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Cane Lignification Levels of Some Table Grape Cultivars and American Vine Rootstocks

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Abstract

The present study was conducted to determine the lignification levels of canes of some table grape cultivars ('Amasya Beyazi', 'Ata Sarisi', 'Cardinal', 'Italia', 'Kozak Beyazi', 'Muskule', 'Yalova Cekirdeksizi' and 'Yalova Incisi') and American vine rootstocks ('140Ru', '1613C', '1103P', '110R', '5BB' and '41B') during the years 2013 and 2014. The 7.5–9.5 mm thick scions of table grape cultivars were supplied from 'Table Grapes Research and Implementation Vineyard' of 'COMU Dardanos Campus' and 8.0–9.5 mm grafting cuttings of American vine rootstocks were supplied from 'Manisa Viticulture Research Institute' (Manisa/Turkey). Results revealed that cane lignification levels of *Vitis* species were best represented by width/core and xylem/core ratios and such ratios significantly varied based on cultivars, rootstocks and years. Parameters ratios of American vine rootstocks were much higher than the ratios of table grape cultivars. Such a case was because of genetic differences and much higher fruit cluster loads of grape cultivars than the rootstocks.

Keywords: American vine rootstock, *Vitis vinifera* L., production material quality, lignification, width/core, xylem/core.

Bazı Sofralık Üzüm Çeşitleri ile Amerikan Asma Anaçlarında Yıllık Dalların Odunlaşma Düzeylerinin Belirlenmesi

Özet

Bu araştırma, bazı sofralık üzüm çeşitleri ('Amasya Beyazı', 'Ata Sarısı', 'Cardinal', 'Italia', 'Kozak Beyazı', 'Müşküle', 'Yalova Çekirdeksizi' ve 'Yalova İncisi') ile Amerikan asma anaçlarında ('140Ru', '1613C', '1103P', '110R', '5BB' ve '41B') yıllık dalların odunlaşma düzeylerinin belirlenmesi amacıyla, 2013 ve 2014 yıllarında yürütülmüştür. Üzüm çeşitlerine ait 7,5–9,5 mm kalınlığındaki kalemler 'ÇOMÜ Dardanos Yerleşkesi'ndeki 'Sofralık Üzüm Çeşitleri Uygulama ve Araştırma Bağı'ndan, Amerikan asma anaçlarına ait 8,0–9,5 mm kalınlığındaki aşılanabilir çelikler ise 'Manisa Bağcılık Araştırma Enstitüsü Müdürlüğü'nden (Manisa/Türkiye) temin edilmiştir. Sonuç olarak; *Vitis* cinsinin yıllık dallarındaki odunlaşma (pişkinleşme) düzeyini en iyi ifade eden çap/öz ve ksilem/öz gibi parametre oranları çeşit, anaç ve yıllar bazında değişim göstermiş, Amerikan asma anaçlarının yıllık dallarındaki parametre oranlarının, üzüm çeşitlerinin yıllık dallarına kıyasla çok daha yüksek olduğu belirlenmiştir. Bu durumun, kalem alınan üzüm çeşitleri üzerindeki ürün yükünün anaçlara kıyasla çok daha yüksek olmasından ve genetik farklılıktan kaynaklandığı düşünülmektedir.

Anahtar kelimeler: Amerikan asma anacı, *Vitis vinifera* L., üretim materyali kalitesi, odunlaşma, çap/öz, ksilem/öz.

Introduction

The width of dead core section, live xylem and bark+xylem layers represent the lignification levels of canes. The wider sections are, the more the lignification is and vice versa (Oraman, 1970; Çelik et al., 1998; Dardeniz, 2001; Dardeniz et al.,

2007; Dardeniz et al., 2008). Higher width/core, xylem/core and bark+phloem/core ratios are the indicators of well lignification levels and they present reliable information about such lignification levels (Dardeniz et al., 2007; Dardeniz et al., 2008; Dardeniz et al., 2013; Tirpanci and Dardeniz, 2014; Onder and Dardeniz, 2015). Onder and Dardeniz (2015) identified positive significant relationships between width/core parameters and bark+phloem/core and xylem+(bark+phloem)/core parameters at $p<0.01$ level and positive significant relationships between width and width/core and between width and xylem/core parameters of Cardinal, Yalova Cekirdeksizi and Yalova Incisi grape cultivars at $p<0.01$ level. The researchers also observed significant positive relationships ($p<0.01$) between width/core, xylem/core and xylem+(bark+ phloem)/core parameters of canes of most grape cultivars and number of inflorescence within primary bud of winter knop. Such a case indicated that winter bud performance varied based on cane quality (level of lignification).

Bahar (1996) reported decreasing phloem+ xylem width/core ratio with the growth of core widths of vine sapling canes and such a case indicated poor lignification levels of canes. Increased core surface area ratios in vine sapling canes was found to be related to the first class sapling and decreased starch and total carbohydrate ratios and such a case also indicated low sapling quality or lignification levels.

Bark+phloem widths of canes of grape cultivars and rootstocks gradually increase from defoliation period toward to pruning and awakening period through the changing inner structure (Dardeniz et al., 2008; Dardeniz et al., 2013). Bark+phloem widths also gradually decrease from the bottom knot intervals toward to tip knot intervals (Dardeniz et al., 2008; Onder and Dardeniz, 2015). For instance, while the bark+phloem widths between 1–4 knots of Cardinal, Italia, Yalova Cekirdeksizi and Yalova Incisi grape cultivars respectively were 0.84 mm, 0.80 mm, 0.72, the values gradually decreased respectively to 0.52 mm, 0.54 mm, 0.54 mm and 0.47 mm between 13–16 knots (Onder and Dardeniz, 2015).

Since cambium generates 1 phloem cell after generating 6–8 layers of xylem cells in general, widths of phloem and xylem rings generated within a growth season are not the same (Öner, 1978). Width of xylem layer is not also the same throughout the cane (Oraman, 1972). When a cross–section is taken between two knots of a cane, a better lignification can be seen over anatomically narrower side (Kısmalı, 1978). Therefore, more calluses are generated over the narrower sides of canes than the wider sides. In addition, xylem rings over the narrow side of a cane are more and wider and the xylem rings over wide side are less and smaller. Distinctive decreases were observed in xylem values of rootstocks and grape cultivars through moving from the bottom knot intervals toward to middle or tip know intervals (Dardeniz et al., 2008; Onder and Dardeniz, 2015). For instance, while the xylem widths between 1–4 knots of Cardinal, Italia, Yalova Cekirdeksizi and Yalova Incisi grape cultivars respectively were 2.50 mm, 2.58 mm, 2.41 mm and 2.25 mm, the values regularly decreased respectively to 1.52 mm, 1.86 mm, 1.65 mm and 1.26 mm between 13–16 knots (Onder and Dardeniz, 2015). Xylem widths of rootstock canes increase gradually through the changing inner structure from defoliation period toward to cane pruning after 30–45 days and xylem widths of grape cultivars gradually increase from defoliation period toward to pruning and awakening period (Dardeniz et al., 2007; Dardeniz et al., 2013).

While the core has wider widths when the summer shoots are young, it gets squeezed and smaller with the development of xylems during the vegetative period. The core dies out during the secondary growth period of the trunk and then the cells herein turn into brown and play a passive role (Agaoglu, 1999). The core is narrow in fully developed and lignified cane. As the cane gets older and be 2, 3 or more years old, the core section remains narrower compared to overall width (Çelik, 2007). Core rays extend from the center (core) to bark and act as storage (Çelik, 2007). As the lignification levels in xylem increases, number and frequency of core rays increase. The width of core at mid–section of the cane may vary based on different cultural practices exerted over rootstocks and grape cultivars, the growth period, position and storage conditions of cane (Dardeniz, 2001; Dardeniz et al., 2007; Dardeniz et al., 2008; Dardeniz et al., 2013; Tırpancı and Dardeniz, 2014). The cane does not have the same width and roundness throughout the entire length from bottom to top. While the cane width is high at bottom knots, it gets thinner toward to middle and tip knots (Dardeniz, 2001; Dardeniz et al., 2008; Onder and Dardeniz, 2015). Such a case also reflects over core width values but the change is always has a decreasing trend in rootstocks (Dardeniz et al., 2008). Besides, core widths of canes of grape cultivars exhibit a regular decrease toward to middle and tip knots. For instance, while the core widths between 1–4 knots of Cardinal, Italia, Yalova Cekirdeksizi and Yalova Incisi grape cultivars respectively were 4.18 mm, 4.66 mm, 4.74 mm and 4.09 mm, the values decreased with

the decreasing cane widths regularly to 2.92 mm, 3.14 mm, 3.41 mm and 3.21 mm between 13–16 knots (Onder and Dardeniz, 2015). Knot intervals of rootstock canes get into more oval forms toward to middle and tip sections and core roundness values of these sections mostly follow a course parallel to roundness values of the canes (Dardeniz et al., 2008). The core is long over the projection of narrow side of the cane and thin over the projection of the wide side. Thus, xylem and bark+phloem layers over the narrow side of the case are better developed and thickened (Dardeniz et al., 2013). Decreases were observed in core widths of the canes of American vine rootstocks through the changes in internal structure at 15, 30 and 45 days from defoliation. For instance, while the core width of 140Ru rootstock was 3.53 mm at defoliation date, the value regressed 15, 30 and 45 days after defoliation to 3.40 mm, 3.17 mm and 3.28 mm, respectively and the values of 5BB rootstock decreased from 3.16 mm respectively to 2.93, 2.92 and 2.93 mm (Dardeniz et al., 2007). On the other hand, core widths of the canes of grape cultivars slightly decrease or remain unchanged from defoliation toward to pruning and awakening periods (Dardeniz et al., 2013).

The best lignification in grape cultivars is observed respectively within knot intervals, 10 mm above the knot and 10 mm below the knot; the worst lignification is observed around the knot level. The thickest xylem and bark+phloem layers are observed at 90 degrees right and 90 degrees left of the winter bud; the thinnest xylem and bark+phloem layers are observed at winter bud side and 180 degrees behind the winter bud (Dardeniz et al., 2013).

It was observed in previous studies that width/core ratio of 5BB rootstock between 1–4 knots was 3.80 and the value between 5–8, 9–12, 13–16 and 17–20 knots respectively regressed to 3.36, 2.93, 2.62 and 2.44; the same values of 140Ru rootstock was decreased from 3.49 mm respectively to 2.90, 2.57, 2.40 and 2.33 (Dardeniz et al., 2008). Lignification levels at different knot intervals of the canes were also investigated in previous research works. Width/core ratios of canes between 1–4, 5–8, 9–12 and 13–16 knots were respectively observed as 2.50, 2.64, 2.50 and 2.35 in Cardinal grape cultivar; as 2.47, 2.46, 2.26 and 2.15 in Yalova Incisi grape cultivar; as 2.42, 2.56, 2.57 and 2.57 in Italia grape cultivar; as 2.30, 2.26, 2.35 and 2.31 in Yalova Cekirdeksizi grape cultivar. Based on these values, the highest width/core, xylem/core and xylem+(bark+phloem)/core ratios were observed between 5–8 knots of Cardinal grape cultivar, between 1–4 and 5–8 knots of Yalova Incisi grape cultivar. The highest values of lignification parameters observed between blind bud and the first knot was because this section is the knot interval closest (bottom) to biennial cane (Onder and Dardeniz, 2015).

Different treatments may improve the quality of production materials. The ideal production material was determined to be 5–16 knot interval for 5BB rootstock and 5–12 knot interval for 140Ru rootstock (Dardeniz et al., 2008). Lessening the number of shoots through leaving 12, 8 and 4 summer shoots over rootstock heads increased lignification levels (width/core) (140Ru: Control; 2.76, 12 shoots; 2.85, 8 shoots; 3.13 and 4 shoots; 3.24, 1103P: Control; 3.35, 12 shoots; 3.40, 8 shoots; 3.74 and 4 shoots; 3.96) and improved sapling quality. Therefore, 8 shoots are recommended for 140Ru and 9 shoots are recommended for 1103P rootstocks in nurseries during the years in which grafting cuttings are produced; 11 shoots are recommended for 140Ru and 10 shoots are recommended for 1103P rootstocks during the years in which nursery cuttings are produced; 10 shoots are recommended for both rootstocks during the years in which both types of cuttings are produced (Dardeniz, 2001; Dardeniz and Kısmalı, 2001). The most ideal production material sections of grape cultivars were determined to be 5–12 knot intervals for Cardinal grape cultivar, 5–8 knot intervals for Yalova Incisi grape cultivar, 5–16 knot intervals for Italia grape cultivar and 9–16 knot intervals for Yalova Cekirdeksizi grape cultivar (Onder and Dardeniz, 2015). Inflorescence, bunch and grape thinning also had positive impacts on cane quality. For instance, 30 and 60% thinning in inflorescence improved cane widths, scion performance and width/core (lignification) ratios of Cardinal grape cultivar (the values increased from 2.83 in control treatment respectively to 2.91 and 3.09 with 30 and 60% thinning treatments) (Dardeniz, 2001; Dardeniz and Kısmalı, 2002). In another study, 25, 50 and 75% inflorescence thinning treatments in spring improved top callus development in single bud scions of Yuvarlak Cekirdeksiz grape cultivar (Ilgin, 1997). Cane yields of Cardinal grape cultivar were increased by 48% through extending summer shoots along the upper wireline without pinching and also any changes were not observed in cane quality (width/core) with this implementation (Kısmalı and Dardeniz, 2002).

When the production materials taken from vine stocks are stored at different temperatures and different durations, cane inner structures change from the initial cutting date. While the best scion lignification levels were observed in 50–75

days storage durations, better lignification levels were also observed in production materials stored respectively at 4–6°C, 0–2°C and 8–10°C temperatures. Such an order was also observed in sapling shoot and root weights. In brief, since the inner structure of canes are not developed fully in scions taken at pruning period (end of February–beginning of March), grafting should not be performed right after winter pruning and it is better to be done at the beginning of March after preserving the scions at 4–6°C cold storages for at least 25 days (Tırpancı and Dardeniz, 2014).

In another study carried out with stereo–zoom microscope, decreasing cane epiderm, endoderm, periderm, phloem, xylem and core widths were observed from the bottom knot toward to tip node intervals. According to lignification parameter ratios (width/core, xylem/core and bark+phloem/core), the best lignification levels were observed in middle–tip knot intervals (13–16 and 9–12) in Kozak Beyazi and Muskule grape cultivars and numerical increases were observed in time from the 1st period (defoliation period) toward to 4th period (awakening period) (Gokdemir and Dardeniz, 2014).

The present study was conducted to determine the lignification levels of the canes of some table grape cultivars and American vine rootstocks.

Materials and Methods

The present study was conducted to determine the lignification levels of the canes of Amasya Beyazi, Ata Sarisi (Beyaz Cavus x Cardinal), Kozak Beyazi, Cardinal (Flame Tokay x Alphonse Lavallée), Italia (Bicane x Muscat Hamburg), Muskule, Yalova Cekirdeksizi (Beyrut Hurmasi x Perlette) and Yalova Incisi (Honusu x Siyah Gemre) table grape cultivars and 140Ru (V. rupestris x V. berlandieri), 1613C (V. Solonis x Othello), 1103P (V. rupestris x V. berlandieri), 110R (V. rupestris x V. berlandieri), 5BB (V. riparia x V. berlandieri) and 41B (V. vinifera x V. berlandieri) American vine rootstocks during the years 2013 and 2014. The 7.5–9.5 mm scions of grape cultivars were supplied from 'Table Grapes Research and Implementation Vineyard' (Canakkale, Turkey) in 'COMÜ Dardanos Campus'. Yalova Incisi grape cultivars was grafted over 41B and other grape cultivars were grafted over 5BB American vine rootstocks and they were 10 years old at the beginning of experiments. Vine stocks were planted at 3.0 x 1.5 meter spacing and single–arm fixed cord training system was used.

Scion samples were taken with pruning shears at the beginning of winter pruning period (15th of February). Samples were taken in 4 replications with 5 vine stocks in each replication and 10 cane samples were taken for each replication covering middle knots (5–10). Digital calipers were used to measure inner structures (width, core and xylem) of the canes. A total of 200 horizontal cuts were performed and 1600 inner structure readings (4 replications x 10 canes x 5 knots x 8 different internal structure readings= 1600 readings) were made for each grape cultivar. The 8.0–9.5 mm grafting scions of American vine rootstocks were supplied from 'Manisa Viticulture Research Institute (Manisa/Turkey)'. Grafting scions were cut in December and preserved at cold storage (3–4°C) until February. Then, they were used in experiments. Same numbers of horizontal cut and internal structure readings were performed on grafting scions. Scion and cutting samples were initially taken to cold storages at 4 °C and anatomic inner structure measurements were performed in weekly intervals in 5 days. The measurements and assessments made on grape cultivars and rootstocks are provided below.

Width (mm); measurements were made with digital calipers from the mid–section of each node interval between 5–10 knots, cross sections were taken and measurements were made from two different width sections as of thin and thick and average of them was taken. Core (mm); measurements were made from the same knot intervals at two different points with digital calipers and average was taken. Xylem (mm); measurements were taken from 4 different xylem sections of the same knot intervals and average was taken. Different parameter ratios best representing cane lignification level (width/core and xylem/core) were calculated by dividing the relevant values to core values.

Experimental data were subjected to variance analysis by using 'SAS® 9.1' and 'LSD test' was used to compare means at $p<0.05$ level.

Result and Discussion

The experimental results on lignification levels of the canes of some table grape cultivars and American vine rootstocks have been provided in Table 1. and Table 2. Core and xylem values significantly varied based on different cultivars, rootstocks and years. Width and core values of different table grape cultivars and rootstocks were significantly different in the first and second year. The narrowest core values of the scions of table grape cultivars were observed in Ata Sarısı (3.32 mm), Yalova Incisi (3.44 mm), Cardinal (3.51) and Amasya Beyazi (3.53 mm) grape cultivars. The narrowest core values of cuttings of American vine rootstocks were observed in 1103P (2.19 mm) and 140Ru (2.39 mm) rootstocks and they were

followed by 110R (2.77 mm) rootstock (Table 1.). Crossbreeds of 140 Ru, 1103P and 110R American vine rootstocks from the same parent materials (V. berlandieri x V. rupestris) might be effective in having similar core values.

Considering the parameter ratios of different table grape cultivars and different American vine rootstocks, significant differences were observed only between xylem/core ratios of the table grape cultivars of the years (2013 and 2014). While the xylem/core ratio was 0.476 in the year 2013, the value increased in the year 2014 and reached to 0.529 besides, significant differences were not observed between parameter ratios of table grape cultivars and ratios of American vine rootstocks in different years. Such a case indicated that cane lignification levels of vine stocks grown under standard maintenance practices did not exhibit excessive fluctuations from year to year (Table 2.).

Lignification levels of canes are best represented by the ratios like width/core and xylem/core. The highest width/core ratios of the scions of different table grape cultivars were respectively observed in Amasya Beyazi (2.46), Cardinal (2.32) and Yalova Incisi (2.32) grape cultivars. Xylem/core ratios had also the same order and the highest values were observed respectively in Amasya Beyazi (0.575), Cardinal (0.519) and Yalova Incisi (0.517) grape cultivars. Such well lignification levels of Cardinal and Yalova Incisi grape cultivars were because of their genetic structures since they were early cultivars, they were harvested earlier and their photosynthesis products were able to be stored in their canes. High lignification level of Amasya Beyazi grape cultivar was also related to genetic structure and may also be resulted from deficit regeneration rates and production levels. Yalova Cekirdeksizi is a mid–season cultivar and low width/core value (2.17) was because it was a seedless crossbreed (Beyrut Hurması x Perlette). Low width/core ratios of Kozak Beyazi (2.20) and Muskule (2.16) grape cultivars were because they were the latest cultivars (the last out of season) and they didn't have sufficient time to transfer photosynthesis products to the grapes and then store in their canes. The highest width/core ratios of American vine rootstocks were respectively observed in 1103P (3.89) and 140Ru (3.56) rootstocks. The highest xylem/core values of American vine rootstocks were respectively observed again in 140Ru (1.091) and 1103P (1.006) rootstocks and they were followed by 110R (0.905) rootstock (Table 2.). Similar parameter ratios were because 140 Ru, 1103P and 110R were crossbreeds of the same parents (V. berlandieri x V. rupestris).

The present results obtained from different grape cultivars are parallel to the findings of previous studies carried out with Cardinal, Italia, Yalova Cekirdeksizi and Yalova Incisi grape cultivars (Onder and Dardeniz, 2015). The findings obtained from American vine stocks are also parallel to the findings of previous researches carried out with 5BB and 140Ru rootstocks (Dardeniz et al., 2008).

Conclusion

In the present study, host preferences and the highest width/core and xylem/core ratios of the canes of different table grape cultivars were respectively observed in Amasya Beyazi, Cardinal and Yalova Incisi grape cultivars. The highest width/core ratios of the cuttings of American vine rootstocks were respectively observed in 1103P and 140Ru and the highest xylem/core ratios were respectively observed in 140Ru, 1103P and 110R rootstocks. It was concluded that width/core and xylem/core parameters best representing the lignification levels of the canes of *Vitis* species varied based on cultivars, rootstocks and years. Parameter ratios were higher in scions of American vine rootstocks than in canes of grape cultivars. Such a case was because of higher fruit cluster loads over grape cultivars from which canes were taken than the rootstocks from which scions were taken and because also of genetic differences among them.

The width/core and xylem/core ratios representing lignification levels of the canes have direct positive relationships with regeneration rates. Proper determination of these parameter ratios may provide significant contribution in comprehension of the effects of different practices on lignification levels of canes and may also provide practical and reliable outcomes for pre–estimation of regeneration and productivity rates. Besides, because of anatomic similarities in inner structures, the cultivar/rootstock combinations with closer inner parameter ratios will have higher sapling performances through higher take ratios and further ones will have lower performances through less take ratios. Longer duration and more detailed researches are recommended in these issues to improve production material quality and performance of vine nurseries.

Table 1. Averages of internal structure parameters of scions of different table grape cultivars and rootstock cuttings *

Cultivars	Width (mm)			Core (mm)			Xylem (mm)		
	2013	2014	Aver.	2013	2014	Aver.	2013	2014	Aver.
Kozak Beyazi	8.62 cd	7.60 c	8.11 cd	4.29 a	3.29 c	3.79 bc	1.73 c	1.90 b	1.81 abc
Cardinal	7.90 d	8.26 ab	8.08 cd	3.25 c	3.77 b	3.51 cd	1.75 c	1.86 bc	1.80 bcd
Ata Sarisi	7.71 d	7.06 d	7.39 d	3.51 bc	3.12 c	3.32 d	1.46 d	1.74 c	1.60 d
Muskule	9.11 abc	7.79 bc	8.45 bc	4.17 a	3.83 b	4.00 ab	1.81 bc	1.75 bc	1.78 bcd
Amasya Beyazi	9.05 bc	8.11 ab	8.58 abc	3.80 abc	3.25 c	3.53 cd	1.89 bc	2.06 a	1.97 ab
Yalova Incisi	7.59 d	8.24 ab	7.92 cd	3.23 c	3.64 b	3.44 cd	1.68 cd	1.83 bc	1.76 cd
Y. Cekirdeksizi	10.09 a	8.36 a	9.22 a	4.40 a	4.16 a	4.28 a	2.15 a	1.87 bc	2.01 a
Italia	9.74 ab	8.06 abc	8.90 ab	4.11 ab	3.84 b	3.98 ab	2.01 ab	1.75 c	1.88 abc
LSD	1.0310	0.5040	0.7737	0.6280	0.2900	0.4151	0.2560	0.1460	0.2012
Average	8.73 A	7.94 B		3.85 A	3.61 B		1.81	1.84	
LSD–Year	0.3868			0.2076			NS		
Rootstocks	Width (mm)			Core (mm)			Xylem (mm)		
	2013	2014	Aver.	2013	2014	Aver.	2013	2014	Aver.
140Ru	8.45 b	8.35 a	8.40 b	2.34 c	2.43 d	2.39 d	2.17 ab	2.97 a	2.57 a
1613C	8.69 b	7.76 b	8.22 b	3.14 a	3.31 ab	3.22 ab	2.05 bc	2.13 d	2.10 c
1103P	8.64 b	7.77 b	8.27 b	1.92 d	2.43 d	2.19 d	1.93 c	2.37 bc	2.18 bc
110R	8.87 b	8.28 ab	8.58 ab	2.59 bc	2.90 c	2.77 c	2.37 a	2.50 b	2.43 ab
5BB	9.18 b	8.29 ab	8.70 ab	3.13 a	3.46 a	3.28 a	2.21 ab	2.35 bcd	2.26 bc
41B	10.49 a	8.06 ab	9.28 a	2.78 b	3.17 bc	2.96 bc	2.34 a	2.16 cd	2.25 bc
LSD	1.2980	0.5660	0.8417	0.3260	0.2670	0.2897	0.2110	0.2300	0.2780
Average	9.05 A	8.09 B		2.65 B	2.95 A		2.18 B	2.42 A	
LSD–Year	0.4860			0.1673			0.1605		

*Least significant difference (LSD): 5% significance level. NS: Not–significant.

Table 2. Parameter ratios of different table grape cultivars table grape cultivars and rootstock cuttings *

Cultivars	Width/core			Xylem/core		
	2013	2014	Aver.	2013	2014	Aver.
Kozak Beyazi	2.03 d	2.37 b	2.20 b	0.408 d	0.594 ab	0.501 b
Cardinal	2.44 a	2.20 cd	2.32 ab	0.540 a	0.498 d	0.519 ab
Ata Sarisi	2.20 bcd	2.28 bcd	2.24 b	0.418 cd	0.564 bc	0.491 b
Muskule	2.18 cd	2.13 de	2.16 b	0.434 bcd	0.494 d	0.463 b
Amasya Beyazi	2.39 a	2.53 a	2.46 a	0.502 a	0.646 a	0.575 a
Yalova Incisi	2.35 abc	2.29 bc	2.32 ab	0.523 a	0.511 cd	0.517 ab
Y. Cekirdeksizi	2.31 abc	2.03 e	2.17 b	0.494 ab	0.456 d	0.475 b
Italia	2.38 ab	2.13 de	2.25 b	0.486 abc	0.467 d	0.477 b
LSD	0.1890	0.1510	0.1797	0.0730	0.0570	0.0696
Average	2.29	2.24		0.476 B	0.529 A	
LSD–Year	NS			0.0348		
Rootstocks	Width/core			Xylem/core		
	2013	2014	Aver.	2013	2014	Aver.
140Ru	3.61 b	3.52 a	3.56 ab	0.930 ab	1.252 a	1.091 a
1613C	2.77 c	2.40 c	2.59 d	0.653 c	0.672 c	0.665 d
1103P	4.53 a	3.27 ab	3.89 a	1.010 a	0.994 b	1.006 ab
110R	3.42 b	2.98 b	3.18 c	0.914 ab	0.913 b	0.905 bc
5BB	2.96 c	2.44 c	2.69 d	0.714 c	0.697 c	0.703 d
41B	3.75 b	2.60 c	3.19 bc	0.844 b	0.707 c	0.781 cd
LSD	0.3990	0.2900	0.3837	0.1080	0.1210	0.1429
Average	3.51	2.86		0.844	0.873	
LSD–Year	0.2215			NS		

*Least significant difference (LSD): 5% significance level. NS: Not–significant.

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