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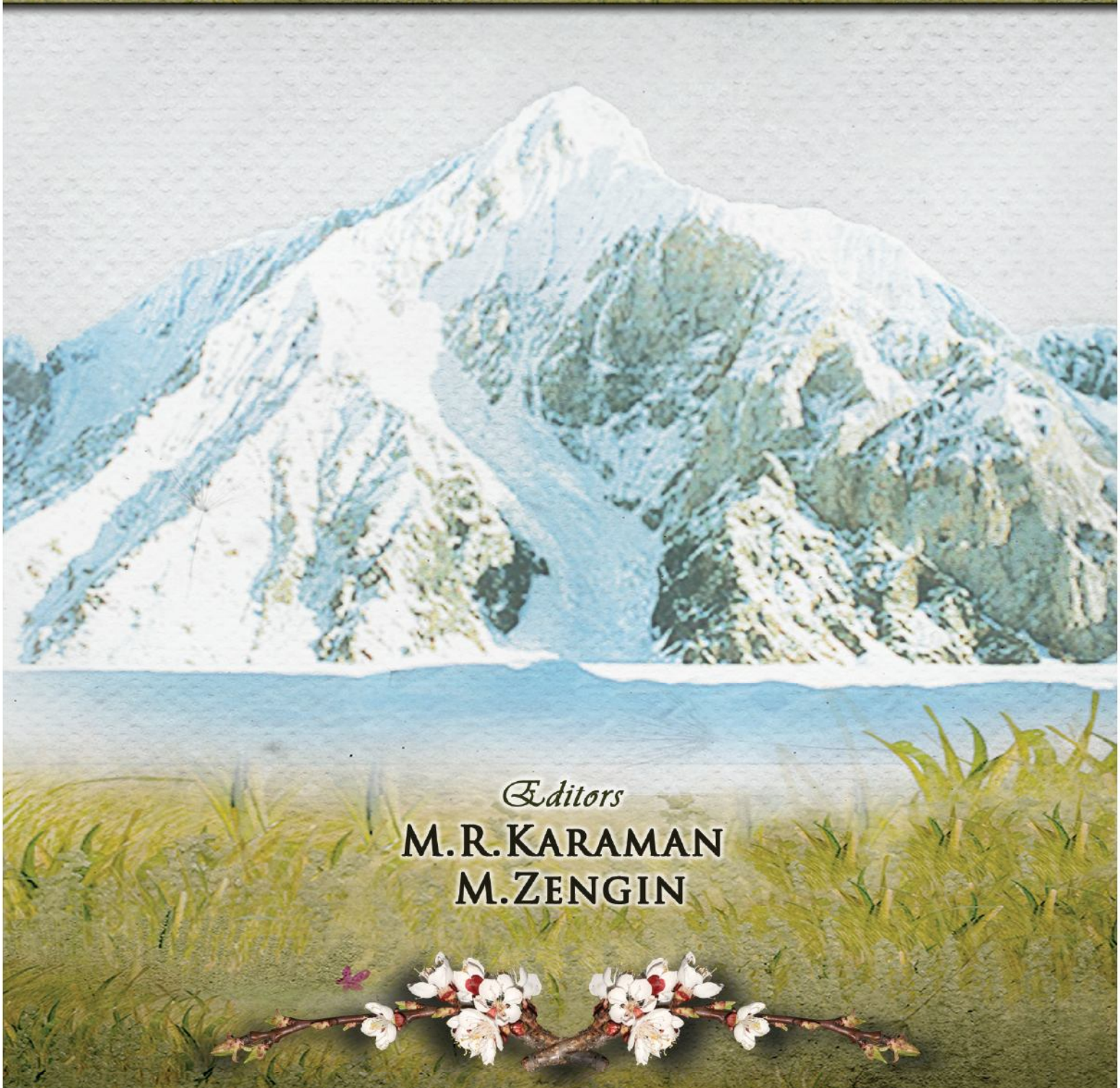

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Nutritional Contents of the Canes of the Yalova Incisi Grape Variety

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Abstract: This research was conducted on the Yalova İncisi grape variety in the "Table Grape Varieties Research Vineyards" between 2009 and 2010. The research was aimed at determining the nutritional elements of the canes, using graft material. The research was done according to randomized plots factorial design with four replications. Five vines were used for each replication and two pieces of cane from each vine were taken for the investigation during the winter pruning season. Cane samples, separated into 1-4, 5-8, 9-12 and 13-16 internodes, were dried and milled and made ready for analysis. A total of 21 elements (C, N, P, K, Ca, Mg, S, Fe, Cu, Zn, Mn, Al, Co, Mo, B, Cd, Cr, Na, Ni, Pb and Se), reducing and total sugars were analyzed in the samples. In the first and second year samples of the Yalova incisi grape variety, the N content was found to be low, while the C/N rate was high in the lower internodes (1-4) of the canes; however, towards the middle and top internodes (8–12 and 13-16), the N content became higher, while the C/N rate dropped lower. According to the average results, in the context of the nodes, some important differences were detected in the case of the Ca, K, Mg, Na and Zn elements, which showed the lowest values in the lower internodes (1-4) of the canes and an increase towards the middle and top internodes, respectively.

Keywords: Cane, Çanakkale, nutrition, *Vitis vinifera* L., winter pruning

1. Introduction

Increased lignin in the cell wall is called lignification (Öner, 1978). Lignification of the summer shoot occurs slowly with associated color transformation; it turns from green to brown (Ağaoğlu, 1999). Unlike K and P which have positive effects on lignification, N shows negative effects (Ağaoğlu, 2002). After the slowdown of shoot elongation in the grapevine (August), lignification occurs from the basal portion of the shoot with the storage of carbohydrates like sugar and starch, and continues towards the top when the end of the season approaches. Sugar and allied substances have significant effects on woodiness; however, glucose, levulose, galactose etc. as well as substances like cellulose synthesized at certain periods of development, affected the lignification (Ağaoğlu, 2002). Water revealed

a rate of 85–90% during the first period of summer shoots, and then dropped to 50–60% with starch accumulation, from the lower end during lignification.

At the beginning of veraison of the grape varieties (mostly in midsummer), the summer shoots showed a partly woody structure with lignification from lower end to the top, towards the defoliation period. Bulges, with irregular swellings on the canes occur, which are called nodium (Kısmalı, 1995). Nodes in *Vitis vinifera,* are the clearest and more bulged when compared with the American grapevine species. A cross-section of the canes, taken close to the nodes, shows an elliptical structure whereas the cross-section of the internodes is more circular (Ağaoğlu, 1999; Dardeniz et al., 2013a). The portion between the two nodes is called the internodium (Kısmalı, 1995). The reserve water in the canes was found to have a rate of 45–50%, when taken from the grapevine during the winter pruning period (Kısmalı, 1978; Dardeniz, 2001). Lignification levels at the lower and middle internodes (1–12) are higher than that at the top internodes (13–16), although it varies with the grape varieties (Önder, 2012). However, in the rootstocks, lignification occurs from the lower part of the cane to the middle and top parts, respectively. As the reserve water levels increase at significant rates towards the top nodes (17–20), the lignification level decreases (Dardeniz et al., 2008).

The well-lignified canes are resistant to –18 to –20°C; however, the ones that are less well lignified show less resistance (Ağaoğlu, 2002). For this reason, the shoot tips which are damaged with the winter frosts due to poor lignification often drop off from the grape vines. The characteristics of the produced material have important effects on the development and efficiency of open rooted grafted vines (Kısmalı, 1979). The development and efficiency of open-rooted grafted vines result from the production material in the root, shoot and callus. Interruption at any of these stages has negative effects on vine sapling development (Schenk, 1965; Samson and Casteran, 1971; Kısmalı, 1978). The content of the different nutritional elements, shows differences in the internodes and cane periods for different rootstocks. For example, in the 5BB rootstock, N 0.51–0.64%, P 0.12–0.13%, K 0.37–0.42%, C 44.3–46.6%, Fe 68.5–99.2 $mg.L^{-1}$, Mg 1069–1169 mgL^{-1}, Zn 6.78–8.34 mgL^{-1}, Na 74.0–87.3 mgL^{-1}, Mn 18.6–25.0 mgL^{-1}, Cu 4.96–7.44 mgL^{-1}, reducing sugar 0.16–0.24 $g100mL^{-1}$ and C/N varied from the rate of 101–153 (Gökbayrak et al., 2009), in the 140Ru rootstock, N 0.61–0.70%, P 0.13–0.14%, K 0.41–0.44%, C 44.7–45.9%, Fe 89–104 mgL^{-1}, Mg 1230–1312 mgL^{-1}, Zn 7.3–7.9 mgL^{-1}, Na; 73–84 mgL^{-1}, Mn 23.2–30.0 mgL^{-1}, Cu 5.5–7.1 mgL^{-1}, reducing sugar 0.13–0.20 $g100mL^{-1}$ and C/N varied from a rate of 76.4–106.2 (Türkmen et al., 2011). The N content is high during the defoliation period of the rootstock, and decreases 15, 30 and 45 days after the defoliation period and the low C and C/N rates begin to increase. The Zn and Mn elements in the canes of the rootstocks decrease 15, 30 and 45 days after the defoliation period (Gökbayrak et al., 2009; Türkmen et al., 2011).

Nutritional elements were determined in the canes of the Yalova Çekirdeksizi grape variety, according to the average results; besides Na and Zn

elements, there were no other important differences to be determined in the context of the internodes, and the highest values of these elements were attained in the top internodes (9–12 and 13–16). Although no significant difference was observed in the average results, Al, B, Cr, Fe, K, Mg, Mn, Ni, P and S elements showed numerical increases from the lower nodes (1–4) towards the middle and top nodes of the canes, although the Ca, Cd and Cu elements showed numerical decreases. At the same time, some fluctuations were observed in the Mo, Pb and Se elements along the cane, although none were found in the Co element. In the context of the nutritional elements, for Al 9.5–83.6 ppm, Mo 0–1.650 ppm, Ca 8818–12166 ppm, B 13.87–22.29 ppm, Cd 0–0.034 ppm, Cr 0.230–0.413 ppm, Cu 21.27–165.91 ppm, Fe 56.90–83.39 ppm, K 7461–9988 ppm, Mg 2385–3065 ppm, Mn 24.89–51.25 ppm, Na 280–430 ppm, Ni 0.585–0.875 ppm, P 1007–1888 ppm, Pb 0.428–0.604 ppm, S 620–966 ppm, Se 0.269–0.933 ppm, Zn 68.2–196.9 ppm, C 42.90–43.72%, N 0.955–1.430% and C/N 30.76–44.99 generally showed variation in these ranges (Dardeniz et al., 2013b).

The most abundant carbohydrate in canes is sucrose, followed by glucose, xylose, fructose, arabinose, rhamnose and galactose, respectively (Baydar et al., 2005). The lipid content was higher in the well-lignified vines compared with those that were less lignified (Ağaoğlu, 2002). In terms of the amounts of reserve carbohydrates (sugar + starch), some differences could be seen varying with the year and variety, when the sugar plus starch content was high in the production material at the beginning, showed significant losses during storage in the sandbox in three months, but with no significant losses under suitable conditions in cold storage. Eventually, for the first year, in different varieties and rootstocks, the sugar 2.0–5.81%, starch 3.98–7.92% and total carbohydrate contents 7.42–13.73% varied; for the second year the sugar 1.84–6.53%, starch 4.93–8.97% and total carbohydrate 7.24-13.37% varied again (Kısmalı, 1978). Carbohydrate accumulation in the canes dropped when the charge of yield increased. According to different yield levels, the amount of total carbohydrate in the canes of the Riesling grape variety varies from 8.6–12.0% (Balasubrahmanyam et al., 1978). In hard rooted cuttings, the sugar, phenolic compound and C/N rate decreased; however, the N and starch content increased (Mokashi, 1980). In the canes of open-rooted grafted vines, the total carbohydrates was determined to be 20.28–18.37%, starch 11.97–8.75%, total sugar 10.59–8.25% and reducing sugar 5.59–2.25% (Tangolar and Ergenoğlu, 1989). This research was conducted on the Yalova İncisi grape variety to determine the nutritional elements of the canes which were taken during the winter pruning period, between 2009 and 2010.

2. Materials and Methods

In this study, a seven-year-old Yalova İncisi grape variety grafted onto the 41B rootstock was used as the material on which the research was conducted, in the Table Grape Varieties Research Vineyards, about 1200 m^2 in area, between 2009 and 2010 on the ÇOMU Dardanos Campus. In the research, we aimed to

determine the nutritional elements of the canes which were used as scion material. The Yalova İncisi grape variety was planted on a one-armed stable wire training system with spacing and distance of 3.0 x 1.5 m in the north-south direction. The research was done according to randomized plots factorial design with four replications. In total, five vines for each replication and two pieces of cane on each vine, were taken for investigation during the winter pruning season (March). During the winter pruning period, the top-most cane, pruned over 16 buds with a piece of biennial branch, was taken to the pomology laboratory of Horticulture Department in the Agriculture Faculty of ÇOMU. Cane samples were divided into 1–4, 5–8, 9–12 and 13–16 internodes, and the analysis of the reducing and total sugar was performed. Analyses of the macro (P, K, Ca, Na, Mg and S), micro (Fe, Cu, Zn, Mn, Mo and B) and other elements were conducted in the laboratory of Konya Selçuk University, while the analysis of C and N were conducted in the laboratory of of ÇOMU. The means were analyzed using the MINITAB 16.0 statistical package software and separated by variance analysis in accordance to randomized plots factorial design. Compared with LSD, the means show no difference from the others indicated with the same letters.

3. Results and Discussion

In the context of different internodes, some elements occurred in only one year, some of them were found in 2009 and some in 2010, while some of the other elements were considered of significance based on average results. In the context of nodes, important differences were seen for the Ca, K, Mg, Na and Zn elements in the mean values, when all of these elements were found with the least results in the lower internodes (1–4) of the canes and were found to be increased towards the middle and top nodes, respectively. B, Fe, Mn, P, S and N elements showed numerical increases from the lower internodes to the top ones, while Cu showed numerical decreases. Some fluctuations were seen in the elements Al, Mo, Cd, Cr, Ni, Pb and Se along the canes; however, the element of Co was never found to occur. In the context of nutritional elements, for Al 40.6–67.5 ppm, Mo 0–1.190 ppm, Ca 7422–10318 ppm, B 12.36–21.97 ppm, Cd 0–0.022 ppm, Cr 0.220–0.525 ppm, Cu 45.3–101.8 ppm, Fe 54.43–92.10 ppm, K 5315–8332 ppm, Mg 1983–3282 ppm, Mn 27.71–37.32 ppm, Na 294–514 ppm, Ni 0.392–0.893 ppm, P 664–1371 ppm, Pb 0.338–0.774 ppm, S 614–1138 ppm, Se 0.225–1.389 ppm, Zn 75.9–222.7 ppm, C 42.70–44.23%, N 0.878–1.325% and C/N 32.55–49.27 generally showed variations in these ranges. While the data obtained in this direction, were compliant with the findings of Dardeniz et al., (2013b), they were also partially parallel to the research findings that were obtained from the 140Ru and 5BB rootstocks (Gökbayrak et al., 2009; Türkmen et al., 2011).

In a few earlier researches on the 140Ru and 5BB rootstocks with the Yalova Çekirdeksizi grape variety, it was determined that the N level was low and the C/N rate was high in the lower internodes (1–4) of the canes, towards the top nodes (17–20) The N level was increasing; however, the C/N rate showed a decrease

(Gökbayrak et al., 2009; Türkmen et al., 2011; Dardeniz et al., 2013b). It was determined that the N level was low and the C/N rate was high in the lower internodes (1–4) of the canes; however, the N level increased towards the middle and top nodes (8–12 and 13–16), while the C/N rate decreased. The K element showed a small increase from the lower to the top nodes in the rootstock canes (Gökbayrak et al., 2009; Türkmen et al., 2011). The same results were obtained from the Yalova Çekirdeksizi grape variety in the first year findings (Dardeniz et al., 2013b). There was a significant increase towards the mid and top nodes (1–4) of the canes of the Yalova İncisi grape variety. They recorded a good amount of increase in the mid and top rootstock internodes (Gökbayrak et al., 2009; Türkmen et al., 2011). For a short period, the Na and Mn elements, which were less in the lower internodes of the canes in the Yalova variety, were seen to increase towards the top nodes (Dardeniz et al., 2013b).

The results, obtained from the Yalova İncisi grape variety, was collateral with the previous researches, where for a time the Mn element showed a numerical increase from the lower towards the mid and top internodes, while the Na element displayed a significant increase from the lower towards the mid and top internodes. In the context of the different internodes, no significant differences were determined besides the Na and Zn elements in the Yalova Çekirdeksizi grape variety. The Al, B, Cr, Fe, K, Mg, Mn, Ni, P and S elements were found to show numerical increases from the lower (1-4) towards the mid and top internodes of the canes, while the Ca, Cd and Cu elements showed numerical decreases (Dardeniz et al., 2013b). Numerical increases were seen in the Ca, K, Mg, Na and Zn elements at significant rates; however, the B, Fe, Mn, P, S and N elements showed numerical increases from the lower towards the top internodes of the canes in the Yalova İncisi grape variety, except for the Cu element which showed numerical decreases. The means indicated that the K, Mg, Na, Zn, B, Fe, Mn, P and S elements increased, while the Cu element decreased from the lower towards the top internodes in the Yalova İncisi grape variety.

These results were similar to the findings of Dardeniz et al., (2013b), except for contradicting with our findings on the Ca element, which showed an increase towards the mid and top nodes. Although, the highest values of the reducing and total sugars were determined from 5–8 (reducing sugars being 0.656 g100 g^{-1} and total sugars being 5.83 g100 g^{-1}) and 13–16 (reducing sugars being 0.614 g100 g^{-1} and total sugars being 5.85 g100 g^{-1}) internodes of the Yalova İncisi grape variety. The N level was low and the C/N rate was high in the lower internodes (1–4) of the canes; for a time the N level increased towards the middle and top nodes (8–12 and 13–16), while the C/N rate decreased. According to the mean results significant differences were observed in the elements Ca, K, Mg, Na and Zn, in the context of the nodes, while all of these elements gave the least results in lower internodes (1–4), although they showed a regular increase towards the mid and top nodes of the canes. Although the B, Fe, Mn, P, S and N elements showed numerical increases, numerical decreases were observed in the Cu element from the lower (1–4) towards

the mid and top internodes of the canes. We concluded that, the repetition of similar studies based on different rootstocks and grape varieties would be very useful for the vine nursery in determining the quality of the production material.

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