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POTENTIAL OF THE LAND IN ARCHAR VILLAGE FOR CREATION OF VINES FOR HIGH-QUALITY WINE GRAPE VARIETIES. SOIL SPECIALITY OF THE TERROIR

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Abstract

The aim of this study was to make the soil characteristics of the land in Archar village and to assess their suitability for creation of new vineyards for growth of high-quality wine grape varieties. Successively were studied the characteristics of the terroir - soil texture and physical properties of the soil, determined was the soil reaction, the content of active calcium, humus, water-soluble salts and the content of nutrient macro elements. Based on the preliminary study results was determined harmful acidity and saturation degree of the soil with bases and has proposed a plan for amelioration of the problem areas and recommended fertilization rates. The presented work was an attempt to systematize of the complex study on the suitability of one complicated terrain in terms of its topography and erosion conditions with regard to its suitability for transformation into vine terroir.

Key words: *soil, vines, terroir, wine grape varieties.*

INTRODUCTION

The aim of this study was to make the soil characteristics of the land in Archar village and to assess their suitability for creation of new vineyards for growth of high-quality wine grape varieties. The preparation of the terrains for vineyards stipulates for formation of terroir. The concept of the terroir in wine viticulture increasingly released from the context of descriptive and analytical characteristics of the areas that were traditionally identified as vineyard terroirs and is directed towards the development of predictive models for the terrain potential for its convert to terroir.

MATERIALS AND METHODS

The object of the study is located in Archar village, Dimovo municipality, Vidin region "Long Meadow" place and the total area of the studied properties was 69.1 ha. The studied objects belong to the Northern wine region "Danubian Plain" and according to the plan for land division of Archar village were within the borders of lands 174 and 175. In the course of this study was accepted a model to take soil samples, where each sample was taken from the terrain with a soil probe, as sample points were located within the borders of the terrain in a square grid. Samples were taken in three depths 0-25, 25-50 and 50-75 cm. After standard preparation, soil samples were analyzed to establish the indicators: soil texture with fotosedimentograf (Trendafilov and Popova, 2007), hydrological characteristics of the soil (Trendafilov and Popova, 2007), bulk density of the soil by paraffin method, relative density - pycnometrically, pH - potentiometric in aqueous extract (Arinushkina, 1970), content of total and alkaline earth carbonates - gas metrically by Scheibler apparatus (Arinushkina, 1970), active calcium precipitable with $(NH_4)_2C_2O_4$ - Druinnot-Gallet (NO1085/ NFX31-106), humus content by Turin method (Trendafilov and Popova, 2007), water-soluble salts (BDS ISO 11265:2002), content of easily absorbable iron, total nitrogen in the soil (BDS ISO 11261: 2002), mobile forms of phosphorus and potassium (GOST 26209-91/01.07.93).

Based on the obtained results from the preliminary study was determined harmful acidity and the degree of saturation of soil bases and is proposed plan for melioration of the problem areas and recommended fertilization rates.

RESULTS AND DISCUSSIONS

Within the studied object are distributed Haplic luvisols. The depth of the soil profile was more than 100 cm and the humus horizon about 25 cm. The location of the sampling points shown in Figure 1.

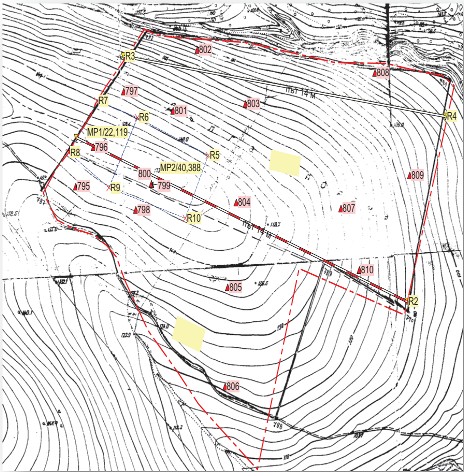

Figure 1. Location of the sampling points

Soil texture and physical properties of the soil

The average content of physical clay and particles <0.001 mm in the studied depths shown in Table 1.

Table 1. Average values of the physical indicators of Haplic luvisols by depths

Indicators	Depth (cm)		
	0-25	25-50	50-75
Physical clay (%)	46.6	55.5	52.7
Particles <0.001 mm (%)	5.5	5.9	5.8
Specific density (g/cm^3)	2.68	2.71	2.71
Bulk density at saturation	1.39	1.47	1.49
Porosity (%)	48.16	45.59	44.98

The average content of the physical clay in a depth from 0 to 75 cm was 51.6% and increased in the depth of the profile. The soil texture in the topsoil horizons was sandy clay. In the subsoil horizons was also sandy clay. The texture coefficient had value 1.08 and was not limitation on the adjustment of the soil for vineyards. The total porosity of the soil was assessed as satisfactory. The saturation was low with an average value 20.96%. In the topsoils horizon the saturation was higher - 24.99%. The maximum total water reserve for the topsoil 1 meter horizon in the terrains with sufficient profile depth was 3000 m^3/ha. In the shallower profile the maximum water reserve did not exceed 2300 m^3/ha. In the moisture at wilting point in the profiles, whose depth exceeds 1 m contains about 2000 m^3/ha not absorbable water reserve. In shallow profiles (with depth up to about 75 cm) the volume of not absorbable water reserve did not exceed 1500 m^3/ha. The approximate estimates for the volumes of easily absorbable and total absorbable water reserve in the deep and shallow (profile depth between 60 and 100 cm) soil profiles of the studied Haplic luvisols shown in Table 2.

Table 2. Water reserve of the soil at different moisture

Hydrological indicator	Haplic luvisols - deep	Haplic luvisols - shallow
Maximum water reserve at saturation (m^3/ha)	3000	2300
Water reserve at field capacity (m^3/ha)	2300	1800
Maximum water reserve at wilting point (m^3/ha)	2000	1500
Easily absorbable water reserve (m^3/ha)	700	500
Total absorbable water reserve (m^3/ha)	1000	800

Soil pH

The average value of the indicator pH (H_2O), found for the whole studied object was 5.58 with a confidence interval from 5.46 to 5.70. The indicator pH in the topsoil horizon had average value 5.3 with a confidence interval from 5.06 to 5.55. The soil reaction of the topsoil horizon was acidic. In the depth of the soil the values of pH increased. The reaction of subsoil horizons was also defined as acidic.

Content of total alkaline earth carbonates

Not found

Active calcium content

The average content of active calcium for the area, occupied by Haplic luvisols was 0.12% and vary in the ranges of confidence interval from 0.06 to 0.18%. The maximum value of the active Ca^{2+}, established within the distribution of the studied soil difference was 0.65%. The average value of the active calcium content for the topsoil horizons was 0.07%.

The distribution of Ca^{2+} in the depth of the soil profile shown in Figure 2. The figure shown, that the content of the active Ca^{2+} increases in the depth of the profile. The difference in the values of the indicator was very high.

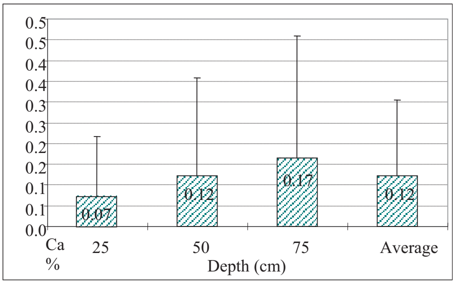

Figure 2. Content of active Ca and distribution in the soil profile

Humus content

The humus content for the topsoil horizon of the studied Haplic luvisols was 1.85% and assessed as low. The humus content highly decreased to 0.73% in depth 25-50 cm and to 0.48% in depth 50-75 cm. It can be expected, that in the depth of the trench horizon will establish low humus content - 1.01%, which will vary within the confidence interval from 0.83 to 1.19%.

The correspond to the humus total nitrogen content in the studied soil was average 0.11% in the top horizon; 0.04% in a depth 25-50 cm and average 0.08% for the depth of the trench soil layer. The total nitrogen reserve in the layer with depth 0-50 cm was 5 t/ha. About 70% of this reserve was in the top 25 cm of the profile.

Content of nutrients macro elements

The content of ammonium, nitrate and total nitrogen in the soil and the content of absorbable phosphorus and potassium shown in Table 3. The content of nitrate, ammonium and total nitrogen was very low and the soil was poorly reserved with nitrogen.

The soil in samples No. 802 and 810 was average reserved with absorbable phosphorus and in samples No. 796 and 807 was well reserved.

In regard to absorbable forms of potassium the soil was average reserved in samples No. 796, 807 and 810 and well reserved in sample No. 802.

Table 3. Content of nutrients macro elements in Haplic luvisols

Sample No.	Content of NH_4, (mg/1000 g soil)	Content of NO_3, (mg/1000 g soil)	Content of total N in the soil (mg/1000 g soil)	Content of P_2O_5 in the soil (mg/100 g soil)	Content of K_2O in the soil (mg/100 g soil)
796	2.8	5.6	8.4	11.2	14
802	2.8	2.8	5.6	9.1	24
807	1.4	1.4	2.8	11.2	16
810	1.4	1.4	2.8	6.5	14

Harmful acidity and lime requirement of the soil

Determinate were the soil reaction in extract with 1m KCl and the content of easily mobile exchange Al^{3+}, H^{+}, Mn^{2+}, Ca^{2+} and Mg^{2+}. Calculated was the degree of saturation of the permanent sorption positions in the soil with easily mobile exchange bases (BDS 17.4.4.07-97). The results of the determination of the harmful acidity indicators shown in Table 4.

Table 4. Results of the determination of the indicators of the harmful soil acidity

Sample No.	Depth (cm)	pH $_{(H2O)}$	pH $_{(KCl)}$	Al+H (meq)	Mn (meq)	Ca+Mg (meq)	V_3 %[1]
795	0-25	5.00	3.80	0.82	0.16	10.49	92
	25-50	5.45	4.00	0.28	0.13	11.04	96
	50-75	5.70	4.10	0.23	0.14	12.42	97
796	0-25	4.55	3.55	2.34	0.07	8.51	78
	25-50	5.40	3.90	0.54	0.14	13.94	95
	50-75	5.40	4.15	0.17	0.1	13.2	98
797	0-25	5.60	4.00	0.34	0.13	10.53	96
	25-50	5.75	3.90	0.53	0.17	16.47	96
	50-75	5.60	4.30	0.11	0.15	16.68	98
798	0-25	5.90	4.50	0.05	0.12	14.49	99
	25-50	5.70	4.10	0.26	0.17	16.42	97
	50-75	6.00	4.15	0.22	0.18	16.56	98
799	0-25	4.35	3.40	6.61	0.13	5.52	45
	25-50	4.70	3.30	9.26	0.18	8.17	46
	50-75	5.50	4.10	0.2	0.11	16.56	98
800	0-75	5.40	3.60	3.06	0.13	12.93	80

The results shows, that regardless of the prevailing acidic reaction in the studied terrains, established in almost all samples, a low degree of saturation of the permanent sorption positions with easily mobile exchange bases cations was found only in a few samples, characterized relatively small area of the terrain. The highest degree of acidification was found in sample 799. However, this sample characterized local spot about 0.1-0.2 ha in the high part of the terrain and its morphology characterized as Planosol with clear signs of secondary hydromorphic as a result of highly differentiated profile. The morphological features of this soil type were not established in other parts or sections of the terrain and therefore, the rate of calcium containing meliorants was not consistent with the calculated for neutralization of the harmful acidity in this soil profile. Based on the obtained results of the analysis were calculated balance lime rates shown in Table 5. The rates in active substance were recalculated in nature based on content of CaO in the liming material 48% and 4% moisture.

Table 5. Balance rates of liming on soil samples

Sample No.	Depth (cm)	Rate CaO, by layer (kg/ha)	Rate CaO for the section (kg/ha)	Rate liming material (kg/ha)
795	0-25	0	0	0
	25-50	0		
	50-75	0	3290	7100
796	0-25	3290		
	25-50	0	0	0
	50-75	0		
797	0-25	0	0	0
	25-50	0		
	50-75	0	0	0
798	0-25	0		
	25-50	0	0	0
	50-75	0		
799	0-25	8660	20650	44400
	25-50	11990		
	50-75	0	4760	10200
800	0-75	4760		

The extrapolation of the data from the analyzes to the area of the studied terrain allow to individuate two ameliorative subsections with a total area of 6.2507 ha. The main benchmarks of the meliorative subsections were coordinated in system UTM - coordinates of the benchmarks marks shown in Table 7.

Table 6. Quantitative account for liming materials

Meliorative subsections	Area, ha	Quantity CaO, kg/ha	Quantity liming material, kg/ha	Liming material for ameliorative rate, t
MP 1	2.2119	3290	7000	154.83
MP2	4.0388	4760	10000	403.88
Total	6.2507			558.71

Organization of the terrain and technology for introduction of lime materials in the soil

Within the studied terrain provides passage of two main roads with a width of 14 m. The routes of the main roads of the plantation shown in Figure 3.

Table 7. Coordinates of the main benchmarks for tracing of ameliorative subsections - Archar object

Benchmarks	OX	OY
R1	653975	4849102
R2	655002	4848714
R3	654132	4849278
R4	655142	4849120
R5	654389	4849053
R6	654169	4849141
R7	654043	4849182
R8	653948	4849069
R9	654071	4848989
R10	654310	4848915

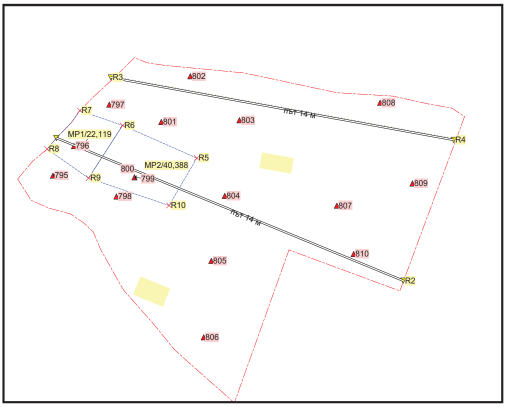

Figure 3. Sketch, M1: 7500 of the main roads

For neutralization of the established harmful soil acidity in the project study and to prevent greater soil acidification in the growth process of the vine plantation was necessary to perform differentiated liming of the sections with acidification. The rate for the amount of calcium oxide for liming of acidic soils is calculated in order to achieve neutralization of the harmful acidity and to cover the cost components in the balance of calcium in the soil. The cost elements in the balance of calcium, which are covered by lime rate were:

Neutralization of the toxicity in regard to the crops effect of the easily mobile exchangeable aluminum, hydrogen, and manganese.

Recovery of the losses from the uptake of calcium with the plant biomass.

Neutralization of the acidification effect of the mineral nitrogen fertilizers accounted by planning balance fertilization rates for the project period, including five years after the liming.

Saturation of the sorption cation capacity with calcium.

Mobilization of nutrient macro and microelements in the soil and regulation of the mineral nutrition of the plants.

Recovery of the losses from partially leaching and compensation of the positional inaccessibility of calcium containing chemical ameliorants.

As a chemical ameliorant for liming it provides for the use of ground limestone, fraction 0-5 mm. Limestone provided for soil application in terms of particle size and content of active substance meets the requirements of technologies for chemical melioration of acidic soils.

The effect of liming depends on the regular distribution of the lime materials in the soil. It is known, that the available fertilizing spreader machines (centrifugal spreader) have limited ability in regard to the quantity of fertilizers and ameliorants what can apply in hectare no more than 800-1000 kg in a single pass of the machine.

The designation of the ameliorative sections of the terrain was performed by marking. It is envisaged that the marking is performed by grooving to their borders with a plow or cased, aggregated with tractor class 14 kN, if this is impossible - by chainage. After scattering of the lime materials in the field was performed the soil tillage provided within the main technological process, associated with the creation of the vine plantation.

Fertilization of the area

Before trenching on the area is performed stockpiling fertilization with phosphorus and potassium fertilizers. The rates for stockpiling fertilization with nutrient macro elements by analyzed soil samples shown in Table 8.

Table 8. Rates for stockpiling fertilization, kg/ha

Sample No.	Rates for stockpiling fertilization with P_2O_5 kg/ha	Rates for stockpiling fertilization with K_2O kg/ha	Rate triple superphosphate, kg/ha	Rate potassium sulphate, kg/ha
796	28.6	10.8	68	22
802	34.5	0	82	0
807	28.6	5.2	68	10
810	41.8	10.8	99	22

Recommended for stockpiling fertilization with phosphorous to be performed with triple superphosphate in rate 790 kg/ha for the whole terrain.

Despite the differences in the rates of potassium fertilization, in order to achieve better ripening of the vine shoots, on the terrain can be performed stockpiling fertilization with potassium sulfate in rate 220 kg/ha.

After performing of stockpiling fertilization, should not apply phosphorus and potassium fertilizers until the third year, or until vine fruit-bearing.

After planting the vines is recommended performance of foliar fertilization twice, as the first one should be performed one month after vines leafing and the second one until the end of July.

In the second and third year applies the following schedule of fertilization: during the vegetation period is performed three or four times a foliar fertilization. The first spraying is performed one month after leafing, and the second and third in two - three weeks.

After the third year during the vegetation period is performed three or four times with a foliar fertilization as using the rates for the second and third year.

Table 9. Fertilization rates with nutrient macro elements during the fruit-bearing

Sample No.	Variety	Fertilization rate N kg/ha	Fertilization rate P_2O_5 kg/ha	Fertilization rate K_2O, kg/ha
796	Cabernet	161.3	97.4	80
	Merlot	112.6	74.3	40
	Pamid	138.6	101.4	90
	Riesling	146.5	107.9	90
802	Cabernet	165.7	100.6	30
	Merlot	117	77.6	50
	Pamid	143	104.7	50
	Riesling	150.9	111.2	40
807	Cabernet	170.1	97.4	70
	Merlot	121.4	74.3	30
	Pamid	147.4	101.4	80
	Riesling	155.3	107.9	80
810	Cabernet	170.1	104.7	80
	Merlot	121.4	81.6	40
	Pamid	147.4	108.8	90
	Riesling	155.3	115.2	90
Average for the terrain	Cabernet	166.8	100	65
	Merlot	118.1	76.9	40
	Pamid	144.1	104	77.5
	Riesling	152	110.5	75

The fertilization rates, after vine fruit-bearing shown in Table 9. The rates are approximate. The accurate determination of the fertilization rates should be performed after annual analysis of soil samples for content of nutrient macro elements.

CONCLUSIONS

The studied terrain was suitable for creation and growth of vineyards in direction of high quality red and white wines. The established values of physical clay shown, that the soil texture was not a restriction on the suitability of the soil for growth of vines.

The established in the analysis pH represents minor restriction for the growth of the vine. To prevent possible soil acidification in the growth process of the vines was necessary to avoid fertilization with ammonium nitrate. The necessary nitrogen for the plants is provided through the use of urea. In the sections with harmful soil acidity is performed liming.

The content of active calcium in the soil was no restriction of the choice of pad for planting.

The content of water soluble salts in the soil was very low and did not exceed the limit of harmfulness (0.25%) and was not a restriction for the growth of the vine.

Recommended for stockpiling fertilization with phosphorous to be performed with triple superphosphate in rate 790 kg/ha for the whole terrain.

Despite the differences in the rates of potassium fertilization, in order to achieve better ripening of the vine shoots, on the terrain can be performed stockpiling fertilization with potassium sulfate in rate 220 kg/ha.

After performing of stockpiling fertilization, should not apply phosphorus and potassium fertilizers until the third year, or until vine plantation fruit-bearing.

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