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LAND IMPROVEMENT AND GLEYSOL'S PROPERTIES

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Abstract: Most of the world's soils have moderate to severe production limitations resulting from their inherent properties (salinity, water excess, acidity, erosion, etc.). In most soils the upper horizons of the soil are lower and relatively impermeable and soil becomes saturated. In this event, there will be a lateral flow of soil water in the upper layers that will find its way into the surface drainage system. The capillary fringe lies above the zone of saturation up to the surface of the soil. Fluctuating water tables creates alternating aerobic and anaerobic conditions. Because $Ca(HCO_3)_2$ is soluble can be leached out of the soil and Fe^{2+} ions are accumulated and a hardpan of iron oxide may build up and create acidity and an impervious layer. The overall process is termed ferrolysis. For this reasons, in order to use Gleysols as arable field, it is necessary to install a drainage system to lower the groundwater table and a complex soil ameliorative measures. For an efficient research in order to reclaims these soils, was installed an experimental field with various meliorative methods. Regarding the yielding water, the largest quantities of water were determined at variants $V_{1.3}$ and $V_{1.5}$, and the low ones at $V_{1.6}$. Intake rate values are, however, lower at 5 m from the drain line, although higher than the blank. For the depth of 50 cm, the highest values are available for $V_{1.3}$. The best results were obtained in the variants where the leveling+ loft + tubular drainage were associated with ceramic tubes ($V_{1.3}$), glass wool ($V_{1.4}$) and ballast ($V_{1.5}$). The worst results were recorded in version $V_{1.6}$, where wheat straw was used around the drain.

Keywords: gleyzation, water movement, drainage, levelling, deep loosening

1. INTRODUCTION

Most civil engineering operations are founded in the uppermost layers of the ground and are therefore carried out in soil. An important characteristic of soil cover is that it varies from place to place, in some cases there changes are rapid over short distances, in other places the changes are gradual over 10s of metres or greater distances.

There are billions of individual soils of Earth.

In order to treat soils according to their properties a solid knowledge is required [1]

Soils can be defined as four dimensional natural bodies, where the lithosphere, the atmosphere, the hydrosphere and the biosphere are unterlinked [2]

Soils are named with classification systems. A universal soil classification was most recently made with the W.R.B. – SR 2014, namely World Reference Base for Soil Resources. Here soils are grouped in 32 different soil Reference Groups. It still in being also national classification, such as SRTS – 2012, namely Romanian Taxonomyc Soil System, with 29 Soil Types grouped in 12 Soil Classes. Both soil classifications are accepted in Romania (WRB – SR and SRTS).

Most of the world's soils have moderate to severe production limitations resulting from their inherent properties (salinity, water excess, acidity, erosion, etc.). The approximate distribution of the Earth's land area based on land use (area %) is: arable 11, permanent crops 4, pasture 24, forests 31, urban 1.5, other 29 [3]

While humans obtain the nutrients they need from food, plants acquire most of their nutrients from the soil.

Soil properties and plant growth are thus closely linked. Soil degradation is now a major threat to agriculture with large and increasing areas of arable and pasture land affected by human errors. Important questions are how to reduce vulnerability of soil to erosion, how to prevent loss of organic matter, how to prevent overland flow of water and increase its infiltration. [4]

In most soils the upper horizons of the soil are lower and relatively impermeable and soil becomes saturated. In this event, there will be a lateral flow of soil water in the upper layers that will find its way into the surface drainage system.

The capillary fringe lies above the zone of saturation up to the surface of the soil.

Under the influence of permanent or temporary saturation by ground water for sufficient time that reduced conditions occur are formed gleysols. In accordance with WRB (2014) gleysols have reducing conditions within 40 cm of the surface, and after SRTS (2012) within 50 cm of the surface. This pattern is essentially made up of reddish, brownish or yellowish colours at aggregate surfaces and / or in the upper soil layers, in combination with greyish / bluish colours inside the aggregates and / or deeper in the soil.

When most of the O has been reduced, a soil is said to be anaerobis. Anaerobiosis results in the

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reduction of NO_3 to form N_{2}- followed by Mn^{4+} to Mn^{2+}, Fe^{3+} to Fe^{2+}, SO_4^{2-} to form H_2S and CO_2 to form methane (CH_4). [5]

Fluctuating water tables creates alternating aerobic and anaerobic conditions. During wet periods iron oxides undergo reduction with organic matter [6]

$$Fe(OH)_3 \rightarrow Fe(HCO_3)_2$$

The Fe^{2+} ions may occupy exchange sites on the soil clays and humus:

$$Fe(HCO_3)_2 + Ca^{2+}colloid \rightarrow Fe\ colloid + $$
$$+ (CaHCO_3)_2$$

Because $Ca(HCO_3)_2$ is soluble can be leached out of the soil and Fe^{2+} ions are accumulated and a hardpan of iron oxide may build up and create acidity and an impervious layer.

The overall process is termed ferrolysis.

For this reasons, in order to use Gleysols as arable field, it is necessary to install a drainage system to lower the groundwater table and a complex soil ameliorative measures.

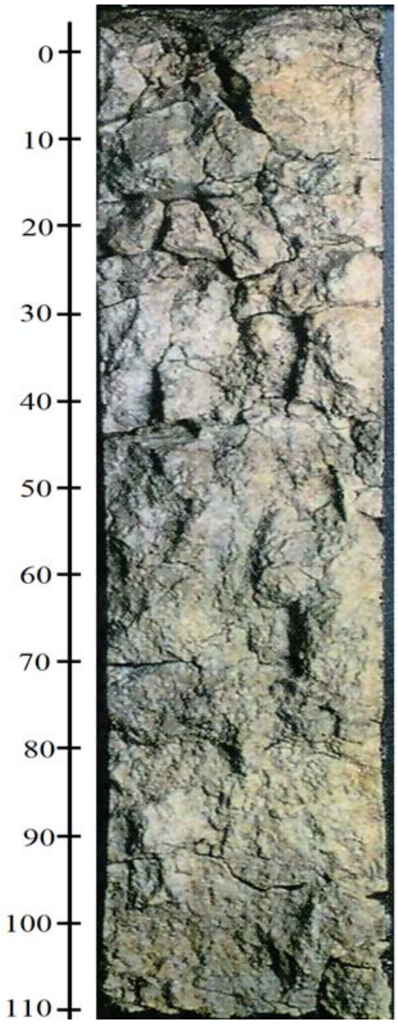

Figure 1. Gleysol

2. MATERIALS AND METHODS

Agricultural land from the subsidence plain Timiș is irregular and with a great variability regarding soil cover.

The majority of them is affected by waterlogging and salts.

For an efficient research in order to reclaims these soils, was installed an experimental field with various meliorative methods.

The main soil type is Salic – Sodic Gleysol but a small area is Hyposalic Solonetz.

From the experimental field were studied the next variants:

Table 1 – Experimental field sheme

Variant	Variant's meaning	Legend
$V_{1.1}$	L, DL, TD_{10} – without filter	L - levelling
$V_{1.2}$	L, DL, TD_{10} – furnace slag	A - deep
$V_{1.3}$	L, DL, TD_{10} – ceramics tube	loosening
$V_{1.4}$	L, DL, TD_{10} – glass wool	TD – tube
$V_{1.5}$	L, DL, TD_{10} – ballast	drain at 10
$V_{1.6}$	L, DL, TD_{10} – wheat straw	m distance
M_t	Natural meadow	

Samplings were made from variants $V_{1.1}$ – $V_{1.6}$ of the drainline and at 5 m distance from the line, at the middle of the variant.

The depth for sampling was from 0 – 25 cm and at the depth 50 cm.

Filtering materials were also analyzed in accordance with standard methods.

Mechanical composition was determined for soil samples and for the settled material into the tube drain.

For the infiltration velocity and hydraulic conductivity values we have used cylinder – infiltrometer and auger – hole methods. Runoffs with suspensions were quantified at all variants.

3. RESULTS AND DISCUSSIONS

The analytical data presented in Table 2 shows that the experimental soil has a high content of clay (the witness evidence from Gleysol has 46% and the Solonetz control samples between 39.6 and 45.8%).

Compared to these contents of the control samples, minor changes were made in the variants (at 5 m from the drainage line). However, the material that is placed over the tubular drain has an average texture.

Table 2. Clay content, bulk density (DA) and yielding water % (at 5m from the drain)

Variant	Depth cm	Clay %		DA g/cm^3		Yielding water % (at 5m from the drain)
		on the drain	at 5m from the drain	on the drain	at 5m from the drain	
$V_{1.1}$	0-25 50-60	25,1 24,8	45,3 46,2	1,18 1,24	1,23 1,38	11,38 11,35
$V_{1.2}$	0-25 50-60	23,4 22,5	44,6 44,8	1,31 1,38	1,25 1,46	10,93 17,70
$V_{1.3}$	0-25 50-60	21,2 20,8	42,4 45,1	1,16 1,21	1,22 1,32	22,08 11,50
$V_{1.4}$	0-25 50-60	20,1 18,9	44,8 46,9	1,24 1,28	1,35 1,42	13,57 6,62
$V_{1.5}$	0-25 50-60	27,4 26,2	45,1 45,3	1,20 1,35	1,29 1,41	18,81 11,01
$V_{1.6}$	0-25 50-60	30,9 31,0	40,0 45,7	1,38 1,42	1,40 1,54	6,16 6,19
$M_{t\,LC}$	0-25 50-60	- -	46,7 46,5	- -	1,63 1,51	6,87 6,39
$M_{t\,SN}$	0-25 50-60	- -	39,6 45,8	- -	1,62 1,74	6,58 5,39

By comparing the bulk density data, it is noted that for all variants, the values are lower; of the variants, the weakest state (DA = 1.22 g / cm^3, at the middle of the variant and 1.16 g / cm^3 on the drain line) was found at $V_{1.3}$.

An advanced state of compaction both in the middle and on the drain line (1.40-1.54 g / cm^3 and 1.38-1.42 g / cm^3) was found at $V_{1.6}$.

Generally, the bulk density values on the drainage line were lower than the middle of the variants.

Regarding the yielding water, the largest quantities of water were determined at variants $V_{1.3}$ and $V_{1.5}$, and the low ones at $V_{1.6}$ (from 22.08% to $V_{1.3}$ to 6.16% at $V_{1.6}$). This situation is due to the fact that variant $V_{1.6}$ is located on the Solonetz, the Na ion manifesting by a strong increase of the water retention force.

In fact, in all variants, the suction of the soil is strong, requiring large amounts of precipitation water to produce yielding water.

To determine the effect of the melioration work on water permeability, intake rate and hydraulic conductivity determinations were performed (table 3). The intake rate, set at the surface and at a depth of 50 cm, showed a good permeability to drain line, particularly in variants $V_{1.4}$, $V_{1.5}$ and $V_{1.3}$.

Table 3 Final intake rate (V_f) şi hydraulic conductivity (K)

Variants	Depth cm	Vf m/zi		K m/zi	
		on the drain	at 5m from the drain	on the drain	at 5m from the drain
$V_{1.1}$	0-25 50-60	4,15 1,12	1,08 0,10	- 0,22	0,06
$V_{1.2}$	0-25 50-60	2,25 1,20	0,91 0,09	- 0,64	0,04
$V_{1.3}$	0-25 50-60	3,52 1,75	1,04 0,36	- 1,05	0,20
$V_{1.4}$	0-25 50-60	11,60 1,35	1,28 0,20	- 0,82	0,16
$V_{1.5}$	0-25 50-60	6,65 3,30	1,12 0,25	- 0,95	0,19
$V_{1.6}$	0-25 50-60	1,10 0,26	0,92 0,08	- 0,18	0,013
$M_{t\,LC}$	0-25 50-60	- T	0,71 0,03	- -	0,011
$M_{t\,SN}$	0-25 50-60	- -	0,35 0,01	- -	0,002

Intake rate values are, however, lower at 5 m from the drain line, although higher than the blank. For the depth of 50 cm, the highest values are available for $V_{1.3}$.

The hydraulic conductivity of the soil overlying the drain is good, except version $V_{1.6}$.

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At a distance of 5 m from the drain line, the hydraulic conductivity is at all variants superior to the situation prior to the improvement, those poor values being at $V_{1.3}$, $V_{1.5}$ and $V_{1.4}$.

The situation is special in variants $V_{1.6}$ and $V_{1.2}$, where K is 0.011 m / day and 0.04 m / day.

It is noted that the most significant runoffs occurred in December and April. It is clear that maximum efficiency is represented by variants $V_{1.3}$, $V_{1.4}$ and $V_{1.5}$, and the lowest runoff is at $V_{1.6}$, $V_{1.2}$, $V_{1.1}$, which is in agreement with the analytical data of the soil overlying the drain and the soil at the middle of the variants.

In order to know the situation of the drainage behavior and their degree of clogging, there have been 7 stripes of drainage variants, and it was found that: in all variants the soil on the filter and the drain tube is loose with the exception of $V_{1.6}$, where it is compressed; the filters are clean except version $V_{1.6}$, where straw used as filter material has broken down; the drainage pipes are deformed, except for version $V_{1.6}$, where the PVC tube is crushed; in versions $V_{1.1}$ (without filter) and $V_{1.4}$ the drainage pipes are clean, the other variants are clogged.

Table 4. Material deposited in drains

Variants	Fraction content (%)					Organic matter %
	0,2	*0,2-0,02*	*0,02-0,01*	*0,01-0,002*	*0,002*	
$V_{1.2}$	1,08	39,62	23,2	21,9	14,2	2,8
$V_{1.5}$	1,37	35,73	11,2	22,3	29,4	2,6
$V_{1.6}$	0,80	46,1	25,7	13,6	13,8	3,2

The analysis of the material that clogged the drains (table 4) has revealed that in the drain tube of $V_{1.2}$ the deposition layer has 8 mm thick, at $V_{1.3}$ (ceramic tube + flint glass fiber sheet) 1, 8 cm sand, $V_{1.5}$ a deposit of 1.5 cm fine material, and at $V_{1.6}$ a layer of 2 cm of fine material, which together with swirling the drain tube left a light from the 1.5 cm leak.

4. CONCLUSIONS

Amelioration works have improved to all variants soil loosening and the water flow on the profile.

The best results were obtained in the variants where the leveling + loft + tubular drainage were associated with ceramic tubes ($V_{1.3}$), glass wool ($V_{1.4}$) and ballast ($V_{1.5}$).

The worst results were recorded in version $V_{1.6}$, where wheat straw was used around the drain.

An important characteristic of soil cover is that it varies from place to place, in some cases there changes are rapid over short distances, in other places the changes are gradual over 10s of metres or greater distances.

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Soil degradation is now a major threat to agriculture with large and increasing areas of arable and pasture land affected by human errors.

Important questions are how to reduce vulnerability of soil to erosion, how to prevent loss of organic matter, how to prevent overland flow of water and increase its infiltration.

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