VARIATION IN HUMUS CONTENT AND SOIL REACTION, IN 2020-2024, IN SOME TYPES OF SOIL FORMED UNDER DIFFERENT PHYSICO-GEOGRAPHICAL CONDITIONS

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Abstract

Given the evolution of the climatic conditions in the last 10 years, especially in terms of reducing rainfall and increasing average annual temperatures, especially in the southern half of Romania, soil profiles and studies have been carried out in different areas of the south of the country including Dobrogea, with different pedoclimatic conditions. For this purpose, soil profiles and surveys were carried out in two counties in the south of the country, respectively: Dolj and Constanta, from which soil samples were taken both in natural and modified settlement. Soil samples were conditioned (drying, mortar and sieving) in USAMV laboratories in Bucharest and analyzed in INCDPA laboratories in Bucharest.

In all analyzed samples, a reduction in humus content was found due to rapid mineralization against the background of reduced precipitation and excessive heating. As for the reaction of the soil, due to the applied technology, in particular, fertilizing with chemical fertilizers with a physiological acid reaction, led to a decrease in the value of the reaction by one unit.

***Key words**: arenosols, chernozems, humus content, soil reaction*

INTRODUCTION

Soil is considered as the basic natural source of any efficient, productive and sustainable agricultural system, while being limited and more complex than air and water, representing the essential support of life. Soil is a dynamic entity, so it represents life. The dynamics of the soil, or of the complex changes that take place in the soil, is evidenced by numerous processes that are in a continuous change, until a certain state of stable relative equilibrium is reached (Dumitru Elisabeta et al., 2009).

In the context of sustainable agriculture, the protection and conservation of soil as well as the achievement of an environment conducive to the development of cultivated plants must be based on knowledge of the physical, chemical and biological state.

Due to its properties and chemical composition, humus is the essential component of the soil, which gives it specific characteristics, as well as a certain level of fertility. Humus is the fundamental specific constituent of soil, resulting from the action of biocenosis throughout the soil formation process. It represents an important ecological determinant of soil, exercising physical, chemical and trophic functions, through its contribution to structure formation, water absorption, adsorption and exchange of cations and through the supply of nutrients resulting from the mineralization of organic matter (Chirita, 1974).

Humus is the main energy source of soils, with a beneficial influence on most soil properties. Land without humus not be considered soil. Soils have a very different content in humus, both quantitatively and qualitatively, depending on the natural vegetation under which they were formed, Climate, relief, soil type, culture technology (Gus et al. 1998). The relationships between soil and humus are not only related on the superficial horizons of the soil (horizons A), but also on the deepest (Chersich, 2018; Bernier et al. 1994).

The structure of the horizon is mainly the result of the action of pedophauna, microorganisms that contribute to the degradation of plant debris and increase the content of organic matter (Galvan et al., 2006; Guggenberger et al., 2003). Humus contributes to the improvement of the physical characteristics of soils, having a strong influence on them. Thus, huminic acids impart dark colors to soils, from Brown to black, increasing the adsorption of caloric radiation and the degree of heating. Indirectly, it has an important role on the porosity, permeability and consistency of the soil. Having a high water retention capacity, humus contributes to its enlargement and preservation in the soil, especially in forms accessible to plants (Blaga et al., 2005).

In order to ensure the fertility of any soil, especially of intensively cultivated agricultural mineral soils, humus, both qualitatively and quantitatively, represents the most important characteristic (Marinca et al., 2009).

The agrochemical study of agricultural land is the one that substantiates the rational use of fertilizers and amendments, in order to obtain higher quantitative and qualitative agricultural productions, under the conditions of continuous increase of soil fertility and Environmental Protection (Borlan, 1998). In the case of the agrochemical layer, the total humus content varies from extremely low to excessively high, with the largest share going to soils with low total humus content (71.64%), followed by soils with medium content (23.3%). By soil type, the percentage of humus decreases from Phaeozems (3.1%) to Chernozems (3.0%), Gleysol (2.9%), Vertisol (2.8%), Luvisol (2.57%). Arenosols have the lowest average value of total humus content in the agrochemical layer (1.75%). In general, the low content of organic matter is due to slope processes and neglect of organic fertilization in the last 30-40 years, agriculture relying more on chemical fertilization (Monitoring of soil quality in Romania, 2011).

MATERIALS AND METHODS

(1) Characterization of physical-geographical conditions, Cogealac area

The experiment was conducted in two different locations, in the southeastern part of Romania, in the cogealac area, Constanta County and Dabuleni, Dolj County.

The Cogealac territory belongs to the prebalkanic platform, on loess formations with thicknesses of 5-6 m, where there are sarmatic formations, represented mainly by shell limestone, and below them compact Cretaceous limestone (Figure 1). From the analysis of loess, it was found that it is medium (40% sand, 42% loam and 18% clay) (Mușat et al., 2024). The relief belongs to the Prebalcanic plateau (Casimcea) or moesic, characterized by elevations higher by 30-40 m compared to the neighboring areas. Groundwater is found at great depth, sometimes over 20 m. The average annual temperature is 11.5° C and the warmest month is 23^0 C in July followed by august. The average absolute temperature is in July, 41^0C, and the absolute minimum -30^0 C in January. The annual amplitude is 71^0C.The average annual rainfall is around 420 mm, the month with the highest rainfall is considered June with 62 mm. The studied territory is located in the zone of arid steppe vegetation, where the following species meet: Quercus pubescens;

Quercus robur; Carpinus orientalis; Prunus mahaleb; Corylus avellana; Fraxinus; Acer platanoides.

The grassy vegetation is represented by: *Dactylis glomerata; Alopecurus myosuroides; Taraxacum officinale; Lotus corniculatus; Trifolium pratense*, etc.

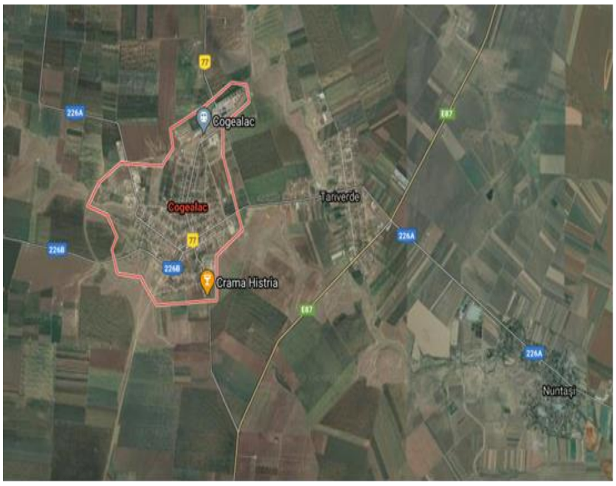

Figure 1. Location of the studied area Cogealac

(2) Characterization of physico-geographical conditions, Dabuleni area

The sandy lands in the south of Oltenia occupy the largest area in our country, about 250 000 ha., being located both on the Danube terraces and between Jiu and Olt and the Western Plain of Oltenia (Tufescu, 1966). In terms of chemical components, the sands near the Danube are richer in SiO_2 and carbonates but poorer in humus, phosphorus and potassium compared to those near the Danube, which are poor in carbonates.

Geomorphologically, the studied area belongs to the Romanati plain, between Jiu and Olt, being made up mostly of dunes and interdune with variable widths between 20-800 m, even up to 1000 m in certain areas. The elevation differences between dunes and interdune reach up to 10 m.

The hydrological network is represented by the two major rivers (Jiu and Olt), which do not influence pedogenetic processes because the phreatic level is located between 5 and 13 meters, lower level was found in the Danube Bend (Bailestilor Plain) being located at 2-5 m. (Maxim, 1964). The studied territory is characterized by a temperate continental climate with high caloric potential, large amplitudes of air temperature, low amounts of precipitation with frequent periods of drought.

These climatic conditions are accentuated also due to the presence of the sandy substrate which has a high and fast heating capacity during the hot summer periods. The average annual temperature for the studied area is around 10.8^0 C which corresponds to the average temperature in the southern part of the Roman plain, and the average annual rainfall below 500 mm.

The characteristic of these sands is the temperature amplitude both diurnal and monthly. Temperature differences recorded between air and soil temperatures reached values of up to 24^0C.

According to the research diurnal amplitude dynamics found that the records made at 8.00 showed higher values of temperature on the sand than in the air, because of sudden cooling of the sand towards evening (20.00), the sand temperature was equal to the air or even lower. Influence of soil surface temperatureis felt up to 40 cm. These diurnal and nocturnal temperature variations are very different on irrigated lands compared to non-irrigated ones.The use of these lands in an irrigated system on a modeled, scarified and fertilized agrofond can substantially alter the level of productions regardless of the use or the cultivated species. The soil cover is and will be affected by the degradation-desertification processes, its main effects on it being represented by the accentuation of erosion, increasing the salinity of soils due to the intensification of the evapotranspiration process, reducing the processes of degeneration and microbial mutability, etc., all these contributing to the decrease of soil fertility.

Soil sampling

In order to characterize the soil cover of the studied territories, two main soil profiles and two agrophysical soil profiles were performed in two different areas, according to the methodology of developing Pedological studies (MESP, 1987). In order to characterize the physicochemical characteristics, soil samples were collected in disturbed structure (plastic bags) and in natural state (metal cylinders) on pedogenetic horizons. The description of the pedogeneric conditions and the soil cover was made according to the' guide for the field description of the soil profile and the specific environmental conditions " (Munteanu and Florea, 2009). Soil framing at type and subtype level was done according to SRTS, 2012. The analyses and determinations carried out are in accordance with the methodology and STAS in force (SRTS, 2003).

Soil analysis

The samples were analyzed in ICPA Bucharest laboratories. Soil samples were dried at room temperature; soil subsamples were homogenized, milled, and sieved through a 250 µm sieve. The following analytical methods were used to determine the chemical properties:

- organic matter (humus): volumetric determination, based on Walkley-Black humidification method, modified by Donut;
- $CaCO_3$ (carbonates): gasometric method using the Scheibler calcimeter;
- the nitrogen content was determined indirectly (by calculation) based on the humus content and the degree of saturation with bases (IN = humus x V / 100);
- mobile phosphorus content (mobile P): Egner-Riehm-Domingo method and colorimetric molybdenum blue, Murphy-Riley method (ascorbic acid reduction);
- mobile potassium content (mobile K): Egner-Riehm-Domingo extraction and flame photometry;
- pH: potentiometrically determined, with combined glass electrode and calomel, in aqueous suspension at soil / water ratio of 1/2, 5;
- Hydrolytic acidity - extraction with sodium acetate at pH 8.2;
- degree of bases saturation V% - Kappen Schoffield method Charge by extraction with 0.05 normal hydrochloric acid.

The following physical characteristics were determined:

- determination of granulometric fractions:
- pipette method, for fractions ≤0.002 mm;
- wet grinding method for fractions of 0,002-0,2 mm and dry grinding method for fractions >0,2 mm. The results are expressed as a percentage of the material remaining after pretreatment.
- bulk density (BD): the known volume of metal cylinders (100 cm^3) at the instant soil moisture (g/cm3);
- total porosity (PT): by calculation (% by volume - % v / v);
- aeration porosity (PA): by calculation (% volume - % v / v);
- compaction degree (GT): by calculation GT = [(PM - PT) / PMN] x 100 (% by volume - % v / v), where: PMN - minimum required porosity, clay of the sample is calculated with the formula PMN = 45 + 0.163 A (% by volume - % v / v); PT = total porosity (% v / v); A - clay content (% w / w);
- hygroscopicity coefficient (CH): drying at 105°C of a pre-moistened soil sample at equilibrium with a saturated atmosphere with water vapor (in the presence of 10% H_2SO_4 solution) - % by weight (% w / g);
- permanent wilting point (CO): by calculation by multiplying by 1.5 the hygroscopicity factor determined by the modified Mitscherlich method (% vacuum), % by weight (% w / w). For the complete soil characterization, in terms of both the physico-chemical properties of the soil and physico-geographic conditions in which the soil was formed, soil properties are represented as symbols grouped in ecopedological indicators, according to the methodology in force (ICPA, 1987, vol. III).

RESULTS AND DISCUSSIONS

Soil characterization

Cogealac area

Soil type: Chernozems calcareous (CZ-ka);
Rok: loessoid deposits;
Use: arable, straw stubble (barley);
Groundwater: > 10 m.
Morphological characterization of the profile (Figure 2).

Am horizon (0-32 cm), powdery clay, light brown (10 YR 2/3 to wet and 10 YR 3/4 to dry), moderately developed glomerular structure, porous, permeable, frequent fine roots from cultivated vegetation, weak effervescence, gradual straight transition to the lower horizon;

AC horizon (32-56 cm), medium clay, yellowish brown, (10 YR 4/3 to wet and 10 YR 4/5 to dry), poorly developed glomerular structure in the upper half of the transition horizon, slightly friable, porous, loose, with accumulations of carbonates in the form of pseudomycelia, moderate effervescence;

Cca horizon (56–115 cm), sandy clay dusty, yellowish (10 YR 5/4 to wet), unstructured, friable, porous, loose, with accumulations of carbonates in the form of pseudomycelia and small crumbly concretions, strong effervescence.

C horizon (115-145 cm), medium sandy clay, yellowish (10 YR 5/5 to wet), unstructured, very friable, porous, loose, with accumulations of carbonates in the form of pseudomycelia and small crumbly concretions, moderate effervescence.

Analytical data for carbonate (calcareous) chernozem in the studied area are presented in Table 1.

Figure 2. Cogealac soil profile (year 2020)

Table 1. Physico-chemical characteristics for calcareous chernozems (Cogealac-2020)

Horizon	Am	AC	Cca	C
Depth (cm)	0-32	32-56	56-115	115-145
Coarse sand (2-0,2 mm)	5,7	14,2	14,1	-
Fine sand (0,2-0,02 mm)	32.0	30,1	29.5	-
Loam (0,02-0,002 mm)	37,6	29,8	39.4	-
Clay (< 0,002 mm)	24,7	25,9	17,0	-
Soil texture	LP	LL	SS	SM
Soil reaction (pH)	7,42	8,18	8,47	8,35
Humus content (%)	2,86	1,31	0,66	0,45
Apparent density (g/cm^3)	1.27	1.26	1.30	-
Total porosity (%)	52.5	54.7	51.2	-
Compaction degree GT (%)	- 6	- 9	- 7	-
Carbonates (%)	3,2	6.5	12,9	12,5
Degree of saturation with bases V(%)	96	100	100	100
Total content of nitrogen IN	2,74	1,31	0,66	-
Mobile phosphorus (ppm)	49	22	14	-
Mobile potassium (ppm)	169	98	81	-
Permanent wilting point (%)	8,9	8,1	7,3	-
Field capacity (%)	13,3	12,1	11	-
Useful water capacity (%)	24,2	22,1	20	-
Total water capacity (%)	41	43	39	-
Humus reserve (t/ha)	116	40	51	-

Interpretation:

Soil reaction	neutral-weakly alkaline
Humus content	Small
Total content of nitrogen IN	Middle
Mobile phosphorus (ppm)	Great
Mobile potassium (ppm)	Middle
Soil texture	Clay
Carbonates	carbonate
Salinization/Alcalization	Unsalinated-non-alkalized
Degree of saturation with bases V (%)	Eubazic
Humus reserve (t/ha)	Middle

Characterization survey (2024)
Soil type: Calcareous chernozem (CZ-ka);
Rok: loessoid deposits;
Use: arable;
Groundwater: > 10 m.

Figure 3. Survey View (year 2024)

Morphological characterization

Am horizon (0-36 cm), powdery clay, light brown (10 YR 3/3 to wet and 10 YR 4/4 to dry), moderately developed glomerular structure, friable, permeable, frequent fine roots from cultivated vegetation, weak effervescence from the surface, diffuse transition to the transition horizon;

AC horizon (36-64 cm), medium clay, yellowish-brown, (10 YR 4/3 to wet and 10 YR 4/5 to dry), moderately developed glomerular structure in the upper half of the transition horizon, slightly friable, crumbly, with accumulations of carbonates in the form of pseudomycelia, moderate effervescence;

Cca horizon (64–122 cm), sandy clay dusty, yellowish (2.5 Y 5/3 to wet and 2.5 Y 6/4 to dry), unstructured, very friable, porous, with accumulations of carbonates in the form of pseudomycelia and small crumbly concretions, strong effervescence.

The analytical data for carbonaceous chernozem in the studied area are presented in Table 2.

Table 2. Physical and chemical analysis for carbonaceous Chernozem

Horizon	Am	AC	Cca
Depth (cm)	0-36	36-64	64-122
Coarse sand (2-0,2 mm)	7,8	12,3	14,7
Fine sand (0,2-0,02 mm)	28,2	32,4	27,5
Loam (0,02-0,002 mm)	37,5	30,6	38,7
Clay (< 0,002 mm)	26,5	24,7	19,1
Soil texture	LP	LL	SS
Soil reaction (pH)	7,15	7,89	8,65
Humus content (%)	2,34	1,40	0,52
Bulk density (g/cm^3)	1,3	1,28	1,26
Total porosity (%)	53	54	54
Degree of saturation with bases V(%)	94	98	100
Total content of nitrogen IN	2,19	1,37	0,52
Mobile phosphorus (ppm)	49	22	14
Mobile potassium (ppm)	169	98	81
Humus reserve (t/ha)	110	50	38

Soil characterization
Dăbuleni area

Soil type: Typical Arenosols (AS-ti);
Rok: deposits wind (Sandy);

Relief: plane field
Use: arable
Groundwater: > 5 m.
Morphological characterization of the profile (Figure 4).

Aț horizon (0-22 cm), sand-fine clay, light brown color, in shades of 7.5 YR 2/2 in wet and 7.5 YR 3/4 in dry, medium grainy structure, moderately developed, moist, not effervescent, frequent fine roots non-adhesive, non-plastic, gradual transition to the lower horizon;

Ao horizon (22-43 cm), sand-fine clay, light brown color, in shades of 7.5 YR 2/3 in wet and 7.5 YR 4/4 in dry, moderately developed grainy structure, jilav, frequent fine roots, non-adhesive, non-plastic, gradual transition to the next horizon;**C_1 horizon** (43-97 cm), coarse clay sand, yellowish-brown color in shades of 7.5 YR 3/4 in wet and 7.5 YR 6/4 in dry, poorly structured, grains of sand visible at the surface of aggregates, non-plastic, non-adhesive, clear passes towards the lower horizon;

C_2 horizon (97-180 cm), coarse sand, light yellowish with shades of 7.5 YR 6/6 in wet and 7.5 YR 6/8 in dry, unstructured, very friable, does not make effervescence.

Figure 4. Dabuleni soil profile (year 2020)

The soil samples were analyzed physico-chemically, the results being shown in Table 3.

Table 3. Physico-chemical characteristics of typical Arenosols from Dabuleni area (year 2020)

Horizon	Ao	C_1	C_2
Depth (cm)	0-43	43-97	97-180
Coarse sand (2-0,2 mm)	29,8	32,8	38,6
Fine sand (0,2-0,02 mm)	31,6	30,1	31,4
Loam (0,02-0,002 mm)	30,4	29,8	28,7
Clay (< 0,002 mm)	8,2	7,3	1,3
Soil texture	UF	UG	NG
Soil reaction (pH)	6,25	6,43	6,61
Humus content (%)	1,90	1,11	0,34
Bulk density (g/cm^3)	1,23	1,22	1.14
Total porosity (%)	52	54	56
Total contect of nitrogen IN	1,37	0,84	0,27
Degree of saturation with bases V (%)	72	76	82
Mobile phosphorus (ppm)	4,94	4.45	4.20
Mobile pottasium (ppm)	1.3	0,78	0,52
Humus reserve (t/ha)	100,5	73	-

Survey characterization (2024)
Soil type: Typical Arenosols
Rok: deposits wind (Sandy);
Relief: plane field
Use: arable
Groundwater: > 5 m

Morphological characterization

Aț horizon (0-18 cm), sand-fine clay, light brown color, in shades of 7.5 YR 2/2 in wet and 7.5 YR 3/4 in dry, medium grainy structure, moderately developed, moist, not effervescent, frequent fine roots non-adhesive, non-plastic, gradual transition to the lower horizon;

Ao horizon (18-38 cm), sand-fine clay, light brown color, in shades of 7.5 YR 2/3 in wet and 7.5 YR 4/4 in dry, moderately developed grainy structure, jilav, frequent fine roots, non-adhesive, non-plastic, gradual transition to the next horizon;
C1 horizon (38-65 cm), coarse clay sand, yellowish-brown color in shades of 7.5 YR 3/4 in wet and 7.5 YR 6/4 in dry, poorly structured, grains of sand visible at the surface of aggregates, non-plastic, non-adhesive, clear passes towards the lower horizon;
C2 horizon (65-110 cm), coarse, reddish-yellow sand with shades of 7.5 YR 4/6 in wet and 7.5 YR 6/6 in dry, unstructured, very friable, does not make effervescence.

The soil samples were analyzed physic-chemically, the results being shown in Table 4.

Figure 4. Survey view (year 2024)

Table 4.Physical and chemical analysis for typical Arenosols

Horizon	Ao	C_1	C_2	C_3
Depth (cm)	0-38	38-65	65-110	>110
Coarse sand (2-0,2 mm)	29,8	32,8	38,6	43,4
Fine sand (0,2-0,02 mm)	31,6	30,1	31,4	30,3
Loam (0,02-0,002 mm)	30,4	29,8	28,7	25,6
Clay (< 0,002 mm)	8,2	7,3	1,3	0,7
Soil texture	UF	UG	NG	NG
Soil reaction (pH)	6,15	6,63	6,71	6,85
Humus content (%)	1,68	1,01	0,44	-
Total content of nitrogen IN	1,24	0,67	0,36	-
Degree of saturation with bases V (%)	63	67	84	-
Mobile phosphorus (ppm)	4,94	4.45	4.20	-
Mobile potassium (ppm)	1.3	0,78	0,52	-
Humus reserve (t/ha)	79	34	-	

The Sandy mineral material is difficult to disintegrate and is very little altered, so this type of soil is very poor in fine fractions (clay and dust). Due to the poverty in organo-mineral colloids, psamosol has a very low cohesion, being easily shattered by the wind, because of this the solification process is constantly interrupted. These Genesis processes specific to sandy areas cause this soil material to present a poorly outlined and little evolved profile.
From the climatic point of view psamosols are characterized by average rainfall ranging from 350 to 650 mm and with average temperatures of 7-11^{0}C, lately it was found that at the surface of the sands were recorded the highest temperatures, over 60 ^{0}C.

Table 5. Variation in humus content and soil reaction value in the period 2020-2024, from the surveyed areas

Pedoclimatic zone	Soil type	Research period			
		2020		*2024*	
		pH	*Humus (%)*	*pH*	*Humus (%)*
Dabuleni, DJ	*AS-ti*	6,25	1,90	6,15	1,68
Cogealac, CT	*CZ-ka*	7,42	2,86	7,15	2,34

Regarding the variation of the humus content and the value of the soil reaction in the period 2020-2024 in the area was found a reduction of the humus content due to the increased mineralization due to the reduction of precipitation and excessive heating. As for the reaction of the soil, due to the Applied Technology, in particular, fertilizing with chemical nitrogen fertilizers with a physiological acid reaction, led to a decrease in the value of the reaction by one unit.

Due to the coarse texture, Arenosols work very easily, in any moisture conditions. They are soils with a very high water permeability and are strongly aerated, very poorly supplied with humus and due to the poverty in the colidal complex, they retain very little water and nutrients.

CONCLUSIONS

Due to the fact that arenosols are soils that do not retain water and nutrients, they have a very low natural fertility.

It is recommended to apply irrigation to fill the large moisture deficit in small water norms applied to 2-3 days.

In order to increase the humus content, it is recommended to apply organic fertilizing with manure embedded at a depth of 30-40 cm, in order to avoid rapid anaerobic decomposition and to apply chemical fertilizers in small quantities in several innings in order to avoid leaching them into the water table.

The establishment of fast and lush growing crops (White lupine), shelterbelts to reduce wind speed and implicitly the evaporation of water from the soil.

The soil cover in the Cogealac area is consistent with the physical and geographical conditions of the area, the texture is loamy and undifferentiated on the profile.

Carrying out soil work on time and good quality, compliance with crop rotation with the inclusion of a species of legumes (peas).

It is recommended to set up forest curtains because it is prone to strong winds that intensify the evaporation of water from the surface.

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