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The Effects Of Two Different Grafting Methods On Some Graft Properties Of The Graft Combinations Consisted Of The Cuttings Of Sultani Seedless Grape Variety And Different American Rootstocks

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Abstract: Scions of Sultani Seedless (S.S.) grapevine variety and cuttings of three vine rootstocks (1103P, 41B and Ramsey) were used in the study. The cuttings were grafted with two different grafting methods (omega and chip-budding). Graft successes of grafting methods and rootstocks in fusion (callusing room) and adaptation rooms were evaluated. In respect of callus level, 1103P rootstock and 1103P rootstock omega grafted cuttings are successful. The 1103P omega grafted cuttings had the highest amount in respect of callus on rootstock side and total callus; as the highest amount callus on scion side were weighed at 41B chip-budding grafted cuttings. 1103P/S.S. omega grafted cuttings had the highest percentage of sprouted grafted cuttings (42nd day, 100%), average of shoot length (42nd day, 19.5 cm), percentage of rooted grafted cuttings (42nd day, 23%), average of root number (42nd day, 35 roots), average of root length (42nd day, 3.8 cm) and the lowest percentage of grafted cuttings having decay on their bottom (10%). Also, chip-budding grafted cuttings of the same scion/rootstock graft combination were second about percentage of sprouted grafted cuttings (42ndday, 46 %), average of shoot length (42ndday, 11 cm), percentage of rooted grafted cuttings (42ndday, 17%), average of root numbers (42ndday, 21 roots) and average of root length (42ndday, 1.9 cm). One-week adaptation phase after four-week fusion phase is considered appropriate, because there were regression in general for the evaluated criteria of 35 days after grafting. Moreover, omega graft method for 1103P and 41B and chip-budding graft method for Ramsey with Sultani Seedless grafting combination were suggestible.

Keywords: Chip-budding, Omega, 1103P, 41B, Ramsey,

İki Farklı Aşı Yönteminin Sultani Çekirdeksiz Üzüm Çeşidi İle Farklı Anaçların Çeliklerinin Oluşturduğu Aşı Kombinasyonlarında Bazı Aşı Özellikleri Üzerine Etkileri

Öz: Denemede Sultani Çekirdeksiz üzüm çeşidi aşı kalemleri ile üç asma anacının (1103P, 41B ve Ramsey) çelikleri kullanılmıştır. Çelikler iki farklı aşı yöntemi (omega ve yonga) ile aşılanmıştır. Denemede aşıların ve anaçların kaynaştırma ve alıştırma odalarındaki aşı başarısı değerlendirilmiştir. Kallus gelişim düzeyi bakımından 1103P anacı ve 1103P omega aşılı çelikleri başarılı olmuştur. 1103P omega aşılı çelikleri anaç tarafında ve toplam kallus bakımından en yüksek değeri alırken kalem tarafında en fazla kallus 41B yonga aşılarında belirlenmiştir. 1103P omega aşılarında en yüksek sürme görülen çelik yüzdesi (%100), en uzun ortalama sürgün uzunluğu (42. gün 19.5 cm), en fazla köklenme görülen aşılı çelik yüzdesi (42. gün %23), en fazla ortalama kök sayısı (42. gün 35 adet), en fazla ortalama kök uzunluğu (42. gün 3.8 cm) ve dip kısmında çürüme olan en az aşılı çelik yüzdesi (%10) belirlenmiştir. Aynı anacın yonga aşılı çelikleri sürme görülen aşılı çelik yüzdesi (42. gün %46), ortalama sürgün uzunluğu (42. gün 11 cm), köklenme görülen aşılı çelik yüzdesi (42. gün %17), ortalama kök sayısı (42. gün 21 adet) ve ortalama kök uzunluğu (42. gün 1.9 cm) bakımından ikinci sırada yer almıştır. İncelenen ölçütlerde genel olarak 35. günden sonra gerileme olduğundan dolayı 4 haftalık kaynaştırmanın ardından 1 haftalık alıştırma süresi uygun bulunmuştur. Ayrıca bu çalışmada 1103P ve 41B anaçları için omega aşı yöntemi ve Ramsey anacı için ise yonga aşı yöntemi ön plana çıkmıştır.

Anahtar Kelimeler: Yonga, Omega, 1103P, 41B, Ramsey

1. Introduction

Turkey is a gene center for grape plant which is also in the most convenient climate zone for viticulture. Turkey has also got an ancient and fundamental viticulture production with a current important position in worldwide grape production (Çelik, 2007). But as in throughout world, factors such as phyloxera, nematode or disease related factors restricts viticulture in Turkey, because of these factors, vineyard establishment with grafted grapevine has gained importance.

The grafted grapevine production was approximately 3,4 million units in 2016 in Turkey (Çelik, 2017). The annual requirement of grafted grapevines is approximately 10 million units (İşçi and Altındişli, 2007). Çelik (2017) also reported that our country has needed 27 million units grafted grapevine annually for preserving the available vineyard area; grafted grapevine shortage in Turkey is about 30% in last years (Çelik, 2012). It is understood that the annual grafted grapevine production is less than the requirement of Turkey's grape production. Besides insufficient production, grafted grapevine final-take rate is not at desired level. Various studies have done for increasing grafted grapevine final-take rate. One of these studies is the application of different grafting methods.

There were many studies have been done for the related topic. Sultani Seedless scions being used in; SO4, 1103P, Teleki 5C and 140Ru (Thompson Seedless; synonym of Sultani Seedless (Değirmenci and Marasalı, 2001)) by El-Boray et al. (2009); 41B by Gargın et al. (2011); 1613C, 140Ru, 110R, 99R, 5BB, SO4, 1103P ve 41B by Çakır et al. (2013); 41B by Dardeniz (2013); 140Ru, 110R, 1613C, 5BB and Ramsey by Yağcı and Gökkaynak (2016); 41B by Dardeniz et al. (2017); Du Lot, 420A, 5BB, SO4, 8B, 110R, 140Ru, 1103P, 41B and Ramsey by Sucu and Yağcı (2017) rootstocks were used. There are also studies about chip-budding grafting of vine cuttings in the literature. Ecevit and Göktürk Baydar (2000) examined effects of grafting methods in grafted grapevine production to callused grafted cuttings percentage (%), grafted grapevine final take rate (%) and first grade graft rate (%). For this purpose, Alphonse Lavallée, Italia and Razakı vine scions were grafted on 5BB and 1103P rootstocks by four different grafting methods (chip-budding, omega, whip, splice grafting). They claimed that the most convenient grafting method was chip-budding grafting and omega grafting was the second and also grafting successes of scion/rootstock combinations showed differences. Çelik et al. (1995) grafted Hamburg Muscat and Kalecik Karası scions on 41B, 5BB and 99R by omega graft (1991 and 1992 April) and by chip-budding (1991 August and 1992 April-August) and by whip and cleft graft (1993 April). They reported chip-budding grafting method could be applied to planted rootstocks in the planting year, August-September period.

For the grafted grapevine production, it is seen that chip-budding grafting has been more successful than other grafting methods (Çelik, 2000; Çelik et al., 1995; Çelik and Odabaş, 1998; Ecevit and Göktürk Baydar, 2000; Sabır and Kara, 2010). However, in grafted grapevine production omega grafting has been widespreadly applied (Çelik et al., 1996; Çelik et al., 2009; Gargın et al., 2011; Çakır et al., 2013; Soltekin et al., 2014; Alço et al., 2015; Bekişli et al., 2015; Dolgun et al., 2016; Yağcı ve Gökkaynak, 2016; Dardeniz et al., 2017; Sucu ve Yağcı, 2017).

Sultani Seedless scions were grafted on 1103P, 41B and Ramsey rootstocks by omega graft (table machine) and chip-budding (hand machine) and grafting successes of these grafting methods and rootstocks in callusing and adaptation rooms were evaluated in the study. The study was performed from PhD thesis of the author (Graduate Faculty of Natural and Applied Science, Ege University).

2. Materıal and Method

The research was carried out in Manisa Celal Bayar University Alaşehir Vocational School (2018). Cuttings of 1103P, 41B and Ramsey rootstocks and Sultani Seedless scions were used as materials in the study. Rootstocks cuttings were obtained commercially and scion

cuttings were obtained from the farmer vineyard; cuttings were stored at cold room (8-12°C temperature and 65-80% humidity) until grafting process. Before grafting, for omega grafting, other buds of rootstocks were shaved off except the bottom bud; for chip-budding grafting other buds of rootstocks were shaved off except bottom and tip buds. At chip-budding grafting, the bud being obtained from scion was grafted to below side of the tip bud of rootstock cutting. Table omega machine and chip-budding hand machine were used for grafting. After grafting process, paraffin application was done with the commercial grafting paraffin melting at 70-80°C. Grafted cuttings which paraffin applied were placed in boxes with 10-20 cm water height and stored in callusing room for four weeks. In callusing room, conditions were provided by working that temperature was 28-30°C for first two week and 26-28°C following two week and humidity was 80-90% and for two-week adaptation phase, conditions were provided by working that temperature was 22-24°C and humidity was 50-55% (Cangi, 1996; Arık, 2013). Ten grafted cuttings were selected for replication and three replications were used for each combination. In 21st after grafting, graft area was separated for weighting callus amount (mg) for both scion and rootstock cuttings and total (Doğan, 2009). After grafting in 7., 14th, 21st, 28th, 35th and 42ndday, callus developing level (0-absent, 1-one side callus forming, 2-two sides callus forming, 3-three sides callus forming and 4-completely callus forming), percentage of rooted grafted cuttings (%), average of root number, average of root length (cm), percentage of sprouted grafted cuttings (%), average of shoot length (cm) and in 42ndday percentage of grafted cuttings having decay (xylem browning) on their bottom (%) (Bekişli et al., 2015) and rooting level (0-absent, 1-one side rooting, 2-two sides rooting, 3-three sides callus rooting and 4-completely rooting) were examined.

The experiment was prepared as completely random block design. Each application consisted of three replications and each replication had thirty cuttings. Statistical analysis was done with Minitab 16 program and mean differences were determined with Tukey ($P<0.05$).

3. Results and Discussion

Callus developing level: In graft area callus development is important for a healthy graft union. Callus mass developing healthy gives support to graft connection by acquiring a healthy differentiation. In this research, 1103P/Sultani Seedless combination was better than others (41B/S.S. and Ramsey/S.S.) about callus developing level. Among rootstocks x graft methods combinations, 1103P/S.S. omega grafted cuttings were the best and chip-budding grafted cuttings of 1103P/S.S. were second. Omega grafting was foremost for 1103P/S.S., while chip-budding grafting was foremost for Ramsey/S.S. and 41B/S.S. (Table 1).

Table 1. Callus development levels of graft combinations

Rootstock/scion	Average of callus developing level	Rootstock/scion x grafting method combination	Average
1103P/S.S.	3.2 a	1103P/S.S. omega	3.5 a
41B/S.S.	1.7 b	1103P/S.S. chip-budding	2.9 b
Ramsey/S.S.	0.9 c	41B/S.S. chip-budding	2.1 c
		Ramsey/S.S. chip-budding	1.5 d
		41B/S.S. omega	1.2 d
		Ramsey/S.S. omega	0.3 e

P<0.05

High callus development level improves graft union. In grafting applications, graft unions of different rootstocks were varied. It's stated that graft developments of 1103P (Çelik, 1998) and Ramsey (Söylemezoğlu, 2003) rootstocks are better than 41B (Çelik, 1998). The 1103P was first about callus development level; poor

callus development level of Ramsey was unexpected in the study.

Callus developing levels of grafted cuttings were evaluated with respect to days of sample taking also. In the 7th day after grafting, callus development wasn't formed in the grafted cuttings. In each sample taking times (except the 7th day), the best callus developing level was on 1103P/S.S. omega grafted cuttings. Callus level increased until 35th day (sample taking time) in omega and chip-budding grafting cuttings of 1103P/S.S. and Ramsey/S.S. omega grafted cuttings but in other days callus level decreased; in omega and chip-budding grafting cuttings of 41B/S.S. callus level increased until 21st days, but it decreased later; in Ramsey/S.S. chip-budding grafted cuttings callus level increased until 28th day, but later callus level decreased (Figure 1). It is thought that in grafted cuttings callus damaged because of being consumed of nourishment source and exposing to diseases.

About average callus levels, in some researches (Dardeniz and Şahin, 2005; Köse et al., 2015), combinations consisted of 1103P rootstock had better callus development level average than 41B rootstock graft combination. And in our research, 1103P graft combinations were best in all combinations.

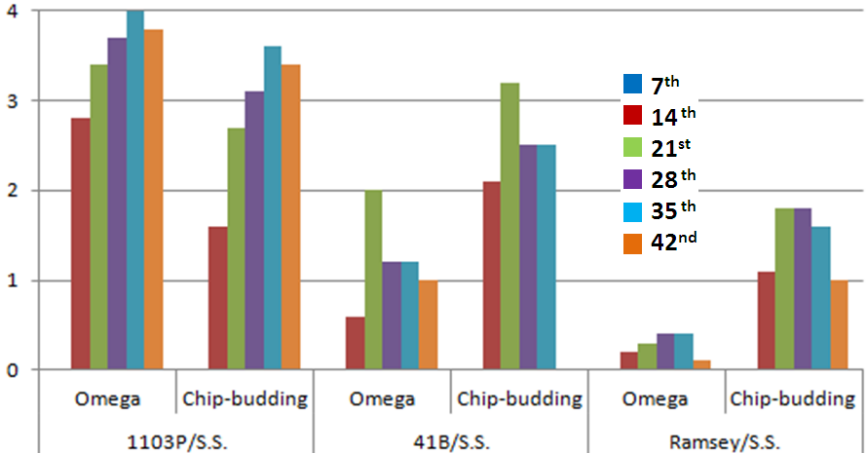

Figure 1. Callus development levels of graft combinations by days

Callus amount (mg): After grafting practice in 21st day, grafting points of the grafted cuttings were broken and then both at rootstock side and at scion side callus mass was got and weighted, thus average of callus amount (mg) was determined. The most total callus and rootstock side callus amount was on 1103P/S.S. omega grafted cuttings and chip-budding grafted cuttings of 1103P/S.S. and 41B/S.S. were second respectively (Table 2).

Table 2. Callus amounts averages of scion side and rootstock side and total of graft combinations (mg)

Rootstock/scion x grafting method	Rootstock side	Scion side	Total callus
1103P/ S.S. omega	707.5 a	23.5 c	731.1 a
1103P/ S.S. chip-budding	367.2 abc	60.0 b	427.2 ab
41B/S.S. omega	537.4 ab	14.1 e	579.1 a
41B/S.S. chip-budding	262.8 bc	121.1 a	383.8 ab
Ramsey/S.S. omega	89.7 c	22.9 d	135.6 b
Ramsey/S.S. chip-budding	52.0 c	3.2 f	58.4 b

$P<0.05$

The most scion side callus amount was weighted on chip-budding grafted cuttings of 41B/S.S. and 1103P/S.S. 1103P/S.S. omega grafted cuttings had high callus amount of

rootstock and low callus amount of scion side; it is a question to think. The lowest scion side callus amount / rootstock side callus amount rates were omega grafted cuttings of 1103P/S.S. and 41B/S.S and Ramsey/S.S. chip-budding grafted cuttings.

Percentage of sprouted grafted cuttings (%): The highest percentage of sprouted grafted cuttings (%) was obtained at 1103P/S.S. omega grafted cuttings. In 14th day, percentage of sprouted grafted cuttings (psgc) of 1103P/S.S. chip-budding grafting was more than omega grafting but decreased in half in 21st day, but still in 28th day, it increased highly but later decreased highly. At 41B/S.S. omega grafted cuttings, the highest percentage was 35th day and later psgc decreased; at 41B/S.S. chip-budding grafted cuttings the highest percentage was obtained in 28nd day and 35th day, but later psgc decreased highly (Table 3).

Table 3. Percentage of sprouted grafted cuttings (%) of graft combinations by days

Rootstock/scion x Graft	7th day	14th day	21st day	28th day	35th day	42nd day
1103P/S.S. Omega	0.0%	36.7%h	73.3% d	100.0% a	100.0% a	100.0% a
1103P/S.S. Chip-budding	0.0%	53.3% e	26.7% i	96.7% b	83.3% c	46.7% f
41B/S.S.Omega	0.0%	0.0%	10.0% l	10.0% l	16.7% j	6.7% m
41B/S.S. Chip-budding	0.0%	0.0%	10.0% l	43.3% g	43.3% g	3.3% n
Ramsey/S.S. Omega	0.0%	0.0%	3.3% n	3.3% n	0.0%	13.3% k
Ramsey/S.S. Chip-budding	0.0%	13.3% k	26.7% i	10.0% l	16.7% j	0.0%

$P<0.05$

At Ramsey/S.S. omega grafted cuttings, in 42th day psgc increased little; at Ramsey/S.S. chip-budding grafted cuttings the highest percentage was counted in 21st day, but in 42nd day, it was seen that shoot vigor ended. The highest average of shoot length (cm) was measured on 1103P/S.S. grafted cuttings. In callusing period, sprouting of the grafted cutting is none asked; because connection between rootstock and scion is poor and because of absence of adventives roots water uptake is insufficient; normally, root development is supported by glucose production via assimilation and growth regulators production of leaves on shoots; but in grafts, sprouts consumed the reserved nutritional needs for callus production in graft union (Dolgun, et al., 2016).

Average of shoot length (cm): The highest average of shoot length (cm) was measured on omega and chip-budding grafted cuttings of 1103P/S.S. (Table 4).

Table 4. Average of shoot length (cm) of graft combinations by days

Rootstock/scion x Graft	7th day	14th day	21st day	28th day	35th day	42nd day
1103P/S.S. Omega	0	0.87 k	5.2 h	20 b	21.2 a	19.5 c
1103P/S.S. Chip-budding	0	0.8 l	5.5 g	12.3 d	10.9 f	11 e
41B/S.S.Omega	0	0.03	0.2 o	0.4 m	0.11 q	0
41B/S.S. Chip-budding	0	0.3 n	2.4 j	3.3 i	0.14 p	0
Ramsey/S.S. Omega	0	0	0.02 s	0.06 r	0	0
Ramsey/S.S. Chip-budding	0	0.09 q	0.3 n	0.14 p	0.29 n	0

$P<0.05$

Percentage of rooted grafted cuttings (%): The highest percentage of rooted grafted cuttings was determined on 1103P/S.S. omega grafted cuttings in 35th day (27%) and chip-budding grafted cuttings of the same rootstock/scion combination (20%, in 28nd day). Also, in 41B/S.S. omega grafted cuttings, existing roots lost their vitality after 28nd day. Rooting began after 14th day in these cuttings. All Ramsey/S.S. grafted cuttings and chip-budding grafted cuttings of 41B/S.S. didn't have any root (Table 5). In literature; root formations of 41B (Bağçevli 2010) and Ramsey (Çelik,

1998) are poor, when 1103P has good root formation (Çelik, 1998).

Average of root number (pieces): Omega grafted cuttings of 1103P/S.S. had the highest root number average (in 42nd day, 35 pieces); root number increased after 28th day. 1103P/S.S. chip-budding grafted cuttings were second about root number (21 pieces, in 35th day); root number increased after 35th day.

Table 5. Average of percentage of rooted grafted cuttings (%) by days

Rootstock/scion x Graft	7th day	14th day	21st day	28th day	35th day	42nd day
1103P/S.S. Omega	0%	0%	20% c	17% d	27% a	23% b
1103P/S.S. Chip-budding	0%	0%	10% e	20% c	7% f	17% d
41B/S.S.Omega	0%	0%	0%	0%	0%	0%
41B/S.S. Chip-budding	0%	0%	3% g	3% g	0%	0%
Ramsey/S.S. Omega	0%	0%	0%	0%	0%	0%
Ramsey/S.S. Chip-budding	0%	0%	0%	0%	0%	0%

P<0.05

The earliest rooting was at 41B/S.S. chip-budding grafted cuttings; rooting decreased highly after 14th day and increased highly after 21st day again but after then roots lost their vitality. When rooting began after 14th day in 1103P/S.S. grafted (both omega and chip-budding) cuttings, in 41B/S.S. chip-budding grafted cuttings rooting began after 7th day. Other grafted cuttings didn't have any root (Table 6).

Table 6. Average of root number (pieces) of graft combinations by days

Rootstock/scion x Graft	7th day	14th day	21st day	28th day	35th day	42nd day
1103P/S.S. Omega	0	0	12.0 f	16.0 e	38.1 a	35.0 b
1103P/S.S. Chip-budding	0	0	6.0 h	3.0 j	9.0 g	21.0 c
41B/S.S.Omega	0	0	0	0	0	0
41B/S.S. Chip-budding	0	16.0 e	4.0 i	18.0 d	0	0
Ramsey/S.S. Omega	0	0	0	0	0	0
Ramsey/S.S. Chip-budding	0	0	0	0	0	0

P<0.05

Being stored of the grafted cuttings in box with 10-20 cm water height for callusing repressed root formation.

Average of root length (cm): At the end of the adaptation period, the highest root length average determined at 1103P/S.S. omega grafted cuttings (3.8 cm). In the 28th day measurement, average root length of 41B/S.S. chip-budding grafted cuttings was more than 1103P/S.S. omega grafted cuttings' (Table 7).

Table 7. Average of root length (cm) of graft combinations by days

Rootstock/scion x Graft	7th day	14th day	21st day	28th day	35th day	42nd day
1103P/S.S. Omega	0	0	2.5 e	3.1 d	3.4 c	3.8 a
1103P/S.S. Chip-budding	0	0	1.5 i	1.6 h	1.3 j	1.9 g
41B/S.S.Omega	0	0	0	0	0	0
41B/S.S. Chip-budding	0	0	2.3 f	3.7 b	0	0
Ramsey/S.S. Omega	0	0	0	0	0	0
Ramsey/S.S. Chip-budding	0	0	0	0	0	0

P<0.05

It was expected that as callus development level, about percentage of rooted grafted cuttings, average of root numbers, average of root length, percentage of sprouted grafted cuttings and average of shoot length, 1103P/S.S. omega grafted cuttings were first and chip-budding grafted cuttings of the same combination come after.

Rooting level: Rooting levels of grafted cuttings was determined in 42nd days and only 1103P/S.S. grafted cuttings had root. Differentiations between rooting levels of rootstock/scion combinations were insignificant (Table 8).

Table 8. Average of rooting level of graft combinations

Rootstock/scion	graft	Rooting level
1103P/S.S.	omega	0.5 a
	chip-budding	0.4 ab
41B/S.S.	omega	0
	chip-budding	0
Ramsey/S.S.	omega	0
	chip-budding	0

Level	1103P/S.S. rooting level average	
	Omega	Chip-budding
1	2 (pieces)	1 (pieces)
2	1	1
3	1	1
4	0	0
0	6	7

$P<0.05$

Percentage of grafted cuttings having decay on their bottom (%): 1103P/S.S. omega grafted cuttings had the lowest percentage of grafted cuttings having decay (xylem browning) on their bottom (10%); also 41B/S.S. omega and Ramsey/S.S. chip-budding grafted cuttings ranked second (17%). The highest decays were Ramsey/S.S. omega, 41B/S.S. chip-budding and 1103P/S.S. chip-budding grafted cuttings. It preoccupies that in 1103P/S.S. and 41B/S.S. grafted cuttings omega graft was better than chip-budding, when in Ramsey/S.S. grafted cuttings chip-budding graft was better than omega graft (Table 9).

Table 9. Average percentage of grafted cuttings having decay on their bottom (%) by days

Rootstock/scion graft combination	Decay (%)
1103P/ S.S. omega	10% e
41B/S.S. omega	17% d
Ramsey/S.S. chip-budding	17% d
1103P/ S.S. chip-budding	43% c
41B/S.S. chip-budding	47% b
Ramsey/S.S. omega	50% a

$P<0.05$

It is understood that in all examined criteria especially callus levels of all rootstock/scion combinations after 35th day, flaws began. It is thought that running out of stored nutritional elements and the suppression on rooting of water media caused this issue.

Some researchers have enlightened that final take rate may be estimated by inspections which conducted at callusing and acclimate phases (Gambetta et al., 2009; Gargın and Altındişli 2014; Dolgun et al., 2016). In a research done by Bekar (2019), it is understood that combinations which consist of 1103P rootstock had higher final sapling yield than combinations which consist of 41B rootstock among all scion x rootstock combinations. The 1103P/S.S. had better callus development level than 41B/S.S in the study.

Also, omega graft method was better for 1103P/S.S. and 41B/S.S. graft combinations, when chip-budding graft method was better for Ramsey/S.S. graft combinations. However, in chip-budding grafting scion is placed inner side of rootstock and scion is supported by both upper side and beneath side and lateral side (three sides) on rootstock. Namely, transmission mechanism of rootstock surrounds scion completely. Also, in omega grafting scion is supported only by scion bottom side. Therefore, it is expected that chip-budding grafting is more successful than omega grafting. In the facility producing both omega and chip-budding grafted grapevines with using the same graft combinations (Sultani Seedless scion and 1103P, 41B and Ramsey rootstocks), the facility owner said that chip-budding was more

successful. But, in this research this expression didn't come true.

4. Conclusions

1103P rootstock had gained the highest grade and for each rootstock, different graft methods were more successful; in 41B and Ramsey rootstocks chip-budding graft method and in 1103P omega graft method were more successful. As a result of this study, for obtaining grafted grapevine which consisted of Sultani Seedless, it's suggested that 1103P rootstock and omega grafting method can be used. And according with this, for improving final take rate, affinity researches should be carried out in this way.

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