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## The effects of cutting times of the rootstock's top and rootstock's stem thickness on graft success in walnut for topworking graft

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### ABSTRACT

One of the important problem in walnut production is establishing orchards with unfruitfulness trees and using cultivars that doesn't suitable for this area. In recent years walnut cultivation is began to be done with high lateral bearing capacity cultivars. For this aim, in unfruitfulness orchards topworking studies has begun with these cultivars. Grafting methods and periods, ecology, the cutting time of the rootstock's top before grafting and the applications made after grafting affect the graft success on walnut. In this study, the effects the cutting times of the rootstock's top before grafting on graft success and shoot growth were examined. Also the effect of the rootstocks thickness to graft success and shoot growth were examined. For this aim rootstocks were divided into three groups and their top were cut in two periods (60 and 20 days before graft). Graft success was determined one month after grafting as sprouting ratio. On the other hand, length and diameter of graft scion shoots, number of internodes per shoot, the distances of internodes, sugar, starch and carbohydrate ( $\text{mg L}^{-1}$ ) contents of shoots were investigated after vegetation period. The cutting time of the rootstock's top affected the graft success, the distance of internodes, sugar, starch and carbohydrate ( $\text{mg L}^{-1}$ ) contents of sprouts statistically. In the study, highest graft sprouting ratio was 92.7% on thick rootstocks which cut off in early period (60 days before grafting). Rootstock's diameter didn't affect the scion's starch, sugar and carbohydrate level statistically. According to the study, we can advise that bark grafting on walnut should be made on thick rootstocks and rootstock's top should be cut before leaf appearance.

### Keywords:

Bark grafting  
Bleeding  
Chandler  
Topworking graft  
Walnut

Cevizde çeşit değiştirme aşılarında anaçlarda tepe kesimi zamanı ve kalınlıklarının aşı başarısı üzerine etkisi

### ÖZET

Ülkemizde ceviz yetiştiriciliğindeki en önemli sorunlardan biri şimdiye kadar ceviz bahçelerinin ekolojije uygun olmayan ve genellikle verimi düşük çeşitler ile kurulmasıdır. Son yıllarda yan dal verimi yüksek çeşitlerin ülkemizde yetiştirilmeye başlanması ile birlikte mevcut bahçelerinde bu çeşitlerle değiştirilmesi amacıyla aşılama çalışmaları yapılmaya başlanmıştır. Cevizde aşı başarısı aşı yöntemi ve zamanına, ekolojije, anaçlarda tepe kesim zamanına ve aşidan sonra yapılan uygulamalara göre değişiklik göstermektedir. Bu çalışmada, cevizde çeşit değiştirme aşısında anaçta aşidan önce yapılan tepe kesimi zamanının aşı sürme ve sürgün gelişimi üzerine etkisinin belirlenmesi hedeflenmiştir. Bunun yanı sıra çevirme aşısı yapılan anaçlarda, anaç kalınlığının aşı başarısı ve sürgün gelişimi üzerine etkisi de belirlenmeye çalışılmıştır. Bu amaçla 3 farklı kalınlıktaki anaçlarda aşılama öncesi iki dönemde (60 ve 20 gün önce) tepe kesimleri yapılmıştır. Çeşit değiştirme aşısı olarak kabuk altı aşı yöntemi kullanılmış ve aşılar 20 Haziran'da yapılmıştır. Uygulamaların cevizde aşı başarısı ve aşı sürgünü gelişimi üzerine etkisini belirlemek amacıyla aşidan bir ay sonra aşı sürme oranı (%), vejetasyon sonunda ise aşı sürgünü boyu (cm) ve çapı (mm), sürgündeki boğum sayısı (adet), boğumlar arası mesafe (cm), sürgünlerde şeker, nişasta ve karbonhidrat ( $\text{mg L}^{-1}$ ) içerikleri belirlenmiştir. Tepe kesimi zamanının aşı sürme oranı (%), boğumlar arası mesafe ile sürgünlerdeki şeker, nişasta ve karbonhidrat içerikleri üzerine istatistiksel olarak önemli etki yaptığı saptanmıştır. Araştırmada en yüksek aşı sürme oranı %92.7 ile erken dönemde kesilen kalın anaçlardan elde edilmiştir. Anaç çapının sürgünlerdeki nişasta, şeker ve karbonhidrat içeriği üzerine etkisi istatistiksel olarak önemsiz bulunmuştur. Araştırma sonucunda, cevizde çeşit değiştirme (kabuk altı) aşılarının özellikle kalın anaçlara uygulanması ve tepe kesimi işleminin erken dönemde yapılması önerilmiştir.

### Anahtar Sözcükler:

Kabuk altı aşı  
Kanama  
Chandler  
Çeşit değiştirme aşısı  
Ceviz

## 1. Introduction

Walnut is one of the most important nut trees in the world. World's total walnut production is 3418559 tones and China is leading with 1700000 tones. Hence Turkey's walnut production is 194298 tones (FAOSTAT, 2016). Walnut is an important species with different using purposes such as fruits, woods, chemical industry and etc. Also its value at the market is high and increasing. So request to the walnut production is getting popular.

Walnut grafting needs more care than the other fruits. The reasons are higher temperature request for callus formation and xylem exudation (Lagerstedt, 1979; Knuyuki and Forde, 1985; Yildiz and Yilmaz, 2003; Sen, 2011). The effect of these factors make difficult to graft walnut and reduce the graft success. Many studies have been carried out for grafting of young walnut plants. In these studies, researchers suggested different times and methods for grafting walnut depending to the ecology (Achim and Botu, 2001; Özkan et al., 2001; Ördek, 2004; Karadeniz, 2005; Dehghan et al., 2009).

Some of the walnut orchards were established with seed which of them were open-pollinated and some of them were established with wrong named cultivars. Because of these reasons yields are low in these kind of walnut orchards. So there is an increasing demand on grafting those trees. Depending on these serious problems on walnut grafting and high cost of orchard replanting (Rezaee et al., 2008), topworking seems to be the best alternative method for changing cultivars in unfruitfulness walnut orchards. Some researchers tried different techniques for topworking of walnut (Dehghan et al., 2009; Serdar et al., 2013; Karadeniz, 2014; Rezaee et al., 2014). But, there have been no studies concerned with the effects of different cutting times of rootstock's top before grafting on graft success in topworking of walnut.

The aims of this study were to determine the effects of; i) the cutting times (60 and 20 days) of the rootstock's top before grafting, ii) thickness of rootstocks on graft success and scion shoot growth.

## 2. Materials and Methods

This research was carried out in 2011-2012 in a private orchard at Samsun's Atakum district. About ten-eleven years old grafted trees with 'Yalova 1', 'Şebin' and 'Bilecik' cultivars were used as rootstock. Hence 'Chandler' cultivar was used as a scion for changing cultivar. The scions were taken in February and they were stored in cases which contain moist perlite at 2-4°C. In the study, rootstocks top was cut off at 15 cm above from the graft area in two different times before grafting. The first time was 20 April (early: sixty days before grafting) and the second time was 30 May (late: twenty days before grafting). Grafts were made in 20

June using bark grafting. In the grafting, the rootstocks were divided into three groups as their stem thickness. These groups are thin (34.00-60.00 mm), medium (60.01-85.00 mm) and thick (85.01-110.00 mm).

In the study, the graft success (sprouting of scion) ratio was determined on 20 July (30 days after grafting). Hence, shoot length (cm), shoot diameter (mm), number of internodes and distances between internodes (cm) on the shoot were measured in December. Also sugar, starch and carbohydrate contents of shoots were examined according to the Candolfi and Koblet (1990). For this aim, about 2 cm part shoots were taken from third internode at the end of the vegetation period (Bates et al., 2002). The shoot parts were dried for 5-7 days at 70 °C in oven. When moisture content of shoots became stable, they were broken into pieces with the mill. 200mg sample taken from them and put into glass tubes. 8 ml 70 % Ethyl alcohol was put into it. After that the mixture extracted at 60°C for 30 minutes (Candolfi and Koblet, 1990). 8ml 1M perchloric acid was added into the mixture and they were stored at 60°C for 1 hour. This procedure repeated twice. The alcohol in the samples were removed at 37 °C and the two mixture combined. The absorbance value was determined at 620 nm with spectrophotometer. Sugar and starch content were determined with anthrone method (Scott and Melvin, 1953). To determine of sugar and starch contents glucose was used as a standard. The results were expressed as mg/L.

The study was established with randomized blocks with three replications. Each replication had five plants. Data were analyzed with SPSS 16 statistical program. Differences between mean values were evaluated with 'Duncan Multiple Range Test' ( $P < 0.05$ ).

## 3. Results

It's founded that cutting times of the rootstocks top and rootstocks thickness affected to graft success as statistically. The higher graft success with 83.7 % was determined from early period (Table 1). On the other hand, the thick rootstocks had the best graft success with 88.8 %. When we look at the interactions, the best graft success was obtained from thick rootstocks which were cut in the early period (92.7 %) and the worst graft success was obtained from thin rootstocks that cut in the late period (61.4 %).

The shoot length was 79.4 cm in the late cutting and 74.1cm in the early cutting period. However, it did not affect from the cutting periods directly. But, in both cutting periods, medium and thick rootstocks had longer and thicker scion shoots and more number of nodes in the interactions. Distances between internodes statistically affected from cutting period and rootstock thickness. Internode length was longer in late cutting period with 4.9 cm. On the other hand the longer internodes distances were obtained from medium and thick rootstocks than thin ones (Table 1).

Table 1. Effects of the cutting times and rootstock thickness on graft success and shoot development, and carbohydrate contents in walnut

Cutting time	Rootstock diameter (mm)	Graft success (%)	Shoot length (cm)	Shoot diameter (mm)	Nodium number	Distance between internodium (cm)	Sugar (mg L <sup>-1</sup> )	Starch (mg L <sup>-1</sup> )	CH (mg L <sup>-1</sup> )
Early	Thin	83.1bc*	43.5 b	10.5 c	11.4 b	3.9 c	20.9	24.7	44.8
	Medium	75.2 d	89.6 a	16.0 ab	18.2 a	4.9 ab	19.2	24.4	42.8
	Thick	92.7 a	89.2 a	17.0 ab	18.7 a	4.6 bc	20.7	22.9	42.7
Late	Thin	61.4 e	54.0 b	13.8 b	11.7 b	4.6 bc	28.7	19.2	47.0
	Medium	76.5 cd	93.3 a	17.2 a	17.0 a	5.5 a	30.5	18.8	48.5
	Thick	84.8 b	90.7 a	16.9 ab	18.4 a	4.8 ab	30.5	19.4	49.1
SEM		4.36	8.96	1.07	1.39	0.21	2.18	1.12	1.14
Factor Means									
Rootstock thickness	Thin	72.3 b	48.8 b	12.2 b	11.6 b	4.2 b	24.8	22.0	45.9
	Medium	75.9 b	91.5 a	16.6 a	17.6 a	5.2 a	24.9	21.6	45.6
	Thick	88.8 a	89.9 a	16.9 a	18.5 a	4.7 ab	25.6	21.2	45.9
Cutting time	Early	83.7 a	74.1	14.5	16.1	4.5 b	20.3 b	24.0 a	43.4 b
	Late	74.3 b	79.4	16.0	15.7	4.9 a	29.9 a	19.1 b	48.2 a
P									
Cutting time		P<0.001	P<0.198	P<0.086	P<0.681	P<0.038	P<0.001	P<0.001	P<0.002
Rootstock thickness		P<0.001	P<0.001	P<0.001	P<0.001	P<0.004	P<0.801	P<0.539	P<0.985
Cutting time x Rootstock thickness		P<0.001	P<0.041	P<0.025	P<0.023	P<0.050	P<0.395	P<0.251	P<0.451

\*: Means with different letters in the same column were significantly different

Cutting times affected statistically to sugar, starch and carbohydrate contents. Starch content was higher in the early cutting time than in the late cutting time. However, sugar and carbohydrate contents were higher in late cutting period (Table 1).

#### 4. Discussion

In the study, the best graft success was taken from thick rootstocks which were cut in the early period. This success may be resulted from these rootstocks didn't spend most of their starches. Also, thick rootstocks had more carbohydrate capacity than the others. Actually, in the late cutting period, rootstocks spent the most of starches to grow the sprouts up to 30 May. On the other hand, cutting the rootstock's top in early period gave much time for distraction of xylem exudation. So, it will reduce xylem exudation problem, when we start grafting. The best scion shoot development was obtained from medium and thick rootstocks. This could be resulted from higher carbohydrate capacity of them. Bleeding should be prevented during the graft healing time in walnut (Reil et al., 1998). Hence, Serdar et al. (2013) advised that cutting the rootstock's top should be done at least 20 days before grafting, on the other hand the optimum time for this application may be immediately before bud burst (from end of March to middle of April) for both graft success and also shoot development in topworking of walnut. And also, obtained results in this study were in accordance with Rezaee and Vahdati (2008) who reported that graft success ratio in bark graft method was varied from 50% to 100% and modified bark grafting method in walnut

represents a simple and effective technique to convert inferior walnut trees to desirable cultivars.

#### 5. Conclusion

In Turkey, most of the producers cut down their unfruitfulness walnut trees. However, we suggest that not to cut these trees. These trees can be grafted with topworking methods and they can grow faster comparing to young grafted plants. As a result of our study when topworking graft on walnut, rootstock's top should be cut in early period before leaf appearance. Also thicker rootstocks should be chosen for both graft success and scion shoot quality. In the study, we made the grafts only one time and also very late date (20 June). So we don't know how success we can get if we make grafts in different periods. So, different grafting times for topworking of walnut should be also studied.

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