

Seasonal root development of Cabernet sauvignon grafted on different rootstocks

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Summary: The minirhizotron system gives opportunity to study the root development without disturbing the soil and root. We have found certified differences in root development during the year 2013 among the rootstocks grafted on 'Cabernet sauvignon'. The number of roots varied according to the rootstocks in different depth of soil layers and also varied the development of ripeness of the root system. We conclude that root system development is affected by soil physical and chemical properties, but differences according to the rootstock genotype on the similar type of soil exist.

Keywords: grape rootstock, vineyard, root system, minirhizotron, soil properties

Introduction

Phylloxera resistant grape rootstocks have been used widely since the end of the nineteenth century (Galet, 1988). Cultivars bred and selected to grape rootstocks originated from different *Vitis* species covering wide range of environmental conditions. Soil is one of the most important factors among environmental factors in viticulture (Seguin 1986, Sotes and Gomez-Miguel, 2003, Ubalde et al., 2011). Therefore grape rootstock selection is one of the key of successful vineyard management all around the world. Environmental factors strongly influence the growth rates, as a result, the role of the grape rootstocks are particularly important, especially when extreme soil conditions are given (Bertamini et al., 1992). The quantity and quality of the yield depends on both component, on grape rootstock and scion, and their combinations (Rives, 1971; Lefort és Legisle, 1977; Howell, 1987). Many efforts have been made to clarify the rootstock-scion relationship (Lefort és Legisle, 1977; Howell, 1987; Bertamini et al., 1992; Kocsis, 1998; Csikászné Krizsics, 2008), but it is very difficult to separate and measure the influence of the rootstock on the stock. The rootstock effect could be direct effect, or primary, and indirect or secondary effect on the scion (Striegler és Howell, 1991). The root system expansion and function through water and mineral uptake cause the direct effect, while growth habit, yield quantity and quality could be influenced through a carbohydrate source sink relation, or through secondary metabolites. Therefore our aim is to enhance our knowledge on seasonal root development of different grape rootstocks grafted on the top one scion, 'Cabernet sauvignon'. Knowledge can be used for better rootstock selection to similar soil conditions and for better coordination of applied phytotechnics and fertilization in the future.

Material and methods

In our study we included five rootstocks (Georgikon 28, TK 5BB, TF SO4, T5C, Fercal) grafted on 'Cabernet sauvignon' and examined the seasonal development of their roots with a minirhizotron root monitoring system. The vineyard was established in 2004 row and vine spacing is 2.9 x 1m, Royat cordon trellis, 20 buds in ten 2 buds short spurs, general canopy management. A minirhizotron camera system (CID Bio-science CI-600) was set it up in 2013. Two observation tubes were placed to one stock (Figure 1) in each combination according to Taryn et al. (2008). Root system development was monitored in biweekly intervals. Total root length and surface area of the roots were measured. Meteorology data of 2013 vegetation period and soil analysis is discussed in detail.

Results and discussion

The monthly mean temperature during the vegetation period (Table 1.) was normal. The maximum temperature was extremely high in June, July and in August. The vegetation period was shorter than usual because of the minimum temperature lowest value was below 0 Celsius in the first decade of April and the last decade of October. The total amount of the precipitation was closely 400 mm which fits into the average. Soil was over heated during July and August at 250 mm depth, but it not caused any harm in root development.

The vineyard was established on brown forest soil based on dolomite stones. The Calcium content is high as it shown in Table 2, the pH is close to eight or above that according

to the measurement methods. It is a clay soil, with moderate humus content. The P content is high in the upper layers (0-600mm), what could be because of usage of manure before the vineyard establishment. The K and Mg level is in the satisfactory level.

Differences were obtained among rootstocks in the root growth. 'Teleki 5C' rootstock has significantly higher proportion of root (244mm in length), than other examined rootstocks in June 13. The date of this measurement was right in the time of blooming; therefore higher amount of newly developed roots could enhance the fertilization process. In controversial the rootstock, which has not developed many roots (Fercal 47mm), focuses mostly to fertilization process and the entire carbohydrate source directed to the flowers. Also it worth to notice that maximum temperature rose above 30 Celsius degree most of days around, therefore the transpiration rate increased. If the plants has the possibility of higher water uptake because of the number and length of the roots will develop normally.

By the end of the season most of the rootstocks have developed largest proportion of roots between 200 and 600mm (Table 3). It is quite evident that the largest amount of root will grow where most of the mineral nutrition and organic compound can be found (Table2).

The measured total root area was also significantly different according to the rootstocks. Different rootstocks have different growing pattern in the row. While 'Teleki 5C' developed higher surface area of its root system on the West side of the grape row (Figure 2) the 'Fercal' rootstock has less differences according to the sites. The root suberization has started very early at the end of August, but there are differences according to the rootstocks in that habit too.

Our data show that differences in vineyard development could happen because of not appropriate rootstock choice to climatic and soil conditions. To have well developed, highly productive plantation (Figure 4) careful scion-rootstock combination needs to be choose.



Figure 1: Installation of observation tubes in the vineyard in Cserszegtomaj

Table 1: Climatic conditions of the experimental vineyard during the vegetation period in 2013

Month	Temperature [°C]			Precipitation (mm)	Soil temperature at 250 mm depth [°C]
	Mean	Max.	Min.		
April	11.1	28.9	-1.9	39.6	6.3
May	16.1	28.4	6.6	73.0	10.2
June	19.0	35.8	7.4	59.8	20.6
July	22.3	37.6	7.2	41.2	22.5
August	21.2	38.3	8.6	71.4	23.1
September	14.7	27.5	3.5	74.6	16.4
October	12.1	24.9	-2.2	15.4	11.3

Table 2: Soil analysis data of the experimental vineyard in Cserszegtomaj, Hungary

	CST 0-20mm	CST 200-600mm	CST 600-800mm	CST 800-1000mm	CST 1000-1200mm	
pH(H ₂ O)	8,06	8,06	8,08	8,4	8,32	8,31
pH(KCl)	7,78	7,73	7,65	7,8	7,74	7,93
Soil water capacity K _d	46,00	46,00	48	44	45	56,00
Total NaCl (m/m%)	0,03	0,02	0,03	0,02	0,03	0,04
Carbonated CaCO ₃ (m/m%)	10,72	14,31	12,18	17,52	8,33	25,63
Humus (m/m%)	1,95	2,20	2,59	1,50	1,95	1,48
P ₂ O ₅ (mg/kg)	752,68	976	2021	549	594	94,24
K ₂ O (mg/kg)	420,60	326,70	401,90	308,90	452,10	274,00
(NO ₃ -N+O ₃ -N) (mg/kg)	3,07	3,45	4,23	0,96	1,18	1,54
Mg (mg/kg)	135,44	143,11	165,76	135,67	157,26	160,87
SO ₄ -S (mg/kg)	78,28	76,21	86,32	75,17	61,72	54,02
Ca (mg/kg)	44390,00	56601	40254	71032	32309	107595

Table 3: Average root length of both side installed tubes of the trunk related to soil depth from 0-1000 mm for five rootstocks at three date in 2013

Rootstock	Date	Soil depth (mm) (from trunk base)				
		0-200	200-400	400-600	600-800	800-1000
Teleki 5C	13. June	11.5	117.5	58.5	25.5	0.0
	25. July	54.0	245.0	208.0	408.0	209.0
	22. October	14.0	140.0	170.0	59.0	401.0
Teleki Fercal 304	13. June	11.0	28.0	17.0	25.5	0.0
	25. July	30.5	314.0	350.0	93.5	108.5
	22. October	0.0	305.0	115.0	85.0	101.0
Teleki Teleki 188	13. June	0.0	22.5	61.5	41.5	0.0
	25. July	0.0	76.0	115.0	75.0	136.0
	22. October	0.0	65.0	92.0	131.0	50.0
Cserszegtomaj 28	13. June	0.0	6.0	0.0	10.0	96.0
	25. July	19.5	73.0	263.0	211.0	181.0
	22. October	43.0	156.0	338.0	206.0	339.0
Fercal	13. June	10.5	0.0	26.0	10.5	0.0
	25. July	17.0	180.0	214.0	380.0	401.0
	22. October	0.0	280.0	202.0	371.0	414.0

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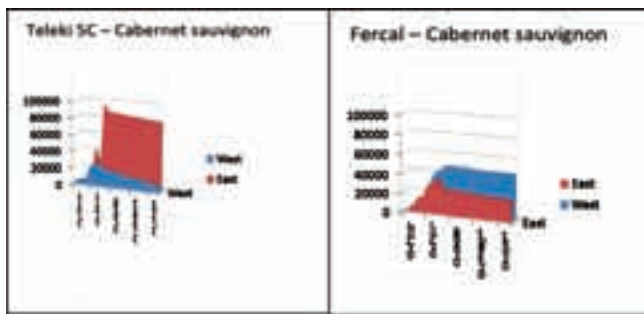


Figure 2: Total area (mm²) of the T5C and Fercal roots in 0-1000mm depth of soil observed in minirizotron tubes at east and western side of the grapevine rows

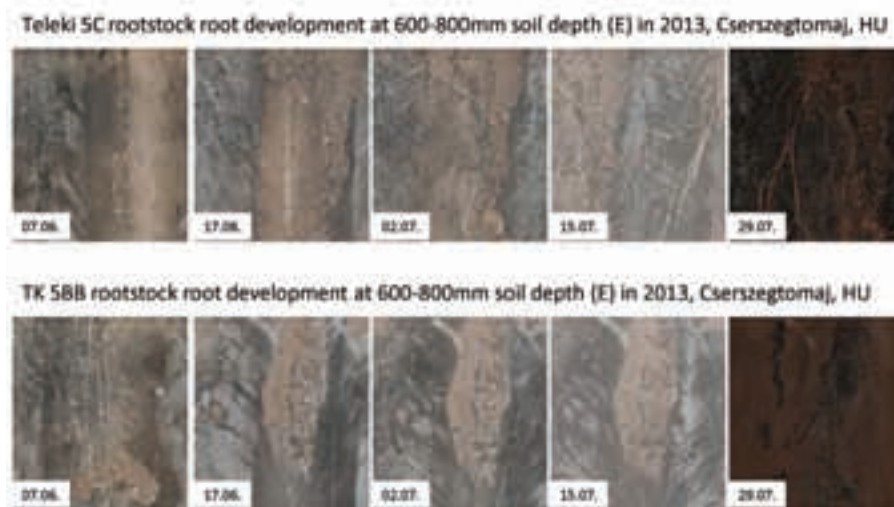


Figure 3: Root development of 'Teleki 5C' and 'Fercal' rootstocks grafted on the top Cabernet sauvignon during the vegetation period in 2013, in Cserszegtomaj, Hungary



Figure 4: Cabernet sauvignon vinestock in Cserszegtomaj, Hungary

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