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EFFECTS OF THE DIFFERENT GRAPE ROOTSTOCKS ON BERRY SKIN B, CU, FE, MN AND ZN CONTENTS OF 'CSERSZEGI FŰSZERES' CULTIVAR

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Abstract

The selection of the most appropriate grape rootstock regarding the production purposes has a positive effect on quality of the grape, the must and the wine: it may produce higher vintage quantity and may increase the vintage quality. Field experiment was set up at the model farm of University of Debrecen on sand soil. 12 different grape rootstocks were compared ('Aramon x Riparia 143B M et de G', 'Vitis Berlandieri', 'Berlandieri x Riparia Szilágyi 157 Pécs', 'Berlandieri x Riparia S.O.4','Berlandieri x Riparia T5C Eger', 'Berlandieri x Riparia T.G. 5.A.5.','Berlandieri x Riparia T.8.B.','Berlandieri x Riparia T.K. 5.BB','Berlandieri x Riparia K.125AA','Riparia Sauvage', 'Riparia Selecta', 'Riparia Tomentosa'). 'Cserszegi fűszeres' scion was grafted into the above rootstocks. The aim of our research was to determine how the B, Cu, Fe, Mn and Zn contents of the berry skins change in case of the different grape rootstocks. In 2011 we obtained valuable differences in the boron, copper, iron, manganese and zinc concentrations of skins of 'Cserszegi fűszeres' grafted into different rootstocks. The concentrations of B, Cu, Fe, Mn and Zn changed between 18.0-32.0 mg kg^{-1}, between 1.27-4.77 mg kg^{-1}, between 11.5-45.0 mg kg^{-1}, between 3.78-14.0 mg kg^{-1}, and between 2.14-8.53 mg kg^{-1}, respectively. On the basis of our results the 'Riparia Sauvage' could be an advantageous rootstock, as the largest boron, iron and manganese concentrations were found in its skin. Advantageous rootstocks could be the 'Berlandieri x Riparia Szilágyi 157 Pécs' because of the largest measured copper content and the 'Vitis Berlandieri' due to the largest measured zinc content. These results support that the selection of the rootstocks influence the B, Cu, Fe, Mn and Zn contents of the grape berry.

Key words: *grape rootstock, berry skin, micro element, 'Cserszegi fűszeres'.*

INTRODUCTION

Grape rootstocks are present in the grape production since the devastation of the phylloxera. Because it is vital to be acquainted with characteristics of different rootstocks to choose the variety most appropriate to given circumstances, these characteristics were broadly inspected by many researchers. Choosing the ideal rootstock-scion cultivar combination at establishment of the vineyard has a determining effect for its whole lifetime. Crucial evaluative characteristics of rootstock cultivars are the following: soil requirement, mineral nutrition, resistant to loam- and salt content, affinity and vegetative cycle (Angeli et al., 1959). Most often utilised grape species in ennobling of rootstock cultivars are *'Vitis Riparia Scheel.'*, *'Vitis Rupestris Mich.'*, *'Vitis Berlandieri Plan.'* and *'Vitis vinifera L.'*. The first three varieties are of North-American origin. *'Vitis Riparia Scheel.'* comes from river valleys of the east coast, *'Vitis Rupestris Mich.'* origins from south-west part of the east coast, while *'Vitis Berlandieri Plan.'* can be find on rocky territories of Texas state. Distinctive characteristics of these species result from many thousand years' evolution (Kocsis, 2010). In ennobling of rootstock cultivars some other, mainly North-American grape species were also used (Galet, 1998). However, there are 19 listed rootstock varieties in the Hungarian National Variety Registry Catalogue, only a few is propagated for commercial use (Lőrincz and Zanathy, 2009). In some other countries possibilities of different rootstock-scion variety combinations corresponding to specific

territorial circumstances is more elaborated, spectrum of used rootstock varieties is broader.
The cultivated vine plant is called vine stock (Balogh, 1991). Vine stocks are propagated on vegetative way by cuttings or grafted cuttings (Prohászka, 2003). Parts differentiating from the cane in the soil form the rooting system, parts forming above ground give the trunk and shoot system of the stock (Kozma, 1993a). In case of propagation by grafts, the root system is formed by the rootstock cultivar (American grape species), and the shoot system growth up from the scion (*'Vitis vinifera L.'*) (Prohászka, 1982). Mineral nutrients are taken up by the root hairs from the soil. These nutrients get into the leaves and bunches through the root system, trunk, canes and shoots (Prohászka, 1982; Kozma, 1993a). Certain nutrients can also be taken up through the leaves in smaller quantities (Kozma, 1993a). Through the lifetime of the graft, scion and rootstock parts live together in mutual service. The rootstock takes up mineral nutrients dissolved in water, the scion fruits and feeds the rootstock with photosynthates (Kocsis, 2010).
Rootstock has direct and indirect effects on the scion (Striegler and Howel, 1991; Csikászné, 2008). Hegedűs and I'só (1965) demonstrated, that different scion cultivars show their best performance on different rootstocks, which differently affect nutrition of scions grafted on them (Lőrincz and Bényei, 1999). Mineral nutrition pattern characteristic for own rooted vine alter in case of grafts (Kozma, 1993b). Quantity and composition of nutrients going to the direction of the scion is predominantly determined by the selection ability/ characteristics of the root system (Kozma, 1993b).
Different rootstocks can be characterized by different root formation. Magnitude, vertical and horizontal extension of the root system is also an important factor of mineral take up (Vercesi, 1987). Certain rootstock cultivars form smaller (*'Berlandieri x Riparia TK5BB'*) others form medium sized (*'Aramon x Rupestris G 1'*) root system. *'Riparia Portalis'* can be characterised by a deeper, while *'Berlandieri x Riparia S.O.4'* can be characterised by a shallow root system (Vanekova, 1995).
Effects of rootstocks do not confine for impinge on mineral take up but also on distribution of nutrients (Mannini et al. 1992). Withstanding that Kocsis (2010) could experimentally prove that scion cultivars show different results when grafted on various rootstocks concerning mineral take up, in field circumstances: effects of production site and ecological factors, affect the modifying power of rootstocks to a great extent, or even minimizes it (Csikászné, 2008).
Minerals taken up are predominantly located into the solid parts of the bunch: in the skin, seed and cellulose-pectinic cell walls of the flesh. The skin of the berry consists of the epiderma and some cell layers beneath (Ferenczi, 1966). Alkalinity of the of the berry regularly increase 2-3 times by the ripening; however only a more intensive relative increase is characteristic for the skin (Kállay, 1998). The most important microelements of the berries are B, Cu, Fe, Mn and Zn (Kállay, 1998). Most important role of iron is formation of chlorophyll (Prohászka, 1982). The least iron can be find in the seeds regarding the berries (Kozma, 1993a). Boron has crucial role in evolution of floral fertility, in amount and quality of the yield, but even a slight overdose of this element can have toxic effects (Bényei and Lőrincz, 1999; Oláh, 1979). Ruckenbauer (1987) found, that boron uptake of the vine is the biggest in the berries in case of 10 tons/ha yield. Experiments of Candolfi-Vasconcelos et al. (1997) state, that grafts are more effective in boron uptake than own rooted vines. Manganese is a mediator in the synthesis of carbohydrates and proteins, since it activates many enzymes (such as polyphenol-oxidase, ascorbic acid-oxidase). Zinc plays its most critical role in catalysing synthesis of tryptophan (Kozma, 1993a). Copper is one of the most important growth factors of the vine plant. One of its important roles is supporting of carbohydrate and protein synthesis (Kozma 1993a; Kállay, 2010).
Microelement content of the grape skin can also be interesting from the point of maceration technology at processing white aromatic grape cultivars, since by this way a certain amount of microelement of the skin dissolves into the must increasing its alkalinity (Kállay, 2010). Microelement content of the must further on

gets serious role through the fermentation process, because enzymatic activity of the yeast requires adequate amount and ratio of microelements (Erdőss, 1973). Further on, in the wine it is also significant from the point of formation of "minerality". This concept refers to the mineral content of the wine, also called "salinity". Both describe a special abundance in the taste complexity (Hajós, 2008).
The aim of our research was to determine how the B, Cu, Fe, Mn and Zn content of the berry skins changes in case of the different grape rootstocks. Data on mineral composition affected by different rootstocks are first year results of a longer, and more complex work.

MATERIALS AND METHODS

Grape variety collection of the University of Debrecen, Centre of Agricultural and Applied Economic Sciences was established in 2003 on immune sandy soil with 3m between row and 1m between vine spacing. 28 rootstock cultivars of the collection were trained to bald head system with one bended wire technology. In 2010 grafting of 'Cserszegi fűszeres' (also called 'Woodcutters' white') on 14 rootstocks out of the 28 was started with woody-green grafting in May, following with green grafting up to 20th of June. On vines grafted in place the scion was situated between 50-150 cm height. Scion was trained to single curtain training system (Figure 1.).

Figure 1. View from a grape variety collection of the University of Debrecen, Centre of Agricultural and Applied Economic Sciences

1st and 2nd tables show soil parameters of the experimental field in Pallag of 0-30 and 30-60 cm depth accordingly. To determine the fraction of soil B, Cu, Fe, Mn and Zn content, which could be utilized by the plant, analysis with NH_4-acetate + EDTA elution, elaborated by Lakanen and Erviö (1971) was used. Analysis of mineral composition of the elution was checked by Thermo Scientific iCAP 6300 Dual type inductively coupled plasma optical emission spectrometry (ICP- OES).

Table 1. Soluble (Lakanen and Erviö, 1971) B, Cu, Fe, Mn and Zn content of soil of Model Farm (mg kg-1)

Parameters	**Average (mg kg^{-1})**	
Sampling depth (cm)	0-30	30-60
B	0.63	0.60
Cu	9.95	7.02
Fe	239	213
Mn	329	382
Zn	6.93	4.65

Table 2. General parameters of soil of Model Farm

Parameters	**Average**	
Sampling depth (cm)	0-30	30-60
pH (KCl)	5.93	5.91
Soil texture	Sand	Sand
All water soluble salt (m/m)	0.005	0.006
$CaCO_3$ % (m/m)	0.5	0.5
Humic % (m/m)	1.12	1.08

In October of 2011 respectful amount of grape could be harvested of scions on 12 rootstock varieties. These are the following: *'Aramon x Riparia 143B M. et de G.', 'Vitis Berlandieri', 'Berlandieri x Riparia Szilágyi 157 Pécs', 'Berlandieri x Riparia S.O.4', 'Berlandieri x Riparia T5C Eger', 'Berlandieri x Riparia T.G. 5.A.5.', 'Berlandieri x Riparia T.8.B.', 'Berlandieri x Riparia T.K. 5.BB', 'Berlandieri x Riparia K.125AA', 'Riparia Sauvage', 'Riparia Selecta', 'Riparia Tomentosa'.*
The scion cultivar 'Cserszegi fűszeres' was ennobled by the crossing of 'Irsai Olivér' and 'Traminer' by Károly Bakonyi in Cserszegtomaj (Hungary). This middle ripe, white wine grape variety is commonly respected for its good wine quality and resistance to fungal diseases (Balogh, 1993; Bényei and Lőrincz, 1999). The point in selection of this cultivar for our study is to focus on its sensitivity to dry periods, and effects of rootstock cultivars on this feature.
Sample preparation and analyses were performed in laboratory of University of

Debrecen, Centre for Agricultural and Applied Economic Sciences, Institute of Food Sciences, Quality Assurance and Microbiology.

By the analysis 5 elements were checked (B, Cu, Fe, Mn and Zn) in three replications. The skin was separated and cleared in laboratory circumstances with laboratory tools (tweezers, flasks). Chemical maceration of the samples was carried out with the use of HNO_3 (wet and closed). Prepared samples were analysed by Thermo Scientific iCAP 6300 Dual type inductively coupled plasma optical emission spectrometry (ICP-OES).

Statistical evaluation of data was done by SPSS v. 14.0 (IBM Company). Correlation between parameters and factors was checked by One-Way ANOVA and Tukey-test. Probes were deemed significant below 5% P-value. Average, deviation and relative standard deviation (RSD%) were also calculated.

RESULTS AND DISCUSSIONS

Our inspection aimed to answer, how change different rootstocks affect B, Cu, Fe, Mn and Zn content of berry skin of 'Cserszegi fűszeres'. 3rd table presents berry skin analytical results of 'Cserszegi fűszeres' grafted on different rootstocks expressed on dry matter basis. Bolded values represent the highest, bolded and dented values represent the lowest concentration.

1. Results of boron concentration

Data clearly show, that the lowest difference was experienced in regard to the different rootstocks in case of boron. The relative standard deviation between the rootstocks was 22.3%, with a mean value of 22.7 mg kg^{-1}. The highest level was experienced at berry skin samples at *'Riparia Sauvage'*, while the lowest value was experienced at *'Berlandieri x Riparia S.O.4'*.

2. Results of copper concentration

Results show, that significant differences were detected between berry skin Cu contents of 'Cserszegi fűszeres' grafted on different rootstocks. The relative standard deviation between Cu content measured in the berry skins was 36.6%, with a mean value of 2.58 mg kg^{-1}. The highest Cu-level was experienced at 'Berlandieri x Riparia Sz 157 Pécs', while the lowest value was experienced at *'Berlandieri x Riparia T5C Eger'*.

3. Results of iron concentration

Significant differences were experienced in case of iron content of the berry skins of 'Cserszegi fűszeres' grafted on different rootstocks. The relative standard deviation of iron content measured in berry skin is 33.3%. The calculated mean value was 26.8 mg kg^{-1}. The highest iron concentration was measured at 'Cserszegi fűszeres' grafted on *'Riparia Sauvage'*, while the lowest was measured at *'Berlandieri x Riparia T5C Eger'*.

4. Results of manganese concentration

Significant differences were experienced in case of manganese concentration of the berry skins in case of the different rootstocks. The relative standard deviation of different rootstocks was 35.1%, with a calculated 9.54 mg kg^{-1} mean value. The highest manganese concentration was measured at skin samples of 'Cserszegi fűszeres' standing on *'Riparia Sauvage'*, the lowest value was measured at *'Berlandieri x Riparia Sz 157 Pécs'*.

5. Results of zinc concentration

Data show well, that the highest differences between rootstocks were experienced at zinc concentration In respect to this element, the relative standard deviation was 40.5%, and the calculated mean value was 4.42 mg kg^{-1}. The highest value was measured in case of *'Vitis Berlandieri'*, the lowest value was experienced at *'Berlandieri x Riparia Sz 157 Pécs'*.

Table 3. Element content of the berry skins of ‘Cserszegi fűszeres’ grafted on different rootstocks (n=3) (2011, Pallag)

ROOTSTOCKS	B (mg kg^{-1})	Cu (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})
’AxR 143B M et de G’	$31.9^{e}\pm0.4$	$1.93^{c}\pm0.03$	$16.8^{b}\pm0.2$	$8.07^{d}\pm0.09$	$3.66^{cd}\pm0.14$
’V. BERLANDIERI’	$20.2^{b}\pm0.6$	$2.64^{e}\pm0.05$	$30.7^{f}\pm0.6$	$13.1^{g}\pm0.1$	**$8.53^{h}\pm0.12$**
’BxR SZ 157 Pécs’	$18,4^{a}\pm0,2$	**$4.77^{h}\pm0.15$**	$23.2^{d}\pm0.7$	***$3.78^{a}\pm0.16$***	***$2.14^{a}\pm0.04$***
’BxR S.O.4’	***$18.0^{a}\pm0.3$***	$3.03^{f}\pm0.06$	$21.3^{c}\pm0.3$	$5.76^{b}\pm0.14$	$3.49^{c}\pm0.08$
’BxR T5C Eger’	$19.0^{ab}\pm0.6$	***$1.27^{a}\pm0.05$***	***$11.5^{a}\pm0.1$***	$7.47^{cd}\pm0.16$	$2.25^{a}\pm0.04$
’BxR T.G. 5.A.5.’	$22.0^{c}\pm1.1$	$2.16^{cd}\pm0.08$	$27.5^{e}\pm1.0$	$7.69^{cd}\pm0.49$	$4.31^{de}\pm0.29$
’BxR T.8.B.’	$26.4^{d}\pm1.0$	$3.09^{f}\pm0.08$	$30.3^{f}\pm0.3$	$12.0^{f}\pm0.4$	$4.57^{f}\pm0.10$
’BxR T.K. 5.BB’	$18.1^{a}\pm0.1$	$2.59^{e}\pm0.05$	$31.8^{f}\pm0.3$	$10.2^{e}\pm0.2$	$4.99^{f}\pm0.13$
’BxR K.125 AA’	$24.9^{d}\pm0.1$	$3.55^{g}\pm0.08$	$36.7^{g}\pm0.3$	$12.5^{fg}\pm0.4$	$4.63^{ef}\pm0.17$
’R. SAUVAGE’	**$32.0^{e}\pm0.2$**	$2.30^{d}\pm0.02$	**$45.0^{h}\pm0.9$**	**$14.0^{h}\pm0.1$**	$4.95^{f}\pm0.08$
’R. SELECTA’	$19.4^{ab}\pm0.3$	$1.59^{b}\pm0.02$	$24.3^{d}\pm0.6$	$12.9^{g}\pm0.5$	$6.51^{g}\pm0.22$
’R. TOMENTOSA’	$22.7^{c}\pm0,3$	$2.07^{c}\pm0.06$	$23.0^{d}\pm0.5$	$6.92^{c}\pm0.22$	$3.01^{b}\pm0.10$

Different letters indicate significant differences between rootstocks regarding the element ($P < 5\%$)

CONCLUSIONS

In this research work berry skin B-, Cu-, Fe-, Mn-, and Zn- concentration data have been processed.

Based on our examination it could be stated, that there are significant differences in mineral content of the berry skins of ‘Cserszegi fűszeres’ grafted on different rootstocks in regard to the listed elements. The highest relative standard deviation was experienced in the case of zinc, while the lowest relative standard deviation was shown in the case on boron. Differences between experienced concentrations can either be due to the genetic factor, thus to the different rootstocks, or to climatological factors of the vintage, that greatly affect mineral status of the vine (Szőke and Kiss, 1987; Csikászné, 2008). For evaluation of genetic and climatological (vintage) factors data of many years’ experiment is to be collected.

Based on our results, it could supposed, that *’Riparia Sauvage’* could be an advantageous rootstock, since the highest values on B, Fe and Mn were measured in berry skin samples of ’Cserszegi fűszeres’ grafted on this rootstock variety. From the point of the highest Cu concentration *’Berlandieri x Riparia Szilágyi 157 Pécs’*, while in respect to the Zn concentration *’Vitis Berlandieri’* could be highlighted.

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