FEATURES OF SOIL COVER IN DIFFERENT TERROIR UNITS FROM ROMANIA

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Abstract. *This paper presents the physical characteristics of the soils in different terroir units from Romania it is a guide for soil characterization as a fundamental factor of a terroir. The soil's physical characteristics (texture, edaphic useful volume, gleyzation and stagnogleyzation processes), are ecological factors in the growth and development of the production of vine. Contents of clay < 0,002 mm, soil reaction and* $CaCO_3$ *content are the main characteristics which influence plant, and they together with the processes generated by ground and stagnant water give rise to asphyxiation chlorosis ferro-calcium and salinization.*

Key words: *terroir, ecopedological factors of terroir, chlorosis, active* $CaCO_3$ *content, vine, edaphic useful volume*

INTRODUCTION

The soils of the Romanian vineyards are of great diversity, the vine crop accepting quite various conditions with the best results for the quantity and quality of grapes and wine. From a topographic point of view, these conditions vary from the Black Sea (25 m altitude for Constanta) to altitudes of 600 – 700 m. Between these altitudes, various landforms could be met: alluvial plains, plains (of different types) and Carpathian piedmont hills, aprons and plateaus with various conditions of lithology, topography, hydrology and, in particular, climate and microclimate.

The behaviour of these ecopedological factors, but especially of the soil, provides the specificity of each terroir of the vineyard areas. Combining the influences of two or more factors is very common, with significant influence on the quantity and quality of the final products.

The concept of terroir, in a general sense, includes general ecopedological factors, the interrelations between them, the variety and rootstock, as well as the expertize of wine growers, all of them contributing to the production of high quality grapes and hence of the controlled designation of origin wines.

MATERIAL AND METHOD

In the research and wine production stations in different areas of the country: Murfatlar, Dealul Mare, Drăgăşani, Târnave, Teremia Mare, Cotnari, Iaşi, Odobeşti, Ostrov, Sarica-Niculiţel, Plaiurile Drâncei, etc., several researche studies were developed during time which, besides other researches into expeditionary regime, led to the complex characterization of soil cover in different units of terroir. Field research was conducted at different scales (1: 25000, 1: 5000) and consisted in determining the soil types and their complex analysis, as well as the analysis of the topography, lithology, groundwater, and stagnant water conditions, the influence of trenching and terracing works on the soil physico-chemical properties, and identifying the factors causing chlorosis and designing the affected areas. All this data gathered over a long period of time are an important database that allowed a series of complex analysis between the soil, climate, topography factors and the qauntity and quality of grape yields.

In this paper, a number of factors limiting plant growth and development of vines are analysed. For this purpose, the development of the root system of plants in different conditions has been studied. The root system of vines has been described based on biometric measurements performed in soil profiles located at 50 cm away form the vine plant in a 1 m x 1 m frame. These measurements allowed to identify the spatial distribution of the root system. The thickness of vine roots were measured, their distribution were observed, and necrosis were identified and counted, leading to a classification in the following classes:

- Class I – less than 1 mm;
- Class II – 1 – 3 mm;
- Class III – 3 – 5 mm;
- Class IV – 5 – 7 mm;
- Class V – larger than 7 mm.

To assess the root system development, the sloppy horizon depth, clay content under 0.002 mm and total $CaCO_3$ content were taken into consideration.

The soil types and subtypes were set according SRTS – 2012, the physical, hydrophysical and chemical data interpretation were done according to "Soil survey methodogy", Vol. III, 1987, and the graphic material was based on topographic maps used.

RESULTS AND DISCUSSION

In this paper, from all the natural factors (lithology, topography, groundwater, climate) which affect the metabolism of different varieties and rootstocks only the following physical and chemical properties were discussed: size distribution of the soil particles, the useful edaphic volume, the soil water excess from groundwater or rainfall.

The soil texture of the vineyards of our country is extremely varied, from sand to clay. The data highlights the high variability of texture and chemical characteristics of the mixed horizon depending on the nature of the sediment, landform and pedogenetic processes that have shaped the plain soil cover.

Sandy texture: Dăbuleni, Calafat (Dolj) Dacilor Field (County).

Loamy texture: Murfatlar, Teremia Mare, Ostrov, Măcin, Niculiţel, Târgu Bujor, Nicoreşti, Coteşti, Iaşi, Odobeşti, Târnave (Crăciunelu), Greaca, Segarcea, Miniş, Panciu. It is one of the most common textures in the vineyards of Romania and the most appropriate for vine crop.

Clayey texture: Drăgăşani, Valea Călugărească, Pietroasele, Târnave, Ştefăneşti, Cotnari.

The best quantitatively and qualitatively developments of vine crop are found in soils where clay content (< 0.002 mm) in the mixed horizon varies between 12 – 45%, and the other physical, chemical and agrochemical properties are favourable for vine growth.

On clayey soils, like vertosols, the vine growth and development is limited by the lack of internal drainage and aeration. On these soils weak root system development is recorded, especially related to the oblique direction of the sliding faces. In vertosols, clay content < 0.002 mm in the mixed horizon is between 50 – 70% (Figure 1).

The distribution of clay content in the soil profile of the argic soils, with a sharp textural differentiation (Figure 2) between the mixed horizon, corresponding mostly to the eluvial horizon, and the underlying horizons (usually argic Bt horizon) causes an excessive moistening and an asphyxiating effect on roots (Sâmbureşti, Ştefăneşti).

In such soils (strongly stagnic luvosols, albic stagnic luvosols, planosols, albic planic stagnosols), the Bt horizon behaves mostly like a cemented sediment during the periods of drought or poor wetting, penetrated by rare roots whose existence depends on the variations amplitude of soil water regime. Such situations are found in Drăgăşani and Ştefăneşti vineyards.

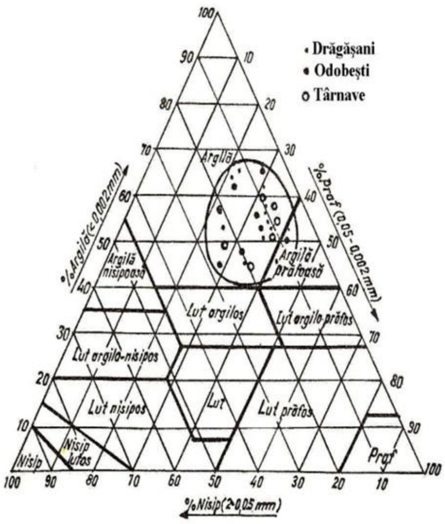


Figure 1. Distribution of soil texture on 0 – 100 cm depth in vertosols of Drăgăşani Odobeşti and Târnave vineyards.

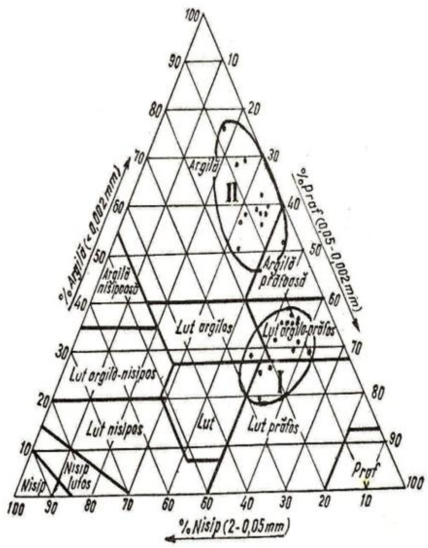


Figure 2. Distribution of soil texture on 0 – 100 cm depth in planosols from Drăgăşani vineyard
I. Mixed horizon 0 – 40 cm
II. Argic B horizon 40 – 100 cm

Depending on the soil particle size distribution, vine root system develops as follows:

On sandy soils the roots explore a large volume of soil horizontally especially (over 2 – 3 m) as a result of favorable conditions for penetration, and leaching of soil nutrients;

On medium textured soils, uniformly distributed on depth, many roots explore the soil profile until 70 – 100 cm depth (Figure 3);

Important limitations are recorded in clayey soils or in soils with very important textural differences, as well as on soils with active $CaCO_3$ formed on marl and loess.

Edaphic useful volume

Edaphic useful volume is the soil volume (expressed as % v/v) that could be effectively used by the plant. It is equal to the soil volume, expressed in %, for the depth upper the hard rock or up to 150 cm, if the hard rock is not met until this depth, from which the scheleton percentage was extracted; hard rocks code is 10 (Table 1).

Soils with the highest values of edaphic useful volume for vines are cambic chernozems, calcaric and argic (Figure 3, 4), greic phaeozems, typical preluvosols and redheads and eutricambosols. Significant limitations are highlighted in argic soils (practically only the first 40 – 60 cm depth configured roots) (Figure 5, 6) and vertosols (most roots deep penetrating in these soils on the slickenside, pressure faces), and in subtypes lithic of various soils and strongly carbonated soils (over 15 – 20% active $CaCO_3$), especially in plantations with the poorly resistant rootstock to soil chlorosis (*Riparia gloire*).

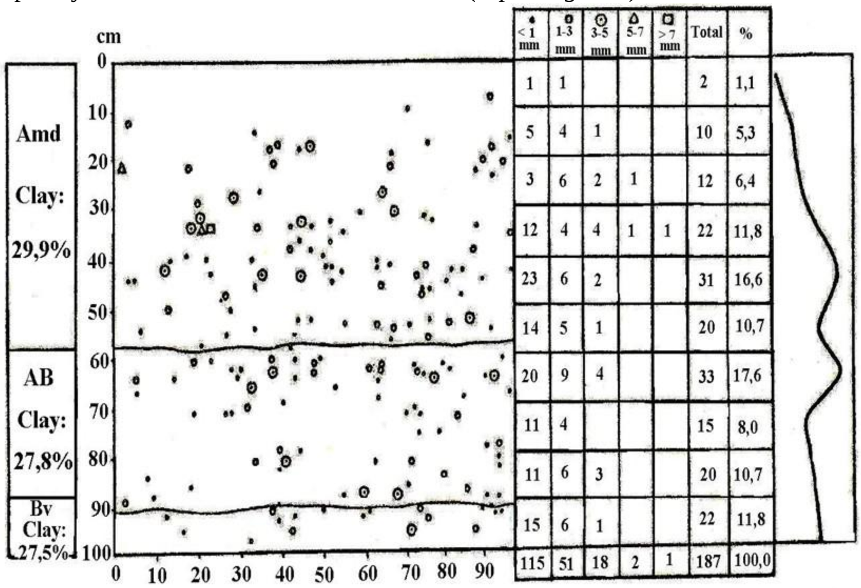


Figure 3. Distribution of the Muscat Ottonel / Kober 5 BB roots in cambic chernozem of Murfatlar Vineyard

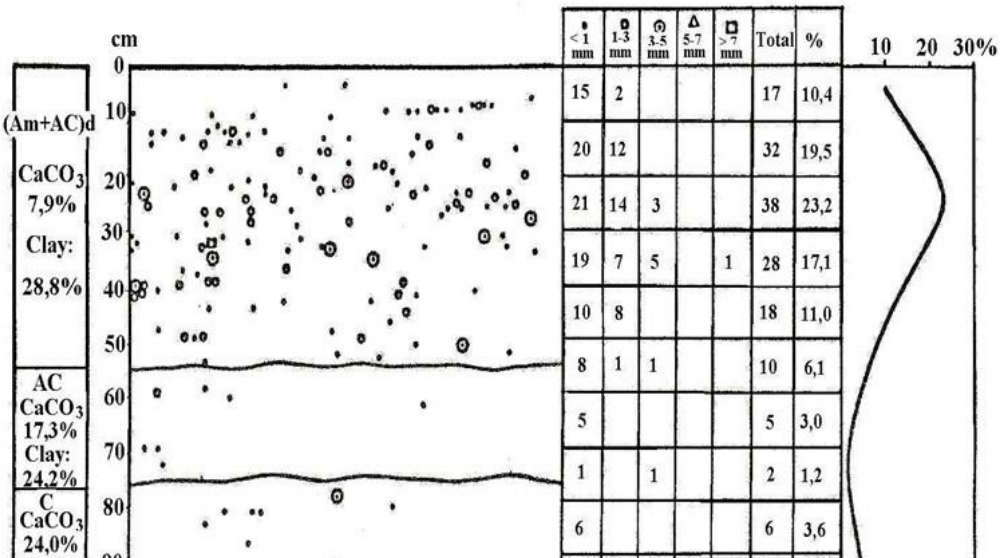


Figure 4. Distribution of the Muscat Ottonel / Kober 5 BB roots in calcaric chernozem of Murfatlar Vineyard

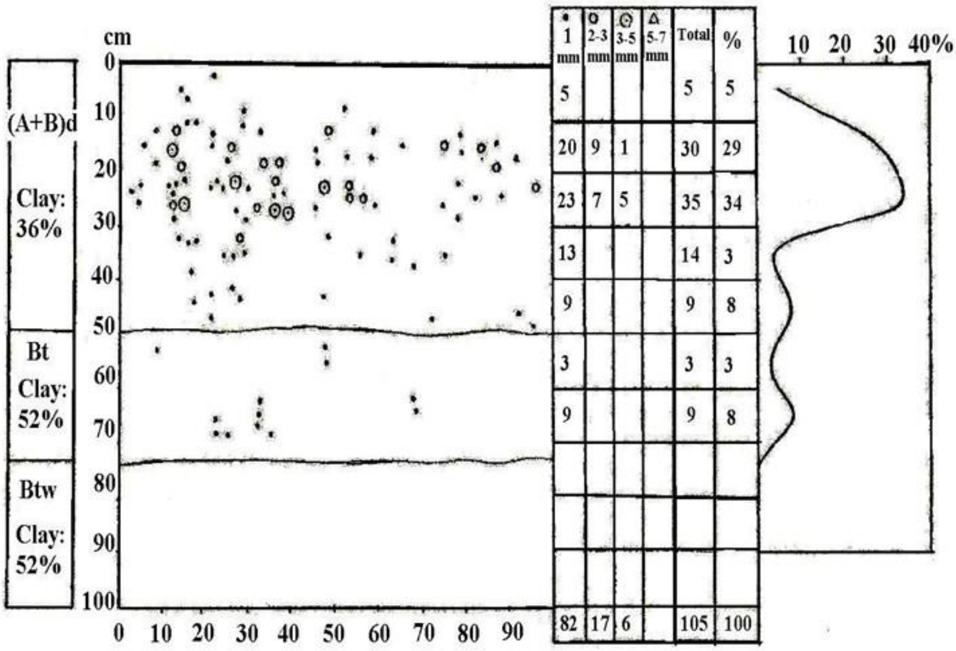


Figure 5. Distribution of the Riesling Italian / Kober 5 BB roots in a stagnic luvosol

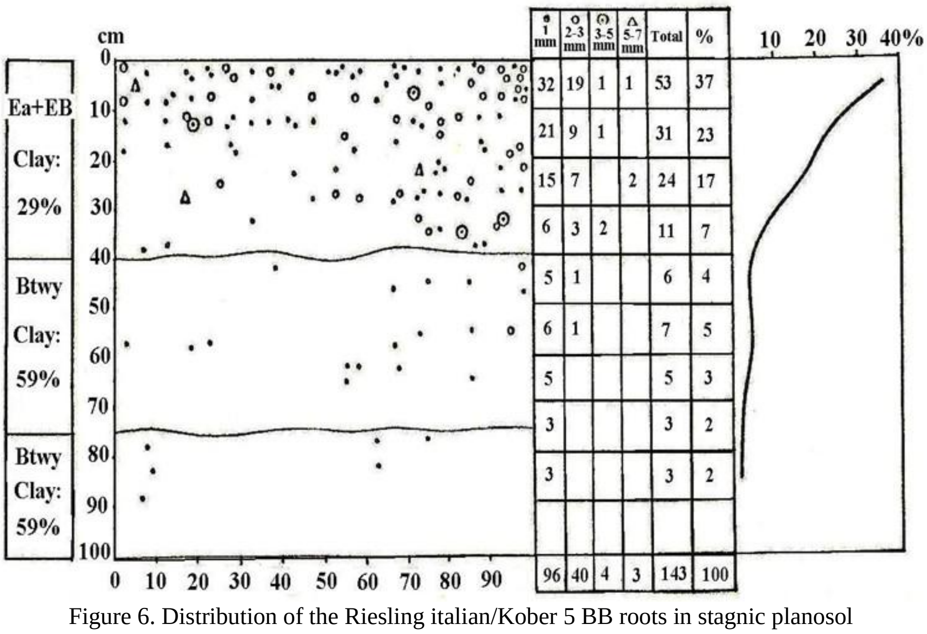


Figure 6. Distribution of the Riesling italian/Kober 5 BB roots in stagnic planosol

Table 1

Depth of the hard rock [1)] (lithic contact)

Code	Limit (cm)	Favourability for vines
020	≤ 20	Very weak
030	21 – 50	Weak
050	51 – 70	Moderate
100	71 – 100	Good
150	101 – 150	Very good
500	≥ 151	Very good

[1)] A conventional hard rocks: compact rocks and gravels

The analysis of root system of two different varieties of vines grafted on same rootstock (Rieslig Italian; Muscat Ottonel / Kobber 5BB) highlighted a different spatial distribution, and a different edaphic useful volume depending on the soil particle size distribution, the content of calcium carbonate and a strong soil textural differentiation.

Classes suitability of the vine to the onset of hard rock in the soil profile (Table 2), stresses that a near surface lithic contact (in the first 51 cm) is unfavorable for the development of this plant.

Table 2

Edaphic useful volume

Code	Limit (cm)	Appreciation	Favourability for vines
10	≤ 10	Extremely small	Unfavorable
20	10 – 20	Very small	Unfavorable
35	21 – 35	Small	Very weak
50	36 – 50	Moderate	Weak-moderate
70	51 – 70	Great	Weak-moderate good
99	≤ 71	Very great	Very good

By analysing the favourability classes of vine related to the edaphic useful volume (Table 2), we can see that the soil is suitable for planting starting from the depth of 51 cm, but really good results are obtained if the useful thickness of the soil is about 71 cm. This is exemplified by the root system of a vine variety (Cabernet sauvignon/Kobber 5 BB) planted on soil with a high content of contractile clay (vertosol) (Figure 7). In this soil the edaphic useful thickness is about 45 cm, the roots being focused here. Also, the analysis on the size and number of roots highlighted that due to the vertic processes that destroy the roots of greater thickness and length, the plant has the only fresh, renewable roots, below 1 mm diameter (91) and between 1 – 3 mm (25). Up to 50 cm deep, 80 roots under 1 mm and 20 roots between 1 – 3 mm are found. Also, only here two roots between from 3 – 5 mm, and 5 – 7 mm are found. In total, in the first 50 cm depth, 102 roots are found (80.64% of the roots of this plant). Roots with larger diameter are sporadic or non-existent, the soil volume remaining mainly unexplored. It could be also noted that the roots have an opportunity to develop only along the path of the sliding faces, but it is a quite low probability.

The soil water excess from groundwater or rainfall

The soil water excess, from whatever source (groundwater or rainfall), limits the growth and development of vineyards. The soils of the Drăgăşani, Ştefăneşti, Odobeşti, Blaj, Teremia Mare vineyards are affected in varying degrees by excess moisture. The intensity of the gleyzation/stagnogleyzation processes and the depth of their occurrence allowed the favourability graduated process of vine crop on soils affected by water excess.

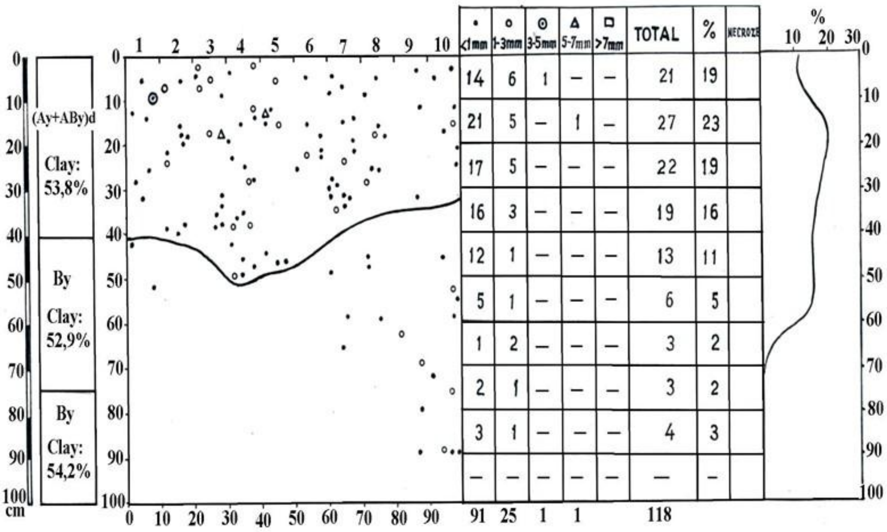
The excess from groundwater source

On soils with gley horizons, the vine limitations are complete due to the presence of groundwater in the soil at depths of 50 – 100 cm and to the excessive moisturing of capillary pores from groundwater of the trenching horizon (gleyic chernozems, cambic gleyic chernozems) in the most part of the year. In addition, in most cases there are also high contents of active $CaCO_3$ (> 10%) in some soils formed on loess, limestone, chalk or clayey marls found in plains areas or in and Dealurile Moldovei or in the terroir sites from the East-Carpathian ecosystem, in Iaşi, Cotnari and Dealurile Moldovei vineyards the high content of soluble salts or sodium adsorption adsorbed in soil (soils formed on salif marl).

Thus, there is no recommendation for vineyards on gleiosols and gleyic chernozems. As an example, there are the vineyards from Cârligele (on alluviosols and gleyic chernozems on alluvial deposits) and Teremia Mare (on gleyic sodic chernozems), where the crops were compromised, vines began presenting the phenomena of chlorosis and then of drying.

The use of such soils for vineyard requires significant hydroamelioration measures, aiming to eliminate the excess of water and salt.

For the chlorosis due to soil water excess from groundwater, the term of asphyxiation chlorosis is used (RĂUȚĂ, 1982), the excess of soil water in the horizons of maximum development of root causing root asphyxiation.



• <1mm	o 1-3mm	⊙ 3-5mm	Δ 5-7mm	□ >7mm	TOTAL	%	NECROZE
14	6	1	–	–	21	19	
21	5	–	1	–	27	23	
17	5	–	–	–	22	19	
16	3	–	–	–	19	16	
12	1	–	–	–	13	11	
5	1	–	–	–	6	5	
1	2	–	–	–	3	2	
2	1	–	–	–	3	2	
3	1	–	–	–	4	3	
–	–	–	–	–	–	–	
91	25	1	1		118		

Figure 7. Profile 151, L-35-113-A-a, NE Chițorani, typical vertosol; vine: Cabernet sauvignon/Kober 5BB, without chlorosis, 6 years

The soil water excess from rainfall

On soils with soil water excess from rainfall, how are planosols, albic stagnosols and stagnic luvosols, the anaerobic conditions affect the development of vine in all development phases, even from plantations. Therefore, in the cases with rainfall excess in the spring, the gripping percentage of vine cuttings is far below the accepted technical rules, requiring subsequent replanting. Anaerobic conditions in these soils creates serious limitations, even complete ones in some cases (Sâmbureşti, Ştefăneşti, Dobra – Dâmboviţa county), the cultivation of vines on these soils being impossible without the application of amelioration measures in order to improve aero–hydric regime.

In the area of Olt terraces from Sâmbureşti, the vine cultivation on the terrace bridges, flat or with little inclination toward the west, southwest is difficult, these terraces being covered with planosols and albic stagnosols with strong differentiated textures and intense phenomena stagnogleyzation, which are strong limiting factors for the growth and development of this crop. The soil data gathered allowed the development of some classes of land marks evaluation for vine favourability on some degradated soils (Table 3).

Table 2

The soil favourability of vineyard in Romania according to the stagnogleyzation

Code	Appreciation	Limits color reduction (%)	Depth limits (cm)	Vine favourability
WI	Without stagnogleysed or weak stagnogleysed in depth	≤ 5	126 – 150	Very good
W2	Weak stagnogleysed	6 – 15	101 – 125	Very good–good
W3	Moderate stagnogleysed	16 – 30	100 – 76	Moderate
W4	Strong stagnogleysed	31 – 50	51 – 75	Moderate-weak
			21 – 50	Very weak
W5	Very strong stagnogleysed	≤ 51	≤ 20	Unfavorable

It can be seen that for a very good to good favourability, the soil mass affected by stagnogleyzation processes has not to exceede 15% or these phenomena to develop in depth of 101 – 125 cm. The emergence of these processes on the soil surface or between 21 – 50 cm deep exclude the vine cultivation possibility on these soils.

The distribution of Rieslig Italian roots hub grown on a highly differentiated textural soil (planosol from Drăgăşani vineyard), strong stagnogleysed in Bt horizon highlights that 84% of the roots are confined aric horizon (Ea + EB) d, while only 12% are located in Bt_1wy horizon and 4% in Bt_2wy.

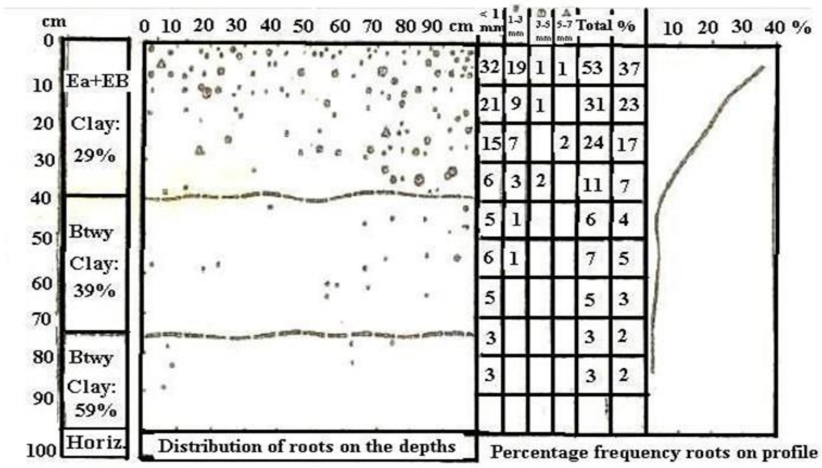


Figure 8. Distribution of roots at Riesling italian/Kobber 5BB in a planosol from Drăgăşani (Lungești) Vineyard

CONCLUSIONS

Depending on the soil particle size distribution, the root system of vines develops differently, important limitations being recorded in extremely clayey or sandy soils, in strongly textural differentiated soils, and on soils rich in active $CaCO_3$ formed on marl and loess. On soils with medium texture, uniformly distributed, the roots explore the soil profile to a depth of 70 – 100 cm.

The suitability classes of the vine related to the depth of hard rock in the soil profile highligts that a occurrence of hard rock near the surface (in the first 71 cm) is unfavorable for the development of vine.

The analysis of favourability classes for vines useful depending on the soil edaphic useful volume shows that the soil is suitable for vines for profile depths of about 51 cm, really good results being obtained for soil thickness greater than 71 cm.

The water excess in soil, from whatever source (groundwater or rainfall) limits the growth and development of vine. The intensity of gleysation/stagnogleysation processes and depth of their occurrence allowed the favourability classes graduation of the vine on soils affected by soil water excess.

On soils with gleyic horizons, due to the presence of groundwater in the soil at depths of 50-100 cm and of the excessive capillary moisting of the groundwater in the aric horizon in the most part of the year, the limitations for the vines are complete; the plants being affected by "asphyxiation chlorosis".

Favorability from very good to good, vines have soils in which the mass of soil affected by stagnogleysation processes do not exceed 15% or these phenomena developing under the depth of 101-125 cm; the occurrence of these processes near the soil surface or between 21-50 cm depth exclude the possibility of growing these soils under vines.

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