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SOIL QUALITY MONITORING FOR HYDROSEEDING NEEDS ON THE SECTION OF THE E-75 HIGHWAY, CORRIDOR 10

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ABSTRACT

The paper presents the results of testing the chemical and physical soil properties for the hydroseeding needs on the section of the E-75 highway, Corridor 10, Gornje polje-Caričina dolina. The tests were performed in the laboratory of the Department of Agricultural and Food Studies in Prokuplje, on 12 average soil samples in 2020 and on 13 average soil samples in 2021. There were analyzed the chemical properties: pH values in H_2O and in 1M KCl, humus by Kotzmann method, total nitrogen calculated from humus, readily available potassium and phosphorus by AL method, and $CaCO_3$ content was determined volumetric, by Schäibler calcimeter. Physical properties were analyzed: water content in the form of mass fraction in soil (SRPS ISO 11465:2002) and mechanical composition of soil by pipette method with preparation of samples with sodium pyrophosphate and classification of texture classes according to ISSS, Baize (1993). The obtained results show that the examined soils are weakly acidic to moderately alkaline reaction in H_2O and moderately acidic to alkaline reaction in 1M KCl, very low content of humus and total nitrogen and weakly carbonate on all analyzed samples. The soils are low to medium supplied with easily accessible potassium and very low provided with easily accessible phosphorus. The water content in the form of mass fraction in the soil is used to translate the results of air-dry samples into the result expressed on the mass of dry soil. Heavy clay to sandy loam dominates by texture classes in the analyzed soils.

Key words: Chemical and physical soil properties, Gornje polje-Caričina dolina.

INTRODUCTION

Land is one of the key limiting factors of plant production due to the simultaneous action of two processes, namely the increase in food needs, on the one hand, and the reduction of agricultural land areas, on the other hand. Soil should be viewed as a multifunctional system, not as a collection of physical and chemical properties.

The functions of soil are numerous: production of biomass and food, binding and storage of mineral substances, water, organic matter, gases, source of biodiversity, environment and source of materials and accumulation of carbon.

The use of land often leads to a disturbance in the balance of individual soil components, which inevitably leads to its degradation. One of the measures of land protection and preservation is the implementation of monitoring, which is permanent monitoring of the state of all changes in agricultural and non-agricultural land, and especially the monitoring of properties caused by the action of anthropogenic factors (Vasin, 2011).

The global assessment of quality, state of fertility and influence of anthropogenic factors at the level of the country or part of it should be monitored at least once every 10 years, in order to draw a conclusion about the global tendency of growth or decline in the content of certain examined parameters. These principles should be guided by the planning of

all agropolitical, economic, agrotechnical and zootechnical measures in the sustainable development of agriculture and food production in the future. This primarily refers to the rational use and preservation of land as a natural resource.

MATERIALS AND METHODS

Field testing of soil for the needs of hydroseeding were carried out on the section of highway E-75, corridor 10, Gornje polje-Caričina dolina. The tests were performed in the accredited laboratory (SRPS ISO/IEC 17025:2017) of the Department of Agricultural and Food Studies in Prokuplje, on 12 average soil samples in 2020 and on 13 average soil samples in 2021. All samples were taken up to a depth of 20 cm (Figure 1).

The basic chemical and physical properties of the soil were determined by standard methods: pH values in H_2O in 1M KCl, humus by the Kotzmann method, total nitrogen calculated from humus, readily available potassium and phosphorus by the AL method, $CaCO_3$ content volumetrically, with a Scheibler calcimeter. Physical properties were analyzed: water content in the form of mass fraction in the soil (SRPS ISO 11465:2002) and mechanical composition of the soil using the sodium pyrophosphate pipette method and classification of texture classes according to ISSS, Baize (1993).

Figure 1. Section of highway E-75, Corridor 10, Gornje polje-Caričina dolina, Cut V, Level II

RESULTS AND DISCUSSION

Results and discussion may be combined into a single section, or in two separate sections. Results should be clear and concise, presented in a logical sequence in the text, tables and figures. The numbers from the tables or figures should not be repeated extensively in the text and long explanations of the tables and figures are not acceptable. The same information given in the table should not be repeated in the figure or vice versa. Relevant

statistical information should be provided in tables and figures. Statistical significance should be clearly indicated where applicable. Repetition of the same data in different forms should be avoided. The discussion should interpret results in light of what was already known about the subject of the investigation, and explain new understanding of the problem after taking into consideration the results. Interpretation of data, related to previous research, should be clearly presented.

The chemical properties of the tested soil samples at the Gornje polje-Caričina dolina location depend on the entire complex of paedogenesis factors. The results of the analysis (Table 1.) show that significant chemical properties are conditioned by the action of all paedogenesis factors, and that the dominant effect is manifested by anthropogenic factors, bearing in mind that the sampling was done on the section next to the E-75 highway, corridor 10.

The obtained results show that the tested soils have a slightly acidic to moderately alkaline reaction in H_2O and vary from 6.03 to 8.33, with the dominance of neutral reaction samples. The tested soil samples are 11.1% of weakly acidic soils, 44.5% are neutral, 22.2% are weakly alkaline and 22.2% are moderately alkaline soils.

The obtained results show that the examined soils have medium acid to alkaline reaction in 1M KCl and vary from 4.46 to 7.90, with the dominance of neutral to alkaline reaction samples. The examined samples are, 16.7% moderately acidic soils, 5.6% are weakly acidic, 22.3% are neutral, 27.7% are weakly alkaline and 27.7% are alkaline reaction soils.

Table 1. Basic chemical soil properties at the investigated locations, Gornje polje-Caričina dolina, Section V, Level II, IV and V in 2020 and Decade IV, V and VI in 2021

Location Cadastral plots no.	**pH value**		**Humus (%)**	**Total N (%)**	**Water Content (%)**	**$CaCO_3$ (%)**	**Available**	
	in H_2O	**in 1M KCl**					**P_2O_5 *mg*/100*g***	**K_2O *mg*/100*g***
Year 2020, Location Gornje polje-Caričina dolina, Cut V, Level II, IV and V								
N II P228/229	6,24	4,62	0,76	0,038	1,70	0,20	4,78	11,4
N II P229/230	6,88	5,56	0,85	0,042	1,39	0,20	4,97	9,4
N II P231/232	6,87	4,46	0,67	0,037	1,49	0,19	5,87	2,6
NIV P228/229	7,29	6,19	1,19	0,059	1,23	0,21	4,97	14,2
NIV P229/230	7,95	6.95	0,59	0,029	0,55	0,21	4,89	2,7
NVI P230/231	7,67	7,15	0,65	0,033	0,80	3,61	5,01	2,6
N V P230/229	6,55	5,01	0,60	0,030	3,07	0,21	5,01	2,7
N V P230/231	6,03	4,87	0,94	0,33	2,69	0,20	4,98	2,6
N V P231/232	7,03	5,54	0,59	0,29	1,65	0,21	4,97	2,5
Year 2021, Location Gornje polje-Caričina dolina, Decade IV, V and VI								
DKIVP228/229	8,10	7,78	1,32	0,066	2,12	1,86	4,72	11,9
DKIVP229/230	8,04	7,90	1,23	0,061	1,44	1,69	4,89	9,6
DKIVP230/231	8,33	7,78	1,26	0,063	2,32	1,78	4,98	10,5
DKIVP231/232	7,95	7,88	1,19	0,060	1,99	1,86	4,99	8,3
DKVP228/229	7,08	7,67	1,33	0,067	2,37	2,11	4,71	10,8
DKVP230/231	7,15	6,97	1,32	0,066	2,68	0,68	4,95	13,4
DKVP231/232	7,70	7,38	1,37	0,069	2,90	0,59	5,01	11,6
DKVIP129/230	6,63	5,75	1,94	0,097	4,59	0,51	5,03	18,9
DKVIP131/132	6,90	6,56	2,03	0,101	4,25	0,59	4,97	15,5

According to research by Jakovljević et al., (1991) in soils that do not contain carbonates in the solid phase, the reaction is not higher than neutral, and soils that contain $CaCO_3$ have a reaction close to neutral or weakly alkaline. In that case, the pH value also depends on the content of CO_2 in the soil air (therefore also in the soil solution), $CaCO_3$ slightly dissolves in water that does not contain CO_2. The solubility of $CaCO_3$ increases and the acidity of the soil decreases with an increase in the content of CO_2.

The results of the analyzes in Table 1 show that the tested samples have a very low content of humus and total nitrogen, which, according to the classification of Gračanin, fall into the category of very low humus to low humus soils, (Figure 2).

Figure 2. Section of highway E-75, Corridor 10, Gornje polje-Caričina dolina, Decade IV

Franzubberis (1995) points out that the state of humus is one of the most important indicators of soil quality through long-term research into the content, composition and properties of humus in various types of soil.

Reeves (1997) emphasizes the importance of monitoring the content of organic matter in the soil, because it is an indicator for many negative physical, chemical and biological processes that occur in the soil.

The average content of calcium carbonate indicates very weak calcareous soils. The tested results vary from 0.20% to 2.11%. The amount of 33.3% of the tested samples belongs to the class of weakly calcareous soils.

The content of calcium in the soil directly depends on the content of calcium in the parent substrate. An organic matter is another source of calcium in the soil, which is subject to the process of mineralization, and in doing so, the Ca_2+ ion is separated, which is used directly by plants, or salts of different solubility are synthesized.

Calcium plays a very important role in maintaining and increasing soil fertility. Soil whose adsorptive complex is saturated with Ca_2+ ions has good physical properties, high

adsorption capacity and favourable conditions for the development of biological and biochemical processes, which affect the mobilization of nutrient elements from soil reserves.

Phosphorus is found in the soil in two forms, organic (20-40%) and mineral (60-80%). The variations are quite pronounced and the differences are primarily due to the unequal content of phosphorus in the parent substrates on which the soils were formed.

Compared to the other most important macronutrients for plant nutrition, the tested soil contains the lowest amount of accessible phosphorus. The amount of phosphorus in the soil solution depends on the pH value of the soil solution, the clay content and the method of use.

The results of our research (Table 1) show that at a depth of 0 to 20 cm, the content of accessible P_2O_5 is from 4.71 to 5.87 mg/100 g, which belongs to very low content, by the Al-method classification according to Egner-Riehm.

The low content of accessible P2O5 in soils rich in clay is the result of binding of PO_4-ions with Fe_2+ and Mn_2+ ions to hard-to-dissolve ferric and manganese-phosphates. Ferric and manganese-phosphates are formed during wet periods, in anaerobic conditions and are moved with water according to the depth of the profile. They are translated into hard-to-dissolve ferric and manganese-phosphates in conditions of enhanced aeration, (Golubović, 2009).

Filipovski (2001), examining the soils of this locality, points out their poor provision of accessible P_2O_5, but good provision of K_2O.

The results of our analysis, shown in Table 1, indicate a medium provision of the soil with readily available potassium, which is due to the action of anthropogenic factors and a higher content of colloidal clay particles.

Table 2. Mechanical composition of soil with textural classes at the investigated locations, Gornje polje-Caričina dolina, Cut V, Level II, IV and V in 2020 and Decade IV, V and VI in 2021

Location Cadastral plots no.	**Depth (*cm*)**	**Fractions diameter (*mm*)**						
		2-0,2	**0,2-0,02**	**0,02-0,002**	**<0,002**	**>0,02**	**<0,02**	**Texture class**
Year 2020, Location Gornje polje-Caričina dolina, Cut V, Level II, IV and V								
N II P228/229	0-20	8,3	11,2	33,2	47,3	19,5	80,8	Clay
N II P229/230	0-20	8,1	21,6	34,2	36,1	29,7	70,3	Clay loam
N II P231/232	0-20	25,4	35,8	25,9	12,9	61,2	38,8	Sandy loam
NIV P228/229	0-20	3,8	15,1	42,3	38,8	18,9	81,1	Powdery mildew
NIV P229/230	0-20	17,4	29,9	15,3	37,4	47,3	52,7	Sandy loam
NVI P230/231	0-20	7,5	24,4	34,2	33,9	31,9	68,1	Clay loam
N V P230/229	0-20	5,8	27,5	49,4	17,3	33,3	66,7	Powdery loam
N V P230/231	0-20	11,2	33,3	39,3	16,2	44,5	55.5	Loam
N V P231/232	0-20	6,7	12,8	46,3	34,2	19,5	80,5	Powdery mildew loam
Year 2021, Location Gornje polje-Caričina dolina, Decade IV, V and VI								
DKIVP229/230	0-20	2,8	12,4	15,1	69,7	15,2	84,8	Clay
DKIVP230/231	0-20	5,2	14,6	18,5	61,7	19,8	80,2	Clay
DKVIP129/230	0-20	7,4	17,9	16,3	58,4	25,3	74,7	Clay
DKVIP131/132	0-20	3,5	15,4	15,2	65,9	18,9	81,1	Clay

The results of our analysis, shown in Table 2, indicate the dominance of the fraction of clay particles in relation to other fractions of the mechanical composition. In the analyzed soils, heavy loam to clay loam dominates, according to texture classes. (Figure 3).

Figure 3. Section of highway E-75, Corridor 10, Gornje polje-Caričina dolina, Hydroseeding

Ćirić (1991) and Filipovski (1999) point out that the mechanical composition of soil is of great importance for all other properties, and in the first place for plasticity, swelling, stickiness and stability of structural soil aggregates. The high content of clay and colloids, together with their hydrophilic character, and the large presence of clay minerals of the montmorionite group with a very low content of sand, is the cause of unfavourable physical, water, air and physical-mechanical properties of the soil.

CONCLUSIONS

The parameters necessary to preserve soil as an irreplaceable natural resource and the action of anthropogenic factors on soil processes can be monitoring and controlled by appropriate procedures, standards and regulations, based on the obtained results, thanks to the increasing progress of technology, industrialization and increasing standards.

The obtained results of soil monitoring for the needs of hydroseeding on the section of highway E-75, corridor 10, Gornje polje-Caričina dolina, show that the examined soils are weakly acidic to moderately alkaline reaction in H_2O and moderately acidic to alkaline reaction in 1M KCl, very low content of humus and total nitrogen and weakly carbonate on all analyzed samples.

The soils are low to medium supplied with easily accessible potassium and very low provided with easily accessible phosphorus. The water content in the form of mass fraction in the soil is used to translate the results of air-dry samples into the result expressed on the mass of dry soil. Heavy clay to sandy loam dominates by texture classes in the analyzed soils.

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