GRAFTING PERFORMANCE OF SOME WINE GRAPE (*VITIS VINIFERA* L.) CULTIVARS GRAFTED ON DIFFERENT AMERICAN GRAPEVINE ROOTSTOCKS

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Abstract. This study was conducted in the vine sapling production unit of "Kazova Vasfi Diren Agricultural Enterprise" located in central town of Tokat province in Turkey. The article attempted to graft five wine grape cultivars (Narince, Chardonnay, Merlot, Syrah, Öküzgözü) with five different American grapevine rootstocks (1103 Paulsen, 5BB, 41B, 110 R, 140 Ru) in order to combat mainly Phylloxera, but also provide protection against nematodes, lime and salinity-like soil-borne problems. Sapling yields of different cultivar/rootstock combinations were investigated. While the greatest sapling yield was observed in Narince/1103 Paulsen combination (98.03%), the lowest sapling yield was observed in Chardonnay/110R combination (43.64%).
Keywords: *vine rootstock, grapevine sapling, omega grafting, stratification room, sapling yield*

Introduction

Phylloxera (*Viteus vitifolii* Fitch.) was first encountered in France in 1863, then spread to European and Turkish lands. This pest feeds on the roots of culture vines and causes the termination of several grape cultivars (Yayla, 2008). Therefore, viticulture through direct rooting of scions of the local grape cultivars will not be economical. Laliman observed that some American grapevine rootstocks were resistant to Phylloxera, thus resistance to Phylloxera was achieved through grafting culture cultivars on these rootstocks (Winkler et al., 1974). For an economic viticulture, it is more appropriate to establish vineyards with vine saplings grafted on American grapevine rootstocks. American vine rootstocks are not only resistant to Phylloxera, but also serve alternative solutions for the problems related to nematodes, lime, salinity and the other soil-borne problems (Çelik et al., 1998).

Success of grafting is generally understood as callus layer formation between the rootstock and scion tissues and full-bonding and cohesion of them into a single plant (Janick, 1986; Çelik, 2007). In vine sapling production, sapling quality and final take ratios are largely dependent on whether or not the vines from which grafting materials were taken are free of pests and diseases, nutritional status of grafting materials, pre-grafting storage conditions of the rootstocks and scions, grafting method, attention paid to grafting, time of grafting, ambient conditions at stratification and following stages of grafted scions, mulching treatments, care and maintenance conditions after planting and the most important of all, cultivar/rootstock combinations (Kısmalı, 1978; Çelik and Ağaoğlu, 1982; Eriş et al., 1989; Kelen, 1994; Baydar and Ece, 2005).

Bhujbal (1993) used 1103P, 41B, SO4, Dogridge and Salt Creek rootstocks and Thompson Seedless cultivar and reported the best rooting and the greatest final take ratio for 1103P rootstock.

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Dardeniz and Şahin (2005) grafted Uslu and Yalova İncisi grape cultivars on 1103P, 5BB, 41B and 140 Ru rootstocks and reported the greatest final take ratios as 44.61% and 37.47% for Uslu cultivar respectively grafted on 41B and 5BB rootstocks.

Ağaoğlu and Çelik (1982) grafted Hamburg Misketi, Hafızali and Hasandede grape cultivars on Kober 5BB and 99R rootstocks and reported total final take ratios varied as between 20-60%.

Kavak (2006) investigated the effects of Mycorrhiza and humic acid treatments on sapling final take ratios and reported the greatest grafting success (70.00%) for Yalova İncisi/1103P combinations and the lowest success ratio (52.67%) for Kalecik Karası/1103 P and Kalecik Karası/Fercal combinations.

Günen (2008) compared combinations of Cabernet Sauvignon and Syrah cultivars with five different rootstocks under open-field and greenhouse conditions and reported that ambient growth was significant. The greatest success was reported for Cabernet Sauvignon cultivar/1103 Paulsen combination as 90.08% in the first year and as 63.33% in the second year and for Syrah cultivar/1103 Paulsen combination as 91.67% in the first year and as 60.42% in the second year.

In this study, open-root sapling production was performed to assess the compatibility problems of commercially valuable wine grape cultivars of Narince, Chardonnay, Merlot, Syrah and Öküzgözü grafted on 1103 P, 5 BB, 41 B, 110 R and 140 Ru rootstocks commonly used in Turkey to propose solutions for Phylloxera, nematode, lime and salinity-like soil-born problems.

Material and method

This study was conducted in 2017 at the vine sapling production facility of Kazova Vasfi Diren Agricultural Enterprise in central town of Tokat province in Turkey (*Figure 1*). The 1103 P, 5 BB, 41 B, 110 R and 140 Ru American vine rootstocks and Narince, Chardonnay, Merlot, Syrah and Öküzgözü wine grape cultivars were used as the plant material of the study.

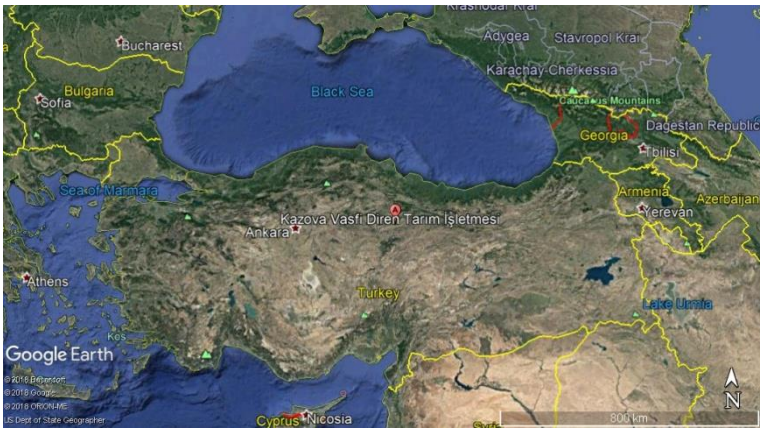

Figure 1. *Study site*

Shoots were taken from well-lignified mid-sections of annual branches, they were cut into single-bud scions and classified based on their thickness (7-8 mm, 9-10 mm and 11-12 mm thick) (Roux, 1988). Scions were treated with perlite moistened with water with

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500 g/l Fenhexamid active ingredient against grey mold disease (*Botrytis cinerea)*. Treated scions were then placed into plastic bags and stored in a cold storage at +4˚C temperature for 2 months until the time of grafting (*Figure 2*).

Scions were cut into 30 cm long pieces as to have a single bud at the bottom and classified based on their thickness (7-8 mm, 9-10 mm and 11-12 mm thick). As can be seen in *Figure 3*, all buds were blunted except for the bottom one. Scions were then tied in bunches of 100 scions, placed into aseptic sacks and stored in a cold storage.

Figure 2. *Processes applied to grafting scions*

Figure 3. *Processes applied to rootstocks*

The scions (washed from the perlite over them) and rootstocks taken out of cold storage were kept outside (in a closed place) for three days. Rootstocks were kept in water-filled barrels and pools for two days (48 hours) and scions of the cultivars were kept in these places for one day (24 hours) (*Figure 4*). Just 6 hours before the end of this processes, 50% Benomyl was added only to holding water of scions to prevent the development of fungal diseases.

In this study, 37 500 grafted scions were produced [5 wine cultivars (Narince, Chardonnay, Merlot, Syrah and Öküzgözü) X 5 American Vine Rootstocks (1103 Paulsen, 5 BB, 41 B, 110 R and 140 Ru) X 3 replications X 500 grafted scions in each replicate] with omega bench grafting technique. Right after grafting, about 6 cm top section of grafted scions were coated with commercial paraffin prepared by using 1-5% wax, Vaseline, resin, bitumen, tar, mineral oil as well as efficient rate of fungicide and auxin and melted at 82°C. Following paraffin coating, grafted scions were taken into germination media and they were stacked into poplar shavings in Richter crates as recommended by Cangi et al. (2000) (*Figure 5*).

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Richter crates were then taken into stratification room for callusing. Stratification room conditions were arranged as 28-29°C temperature, 85-90% relative humidity and ventilation at every 6 hours (Çelik, 1982). The grafted scions left in Richter crates in stratification room for 21 days were taken out and placed in a closed facility for 2 days. Richter crates were opened, cleaned and second paraffin coating was applied to scions with full overall callusing. Grafted scions were placed into water pools for 12 days (a night) and they were removed from the water and rested for 2 days (*Figure 6*).

Figure 4. *Pre-grafting processes applied to rootstocks and scions*

Figure 5. *Omega grafting, paraffin coating and placement into Richter crates*

Figure 6. *Processes applied after stratification room*

Before to take the grafted scions to the field on 25th of April, they were subjected to 2000 ppm IBA (indole-3 butyric acid) and planted onto previously mulch-covered seed beds at 20 x 10 cm (row spacing x on-row plant spacing) spacing (*Figure 7*).

Figure 7. *Plantation of grafted scions to the field*

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Following the defoliation, saplings were removed from the field on 23rd of November. Saplings offered for sale were counted and sapling yield (final take) (%) for five wine grape cultivars and five American vine rootstock combinations was calculated as the ratio of number of saplings offered for sale to number of grafted scions.

$$SY = \left[\frac{NSOS}{NGS}\right] x100 \quad \text{(Eq.1)}$$

where; SY= Sapling Yield (%), NSOS= Number of Saplings Offered for Sale, NGS= Number of Grafted Scions.

Statistical analysis

Experiments were conducted in randomized plots design with 3 replications. Following the analysis of variance, means were compared with Tukey's multiple range test at 1% significance level. JMP software was used in statistical analyses. Significant differences were indicated with the small letters by the data.

Standard delusion (SD)

Standard delusion calculations were performed to compare all experimental data in themselves.

Results and discussion

The results obtained for different cultivars are provided in *Tables 1, 2, 3, 4 and 5*. There were significant differences in number of saplings offered for sale and sapling yields of the cultivars ($p<0.01$).

In Narince cultivar, the greatest number of saplings offered for sale and sapling yield (491.33 and 98.27%, respectively) were obtained from 1103 P combination and the lowest values (265.33 and 53.07%) were obtained from 110 R combination (*Table 1*).

Table 1. *Sapling yields for Narince cultivar with different rootstocks (Mean ± SD)*

CULTIVAR	ROOTSTOCKS	NGS	NSOS	SY (%)
NARİNCE	**1103 P**	500	491.33±2.60 a	98.27±0.52 a
	5 BB	500	424.00±2.08 c	84.80±0.42 c
	41 B	500	457.00±3.21 b	91.40±0.64 b
	110 R	500	265.33±1.45 e	53.07±0.29 e
	140 Ru	500	294.67±2.91 d	58.93±0.58 d

The means indicated with different letters in the same column are significantly different according to Tukey's test at $p<0.01$. NGS: Number of Grafted Scions, NSOS: Number of Saplings Offered for Sale, SY: Sapling Yield

In Chardonnay cultivar, the greatest number of saplings offered for sale and sapling yield (399.00 and 79.80%, respectively) were obtained from 1103 P combination and the lowest values (218.67 and 43.73%) were obtained from 110 R combination (*Table 2*). The differences between 5 BB and 41 B rootstocks were not found to be significant.

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Table 2. *Sapling yields for Chardonnay cultivar with different rootstocks (Mean ± SD)*

CULTIVAR	ROOTSTOCKS	NGS	NSOS	SY (%)
CHARDONNAY	**1103 P**	500	399.00±5.20 a	79.80±1.04 a
	5 BB	500	375.33±1.45 b	75.07±0.29 b
	41 B	500	373.67±2.60 b	74.73±0.52 b
	110 R	500	218.67±1.20 d	43.73±0.24 d
	140 Ru	500	277.33±1.20 c	55.47±0.24 c

The means indicated with different letters in the same column are significantly different according to Tukey's test at p<0.01. NGS: Number of Grafted Scions, NSOS: Number of Saplings Offered for Sale, SY: Sapling Yield

In Merlot cultivar, the greatest number of saplings offered for sale and sapling yield (413.00 and 82.60%, respectively) were obtained from 1103 P combination and the lowest values (269.00 and 53.80%) were obtained from 110 R combination. The differences between 1103 P and 5 BB rootstocks were not found to be significant (*Table 3*).

Table 3. *Sapling yields for Merlot cultivar with different rootstocks (Mean ± SD)*

CULTIVAR	ROOTSTOCKS	NGS	NSOS	SY (%)
MERLOT	**1103 P**	500	413.00±2.08 a	82.60±0.42 a
	5 BB	500	407.67±2.03 a	81.53±0.41 a
	41 B	500	373.67±5.21 b	74.73±1.04 b
	110 R	500	269.00±2.08 d	53.80±0.42 d
	140 Ru	500	297.33±4.33 c	59.47±0.87 c

The means indicated with different letters in the same column are significantly different according to Tukey's test at p<0.01. NGS: Number of Grafted Scions, NSOS: Number of Saplings Offered for Sale, SY: Sapling Yield

In Syrah cultivar, the greatest number of saplings offered for sale and sapling yield (391.33 and 78.27%, respectively) were obtained from 1103 P combination and the lowest values (254.33 and 50.87%) were obtained from 110 R combination (*Table 4*).

Table 4. *Sapling yields for Syrah cultivar with different rootstocks (Mean ± SD)*

CULTIVAR	ROOTSTOCKS	NGS	NSOS	SY (%)
SYRAH	**1103 P**	500	391.33±2.33 a	78.27±0.47 a
	5 BB	500	364.00±2.52 b	72.80±0.50 b
	41 B	500	379.00±1.53 ab	75.80±0.31 ab
	110 R	500	254.33±3.76 d	50.87±0.75 d
	140 Ru	500	310.33±1.20 c	62.07±0.24 c

The means indicated with different letters in the same column are significantly different according to Tukey's test at p<0.01. NGS: Number of Grafted Scions, NSOS: Number of Saplings Offered for Sale, SY: Sapling Yield

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In Öküzgözü cultivar, the greatest number of saplings offered for sale and sapling yield (376.67 and 75.33%, respectively) were obtained from 1103 P combination and the lowest values (248.67 and 49.73%) were obtained from 110 R combination (*Table 5*).

In a previous study comparing different cultivar/rootstock combinations under Isparta conditions, grafted vine saplings were produced through omega bench grafting and the greatest final take values were respectively reported for Razakı/SO4 combination (97.22%), Alphonse Lavallèe/SO4 combination (98.33%) and Italia/1103 Paulsen combination (98.04%) (Baydar and Ece, 2005). In present study, the greatest final take values (yield) of all cultivars were reported for 1103 Paulsen combination.

Table 5. *Sapling yields for Öküzgözü cultivar with different rootstocks (Mean ± SD)*

CULTIVAR	ROOTSTOCKS	NGS	NSOS	SY (%)
ÖKÜZGÖZÜ	**1103 P**	500	376.67±0.33 a	75.33±0.07 a
	5 BB	500	355.67±2.60 b	71.13±0.52 b
	41 B	500	367.33±2.33 ab	73.47±0.47 ab
	110 R	500	248.67±1.45 d	49.73±0.29 d
	140 Ru	500	322.00±2.31 c	64.40±0.46 c

The means indicated with different letters in the same column are significantly different according to Tukey's test at $p<0.01$. NGS: Number of Grafted Scions, NSOS: Number of Saplings Offered for Sale, SY: Sapling Yield

The greatest number of saplings offered for sale (491.33%) was obtained from Narince/1103 P interaction and the lowest value (218.67%) was obtained from Chardonnay/110 R interaction. The greatest sapling yield (98.27%) was obtained from Narince/1103 P interaction and the lowest value (43.73%) was obtained from Chardonnay/110 R interaction. While the greatest number of saplings offered for sale and sapling yields were observed in scions grafted on 1103 P rootstock and the lowest values were observed in scions grafted on 110 R rootstock. The differences in relevant values of Chardonnay/5 BB, Chardonnay/41 B, Merlot/41 B, Öküzgözü/1103 P, Chardonnay/140 Ru and Merlot/110 R interactions were not found to be significant (*Table 6*).

İşçi and Altındişli (2006) cleft-grafted different grape cultivars on rooted American vine rootstocks in place and reported final take ratios in 41 B and 110 R rootstocks respectively as 83 and 100% for Yuvarlak Çekirdeksiz cultivar, as 77 and 83% for Red Globe cultivar, as 84 and 80% for Buca Razakısı cultivar, as 100 and 81% for Trakya İlkereni cultivar and as 96 and 87% for Alphonse Lavallèe cultivar. Similar different values were also observed in this study for different cultivars.

Alço et al. (2015) investigated the grafting room performance of different cultivar/rootstock combinations and reported grafting room performance of Cardinal, Merlot and Cabernet Sauvignon grape cultivars grafted on 110 R rootstock respectively as 96.50, 98.75 and 98.75% in 2012 and as 97.75, 96.25 and 86.25% in 2013. Researchers reported the grafting room performance of the same grape cultivars grafted on 5 BB rootstock respectively as 99.50, 99.75 and 99.50% in 2012 and as 74.25, 70.50 and 86.75% in 2013. Present values obtained for Merlot/110 R and 5 BB combinations were lower than those values.

Günen and Altındişli (2017) compared combinations of Cabernet Sauvignon cultivar with three different rootstocks in open field and undercover conditions. Researchers indicated that growth ambient did not have significant effects on grafting success ratios

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and reported the greatest grafting success for 1103 Paulsen rootstock as 90.08% in the first year and as 63.33% in the second year, the lowest grafting success for 110 R rootstock in the first year (53.18%) and for 99 R rootstock in the second year (23.34%). Present findings were parallel to those results obtained for 1103 R rootstock.

Table 6. *Sapling yields of cultivar/rootstock interactions (Mean ± SD)*

CULTIVARS	ROOTSTOCKS	NGS	NSOS	SY (%)
Narince	**1103 P**	500	491.33±2.60 a	98.27±0.52 a
	5 BB	500	424.00±2.08 c	84.80±0.42 c
	41 B	500	457.00±3.21 b	91.40±0.64 b
	110 R	500	265.33±1.45 mn	53.07±0.29 mn
	140 Ru	500	294.67±2.91 l	58.93±0.58 l
Chardonnay	**1103 P**	500	399.00±5.20 de	79.80±1.04 de
	5 BB	500	375.33±1.45 gh	75.07±0.29 gh
	41 B	500	373.67±2.60 gh	74.73±0.52 gh
	110 R	500	218.67±1.20 p	43.73±0.24 p
	140 Ru	500	277.33±1.20 m	55.47±0.24 m
Merlot	**1103 P**	500	413.00±2.08 cd	82.60±0.42 cd
	5 BB	500	407.67±2.03 d	81.53±0.41 d
	41 B	500	373.67±5.21 gh	74.73±1.04 gh
	110 R	500	269.00±2.08 m	53.80±0.42 m
	140 Ru	500	297.33±4.33 kl	59.47±0.87 kl
Syrah	**1103 P**	500	391.33±2.33 ef	78.27±0.47 ef
	5 BB	500	364.00±2.52 hı	72.80±0.50 hı
	41 B	500	379.00±1.53 fg	75.80±0.31 fg
	110 R	500	254.33±3.76 no	50.87±0.75 no
	140 Ru	500	310.33±1.20 jk	62.07±0.24 jk
Öküzgözü	**1103 P**	500	376.67±0.33 gh	75.33±0.07 gh
	5 BB	500	355.67±2.60 ı	71.13±0.52 ı
	41 B	500	367.33±2.33 ghı	73.47±0.47 ghı
	110 R	500	248.67±1.45 o	49.73±0.29 o
	140 Ru	500	322.00±2.31 j	64.40±0.46 j

The means indicated with different letters in the same column are significantly different according to Tukey's test at $p<0.01$. NGS: Number of Grafted Scions, NSOS: Number of Saplings Offered for Sale, SY: Sapling Yield

Çelik and Gider (1991) grafted Alphonse Lavallèe and Cardinal grape cultivars on 1103 Paulsen, 5 BB and S04 rooted rootstocks and indicated that grafting success varied with the cultivar/rootstock combinations and reported the greatest grafting success (98.08%) for Cardinal/1103P combination. Present findings were similar with those findings.

Eroğlu (2014) grafted Alphonse Lavallèe and Red Globe grape cultivars on 110 R and 1103 P rootstocks and investigated the effects of different biological preparates on sapling performance. Researcher reported grafting success in 110 R and 1103 P rootstocks respectively as 97.00 and 99.00% for Alphonse Lavallèe cultivar and as 97.60 and 97.90%

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for Red Globe cultivar. While present findings were lower than those findings on 110 R and were parallel to findings on 1103 P rootstock.

Çoban and Kara (2003) investigated sapling quality of combinations of four different grape cultivars and three different American vine root stocks and reported sapling performance of Lival, Ribol, Danam and Datal cultivars respectively as 51.0, 60.0, 61.0 and 70.0% in 5 BB rootstock, as 45.0, 65.0, 60.0 and 65.0% in 99 R rootstock and as 48.6, 50.0, 60.0 and 60.0% in 110 R rootstock.

Çakır and Yücel (2016) investigated grafting performance of Narince and Kalecik Karası grape cultures on 1103 Paulsen rootstock and reported callus formation ratios as 77% in Narince and as 60% in Kalecik Karası grape cultivar.

Yağcı and Gökkaynak (2016) investigated sapling performance of Sultani Seedless grape cultivar on different rootstocks (110 R, 140 Ruggeri, 1613 C, 5 BB and Ramsey) and reported total sapling performance respectively as 51.5, 40.4, 50.3, 57.3 and 50.2%. While present findings were lower than those findings on 5 BB rootstock, they were parallel to findings on 110 R rootstock.

Conclusion

With the intrusion of Phylloxera pest into vineyards, local viticulture practices have become impossible in Turkey. Therefore, growers had to establish their vineyards with American vine rootstocks resistant to Phylloxera, well-adapted to ecological conditions and with a good affinity to grape cultivars to be grown. This study was conducted through omega bench grafting of five different wine grape cultivars (Narince, Chardonnay, Merlot, Syrah and Öküzgözü) on five different American vine rootstocks (1103 P, 5 BB, 41 B, 110 R and 140 Ru) compatible with different soil characteristics of Turkish vineyards. While the greatest sapling yield (98.03%) was observed in Narince/1103 Paulsen combination, the lowest yield (43.64%) was observed in Chardonnay/110R combination. Present findings provide significant background information against potential incompatibilities in grafted vine saplings. Before to decide on any combinations, compatibility and affinity of the available rootstocks to the cultivar, adaptation of the rootstocks to local ecological conditions, effects of the rootstocks on yield, quality, growth, development and nourishment of the cultivar all should be well put forth. Such attributes of the rootstocks should be taken into consideration while recommending rootstocks to growers for the cultivars they wish to grow. Such appropriate recommendations will have great contributions to success and yield in viticulture activities of the growers.

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