nutrition elements

Özet

Bu çalışma farklı çeşit ve ara anaç uzunluklarının Kütdiken limon (KL) ve Star Ruby (SR) altıntopunun yaprak besin içeriği üzerine etkilerini belirlemek için yürütülmüştür. Faklı uzunluklardaki SR (5, 10, 20 ve 40 cm) Kütdiken limonu için ara anaç olarak ve benzer uzunluklardaki Minneola tanjelo (MT)'da SR için ara anaç olarak kullanıldı. Her iki çeşit için de Turunç (SO) anaç olarak kullanıldı. SO üzerine aşılı KL ve SR çeşitleri kontrol uygulaması olmuştur. Yaprak besin elementi konsantrasyonu [Fosfor (P), potasyum (K), kalsiyum (Ca), magnezyum (Mg), mangan (Mn), demir (Fe), çinko (Zn), bakır (Cu)] 2010 yılı sezonunda belirlenmiştir. Sonuçlar farklı ara anaç uzunluğunun microelement içeriği üzerine belirgin bir etkiye sahip olmadığı ancak, KL'nun yapraklarında Mn içeriği üzerine önemli etkilerinin olduğunu göstermiştir. En yüksek Mn içeriği KL/SR-20 cm/SO; en düşük ise KL/SR-10 cm/SO kombinasyonunda bulunmuştur. Star Ruby altıntopunda ara anaç uzunluğu arasındaki farklılıklar P ve Ca için önemli bulunmuştur. En yüksek P içeriği SR/SO (kontrol), SR/MT-10 cm/SO ve SR/MT-40 cm/SO ağaçlarında saptanmıştır. Ca içeriği de en yüksek olarak SR/SO (kontrol), SR/MT-20 cm/SO, SR/MT-40 cm/SO ve SR/MT-5 cm/SO kombinasyonlarında belirlenmiştir. En yüksek K içeriğini KL/SO (kontrol) ağaçlarında bulunmuş ve bunu KL/SR-10 cm/SO kombinasyonu izlerken , en düşük K içeriği ise KL/SR-5 cm/SO'nın yapraklarında saptanmıştır.

Anahtar Kelimeler: Ara anaç, Turunçgil, altıntop, limon, besin elementi

Introduction

Rootstocks affect plant growth, tree performance, fruit yield, fruit quality, salinity tolerance, disease tolerance and scion compatibility, which provide adaptation to different types of soil and different climates. The use of the rootstocks allows control of the tree size and provides the opportunity for high density planting. On the other hand, interstocks have the ability to control tree size by using non-dwarfing rootstocks. Some scion/rootstock combinations are incompatible. Therefore, interstocks are used to act as a bridge between a desirable rootstock and scion

by being compatible with both and without a decrease in yield. Furthermore, interstocks may improve tree growth, fruit quality or fruit yield (Batchelor and Webber, 1948; Castle and Krezdorn, 1992; Yonemoto et al., 2004; Ferguson and Chaparro, 2005; Girardi and Mourão Filho, 2006).

Moreover, as the length of the interstock influences tree size in apple trees, the interstock length should be further evaluated for citrus trees (Ferguson and Chaparro, 2005). The overgrowth of Monachello lemon scion on sour orange must be considered as a case of incompatibility between stock and scion that can be avoided by using a suitable interstock (Russo, 1973). The different lengths of *Hesperethusa crenulata* interstocks have minor affects on tree size and fruit quality (Castle and Krezdorn, 1992). In addition, Volkamer lemon trees with Flying Dragon *Trifoliate orange* budded interstocks are smaller than those without the interstocks. Furthermore, the interstocks did not affect yield or juice quality.

Interstocks provide a mechanism for improving the growth rate and salinity resistance of orange trees (Cámara Zapata et al., 2004). Interstocks are used with various fruit trees to control tree size, fruit production, quality and aging. Lemon trees grafted with interstocks have increased longevity, fruit production, and these trees have a decreased trunk thickness at the grafting points (Gil-Izquierdo et al., 2004). Eaton and Robinson (1976) indicated that Tukey et al. (1962), when studying the influence of rootstock, bodystock and interstock on leaf nutrient composition, concluded that each graft component was capable of influencing the quantity of the five major elements (N,P,K,Ca and Mg) in the tree. Eaton and Robinson (1976) indicated that Koksal (1975) found some reduction in leaf mineral concentration with spesific graft combinations.

Sour orange is the main rootstock (approximately 95%) used in citrus growing in Turkey. Sour orange has many excellent horticultural advantages such as performs well on calcareous soils, giving high quality fruit. However, when sour orange is used as a rootstock with lemon varieties, it has several resulting problems because of the proportional conflict (Tuzcu, 1978). Grapefruit is known as the best rootstock for lemon trees (Webber, 1948).

The aim of study was to determine the effects of different varieties and the lengths of interstock on leaf nutrient concentrations of Kütdiken lemon (KL) and Star Ruby grapefruit (SR).

Materials and Methods

This study was conducted to determine the effects of different varieties and the lengths of interstock on leaf nutrient concentrations of Kütdiken lemon (KL) and Star Ruby grapefruit (SR) in season 2010. SR with different lengths (5, 10, 20 and 40 cm) was used as interstock for KL and Minneola tanjelo (MT) with same lengths was used as interstock for SR. Sour orange (SO) was used as rootstock for both species.

The grafted trees were planted in 1991 with 8 m x 8 m spacing at the Research Station of Çukurova University, Agricultural Faculty Citrus Experiment Station, Adana (Latitude, 35° 23′ N; Longitude, 36° 50′ E; altitude 27 m). In the experimental area, the soil was a clay loam (40% clay, 36% silt and 24% sand containing 39% $CaCO_3$), and the soil pH was in the range of 7.57 to 7.81 at a depth of 0 cm – 90 cm. The electrical conductivity of the soil was 0.042 mmhos/cm. The experimental area had an average temperature ranging between 26°C and 14.5°C with an average annual rainfall of 465 mm. The trees were irrigated weekly from May to October using a drip irrigation system. Nitrogen (N) was applied at a rate of 1.5 kg/tree (2/3 in mid-February and 1/3 in mid-May), and phosphorus (P) was applied at a rate of 1 kg/tree (December). Potassium (K) was applied at a rate of 1 kg/tree (January). Pest populations were controlled with a recommended pest management program.

In order to assess nutritional status of lemon and grapefruit, leaf samples were collected from nonfruiting shoots, fully expanded four to seven month old leaves and transferred to the laboratory in the ice box (Chapman, 1960). Then samples were freed from the contaminants by washing surface-active detergent solution, tap water and finally by rinsing with distilled water. Samples were dried at 70◦C until constant weight and homogenized by reducing the particle size <0.5 mm. Powdered samples were digested with nitric acid (HNO3)/perchloric acid (HClO4) mixture (3:1 v/v) (Kacar, 1972). The concentrations of calcium (Ca), magnesium (Mg), potassium (K), iron (Fe), copper (Cu), manganese (Mn), and zinc (Zn) in digest were determined by means of Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES, Varian, Liberty Series II; Varian Inc., Palo Alto, CA, USA). Phosphorus content was spectrophotometrically determined by Barton reagent (Barton, 1948).

A 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 interstock lengths were significant at P < 0.05.

Results

In general, interstock lengths were not significantly affect the nutrient level in the leaves of Star Ruby grapefruit and Kutdiken lemon (Table 1 and Table 2). The results indicated that the different lengths of interstock had no obvious effects on the contents of microelement but had noted significant effects in the contents of Mn in KL leaves (Table 1).

Table 1. The effects of Star Ruby interstock on mean leaf mineral conditions of Kutdiken lemon

Combinations	P (%)	K (%)	Mg (%)	Ca (%)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Zn (ppm)
KL-SR5-SO	0,08	0,81 c[x]	0,13	3,89	6,78	22,99	27,77 bc	7,88
KL-SR10-SO	0,08	1,16 ab	0,13	3,48	7,45	19,66	25,52 c	4,97
KL-SR20-SO	0,09	1,01 b	0,12	3,65	8,39	20,57	39,17 a	6,43
KL-SR40-SO	0,08	0,99 b	0,15	3,26	7,34	19,40	27,11 bc	6,89
KL-SO (control)	0,10	1,20 a	0,14	3,35	7,76	20,79	28,78 b	6,44
Significant [y]	**ns**	*	**ns**	**ns**	**ns**	**ns**	*	**ns**

[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

Manganese was the highest on KL/SR-20 cm/SO and the lowest on KL/SR-10 cm/SO. Differences among interstock length were important for K content of Kütdiken lemon and the highest K content were found KL/SO (control), followed by KL/SR-10 cm/SO, whereas the lowest K content was obtained in the leaves of KL/SR-5 cm/SO (Table 1). Bojić and Paunović (1988) indicated that K contents a significant difference in the leaves of apricot cv Hungarian best on different studied interstocks.

Differences among interstock length were important for P and Ca content in leaves of Star Ruby. SR/SO (control), SR/MT-10cm/SO and SR/MT-40 cm/SO combinations resulted in higher P levels than SR/MT-20 cm/SO and SR/MT-5 cm/SO.

Table 2. The effects of Minneola tangelo interstock on mean leaf mineral conditions of Star Ruby

Combinations	P (%)	K (%)	Mg (%)	Ca (%)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Zn (ppm)
SR-MT5-SO	0.01 b[x]	0.42	0.16	6.03 ab	7.45	28.97	28.25	12.98
SR-MT10-SO	0.09 a	0.49	0.16	5.34 b	7.71	17.01	26.53	10.69
SR-MT20-SO	0.02 b	0.39	0.14	6.31 ab	5.52	35.14	27.08	15.16
SR-MT40-SO	0.08 a	0.52	0.17	6.21 ab	8.69	13.48	27.14	10.18
SR-SO (control)	0.09 a	0.55	0.17	6.47 a	22.08	84.13	48.60	34.83
Significant [y]	*	**ns**	**ns**	*	**ns**	**ns**	**ns**	**ns**

[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

The content of Ca was determined as the highest in the leaves of SR/SO (control), followed by SR/MT-20 cm/SO, SR/MT-40 cm/SO and SR/MT-5 cm/SO whereas the lowest Ca content was obtained in the leaves of SR/MT-10 cm/SO (Table 2). Wutscher (1974) mentioned that *E.glauca* hybrids interstocks resulted in higher K levels than Changsha mandarin interstocks. Zhu et al. (1983) noted that there were significant differences in scion and interstock bark elemental composition due to interstock combination but, leaf composition varied slightly among different interstock combination.

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