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Original article

Determination of Nursery Plant Development of New Mandarin Varieties Grafted on Carrizo Citrange Rootstock

Carrizo Anacı Üzerine Aşılı Bazı Yeni Mandarin Çeşitlerinde Fidan Gelişme Durumlarının Belirlenmesi

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Abstract

Originating in southeast Asia, citrus currently have a large geographical distribution around the world. Sourced in tropical and semitropical regions, cultivation of citrus for the table is mainly focused in subtropical regions. The study aimed to fully determine the compatibility status for the Carrizo citrange with new mandarin varieties and the rootstock-scion relationships. As rootstock Carrizo citrange (Citrus sinensis x Poncirus trifoliata) was used with Dart, Mandalate, Mihowase, Tango and W. Murcott mandarin used as varieties. Grafting was completed on 10 April 2016 with T bud grafting and the graft band was opened 1 month after grafting with rootstock diameter (mm), scion diameter (mm) and shoot length (cm) measured one time per month and the differences between varieties in terms of these characteristics were revealed. The highest rootstock diameter measurement was in the Dart variety, with highest scion diameter value in the Mihowase variety. When seedling development is evaluated, sapling crown height of 60-65 cm was first reached by the Tango variety at the end of October, followed by W. Murcott, Mihowase, Mandalate and Dart varieties.

Keywords: Rutaceae, Citrus, rootstock, scion, grafting.

Özet

Anavatanı Güneydoğu Asya olan turunçgiller günümüzde dünyada geniş bir coğrafyaya dağılım göstermektedir. Tropik ve semitropik kökenli olan turunçgillerin sofralık olarak yetiştiriciliği daha çok subtropik bölgelerde yoğunlaşmış durumdadır. Çalışma da Carrizo sitranjının mevcut ve yeni mandarin çeşitleriyle uyuşma durumlarının ve anaç–kalem ilişkilerinin tam olarak belirlenmesi amaçlanmıştır. Anaç olarak Carrizo sitranjı (Poncirus trifoliata x Citrus sinensis), çeşit olarak ise Dart, Mandalate, Mihowase, Tango ve W. Murcott mandarin çeşitleri kullanılmıştır. Aşılama 10 nisan 2016 tarihinde T göz aşısı olarak yapılmış ve aşılamadan 1 ay sonra aşı bandı açılarak ayda bir olmak üzere anaç çapı(mm), kalem çapı (mm) ve sürgün uzunlukları (cm) ölçülmüş olup, incelenen özellikler bakımından çeşitler arasındaki farklılıklar ortaya konulmuştur. En yüksek anaç çap ölçümü Dart çeşidinde, en yüksek kalem çap değeri Mihowase çeşidinde belirlenmiştir. Fidanların gelişimleri değerlendirildiğinde 60-65 cm olan fidan taç yüksekliğine ekim ayı dönemi sonunda en erken Tango çeşidi gelip, bu çeşidi sırasıyla W. Murcott, Mihowase, Mandalate ve Dart çeşitleri izlemiştir.

Anahtar Kelimeler: Rutaceae, turunçgil, anaç, kalem, aşılama.

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INTRODUCTION

Originating in southeast Asia, citrus currently have a large geographical distribution around the world. In this sense the rapid type of dynamics among citrus is an important factor in obtaining rootstock and varieties that can adapt to varying climate and soil conditions with different breeding methods. Sourced in tropical and semitropical regions, cultivation of table citrus fruits has mainly focused in subtropical regions. Turkey, located in the Mediterranean basin, has appropriate ecologic conditions in terms of quality table production (Davies et al., 1994). Citrus cultivation is rapidly increasing in the world and in our country. Global citrus production reached 146.599.168 tons. With this production value, citrus are fruits with highest production and commercial volume in the world (FAO, 2017). Turkey's total citrus production is 4.769.726 tons. Of this amount, 1.950.000 tons are orange, 1.550.469 tons are mandarin, 1.007.133 tons are lemon, 260.000 tons are grapefruit and 2.124 tons are other citrus species. Turkey produces nearly 3.2 % of the global total citrus fruit production (FAO, 2017). For grafted seedling production, there should be compatibility between the variety and rootstock used. If there is no good compatibility between rootstock and scion, grafting will not take or developmental disorders at the graft site and in some cases death of the tree in later years may be observed and the graft is qualified as unsuccessful (Andrews et al., 1993; Ağaoğlu et al., 1997). Incompatibility between rootstock and scion is mostly observed between and within certain species and even if grafts appear to bond, it may result in death due to inability to sustain normal development (Ağaoğlu et al., 1997; Darikova et al., 2011; Bayram et al., 2014). Incompatibility occurs when two different grafted plants do not form common tissue or form two separate pieces and not a single plant (Yılmaz, 1994). As a result of lack of strong union at the graft site, the tree may be observed to have yellowing of leaves in the growth season, drying of shoots from the tip backward in the vegetative period, death of seedlings in the early period, clear growth differences between rootstock and scion, swelling above or below the graft site, sudden breakage at the graft site, cellular differentiation and linked to this lack of formation of new tissue, and cellular death on the interior surface at the graft site (Gülen-Sertli, 2003; Uysal, 2009). The aim of grafting in garden culture is to combine and join two plant pieces and ensure growth and development as a single plant. As a result of grafting the overlapping cambium tissue of the rootstock and scion develop a callous (wound tissue) of meristematic cells and these meristematic cells forming from two different sources join along a line. As a result of union, wood and phloem tissues in both the rootstock and scion allow passage of water and plant nutrient elements with assimilation products through the graft site (Ağaoğlu et al., 1997; Bayram et al., 2014). Graft application in fruit cultivation involves inserting a plant piece from the variety with proliferation desired with one or a few buds into another plant and joining them ensuring growth and development as a single plant. Thus, the portion above the soil of the new plant formed, in other words the crown, is called the "scion" or "variety", while the portion forming the root system is called the "rootstock" (Özçağıran, 1974; Yılmaz, 1994; Ağaoğlu et al., 1997; Uysal, 2009). The use of rootstock occurs with the effect of climate, soil and plant factors with a range of events

forming the plant body. Differences in construction, transport and storage of carbohydrates synthesized in the plant body may cause plants to have different reactions to environmental conditions. Carbohydrates play roles in many events like fruit yield, growth and development as stated by various researchers. Carbohydrate metabolism is affected by mutual interactions between rootstock and scion (Kaplankıran et al., 1985). Nucellar embryony observed in citrus is an important advantage ensuring plants with the same genetic features of the main parent can be obtained by growing from seed. However, not all seeds have nucellar origin, sufficient numbers of seeds may not be obtained every time, problems with seed germination and different rates of nucellar embryony in citrus species make it more advantageous to obtain sample material by proliferation with the vegetative route on some rootstocks. As a result, for most citrus grafting is currently used as the proliferation method. In Turkey, the most commonly used rootstock for citrus cultivation is bitter orange (Citrus aurantium L.) rootstock. Additionally, Carrizo and Troyer citranges are used in the Aegean region and trifoliate (Poncirus trifoliata) is used as rootstock in the Black Sea region. Due to the bitter orange rootstock being susceptible to Citrus Tristeza Virus (CTV) disease, studies are required about alternative rootstocks. As a result, the use of Carrizo citrange as rootstock is increasing (Toplu et al., 2008). The aim of this study is to fully determine the compatibility status and rootstock-scion relationships in Carrizo citrange with current and new mandarin varieties.

MATERIALS and METHODS

Materials

The study was performed in greenhouse conditions in the Future Fruit seedling production facility producing modern seedlings in the Çukurova region from 2014-2016. Carrizo citrange (*Citrus sinensis x Poncirus trifoliata*) was used as rootstock, while Dart (*Citrus unshiu* Marcovitch), Mandalate (Fortune mandarin x *Citrus deliciosa cv* 'Avana'), Mihowase (*Citrus unshiu* Marcovitch), Tango (*Citrus reticulata* Blanco) and W. Murcott (*Citrus reticulata* Blanco) mandarin varieties were used as varieties.

Methods

The trial was completed with 3 repeats of 3 seedlings in each repeat in accordance with the 'random block trial pattern'. Carrizo seeds were sown in seed trays in 2014 in November with environmental temperature 28-32 °C and transplanted into vials in greenhouse conditions 3 weeks later. The plants in vials were transferred to large sacks containing 50% sand and 50% briquette soil when they reached 40-50 cm. Grafting was performed with T bud grafting on 10 April 2016 and 1 month after grafting the graft band was opened and rootstock diameter (mm), scion diameter (mm) and shoot lengths (cm) were measured one time per month. The obtained data were analyzed with the Tukey test in the JMP 5.01 statistical program, with differences between varieties revealed in terms of the characteristics investigated.

RESULTS and DISCUSSION

When rootstock diameter is investigated, statistical differences were determined for measurements in May, June, July and August. The highest values were obtained in May, June, July and August for the Dart variety (6.34 mm, 6.82 mm, 7.05 mm and 7.52 mm, respectively). Measurements were not statistically significant in October. For rootstock diameter measurements, the Dart variety was followed by Mihowase, Mandalate, Tango and W. Murcott varieties (Table-1 and Figure-1). After variety grafting in the trial, the development difference in rootstock diameter between the first measurement period and the final measurement period was greatest for W. Murcott variety. Takishita et al. (2000) researched development of some important mandarin varieties, the most important citrus species in Japan, on Flying Dragon, Citrumelo and trifoliate rootstock. They found the trunk circumference, rootstock circumference and crown sizes for Aoshima Outsu no. 4, Sweet Spring and Kiyomi on Flying Dragon were lower than those grafted on normal trifoliate.

When scion diameters are investigated, there were statistical differences between varieties in May, June, July and August. The highest scion diameter measurement in May was for the Dart variety (1.27 mm), in June and July for Mihowase (2.28 mm; 2.84 mm) and in August and October for the Mandalate variety (4.00 mm; 5.15 mm). The lowest measurements were obtained for Tango and W. Murcott varieties (Table-2 and Figure-2). After grafting of varieties in the study, the development difference between first measurement and last measurement periods for scion diameter was highest for the Mandalate variety.

Table 1. The measurements of rootstock diameters (mm)

	Rootstock Diameter (mm)									
Varieties	**25 May**		**22 Jun**		**22 Jul**		**22 Aug**		**22 Oct**	
Dart	6,34	a[(1)]	6,82	a	7,05	a	7,52	a	8,57	a
Mandalate	5,70	bc	6,20	bc	6,58	bc	7,12	ab	8,59	a
Mihowase	6,07	ab	6,60	ab	6,88	ab	7,29	ab	8,39	a
Tango	5,73	bc	6,02	c	6,30	c	6,91	b	8,50	a
W.Murcott	5,63	c	5,95	c	6,45	c	7,02	b	9,09	a
D %5	**0,43**		**0,43**		**0,42**		**0,48**		**0,72**	

1: Differences between means are shown in separate letters.

Table 2. The measurements of scion diameters (mm)

	Scion Diameter (mm)									
Varieties	**25 May**		**22 Jun**		**22 Jul**		**22 Aug**		**22 Oct**	
Dart	1,27	a[(1)]	1,89	bc	2,71	ab	3,53	bc	4,96	a
Mandalate	1,03	ab	1,93	bc	2,53	b	4,00	a	5,15	a
Mihowase	1,22	ab	2,28	a	2,84	a	3,78	ab	5,11	a
Tango	0,99	b	2,10	ab	2,48	b	3,27	c	4,58	a
W.Murcott	0,96	b	1,76	c	2,47	b	3,31	c	4,63	a
D%5	**0,26**		**0,32**		**0,31**		**0,42**		**0,70**	

1: Differences between means are shown in separate letters.

After grafting of varieties, buds began to shoot and shoot length was measured with calipers once per month. When shoots reached 60 cm, end pruning was done and length measurements ended. Apart from July, all shoot length measurements were determined to be statistically different between species. In May and July, highest values were found for the Mihowase variety (2.17 cm; 35.75 cm), in June highest value was for Mandalate (14.33 cm), and in August and October highest values were found for the Tango variety (45.79 cm; 63.58 cm). The lowest shoot lengths were for the Tango variety in May (1.50 cm), for the Dart variety in June (7.38 cm), for the Mandalate and W. Murcott varieties in July (29.17 cm) and for the Dart variety in August and October (40.00 cm; 51.25 cm) (Table-3, Fıgure-3). In May the Tango variety had slow development of shoot length, while growth increased rapidly in August and October. When all periods are evaluated according to shoot length values at the end of the measurement period, the highest was for the Tango variety, followed by Mihowase and W. Murcott varieties. The development difference in shoot length between the first measurement period and the last measurement period was highest for the Tango variety. Camara et al. (2003) investigated Cleopatra mandarin seedlings with Cleopatra/Valencia orange, Cleopatra/Salustiano orange, Cleopatra/Salustiano orange/Valencia orange plant combinations in sand culture in a greenhouse. They found that in controlled conditions, the Cleopatra/Salustiano orange/Valencia orange combination had lowest root/shoot ratio.

Table 3. The measurements of shoot length (cm)

	Shoot Length (cm)									
Varieties	**25 May**		**22 Jun**		**22 Jul**		**22 Aug**		**22 Oct**	
Dart	1,62	ab[(1)]	7,38	b	30,42	a	40,00	b	51,25	b
Mandalate	1,77	ab	14,33	a	29,17	a	42,08	ab	55,83	ab
Mihowase	2,17	a	11,63	a	35,75	a	44,92	ab	56,00	ab
Tango	1,50	b	11,75	a	31,17	a	45,79	a	63,58	a
W.Murcott	1,71	ab	11,50	a	29,17	a	44,79	ab	58,71	ab
D%5	**0,62**		**3,39**		**6,97**		**5,46**		**10,22**	

1: Differences between means are shown in separate letters.

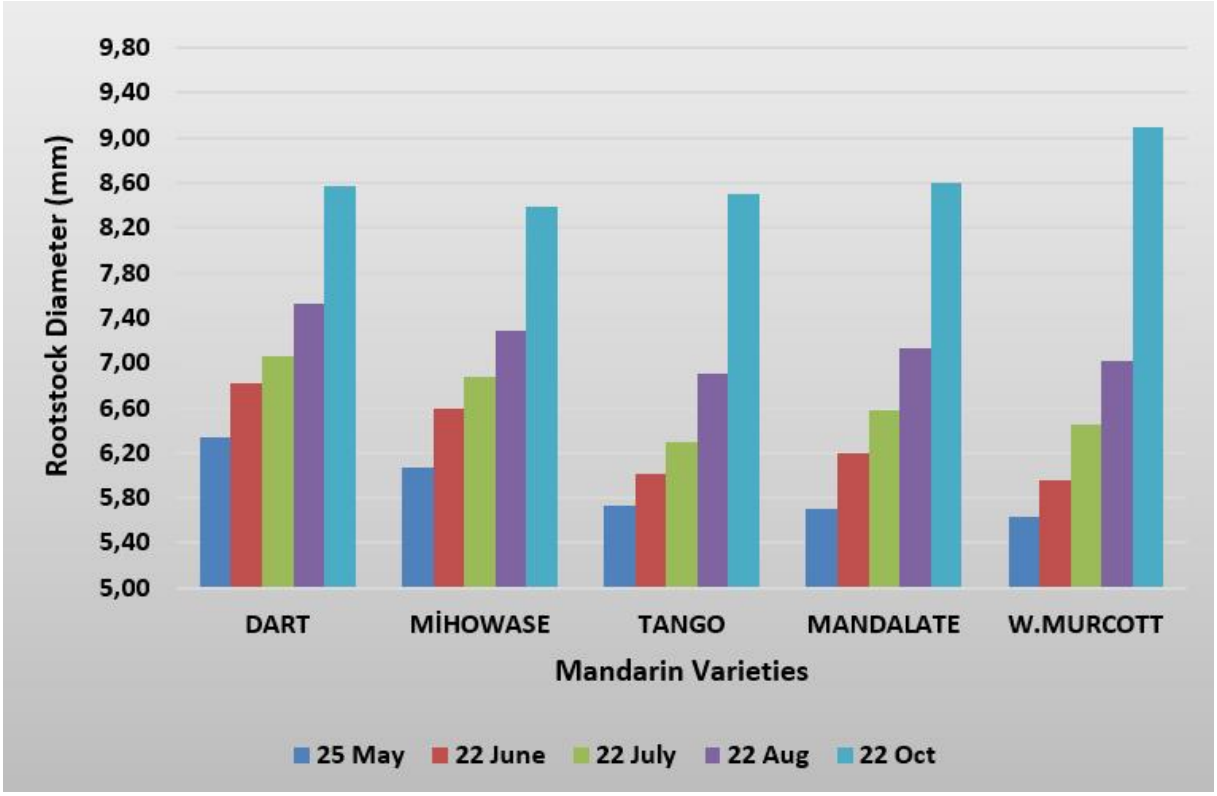

Figure 1. Comparison of rootstock diameters of different mandarin varieties (mm)

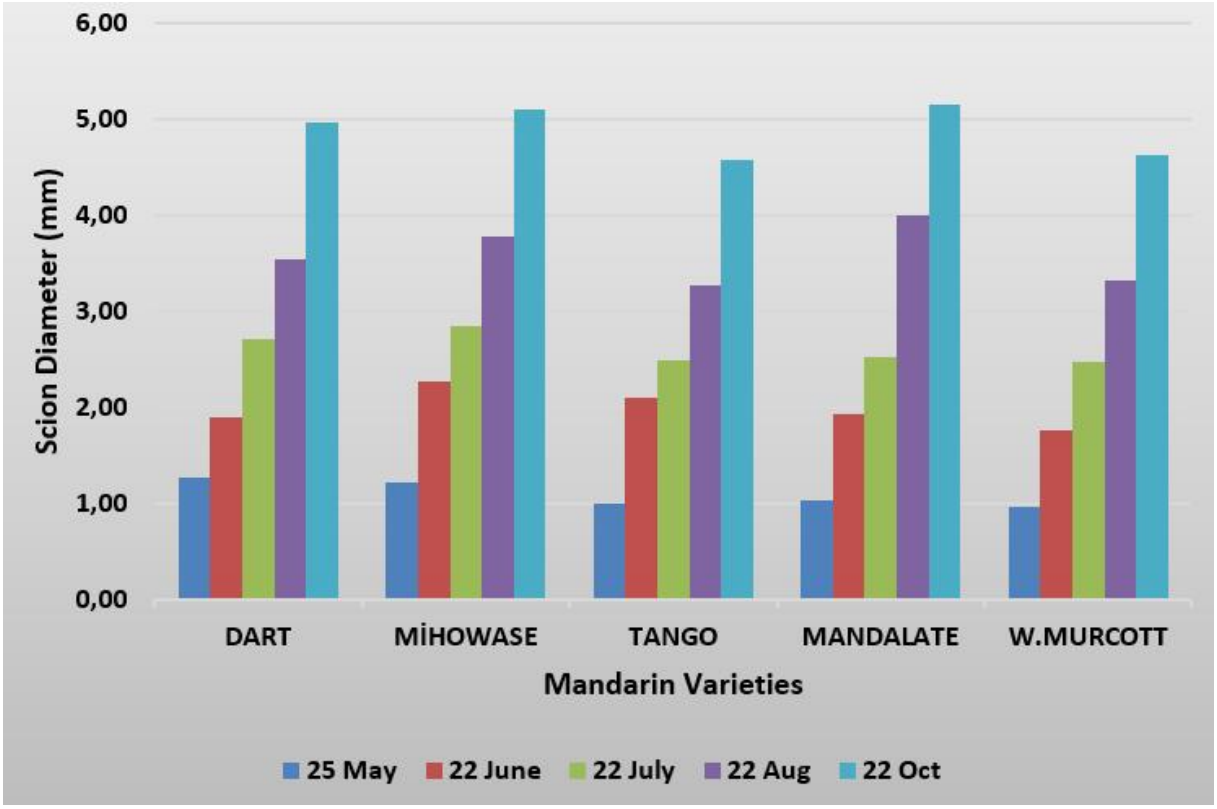

Figure 2. Comparison of scion diameters of different mandarin varieties (mm)

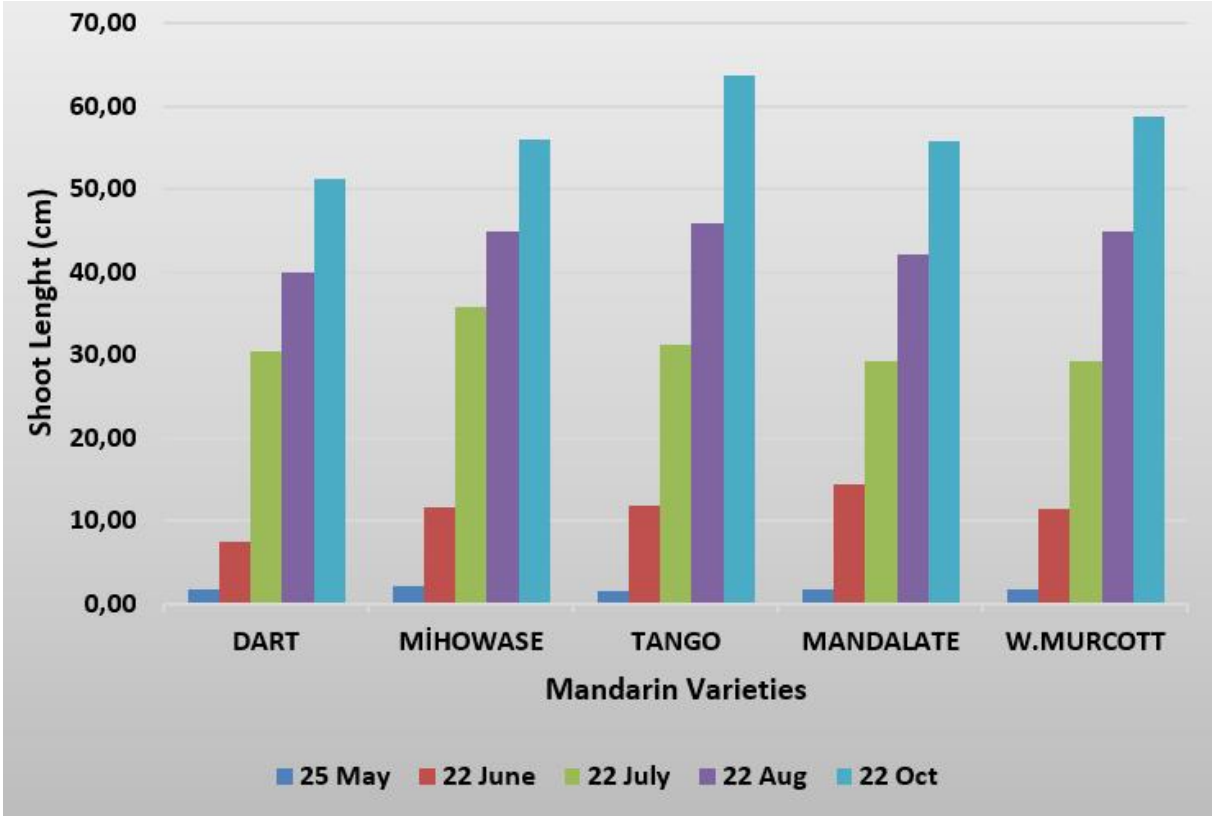

Figure 3. Comparison of shoot lenghts of different mandarin varieties (cm)

CONCLUSION

In addition to the importance of creating groves with certified and accurately named saplings for citrus nurseries, knowing compatibility of rootstock-scion is an important topic. The study found no compatibility problems for mandarin varieties grafted on Carrizo rootstock and there is a need to perform studies to determine possible compatibility status and fruit yield and quality features after new research using these varieties in field conditions. Dalkılıç (2005) reported citrus shoot growth was affected by temperature and wetting. In subtropical climate conditions, the spring shoot period in the northern hemisphere is in March-April and in this period many shoots form from growth points. When development of Dart, Mandalate, Mihowase, Tango and W. Murcott mandarin varieties grafted on Carrizo rootstock is evaluated, Tango variety developed 60-65 cm sapling crown height by the end of October, followed by W. Murcott, Mihowase, Mandalate and Dart varieties. Citrus sapling cultivation is commonly performed in the Çukurova region, which has an important share of citrus production. Firstly, importance should be given to the use of healthy and certified saplings in newly created citrus groves in the region, with groves created using new varieties determined to be appropriate for foreign market demands to increase possibilities for export.

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