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Cycle of water in the soils with Bargic horizons

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Abstract: The amount of moisture stored in the soil and available to the crop can be inferred from determinations of soil texture, structure and porosity, or measured directly by pF curve determinations. When water is added to the soil by rain or irrigation, the soil surface becomes saturated, and the water travels downwards under gravity and capillarity, i.e. drainage takes place. The amount of moisture stored in the soil and available for plants can be measured directly by pF curve determinations. An argic horizon is a subsurface horizon with distinctly higher clay content than the overlying horizon. The Romanian Soil Taxonomy System (SRTS - 2012) contains soil types with B argic horizons, as follows: Preluvosol, Luvosol, Planosol, Alosol, and Stagnosol. For low suction values, samples are placed on a porous plate, saturated with water. Suction is applied by lowering the water level in the manometer. For high suction values, samples are equilibrated in pressure plate extractors. For practical use it is necessary to know the amount of water which can be depleted before these suctions are reached. On the base of data, presented were calculated the curve suction – moisture content for a Stagnic – albic Luvisols from Lalasint. The suction – moisture curves allow to establish the irrigation requirement, leaching requirement, deep loosening requirement, the moisture reserve.

Keywords: soil, water, horizon, pF, hydrologic cycle

1. INTRODUCTION

The soil water cycle is part of the hydrological cycle. Even though the soil contains only a small amount of the total water, the soil water component of hydrologic cycle is of primary importance in growing plants (Casel and Thapa, 2005)

The amount of moisture stored in the soil and available to the crop can be inferred from determinations of soil texture, structure and porosity, or measured directly by pF curve determinations. This should be done for each distinct and important horizon or layer and summed for all layers within the crop's expected depth of rooting.

The hydrologic cycle undergoes the processes of precipitation, runoff, infiltration, evaporation, transpiration, percolation, and groundwater flow (Kirkham, 2015)

Soil is capable of storing a limited amount of water and, of this, only part is available to the plant. The problem of the amount of water to be applied is to determine the quantity which will restore the soil moisture to more favorable conditions for the plant.

This is usually the maximum the soil can store in the root zone.

Soils are a dynamic part of the earth's geomorphic cycle of surficial weathering, erosion, deposition, sinking, diagenesis, metamorphosis, uplift, and mountain building. The mineralogical composition of soils influences that of the sedimentary rocks of which erodes soil material becomes a part, just as the rocks which serve as parent materials of soils in turn influence the chemical and mineralogical composition of soils.

Under control of climatic, biotic, topographic, and time factors, chemical elements are translocated and deposited in deeper soil horizons (Rogobete and Grozav, 2016)

Soils are named with classification systems: a Romanian national system is SRTS – 2012, and an attempt to produce a universal soil classification was most recently made with the World Reference Base (WRB) edition 2014, in which soils are grouped in 32 different Soil Reference Groups, subdivided by qualifiers.

The object classified in the WRB is: any material within 2 m of the Earth's surface that is in contact with the atmosphere, excluding living organisms, areas with continuous ice not covered by other material, and water bodies deeper than 2 m (World Reference Base, SR 2014)

The definition includes continuous rock, paved urban soils, soils of industrial areas, cave soils as well oas subaqueous soils. From soil physics we know that the driving force for the movement of water in the soil and hence also towards the plant roots is constituted by the so called hydraulic potential gradient, i.e. the gradients of the components of matric and gravitational potential only. The osmotic potential of soil water does contribute to the driving force only in the saline soils, unless there is a barrier for salt movement. In some instances in order to account for pressure on the water resulting from overburden of soil or water appears the pressure potential.

When water is added to the soil by rain or irrigation, the soil surface becomes saturated, and the water travels downwards under gravity and capillarity, i.e. drainage takes place. It will be found that some water remains in the soil, in fact in the pore space, because of the soil matrix. This force is maximum in

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the clay soils or in the B argic horizons.

The amount of moisture stored in the soil and available for plants can be inferred from determinations of soil texture, structure and porosity, or measured directly by pF curve determinations. This should be done for each distinct and important layer or horizon and summed for all layers within the crop's expected depth of rooting.

Clay soils, having a large number of small pores, possess the ability to hold a large amount of water, but moisture extraction by the plant is resisted by greater forces.

In the International soil classification system (WRB - 2014), an argic horizon (from Latin "argilla", white clay) is a subsurface horizon with distinctly higher clay content than the overlying horizon.

The textural differentiation may be caused by an illuvial accumulation of clay, predominant of clay from pedogenetic formation in the subsoil, or by destruction of clay in the surface horizon.

B argic horizon has a thickness ≥15 cm (WRB - 2014) or a thickness >25 cm (SRTS - 2012)

Argic horizons are normally situated below eluvial horizons i. E. Horizons from which clay and Fe have been removed.

In the WRB – 2014 system soils with B argic horizon are:

- Luvisols with a higher clay content in the subsoil than in the topsoil, as a result of pedogenetic processes; extend over 500-600 million ha. worldwide, mainly in temperate regions.
- Planosols, soils with a horizon that shows signs of periodic water stagnation and that abruptly overlies adense, slowly permeable subsoil with significantly more clay. Their total extent is estimated at some 130 million ha.
- Retisols, from Latin "rete", net. The climate is temperate to boreal, 500-1000 mm precipitation. The albic material forms tongues (albeluvic glossae) into the argic horizon. Stagnic properties are common in Retisols. Retisols cover an estimated 320 million ha in Europe and Asia.
- Stagnosols, from Latin "stagnare", to flood. Most common in cool temperate to subtropical regions, cover 150-200 million ha, with oxygen deficiency resulting from stagnating water above B argic horizon.

The Romanian Soil Taxonomy System (SRTS - 2012) contains soil types with B argic horizons, as follows: Preluvosol, Luvosol, Planosol, Alosol, and Stagnosol.

- Preluvosol and Luvosol are distributed in WRB system to Luvisols and Retisols;
- Planosol to Planosols;
- Alosol is distributed partially to Alisols;
- Stagnosol is included in Stagnosols.

2. MATERIALS AND METHODS

The water content from three soil profiles situated in the hilly region called "Dealurile Lipovei" is determinate of soil samples that have been equilibrated with water in various suction (tension) values.

The suction can be expressed by pF, atmosphere, centimetre, bar, values. For low suction values, samples are placed on a porous plate, saturated with water. Suction is applied by lowering the water level in the manometer. When the equilibrium is reached, the sample is taken out and weighed.

The experiment is continued for increasing suction up to the maximum possible which is pF 2.53 (or 0.33 atm.).

For high suction values, disturbed samples are equilibrated in pressure plate extractors with a thin cellulose membrane which is permeable to water but not to air. The suction values determined arrives pF 4.18 or 15 bars. At this point, the water is not available for plants and the leaves show wilting symptoms and after that, permanent wilting.

For a suction of 4.75 pF, samplex are held in an air with a relative moisture content of 94.3 % in the presence of H_2SO_4 10 % solution.

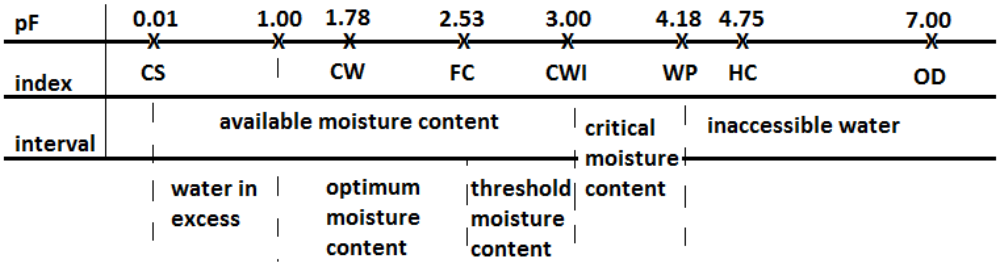
This point is called hygroscopic coefficient.

For the maximum dry of soil, the samples are held in a drying oven, at a temperature of 105-110^{0}C, until a constant weight, whent the pF = 7.0, and the soil sample don't content water (except chemically bound water).

For practical use it is necessary to know the amount of water which can be depleted before these suctions are reached. The soil's moisture characteristic, a curve of suction against moisture content, provides this information.

3. RESULTS AND DISCUSSIONS

Detailed knowledge of suction values allows to determine soil moisture characteristics.



in which:
CS – saturation capacity; CW – capillary water; FC – field capacity; CWI – capillary interruption; WP – wilting point; HC – hygroscopic coefficient; OD – oven dry.

Table 1. Water content (%) at pF 0-7, profile Lalasint – Arad

Depth, cm	pF								
	0.01	**1.78**	**2.00**	**2.53**	**3.00**	**3.89**	**4.18**	**4.75**	7.**00**
0-19	65.75	44.31	35.75	34.66	26.60	15.12	10.69	2.72	0.24
19-37	49.51	37.20	37.19	29.28	21.40	12.99	11.48	3.38	0.23
37-48	48.86	36.99	32.20	29.09	20.92	13.13	11.16	5.18	0.82
48-67	48.25	37.50	32.79	29.23	24.12	15.84	14.06	5.61	0.88
67-101	55.84	42.12	36.84	31.99	27.07	21.49	19.77	8.60	1.32
106-120	69.94	54.32	47.14	41.51	34.27	28.29	26.19	11.60	3.39
Drainage	drained		undrained						

On the base of data, presented in the table 1 were calculated the curve suction – moisture content for a Stagnic – albic Luvisols from Lalasint.

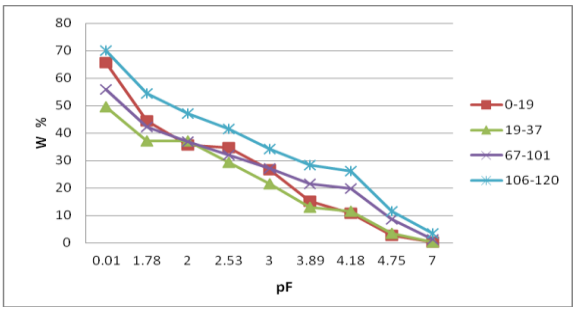


Figure 1. Suction – moisture content Lalasint

Pedogenetic differentiation of clay content, with 27.7 – 20.2 % clay in the topsoil (A_o+E_a), 0-37 cm depth, and a higher content in the argic horizon (B_t) between 48-120 cm depth, created a distinct difference between the topsoil and argic horizon.

So called, range of available moisture content comprises between pF 2.53- pF 4.18 has the following values, in per cent:

0 - 19 cm = 23.97
19 - 37 cm = 17.80
48 – 67 cm = 15.17
67-101 cm = 12.22

It is evidently that in the topsoil there are a lot of water (17.80 – 23.97 %) then in the argic horizon (12.02 – 15.17 %)

In order to establish the correlation between the moisture (x) retained on different pF and the clay content (y):

$$R = \frac{\sum xy - \frac{\sum x \cdot \sum y}{n}}{\sqrt{\left(\sum x^2 - \frac{(x)^2}{n}\right)\left(\sum y^2 - \frac{(y)^2}{n}\right)}}$$

Giving values for x equal with the moisture content retained for pF 2.53 and pF 4.18 and for y equal with the clay content for depths, it were obtained for:

pF 2.53 R=+0.711
clear significant correlation
pF 4.18 R=+0.966
clear significant correlation

The suction – moisture curves allow to establish the irrigation requirement, leaching requirement, deep loosening requirement, the moisture reserve.

4. CONCLUSIONS

Soils with an argic horizon, like Luvisols, Planosols and Retisols cover 1050 million ha worldwide, the greater part in the temperate regions of Europe.

In the Timis county, they represent 23.62% from the total area (165906 ha). The characteristics for Luvisols are the textural differentiation.

The genesis of an argic horizon is ascribed to eluviation of clay from an eluvial horizon near the surface to the subsurface argic horizon. Water holding capacity in the argic horizon is high (54.32%) versus eluvial horizon (45.75%) of volume, so that water stagnates in the upper horizons.

Planosols have an abrupt textural change from the topsoil because of the process of ferrolysis. The amount of available moisture content (pF 2.53-pF 4.10) is high in the eluvial horizon (23.97%), and small in the argic horizon (15.32%).

REFERENCES

[1] A., Conea, I., Vintila., A., Canarache, Dictionar de Stiinta Solului, Edit. Stiintifica si Enciclopedica, 1997, Bucureşti;
[2] Gh. Rogobete, A. Grozav, Stiinta Solului – cu elemente de geologie si geomorfologie, 2016, Edit. Politehnica, Timişoara;
[3] Gh. Rogobete, Solurile din Dealurile Lipovei, teza de doctorat, Universitatea din Craiova, 1979;
*[4] ***, Sistemul Român de Taxonomie a Solurilor - SRTS 2012, Edit. Sitech, Craiova;*
*[5] ***Task Force: Soil Matters, Solutions under Foot, Catewa Verlag, GeoEcology Essays;*
*[6] ***World reference base for soil resources 2014, Food and Agricultural Organization of the United Nations, Rome.*