

Araştırma Makalesi/Research Article (Original Paper)

The Effects of Rootstock Cutting Thickness on Final Take, Quality of Potted Grapevine Saplings

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Abstract: In grapevine propagation, dormant cutting quality of rootstock and scion is as equally important as the quantity. The best length and thickness of cuttings for propagation were determined by researches. Cuttings should be at least 7-12 mm in diameter at the top. The length can vary from 30 to 40 cm, depending on location and soil type. In this study, the effects of rootstock cutting thickness (diameter) on rafting success, final take and quality of potted grapevine plants were investigated. The dormant cuttings of 5BB, 1103 P and 110 R dormant cuttings were grouped by their diameters (6-9 mm, 10-13 mm, 14 mm \leq), then scions of Narince cultivars were grafted by omega grafting machine on cuttings. In the study, the callusing and rooting performance of grafted cuttings and final take were evaluated. The ratios of round callusing on graft union in 5BB and 1103P rootstocks decreased with increasing of cutting thickness. The callusing formation on base part in three rootstocks increased with increasing of cutting thickness, but root formation decreased. Total final take ratios ranged from 94 % to 98%. The ratios of total final take decreased with increasing in cutting thickness. As a result, it has been successfully exhibited that cutting with a thickness of 7-18 mm can be used in grapevine saplings production.

Keywords: 5BB, 110 R, 1103 P, Shoot length, Root fresh weight, Potted-grapevine

Özet: Asmanın çoğaltılmasında, çoğaltma materyali olarak kullanılan çelik ve kalemlerinin miktarı kadar kalitesi de aynı derecede önemlidir. Çoğaltma için en iyi çelik uzunluk ve kalınlığı araştırmalarla belirlenmektedir. Çelik uzunluğu bölge ve toprak tipine göre 30-40 cm arasında değişmektedir. Bu araştırmada, aşılı tüplü asma fidanı üretiminde anaç çapının aşı başarısı, fidan randımanı ve kalitesine etkileri araştırılmıştır. 5BB, 1103 P ve 110 R anaçlarına ait odun çelikleri çaplarına göre üç boya (6-9 mm, 10-13 mm, 14 mm \leq) tasnif edildi, daha sonra Narince çeşidi ile omega aşı makinesi ile aşılandı. Araştırmada aşılı çeliklerin kallus, köklenme performansı ve fidan randıman verileri değerlendirildi. 5BB ve 1103 P anaçlarında çap arttıkça aşı bölgesinde çepeçevre kallus oluşumu azalmıştır. Üç anaçta da genellikle çelik çapı arttıkça aşılı çeliklerin bazal kısmında kallus oluşumu artarken kök oluşumu ise azalmıştır. Toplam fidan randımanları % 94-98 arasında değişmiştir. Çelik çapı arttıkça toplam fidan randımanı azalmıştır. Sonuç olarak, 7-18 mm çapa sahip çeliklerin aşılı asma fidanı üretiminde kullanılabileceği ortaya koyulmuştur.

Anahtar kelimeler: 5BB, 110 R, 1103 P, Sürgün uzunluğu, Kök yaş ağırlığı, Tüplü asma fidanı

Introduction

Grafted grapevine saplings on different rootstocks are commonly used in modern viticulture practices to prevent the spread of Phylloxera pest or to benefit from various advantages of the rootstocks. Today, it is estimated that 80–85% of the vineyards worldwide are using rootstocks.

Indoor grafted grapevine sapling production over the benches has been used worldwide since 1930s (Alley, 1980). Grafted cuttings are transplanted into fields or greenhouse after grafting, callusing, adaptation and second waxing. Potted grapevine saplings are produced through rooting grafted scions under greenhouse conditions (Çelik et al., 1998).

The cuttings used in grafted grapevine sapling production should be supplied from pure or hybrid grapevine rootstocks. Scion characteristics of grapevine rootstocks were classified according to TSE 4027: The 1st class scions have 3-5 buds, 7-10 mm in diameter and 35-45 cm long; the 2nd class scions have 3-5 buds, 5-7 mm in diameter 35-45 cm long (Çelik et al., 1998).

Characteristics of the plant material are the primary factors influencing success in sapling production. In grapevine sapling production, rooting capacity of the rootstocks, scion taking times, health and development status of the main plant, preservation conditions and etc. Issues have significant effects on success in production. Especially the nutrition and lignification status of the rootstock are quite effective in callusing and rooting of the grafted scions (Dardeniz et al., 2007; 2008; Rodoplu and Dardeniz, 2015).

For a well lignification in scions, core/cane diameter ratio should be 1/2 (Çelik et al., 1998). Before grafting, rootstocks and scions should be subjected to diameter classification (6-8, 8-10, 10-12 mm and etc.) to improve productivity in grafting and to improve compatibility of the scions in diameter (Çelik et al., 1995).

Many external factors such as cutting length and diameter, indole-3-butyric acid (IBA) concentration, date of cutting collection, and preheating can affect and increase rooting of hardwood cuttings of many species (Tofanelli et al., 2003)

Beyl et al. (1995) investigated rooting characteristics of ligneous scions of 13 *Actinidia arguta* kiwi genotypes. Results indicated that scion lengths and diameters were effective in root development and reported the best outcomes for scions 2-8 mm in diameter and 8 cm long. They also pointed out the results varied based on the genotypes.

Çelik and Gargın (2009) investigated the effects of different IBA concentrations and scion thickness on rooting of four different grapevine rootstocks. Results showed that the best rooting ratio for 420A rootstock and lower number of roots, root fresh and dry weights for 110R rootstock than the others. They also indicated that scion thickness did not have significant effects on rooting.

Doğan et al. (2016) investigated the effects of scion diameter (4-7mm, 8-10 mm, 10-12 mm), rooting medium and IBA concentrations on rooting and root quality of 3 grapevine rootstocks (5BB, 420 A and 41B). Researchers reported for rooting and root quality parameters that the best outcomes were achieved from 10-12 mm scions for rooting ratio, from 8-10 mm scions for number of roots, from 10-12 mm scions for root length and from 10-12 mm scions for root fresh weight. In general, medium or thick scions exhibited better performance values.

This study was carried out to determine the effects of scion diameter on the success of callusing, final take and quality of shoot and root in grafted potted grapevine sapling production.

Material and Methods

This study was conducted at Grapevine Sapling Production Unit of Tokat Gaziosmanpaşa University in the year 2014. The scions of 5BB, 110 R and 1103 P rootstocks and cuttings of Narince grape cultivar were used as the material of the study. Omega-cut grafting tool was used in grafting. For potted sapling production, 1 l plastic bags filled with 1:1 perlite:peat mixture were used for all treatments. Pine chips and plastic crates were used for callusing of grafted scions.

The scions and cuttings used in this study were divided into 3 different thickness (diameter) groups (Diameter 1: 6-9 mm, Diameter 2: 10-13 mm, Diameter 3: 14-18 mm). Standard procedures were practiced throughout the stages of grafted grapevine production as of preparation of scions for grafting, water immersion, sanitation (thermotherapy, fungicide treatments), bench grafting, the first waxing, callusing, adaptation, the second waxing, 2000 ppm IBA treatments, planting into tubes and arboriculture (Akman and İlgin, 1991; İlgin et al., 1990; Çelik, 1983).

Data were collected at two periods.

1-Following the removal of grafted scions from the callusing unit: Grafting success ratio (%), callus development ratio on grafting section (%), root and callus development ratio on basal sections of the scions.

2-Following the development of grapevine saplings: Total final take, shoot length (cm), shoot and root fresh and dry weight (g).



Figure 1. Pre-grafted cuttings were classified according to their diameter.

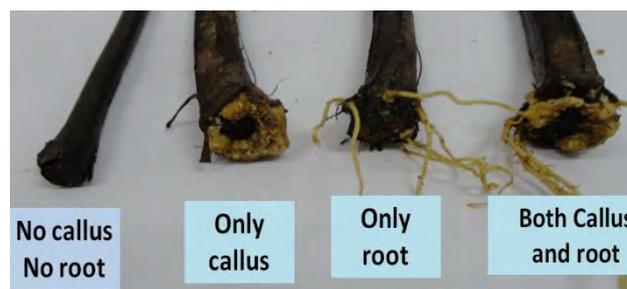


Figure 2. The root and callus development on the basal of cutting.

Experiments were conducted in randomized plots experimental design with two factors (rootstock and cutting diameter) and 4 replications with 25 grafting for each replication. Experimental results were subjected to variance analysis and means were compared with Duncan's multiple range test.

Results and Discussion

Scion thickness had significant effects on grafting success ratios. Success ratios varied between 94,0-100,0% and success ratios were generally identified as 100% in scions with a diameter greater than 10 mm (Table 1). Scion thickness also had significant effects on callus development ratio around the grafting section and overall callus development ratio of 5BB and 1103P rootstocks at %5 level. Callus development ratios around the grafting sections varied between 61-89% and overall callus development ratios varied between 82.3-96.2%. The greatest surrounding and overall callus development ratio was observed in 1103P rootstock and the lowest values were seen in 110R rootstock (Table 1).

Table 1. Effect of cutting thickness on callus development and grafting success ratios

Rootstock	Thickness	Grafting success ratio(%)	Callus development ratio (%)				Average Callus Ratio
			25	50	75	100	
5BB	6-9 mm	100.0a	3	2	13	82a	93.5 a
	10-13 mm	100.0a	1	2	11	86a	95.5 a
	14 mm≤	100.0a	14	20	32	34b	71.5 b
1103 P	6-9 mm	99.0a	2	1	7	89a	96.21 a
	10-13 mm	100.0a	1	7	14	78b	92.25 b
	14 mm≤	100.0a	1	14	24	61c	86.25 c
110 R	6-9 mm	94.0a	7	8	13	66a	86.70 a
	10-13 mm	100.0a	13	7	18	62a	82.25 a
	14 mm≤	100.0a	2	8	27	63a	87.75 a

*Each rootstock has been evaluated in its own right

** The means indicated with the same small letter in the same column are not significantly different ($p < 0.05$)

Previous researchers indicated that rootstock-scion compatibility (Kester,1965; Coombe and Dry,1992), rootstock/scion combination (Türkben and Sivritepe,2000; Dardeniz and Şahin, 2005; Cakir at al., 2015; İşçi et al., 2015; Köse et al., 2015) and lignification levels of the scions (Exadaktylou et al., 2009) had significant effects on callus development around the grafting section.

Scion thickness had significant effects on callus, root and callus+root development on basal sections of the scions at 5% level. Callus development ratios on basal sections of the scions varied between 5-97%; callus+root development ratios varied between 3-88%. With regard to callus+root development ratios on basal sections of the scions, the best performance was observed in 1103P and the worst performance was observed in 110R rootstock (Table 2).

Table 2. Effect of cutting thickness on callus and root development in the basal part of the cuttings

Rootstock	Thickness	Callus and root development rate on the basal part of cuttings (%)			
		No callus – noroot	Only Callus	Only Root	Both callus and root
5BB	6-9 mm	7	46c	3b	44a
	10-13 mm	3	69a	0c	28b
	14 mm≤	10	62b	10a	18c
1103 P	6-9 mm	0	5c	7a	88a
	10-13 mm	0	19b	6a	75b
	14 mm≤	0	43a	2b	55c
110 R	6-9 mm	14	77c	0a	9a
	10-13 mm	8	86b	0a	6ab
	14 mm≤	0	97a	0a	3b

*Each rootstock has been evaluated in its own right

** The means indicated with the same small letter in the same column are not significantly different ($p < 0.05$)

Lower performance of the grafted scions of 110R rootstock in callus and root development than the other rootstocks probable resulted from the genetic differences between the rootstocks. Thusly, Sucu and Yağcı (2015) investigated the effects of pre-grafting storage durations in callusing rooms on final take of the saplings and indicated that 100R and 140 Ru rootstocks started physiological activity later than the other rootstocks.

It was reported in another study carried out about the scion diameter and callus-root development of Gisela 5 rootstocks that callusing and rooting ratios decreased with increasing scion diameters and the greatest values were obtained from the thinnest (6-8 mm) scions (Exadaktylou et al., 2009).

In previous studies, significant effects of rootstock development and vigor (Williams and Smith, 1991; Tandonnet et al., 2010), root structure (Jogaiah et al., 2013), lignification status of the scions and genotypes (Beyl et al., 1995), scion taking time, scion length, scion diameter, scion position, pre-heating and hormone treatments (Hartmann et al., 2002; Tofanelli et al., 2003) on rooting and root parameters of ligneous scions of several cultivars were reported.

Scion thickness had significant effects on final take of the saplings. Final takes varied between 94-98%, which were quite a high ratio. While final takes decreased with increasing scion diameters in 5BB and 1103 P rootstocks, a relative increase was observed in 110R rootstock (Table 3).

Table 3. Effect of cutting thickness on total final take

	5BB			1103 P			110 R		
	Cutting thickness (mm)			Cutting thickness (mm)			Cutting thickness (mm)		
	6-9	10-13	14+	6-9	10-13	14+	6-9	10-13	14+
Final take ratio (%)	96a	94a	88b	98a	94b	86c	90b	98a	96a

*Each rootstock has been evaluated in its own right

** The means indicated with the same small letter in the same column are not significantly different ($p < 0.05$)

Exadaktylou et al. (2009) reported decreasing rooting ratios with increasing scion diameters in Gisela 5 scions. On the other hand, Dogan et al. (2016) reported increasing rooting ratios with increasing scion diameters in 3 grapevine rootstocks and also indicated varying rooting ratios with the rooting mediums and scions diameters. Çelik and Gargın(2009) indicated that scion diameters did not have significant effects on rooting ratios of hard-rooting 41 B, 110 R and 420 A grapevine rootstocks.

Several factors effects total final take in grafted grapevine sapling production. Such factors include rootstock/cultivar combinations, rooting capacity of the rootstocks, frost damage on winter buds, practices in grafting phase, grafted scion planting time and care conditions (Çelik and Ağaoğlu, 1979; Cangi, 1998; Baydar and Ece, 2005; Dardeniz and Şahin, 2005; Cangi et al., 2015). Quite high final takes of the present study indicated that the scions were quite healthy, well-lignified and optimum experimental conditions were provided.

Shoot and root parameters were determined when the potted grapevine saplings reached to a stage of planting. While scion thickness significantly influenced shoot fresh and dry weights of 5BB rootstock, the differences in

shoot lengths were not found to be significant. Shoot lengths of potted saplings varied between 13,95 - 38,50 cm. Shoot fresh weights varied between 6.57 - 13.20 g/vine, shoot dry weights varied between 1,05 - 1,91 g/vine. The heaviest and the longest shoots were observed in 1103P rootstock and the shortest and the lightest shoots were observed in 110R rootstocks. Scion thickness had relatively positive effects on shoot weights of 5BB and 1103P rootstocks (Table 4).

Table 4. Effect of root diameter on shoot parameters

Parameters	5BB			1103 P			110 R		
	Cutting thickness (mm)			Cutting thickness (mm)			Cutting thickness (mm)		
	6-9	10-13	14+	6-9	10-13	14+	6-9	10-13	14+
Shoot length (cm)	32.45a	31.21 a	33.30a	36.61a	36.91 a	38.50a	19.10a	13.95a	22.00a
Shoot fresh weight (g/sapling)	9.06 b	10.83 ab	15.04a	11.68a	12.63a	13.20a	8.07 a	6.57 a	7.75 a
Shoot dry weight (g/sapling)	1.29 b	1.72ab	2.31a	1.81 a	1.84 a	191 a	1.24 a	1.05 a	1.20 a

*Each rootstock has been evaluated in its own right

** The means indicated with the same small letter in the same column are not significantly different ($p < 0.05$)

It was reported in previous studies about the potted grapevine sapling production that shoot lengths varied with grafting combinations (Kılıç, 2014) and scion thickness did not have any significant effects on shoot lengths of the American grapevine saplings (Çelik and Gargin, 2009).

While the effects of scion thickness on root fresh weights were not found to be significant, scion thickness had significant effects on root dry weights of 5BB rootstock. Root fresh weights of the saplings varied between 1.60 - 3.26 g/vine and root dry weights varied between 0.08 - 0.6 g/vine. In general, weaker root developments were observed in 110R and 1103P rootstock with increasing scion thicknesses (Table 5).

It was reported in previous studies about grapevine sapling production that number of roots, root lengths, root development levels or weights varied with the rootstocks and similar with the present findings, the 110R rootstock had lower performance values with regard to these parameters (Çelik and Gargin, 2009; Sucu and Yağcı, 2015; Köse et al., 2015).

In scion-propagation, quality and successful productions, shoot and root development are influenced by various factors including scion diameter, scion length, plant genotype, scion taking time, lignification level and etc. (Mannini and Schneider, 1990; Beyl et al., 1995; Hartmann et al., 2002; Tofanelli et al., 2003; Çelik and Gargin, 2009).

Table 5. Effect of cutting thickness on root fresh and dry weight

Parameters	5BB			1103 P			110 R		
	Cutting thickness (mm)			Cutting thickness (mm)			Cutting thickness (mm)		
	6-9	10-13	14+	6-9	10-13	14+	6-9	10-13	14+
Root fresh weight (g)	2.49 a	2.24a	3.26 a	3.13 a	3.00a	1.60 a	3.08 a	2.22 a	2.00a
Root dry weight (g)	0.6 a	0.14b	0.20b	0.18 a	0.20a	0.08 a	0.18 a	0.11 a	0.11a

*Each rootstock has been evaluated in its own right

** The means indicated with the same small letter in the same column are not significantly different ($p < 0.05$)

Conclusion

The following conclusions were drawn from the present study carried out to determine the effects of 3 different scion diameters of 5BB, 1103 P and 110 R rootstocks on potted grafted grapevine sapling production in greenhouse and sapling development in vineyard;

- * In grafted scions, basal root and callus development varied with the rootstock genotype and scion diameter. Callus+root development generally decreased with increasing scion diameters.
- * Quite high final takes (94-98%) were achieved in all rootstocks.
- * Sapling root and shoot development were influenced by rootstock genotypes.
- * Shoot biomass increased, but root biomass decreased with increasing scion diameters.
- * With regard to sapling final take and quality, 5BB and 1103P rootstocks had better performance with thin and medium (6-13 mm) diameter scions and 110R had better performance with thick (14-18 mm) scions.

It was finally concluded that 7-18 mm thick scions could reliably be used in potted grapevine sapling production.

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