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Research Article

Effects Of Different Uprooting Dates on Rooting and Vegetative Development Parameters of Different American Grapevine Rootstock Cuttings

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Öz

This study was conducted in the years 2013 and 2014 to determine rooting and vegetative development parameters of different American grapevine rootstock ('5BB', '110R', '140Ru', '1613C', '1103P' and '41B') cuttings uprooted in different dates. It was concluded based on present findings that weak and insufficient rooting problems especially in 110R, 140Ru and 41B American grapevine rootstock cuttings were mostly resulted from genetic characteristics and insufficient number of days between planting and uprooting dates. Significant increases were provided in rooting ratio (%), number of roots (roots cutting^{-1}), root fresh weight (g cutting^{-1}), root scale (0–4), shoot length (cm), number of nodes (leaves) (nodes cutting^{-1}), shoot fresh weight (g cutting^{-1}), cutting weight (g) and shooting ratio (%) of American grapevine rootstock cuttings with the increasing number of days between uprooting and planting dates.

Anahtar kelimeler: American grapevine rootstock, rooting ratio, root fresh weight, uprooting date, vegetative development.

Amerikan Asma Anacı Çeliklerinin Köklenme ve Vejetatif Gelişimi Üzerine Farklı Söküm Tarihlerinin Etkisi

Abstract

Bu Araştırma, farklı tarihlerde sökülen Amerikan asma anacı çeliklerinin ('5BB', '110R', '140Ru', '1613C', '1103P' ve '41B') köklenme ve vejetatif gelişim özelliklerinin belirlenmesi amacıyla, 2013 ve 2014 yıllarında yürütülmüştür. Mevcut bulgular, özellikle '140Ru', '41B' ve '110R' Amerikan asma anacı çeliklerinde yaşanan zor ve yetersiz köklenme sorunlarının genetik özelliklerden ve köklenme ile dikim tarihleri arasındaki gün sayısının yetersiz olmasından kaynaklandığını ortaya koymuştur. Amerikan asma anacı çeliklerinin köklenme oranı (%), kök sayısı (kök çelik^{-1}), kök yaş ağırlığı (g çelik^{-1}), kök skalası (0–4), sürgün uzunluğu (cm), boğum sayısı (yapraklar) (boğum çelik^{-1}), sürgün yaş ağırlığı (g çelik^{-1}), çelik ağırlığı (g) ve sürme oranlarında (%) söküm ve dikim tarihleri arasındaki gün sayısının artmasıyla birlikte önemli artışlar sağlanmıştır.

Key words: Amerikan asma anacı, köklenme oranı, kök yaş ağırlığı, söküm zamanı, vejetatif gelişim.

Introduction

Grapevine is among the oldest cultured fruit species. Viticulture and oenology started in northeastern sections of Anatolia thousands of years ego and widespread from there to different sections of the world (Celik et al., 2005).

In the 2020 production period, 4.1 million tons of grapes were produced on 4.2 million decares in Turkey. Manisa, Mardin and Denizli rank first in vineyard areas. The export amount of 2019/2020 in Turkey is 1.2 million tons. In 2020, 78 million tons of grapes were produced in an area of 6.9 million hectares. China, Italy and Spain rank first in the production of fresh grapes in the world. 4.7 million tons of fresh grapes are exported worldwide. Turkey realizes 32.1% of the world's raisin exports. Turkey ranks 5th in grape production (Anonymous, 2019).

Viticulture constitutes a significant agricultural practice in Turkey. New grapevine plantations are established every year either to renew the old ones or to change cultivars. Phylloxera (*Phylloxera vitifolii* Fitch.) is the most significant insect to be considered while establishing new grapevine plantations since all soils are assumed to be infected with this pest. Today, the only measure to be taken against this pest is to use grafted saplings on American grapevine rootstocks resistant to Phylloxera. Cuttings of American grapevine rootstocks have quite various rooting characteristics and hard–rooting and callusing ones negatively influence success in grapevine sapling production. Therefore, various treatments are applied to improve rooting of hard–rooting American grapevine rootstocks (Uzun, 1996; Dardeniz, 2001).

Previous studies on grapevine sapling production revealed that different treatments had significant effects on nursery performance, 1st quality sapling performance, shoot length, shoot diameter, stem diameter, shoot development level, number of shoots, rootstock thickness, cutting thickness, sapling quality and several other vegetative growth parameters (Sabir et al., 2005; Caglar and Bayram, 2006; Kara and Ozdemir, 2009; Kucukyumuk, 2009; Kara and Sabir, 2010; Ozdemir et al., 2010; Kara et al., 2011a; Kara et al., 2011b).

Alco et al. (2015) investigated different cultivar/rootstock combinations and reported similar grafting performances for 3 grape cultivars grafted on 5BB and 110R rootstocks in 2012, obtained similar performances for 'Cabernet Sauvignon' grape cultivar grafted on both rootstocks in 2013 and reported greater performance for 'Cardinal' and 'Merlot' grape cultivars grafted on 110R rootstock than the 5BB rootstock.

Turhan et al. (2005) compared salt tolerance of some American grapevine rootstocks and ordered the salt tolerance of the rootstocks as 5BB > 1103P > 420A. Kose et al. (2016) grafted different grape cultivars on different rootstocks and grew them in heavy–textured soils. Researchers reported that root scale did not change in 'Kokulu Kara Üzüm' (*V. labrusca* L. cv.) grape cultivar with the rootstocks, but root scale was greater in 'Şiraz' (*Vitis vinifera* L.) grape cultivar on 5BB rootstock than on 110R rootstock. Vrsic et al. (2016) grafted Welschriesling grape cultivar on different rootstocks and reported different effects of rootstocks on root dry weight, cluster weight and yield parameters.

Changing with the rootstocks, previous researchers also reported increasing root development, length and number of roots with different pot media (Altindisli et al., 1998), different rooting media and IBA doses (Kara et al., 1998), Humic acid treatments (Zachariakiis, 2001), different mycorrhiza treatments (Caglar and Bayram, 2006; Kara and Ozdemir, 2009; Ozdemir et al., 2010; Kara et al., 2011a; Kara et al., 2011b) and different mulching treatments (Kucukyumuk, 2009).

In a different study on the subject, 4 rootstocks belonging to different Vitis species were planted in september. After the cuttings were planted in polyethylene bags, rooting status, polyphenol oxidase (PPO) activity and biochemical parameters were investigated at different growth periods. Significant differences were found between Freedom rootstock and maximum germination percentages determined in different rootstocks in terms of rooting success. The highest variation in PPO activity was also recorded in Freedom. The highest PPO activity was recorded in 140Ru rootstock, and the highest root length was recorded in Dog Ridge. In 110R rootstocks, PPO activity was lowest in the first stage, although DAP increased and decreased to 90 DAP (Days After Planting) until 60 days after planting. A higher number of rooting primordials was recorded in Freedom, followed by 110R. This study suggests that differences in rooting behavior of different rootstocks are based on PPO activity at regular time intervals up to 90 DAP (Somkuvar et al., 2011).

There are some problems experienced in rooting and callusing of 41B, 140Ru, 99R and 110R rootstocks. Therefore, this study was conducted for two years to determine the effects of different uprooting dates on rooting and vegetative development parameters of different American grapevine rootstock cuttings.

Material and Method

This study was conducted for two years in 2013 and 2014 to determine rooting and vegetative developments of American grapevine rootstock cuttings uprooted in different uprooting dates. About 8.5–10.5 mm thick 5BB, 110R, 140Ru, 1613C, 1103P and 41B American grapevine rootstock cuttings were used as the material of the experiments. American grapevine rootstock cuttings were supplied from Manisa Viticulture Research Institute and Tekirdag Viticulture Research Institute at the end of February and cuttings were stored in closed bags in a cold storage at 6°C for 3 weeks.

Experiments were conducted in randomized blocks design with 3 replications. Cuttings were uprooted at 3 different dates with 10–day intervals. PVC containers (15 x 25 x 5 cm, a total of 54 containers) were used for plantings. Each container had equal amount of coarse agricultural perlite and 800 ml water (750 ml before planting + 50 ml after planting).

Planting was performed on 03.04.2013 in the first year and on 19.03.2014 in the second year. Nursery cuttings, 40–45 cm long with 4–5 winter buds were cut flat from the bottom and 45� sloped at the top with pruning scissors as to have them 5–10 cm long with 2 winter buds and made ready for planting. The bottom buds of cuttings were disbudded with pruning scissors. The prepared cuttings with 2 buds were kept in fungicide solution (Fundazole 50 WP (Benomyl, a Benzimidazole derivative) for 15 minutes before planting and they were planted as to have 12 cuttings per container. They were squeezed manually to prevent air intake and weights were measured at saturated conditions.

A total of 6 irrigations were performed in each year in 8–10–day intervals. Containers were weighed with a digital scale and depleted water was completed in each irrigation. Chemicals were applied twice in each year against rust mite and red spider mite (insecticide with 500 g l^{-1} Bromoproplate active compound) with fungus (Fundazole 50 WP (Benomyl, a Benzimidazole derivative). The containers were kept at ambient temperature around 22°C room temperature for rooting American vine rootstock cuttings. Cutting uprooting was performed at 3 different dates with 10–day intervals. In the first year, the 1st uprooting was performed on 15.05.2013, 2nd on 24.05.2013 and 3rd on 04.06.2013. In the second year, the 1st uprooting was performed on 06.05.2014, 2nd on 15.05.2014 and 3rd on 27.05.2014. The purpose of uprooting the planted cuttings at 10–day intervals is to determine the increase in rooting ability of the cuttings during the last 10 days. The first uprooting date was determined by checking the rooting status of the rootstocks showing moderate rooting in the containers.

The first cutting uprooting was performed 1.5 months ahead of planting. The following parameters were investigated within the scope of this study;

Rooting ratio (%): Adventive root formation ratio of two–bud cuttings was expressed in percentage (%).

Number of roots (roots $cutting^{-1}$): Adventive roots emerged from the shooted cuttings were counted one by one.

Root fresh weight (g $cutting^{-1}$): All the adventive roots emerged from shooted two–bud cuttings were cut, cleaned and weighed with a digital scale.

Root scale (0–4): A 0–4 scale was used to assess the adventive root development of shooted two–bud cuttings (Dardeniz, 2001; Dardeniz and Sahin, 2005) (0–there is no root, 1–single–sided weak root formation, 2–double–sided root formation, 3–three–sided strong root formation, 4–all around quite strong root formation).

Shoot length (cm): The distance between the bottom and tip bud of the shooted cuttings was measured with a transparent ruler.

Number of nodes (leaves) (nodes $cutting^{-1}$): Nodes over the shoots of the cuttings were counted one by one.

Shoot fresh weight (g $cutting^{-1}$): Shoots of cuttings were broken from the bottom sections and weighed with a digital scale.

Cutting weight (g): The cuttings were freed of shoots and roots and they were then weighed with a digital scale.

Shooting ratio (%): Calculated as the ratio of shooted cuttings to total planted number of cuttings.

Experiments were designed in randomized plots with three replications. Experimental data were subjected to variance analysis with 'SAS® 9.1' statistical software and means were compared with LSD test at $p<0.01$.

Results and Discussion

Rooting ratio (%)

The effects of different uprooting times on rooting ratios (%) of rootstock cuttings are provided in Table 1. Rootstock x uprooting date interaction was found to be significant. As the average of the entire uprooting dates, the greatest rooting ratio was obtained from 1613C (91.20%) and the lowest rooting ratios were obtained from 140Ru (28.70%) and 110R (29.63%) rootstock cuttings. Considering the rooting ratios of the uprooting dates, the greatest value was obtained from the 3rd uprooting date (77.54%) and the lowest value was obtained from the 1st uprooting date (47.92%) (Table 1). Previous studies also indicated that rooting ratios varied with the rootstocks and influenced by different treatments (Altindisli et al., 1998; Aguin et al., 2004; Sabir et al., 2005; Caglar and Bayram, 2006; Kara and Ozdemir, 2009; Kucukyumuk, 2009; Kara and Sabir, 2010; Ozdemir et al., 2010; Kara et al., 2011a; Kara et al., 2011b). In present study, rooting ratios increased with the progress of uprooting dates, especially toward to 2nd and 3rd uprooting dates. Our findings in this direction are in agreement with the previous findings of the researchers (Somkuvar et al., 2011).

Table 1. Effects of different uprooting dates on rooting ratio (%), number of roots (roots cutting^{-1}) root fresh weight (g cutting^{-1}) and root scale (0–4)**

Rootstocks	Uprooting date	Rooting ratio (%)	Number of roots (roots cutting^{-1})	Root fresh weight (g cutting^{-1})	Root scale (0–4)
1613C	1st	86.11 a*	7.08 c*	0.350 efghij*	1.980 c*
	2nd	91.67 a	8.54 b	0.514 cdef	2.760 ab
	3rd	95.83 a	9.47 ab	0.588 cde	2.890 a
	Mean	91.20 A	8.36 A	0.484 C	2.540 A
1103P	1st	52.78 cd	2.27 fg	0.148 hij	0.859 fg
	2nd	80.55 ab	4.46 de	0.396 cdefgh	1.950 cd
	3rd	91.66 a	5.89 cd	0.683 cd	2.310 c
	Mean	74.10 BC	4.21 B	0.409 CD	1.710 C
110R	1st	8.34 g	0.35 h	0.054 ij	0.145 h
	2nd	27.77 ef	1.02 gh	0.248 fghij	0.565 gh
	3rd	52.77 cd	2.22 fg	0.471 cdefg	1.190 ef
	Mean	29.63 D	1.20 C	0.258 DE	0.633 D
41B	1st	50.00 cd	2.23 fg	0.172ghij	0.730 g
	2nd	65.27 bc	3.28 ef	0.696 c	1.470 e
	3rd	88.89 a	5.95 c	1.230 b	2.230 c
	Mean	68.05 C	3.82 B	0.699 B	1.480 C
140Ru	1st	12.50 fg	0.29 h	0.034 j	0.156 h
	2nd	29.16 ef	1.19 gh	0.141 hij	0.579 gh
	3rd	44.44 de	1.85 fg	0.364 defghi	0.916 fg
	Mean	28.70 D	1.11 C	0.180 E	0.550 D
5BB	1st	77.77 ab	5.85 cd	0.638 cde	1.520 de
	2nd	83.33 ab	9.19 ab	1.090 b	2.360 bc
	3rd	91.66 a	10.4 a	1.660 a	2.770 ab
	Mean	84.25 AB	8.48 A	1.130 A	2.220 B
1st uprooting date		*47.92 C*	*3.01 C*	*0.233 C*	*0.898 C*
2nd uprooting date		*62.96 B*	*4.61 B*	*0.514 B*	*1.610 B*
3rd uprooting date		*77.54 A*	*5.96 A*	*0.833 A*	*2.050 A*
LSD***		11.199	0.8676	0.1989	0.2571
LSD****		7.91898	0.6135	0.1406	0.1818
LSD*****		19.178	1.4455	0.3221	0.4362

*Different means were indicated with different letters (p<0.01), **Presented as the average of two years, ns: not significant, ***LSD (rootstock), ****LSD (uprooting date), *****LSD (rootstock x uprooting date

Number of roots (roots cutting^{-1})

The effects of different uprooting dates on number of roots (roots cutting^{-1}) of rootstock cuttings are provided in Table 1. Again, rootstock x uprooting date interaction was found to be significant. As the average of entire uprooting dates, the greatest number of roots was obtained from 5BB (8.48 roots cutting^{-1}) and 1613C (8.36 roots cutting^{-1}) rootstock cuttings and the lowest number of roots was obtained from 140Ru (1.11 roots cutting^{-1}) rootstock cuttings. With regard to number of roots of uprooting dates, the greatest value was obtained from 3rd uprooting date (5.96 roots cutting^{-1}) and the lowest value was obtained from the 1st uprooting date (3.01 roots cutting^{-1}) (Table 1).

Root fresh weight (g cutting^{-1})

The effects of different uprooting dates on root fresh weight (g cutting^{-1}) of rootstock cuttings are provided in Table 1. Rootstock x uprooting date interaction was found to be significant. As the average of entire uprooting dates, the greatest root fresh weight was obtained from 5BB (1.130 g cutting^{-1}) and the lowest root fresh weight was obtained from 140Ru (0.180 g cutting^{-1}) rootstock cuttings. With regard to root fresh weight of uprooting dates, the greatest value was obtained from the 3rd uprooting date (0.833 g cutting^{-1}) and the lowest value was obtained from the 1st uprooting date (0.233 g cutting^{-1}) (Table 1).

Present findings on root fresh weights comply with the findings of earlier studies carried out with different treatments (Altindisli et al., 1998; Aguin et al., 2004; Sabir et al., 2005; Kara and Ozdemir, 2009; Kara and Sabir, 2010; Ozdemir et al., 2010; Kara et al., 2011a; Kara et al., 2011b). In present study, root fresh weight increased with the progress of uprooting dates, especially toward to 2nd and 3rd uprooting dates. Our findings in this direction are in agreement with the previous findings of the researchers (Somkuvar et al., 2011).

Root scale (0–4)

The effects of different uprooting dates on root scale (0–4) of rootstock cuttings are provided in Table 1. Again, rootstock x uprooting date interaction was found to be significant. As the average of entire uprooting dates, the greatest root scale was obtained from 1613C (2.540) and the lowest root scale was obtained from 140Ru (0.550) rootstock cuttings. With regard to root scale of uprooting dates, the greatest value was obtained from the 3rd uprooting date (2.050) and the lowest value was obtained from the 1st uprooting date (0.898) (Table 1).

Table 2. Effects of different uprooting dates on shoot length (cm), number of nodes (nodes cutting^{-1}), shoot fresh weight (g cutting^{-1}), cutting weight (g), shooting ratio (%)**

Rootstocks	Uprooting date	Shoot length (cm)	Number of nodes (nodes cutting^{-1})	Shoot fresh weight (g cutting^{-1})	Cutting weight (g)	Shooting ratio (%)
1613C	1st	9.81 def*	7.71 a*	1.320 def*	8.69 ef*	97.22 ab*
	2nd	11.81 bcde	7.83 a	1.650 bc	8.77 ef	100.0 a
	3rd	13.60 abc	7.69 a	2.000 a	8.63 f	100.0 a
	Mean	11.74 A	7.74 A	1.660 A	8.70 C	99.07 A
1103P	1st	9.46 def	5.36 cd	0.837 hij	8.61 f	91.67 ab
	2nd	11.23 cde	5.69 c	1.030 fghi	8.67 ef	94.44 ab
	3rd	14.29 abc	6.27 bc	1.570 bcd	8.69 ef	100.0 a
	Mean	11.66 A	5.77 B	1.150 B	8.66 C	95.37 AB
110R	1st	5.45 g	4.27 e	0.637 j	10.30 cde	88.89 bc
	2nd	7.04 fg	4.28 e	0.701 j	10.47 cd	79.17 c
	3rd	15.27 a	7.18 ab	1.390 cde	11.24 bc	94.45 ab
	Mean	9.25 BC	5.24 BC	0.909 C	10.67 B	87.50 C
41B	1st	9.03 ef	4.25 e	1.020 ghi	9.71 cdef	94.45 ab
	2nd	7.35 fg	4.19 e	1.100 efgh	10.52 bcd	87.50 bc
	3rd	9.67 def	4.29 e	1.520 bcd	9.40 def	91.67 ab
	Mean	8.68 C	4.24 D	1.210 B	9.88 B	91.21 BC
140Ru	1st	6.94 fg	5.76 c	0.713 j	9.40 def	100.0 a
	2nd	9.53 def	5.61 c	0.795 ij	10.67 bcd	91.67 ab
	3rd	13.13 abc	6.04 c	1.140 efg	9.38 def	88.89 bc
	Mean	9.87 ABC	5.80 B	0.883 C	9.82 B	93.52 ABC
5BB	1st	6.75 fg	4.11 e	0.681 j	12.10 ab	94.45 ab
	2nd	12.15 bcd	4.59 de	1.390 cde	13.33 a	91.67 ab
	3rd	14.39 ab	5.35 cd	1.730 ab	12.10 ab	97.22 ab
	Mean	11.10 AB	4.68 CD	1.260 B	12.51 A	94.45 AB
1st uprooting date		7.91 C	5.24 B	0.868 C	9.8	94.45 AB
2nd uprooting date		9.85 B	5.36 B	1.110 B	10.4	90.74 B
3rd uprooting date		14.39 A	6.14 A	1.560 A	9.91	95.37 A
LSD***		1.9434	0.6052	0.1812	0.922	6.0332
LSD****		1.3742	0.428	0.1281	ns	4.2661
LSD*****		3.0885	0.9276	0.3005	1.632	9.8482

*Different means were indicated with different letters ($p<0.01$), **Presented as the average of two years, ns: not significant, ***LSD (rootstock), ****LSD (uprooting date), *****LSD (rootstock x uprooting date).

Shoot length (cm)

The effects of different uprooting dates on shoot length (cm) of rootstock cuttings are provided in Table 2. Rootstock x uprooting date interaction was found to be significant. As the average of entire uprooting dates, the greatest shoot lengths were obtained from 1613C (11.74 cm) and 1103P (11.66 cm) rootstock cuttings and the lowest shoot length was obtained from 41B (8.68 cm) rootstock cuttings. With regard to shoot length of uprooting dates, the greatest value was obtained from the 3rd uprooting date (14.39 cm) and the lowest value was obtained from the 1st uprooting date (7.91 cm) (Table 2).

Number of nodes (leaves) (nodes cutting^{-1})

The effects of different uprooting dates on number of nodes (leaves) (nodes cutting^{-1}) of rootstock cuttings are provided in Table 2. Again, rootstock x uprooting date interaction was found to be significant. As the average of entire uprooting dates, the greatest number of nodes was obtained from 1613C (7.74 nodes cutting^{-1}) and the lowest number of nodes was obtained from 41B (4.24 nodes cutting^{-1}) rootstock cuttings. With regard to number of nodes of uprooting dates, the greatest value was obtained from the 3rd uprooting date (6.4 nodes cutting^{-1}) (Table 2).

Shoot fresh weight (g cutting^{-1})

The effects of different uprooting dates on shoot fresh weight (g cutting^{-1}) of rootstock cuttings are provided in Table 2. Rootstock x uprooting date interaction was found to be significant. As the average of entire uprooting dates, the greatest shoot fresh weight was obtained from 1613C (1.660 g cutting^{-}1) and the lowest shoot fresh weight was obtained from 140Ru (0.883 g cutting^{-1}) rootstock cuttings. With regard to shoot fresh weight of uprooting dates, the greatest value was obtained from the 3rd uprooting date (1.560 g cutting^{-1}) (Table 2).

Cutting weight (g)

The effects of different uprooting dates on cutting weight (g) of rootstock cuttings are provided in Table 2. Again, rootstock x uprooting date interaction was found to be significant. As the average of entire uprooting dates, the greatest cutting weight was obtained from 5BB (12.51 g) and the lowest cutting weights were obtained from 1103P (8.66 g) and 1613C (8.70 g) rootstock cuttings. The differences in cutting weights of the uprooting dates were not found to be significant (Table 2).

Shooting ratio (%)

The effects of different uprooting dates on shooting ratio (%) of rootstock cuttings are provided in Table 2. Rootstock x uprooting date interaction was found to be significant. As the average of entire uprooting dates, the greatest shooting ratio was obtained from 1613C (99.07%) and the lowest shooting ratio was obtained from 110R (87.50%) rootstock cuttings. With regard to shooting ratio of uprooting dates, the greatest value was obtained from the 3rd uprooting date (95.37%) (Table 2).

Conclusion

It was concluded based on present findings that weak and insufficient rooting problems especially in 110R, 140Ru and 41B American grapevine rootstock cuttings were mostly resulted from genetic characteristics and insufficient number of days between planting and uprooting dates. Significant increases were observed in rooting ratio, number of roots, root fresh weight, root scale, shoot length, number of nodes (leaves), shoot fresh weight, cutting weight and shooting ratio of American grapevine rootstock cuttings with the increasing number of days between uprooting and planting dates.

According to the findings of this research; it was determined that rootstocks such as 110R, 140Ru and 41B formed weaker–insufficient roots due to early uprooting compared to other American grapevine rootstocks. This problem, which is caused by the later activation of the rootstock cuttings mentioned above, almost completely disappears with later uprootings. Within the same logically, it is thought that weak–insufficient callus formation can be prevented by keeping the grafted cuttings belonging to the same rootstocks kept in germination rooms for longer periods in these rooms.

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