EFFECTS OF VARIOUS GRAPE ROOTSTOCKS ON MACRO AND MICROELEMENT UPTAKE OF 'CSERSZEGI FŰSZERES' GRAPE CULTIVAR

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Data on mineral uptake of various scion-cultivar combinations demonstrated in the paper represent preliminary findings of a long term field experiment. The variety collection was established on immune sand soil in 2003. In the experimental field leaf samples were collected from 9 different rootstock and 'Cserszegi fűszeres' scion cultivars (the same stocks) before vintage of 2011, along with that of own rooted stocks as control. In the samples 9 elements were analysed (K, Ca, Mg, Cu, P, B, Mn, Fe and Zn). Differences were found between mineral composition of leaf samples of rootstocks and 'Cserszegi fűszeres' scion grafted on them. A consequently higher content of K, Mg, Mn, and Zn was found in scion, and P, Ca, B, Cu, Fe in rootstock leaf samples.

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Introduction

After devastative invasion of phylloxera (Dactulosphaira vitifoliae Fitch.) to Europe the common biological preventive technology of graft making is used to eliminate the risk of infection. Since then, plantations on not immune sandy soils (with quartz content lower than 75%[15]) can only be established with the use of grafts.

According to summary of Angeli et al. (1959)[1] some characteristics of rootstock varieties are the following: mineral take up, soil demand, tolerance to lime and salt content of the soil, affinity and effects on biological cycle of the scion. Characteristics of rootstock varieties were studied by many researchers, since at their selection this crucial information give basic guideline to find the one, which mostly suits conditions of the planed vineyard. These characteristics of commonly used rootstock varieties show good correlation with corresponding data on their parent species of different geographical origin. The most common parental species used in ennobling of rootstocks are the following: Vitis Riparia Scheel., Vitis Rupestris Mich., Vitis Berlandieri Plan. and Vitis Vinifera L..[8]

Lately there are 19 rootstock varieties listed in National Variety Register of Hungary, however only a few is used.[2]

Range of commonly propagated rootstock varieties is larger in the neighbouring countries. Choice of ideal rootstock-scion combination at the establishment has determinative role in the life of a plantation. An ideal rootstock-scion combination according to the aim of the production (wine- or table grape) has beneficial effects on the quality parameters of the grape, must and wine, and it can even result higher yields together with better quality.[2, 11] In this context, an important result was highlighted by Hegedűs and I'só (1965)[6], that showed, that not the same rootstock result the best data on the range of scion cultivars.

Rootstocks have direct and indirect effects on scion.[4, 13] Rootstock varieties differently affect fruiting, rate of growth, yield and fruit quality. In the process of these effects a highly crucial role has both the rootstock and the scion.[3] It is important from the point of growth and evolution of the stocks, that grafts fruit earlier than own rooted plants.[16]

Accumulation of inorganic mineral elements change in grafts compared to that of own rooted stocks[9]. However rootstock-scion interaction has a crucial effect on mineral uptake of the grape[7], this effect might alter or decrease to a great extent due to ecological factors and geographical characteristics.[4]

Materials and methods

Grape variety collecting point of the University of Debrecen was established in 2003 on immune sand soil in Pallag (10 km north from Debrecen) having 3 m between row and 1 m between stock spacing.

The Table 1. shows the properties of soil of model farm at 0-30 cm and 30-60 cm sampling depths. Table 2. shows the plant available K, Mg, P, Ca, Mn, B, Cu, Fe and Zn content of soil of model farm in 0-30 cm and 30-60 cm sampling depths. The soil samples were prepared for chemical analyses by extraction with 0.5 M ammonium acetate + 0.5 M acetic acid + 0.02 M EDTA solution (pH 4.65) according to Lakanen-Erviö .[10] Analyses of 9 elements in soil extract were performed with an iCAP 6300 Dual type ICP-OES.

Table 1. Properties of soil of model farm

PARAMETERS	AVERAGE	
Sampling depth (cm)	0-30	30-60
pH (KCl)	5.93	5.91
pH (distilled water)	6.85	6.87
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

Table 2. Plant available elements content of soil of model farm

PARAMETERS	AVERAGE (mg kg^{-1})	
Sampling depth (cm)	0-30	30-60
Potassium (K)	337	288
Magnesium (Mg)	171	191
Phosphorus (P)	144	105
Calcium (Ca)	1790	1891
Boron (B)	0.63	0.60
Manganese (Mn)	329	382
Copper (Cu)	9.95	7.02
Iron (Fe)	239	213
Zinc (Zn)	6.93	4.65

The 28 rootstock variety of the collection was trained with bald-head training leaving no buds at regular pruning on the heads. Green grafting of 'Cserszegi fűszeres' on 14 rootstock varieties out of 28 was started in 2010. Further on grafts were trained according to single curtain training system, together with leaving one sampling shoot growing each year from the rootstock.

Leaf samples were collected about 2-3 weeks before vintage, from 'Cserszegi fűszeres' standing on 9 rootstocks and from sample shoots of the rootstocks in the cropping year 2011. Thus leaf samples of the scion and rootstock originate from the same stocks.

Rootstocks of the 1st year of the experiment were: '*Vitis Berlandieri', 'Berlandieri x Riparia S.O.4', '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.125 AA', 'Riparia Sauvage', 'Riparia Selecta' 'Riparia Tomentosa'.*

The scion, 'Cserszegi fűszeres' ('Traminer' x 'Irsai Olivér'), also called 'Woodcutters white' is a tolerant, middle time ripening white grape cultivar.

In 2011 and 2012 grafting of the 28 rootstocks was continued with changing success, since the range of the rootstocks represent a broad range of different compatibility.

Sample preparation was conducted in laboratory of University of Debrecen, Centre for Agricultural and Applied Economic Sciences, Institute of Food Sciences, Quality Assurance and Microbiology. Nine elements were analysed (K, Ca, Mg, P, B, Mn, Cu, Fe, Zn), which could be informative from the point of plant physiology. Digestion of the leaf samples was done open with HNO_3-H_2O_2. Prepared samples were measured by iCAP 6300 Dual type ICP-OES.

Data shown in our paper represented first year results of a provisional long term experiment. Counting with the great impact of ecological factors, we would not draw conclusion. Vintage of 2011 could be characterised with rainy July and extremely arid August.

Results and discussion

The aim of our experiment was to show how different rootstocks affect mineral composition of the scion. The Table 3.- 4. represents data on mineral composition of leaf samples of 'Cserszegi fűszeres' standing on 9 rootstocks and leaf samples of the rootstocks correspondingly, collected 2-3 weeks before vintage from the same stocks.

Results show, that potassium content of rootstock leaf samples were below optimum values given by reference data[14], withstanding that potassium contents of scion leaf samples show optimum status concerning this element. Data of 2011 show a higher potassium concentration in leaf samples of the scion independent to the rootstock cultivar.

It is obvious, that magnesium contents of leaf samples both of rootstocks and of the scion show lower values compared to previous data. The reason could be the period of extreme drought during August 2011. It is also visible, that magnesium content of scion leaves was somewhat higher than measured in the case of rootstocks. Exceptions were *Vitis Berlandieri, Berlandieri x Riparia T.G. 5A5* and *Berlandieri x Riparia S.O.4.* with higher values in the rootstock leaf samples.

Results show, that average phosphorus content of leaf samples both in the case of rootstock and scion was over the reference optimum level given by Szűcs et al. (1981)[14]. Data of 2011 also show, that average phosphorus content of rootstock leaves was higher than that of scion leaves. For two exceptions, *Vitis Berlandieri* and *Berlandieri x Riparia T.G. 5A5* stands the opposite.

Average calcium content of the leaf samples of rootstock and scion grafted on them is well according to reference optimum value given by Szűcs et al. (1981)[14]. According to data of 2011, higher average calcium content was experienced in rootstock leaves. In the case of three exceptions, *Berlandieri x Riparia T. 8B, Riparia Tomentosa*, and *Riparia Selecta* the higher calcium level was measured in scion leaf samples.

Average boron content both of rootstock and scion leaf samples was in accordance with reference optimum values. Data of 2011 showed, that boron content of rootstock leaves was somewhat higher compared to scion samples.

In respect to manganese content it is clear to see, that a much higher level was experienced in both cases compared to the reference data (Szűcs et al., 1981)[14]. More over a toxic manganese level was measured in the case of own rooted control 'Cserszegi fűszeres' leaf samples. Data of 2011 showed, that manganese level of scion leaves was higher than in the case of rootstock samples.

Table 3. Element content of leaf samples of 9 rootstocks and 'Cserszegi fűszeres' grafted on them (Pallag, 2011)

Variety/ Element	K %	Mg %	P %	Ca %
Optimum values of leaf analysis*	1.01-1.40	0.30-0.40	0.16-0.23	2.50-3.20
Cserszegi fűszeres own rooted	1.25	**<u>0.295</u>**	0.257	**<u>3.48</u>**
V. Berlandieri rootstock	0.950	0.184	**0.269**	2.83
V. Berlandieri scion	1.32	0.176	0.277	2.78
BxR T.G. 5 A 5 rootstock	0.739	**<u>0.216</u>**	0.337	3.37
BxR T.G. 5 A 5 scion	1.05	0.205	**<u>0.372</u>**	2.95
BxR S.O.4 rootstock	**0.727**	0.152	0.365	3.01
BxR S.O.4 scion	1.19	**0.143**	**0.188**	**1.95**
Riparia Sauvage rootstock	0.786	0.178	**<u>0.509</u>**	**<u>3.83</u>**
Riparia Sauvage scion	1.27	0.208	0.289	2.86
BxR T. 8B rootstock	0.843	0.169	0.350	2.39
BxR T. 8B scion	1.29	0.203	0.248	3.11
Riparia Tomentosa rootstock	**<u>0.999</u>**	**0.124**	0.300	**1.45**
Riparia Tomentosa scion	1.14	0.172	0.266	3.05
BxR K 125 AA rootstock	0.997	0.160	0.318	3.14
BxR K 125 AA scion	1.09	0.205	0.313	3.06
BxR T.K. 5BB rootstock	0.825	0.163	0.321	3.75
BxR T.K. 5BB scion	**1.022**	0.168	0.220	3.11
Riparia Selecta rootstock	0.900	0.150	0.330	2.23
Riparia Selecta scion	**<u>1.46</u>**	0.161	0.253	2.55
Average rootstock	0.863	0.166	0.344	2.89
Average scion	1.208	0.194	0.268	2.89
Deviation rootstock	0.100	0.030	0.070	0.76
Deviation scion	0.140	0.040	0.050	0.41
RSD% rootstock	12.1	15.4	19.7	26.5
RSD% scion	11.3	21.7	18.8	14.3

Comments: K-, Mg-, P- and Ca: %, B-, Mn-, Cu, Fe- and Zn: ppm (in dry matter) **Data in boldface type** represent the lowest values of the element, whereas **<u>Underlined and bolded data</u>** represent the highest values, in respect to rootstock varieties and scion grafted on them.[5, 14]

Data show, that average copper content both in the case of rootstock and scion leaf samples was much lower, than the reference data. A reason for this effect could be the extremely dry vintage of 2011, and the well-known antagonism of manganese and copper.[12] Data of 2011 showed, that average copper concentration of rootstock leaves was higher than in the case of leaf samples collected from the scion parts of the stocks.

One exception was experienced in this comparison. In the case of *Berlandieri x Riparia K 125 AA* rootstock, leaf sample from the scion showed higher copper content.

Table 4. Element content of leaf samples of 9 rootstocks and 'Cserszegi fűszeres' grafted on them (Pallag, 2011)

Variety/ Element	B ppm	Mn ppm	Cu ppm	Fe ppm	Zn ppm
Optimum values of leaf analysis*	20-40	80-120	20-25	80-120	25-40
Cserszegi fűszeres own rooted	**<u>28.2</u>**	**<u>336</u>**	**<u>6.28</u>**	137	**<u>122</u>**
V. Berlandieri rootstock	23.7	**<u>224</u>**	4.87	181	**16.1**
V. Berlandieri scion	19.5	247	2.96	193	16.0
BxR T.G. 5 A 5 rootstock	28.1	171	**<u>5.52</u>**	**<u>310</u>**	**<u>21.0</u>**
BxR T.G. 5 A 5 scion	27.0	217	5.28	**<u>257</u>**	23.3
BxR S.O.4 rootstock	**14.7**	140	4.86	166	20.7
BxR S.O.4 scion	11.7	**143**	3.30	115	13.6
Riparia Sauvage rootstock	25.5	181	4.31	203	20.5
Riparia Sauvage scion	24.3	247	2.81	211	17.1
BxR T. 8B rootstock	**<u>28.2</u>**	148	5.14	302	20.3
BxR T. 8B scion	22.1	219	2.82	184	16.4
Riparia Tomentosa rootstock	19.1	**122**	**3.18**	172	17.2
Riparia Tomentosa scion	18.0	155	2.81	**105**	15.1
BxR K 125 AA rootstock	26.1	171	4.75	161	16.4
BxR K 125 AA scion	19.9	233	6.11	181	17.5
BxR T.K. 5BB rootstock	16.7	211	4.10	164	16.6
BxR T.K. 5BB scion	**10.8**	211	2.80	149	**12.8**
Riparia Selecta rootstock	21.9	157	5.16	**113**	19.8
Riparia Selecta scion	18.6	261	**2.32**	109	26.2
Average rootstock	22.7	169	4.65	197	18.7
Average scion	20.0	227	3.75	164	28.0
Deviation rootstock	4.93	32.7	0.70	66.1	2.09
Deviation scion	5.75	54.3	1.52	49.7	33.4
RSD% rootstock	21.8	19.3	15.1	33.6	11.1
RSD% scion	28.7	23.9	40.5	30.3	119.1

Comments: K-, Mg-, P- and Ca: %, B-, Mn-, Cu, Fe- and Zn: ppm (in dry matter) **Data in boldface type** represent the lowest values of the element, whereas **<u>Underlined and bolded data</u>** represent the highest values, in respect to rootstock varieties and scion grafted on them.[5, 14]

In respect to both leaf samples average iron content was higher, zinc content was lower, then the reference data.[14] In the case of own rooted 'Cserszegi fűszeres' an extremely high zinc level (110%) was measured.

Conclusion

In our experiment leaf samples of 9 different rootstock varieties and 'Cserszegi fűszeres' grafted on the same stocks were analysed. Results of 2011 support the statement, that rootstock variety affect mineral take up of the scion. Experienced differences between rootstocks can be due to genetic background, environmental factors of the vintage and differences in compatibility of the scion-rootstock combination, since the range of examined rootstocks represent a broad range of compatibility and affinity. A comprehensive examination of this question needs a long term experiment to define the range of rootstocks, that facilitate best quality potential and stability in mineral take up and resistance to climatic extremities.

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