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INFLUENCE OF APPLIED TECHNOLOGIES ON THE PHYSICO-CHEMICAL PROPERTIES OF SOILS IN PERIȘORU AREA, CĂLĂRAȘI COUNTY

Iulian Bogdan MUȘAT, Valentina Mihaela VASILE, Mircea MIHALACHE

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: mihaelapetcu2505@yahoo.com

Abstract

The studied area is located the north-eastern part of Călărași County, belonging to the cadastral territory Perişoru, currently used as arable. The pedological mapping was carried out with the purpose of identifying the zonal soil, by assessing its fertility as well as the influence of applied technologies on the physico-chemical properties of the soil. A soil profile and several surveys were opened from which soil samples were collected in natural and modified settlement, for morphological, physical and chemical analysis. The soil type identified is represented by typical chernozem, vermic with undifferentiated loamy texture on the profile. The main physical characteristics (bulk density, total porosity and compaction degree), chemical (soil reaction, humus content, nitrogen, phosphorus, potassium) and hydrophysical indices were determined by indirect methods. Applying high-performance culture technologies, they highlighted the improvement of the aforementioned characteristics, by creating a favorable aerohydric regime and implicitly important production increases.

Key words*: bulk density, total porosity, compaction degree, typical chernozem, performance technologies.*

INTRODUCTION

Soil work can directly or indirectly influence its physical characteristics, both on the mobilized depth and below this limit. The main physical characteristics of the soil that can be influenced as a result of these works are: structure, total porosity and aeration, bulk density, penetration resistance, permeability, which in turn can influence the physical-mechanical characteristics of the soil (consistency, adhesiveness, plasticity, plowing resistance, etc.) (Cârciu et al., 2019; Coronavski, 2010).

The structure of the soil is often damaged by incorrect execution of soil work and inappropriate moisture content or by repeated passes without justification. Soil moisture at the time of execution of the work has a very important role because, in the case of a soil that is too dry, plowing results in clumped soil, it is performed with high energy consumption (fuel) and requires additional work for the soil to be shredded (Mihalache, 2014).

By plowing, the upper horizon is covered by bringing to the surface the soil layer restored and sometimes enriched in nutrients, achieving favorable conditions for germination and plant growth. At the same time, when a loosening of the soil is effectuated, its volume is increased by at least 25%, hydrostable aggregates are created especially at bulk density values of 1.1-1.3 g/cm^3.

This volume disappears over time, by natural laying, when preparing the seedbed or during the growing season (Dumitru et al., 2011; Mihalache & Ilie, 2008).

Total porosity and aeration are variable characteristics, depending on the texture and soil works, specific to each type of soil from the clay (vertosols) to the sandy (alluvial soils or psamosols). Both characteristics have unfavorable consequences on the growth and development of plants, when their values are low because the root system develops hard, infiltration is reduced, so is the activity of aerobic microorganisms.

The optimal limits of total porosity for plants are 48-58% of soil volume, capillary porosity of 30-36% and aeration porosity of 18-24%.

Through the agrotechnical works applied to the soil, its physical characteristics and implicitly the aerohydric regime are modified, thus conferring favorable conditions for the activity of microorganisms. Changes due to soil work have direct implications also on the chemical and biological characteristics of the soil, by increasing porosity, reducing the bulk density value and changing the temperature regime.

As a result of these works, aerobiosis conditions are created in the soil, favoring microflora (bacteria, fungi and actinomycetes), with a role in the decomposition of organic cellulosic substances. Due to the fact that fresh organic substances decompose intensively, the coefficient of their transformation into humus is greatly reduced.

By creating the conditions of aerobiosis, the mineralization of organic debris is intensified and, as a result, a deficit of energy material is created in the soil and bacteria are forced to decompose humus. This phenomenon can be reduced by avoiding excessive loosening work.

After Munteanu and Florea (2009), in löess soil the nitrification process is more intense, reaching the maximum intensity when the volumetric weight values are between 1.11 and 1.15 g/cm^3. Due to nitrification, the favorable processes by which phosphorus, potassium, calcium and other nutrients pass from hardly soluble forms into forms easily accessible to plants are emphasized. The typical example, is the solubilization of phosphorus (Budoi & Penescu, 1996).

Compaction leads to the degradation of the soil structure, which causes damage to its other physical properties (Richard et al., 2001).

An indicator of compaction is the bulk density, which represents the most accurate possibility of assessing soil horizons, being also a determining factor of the other physical and chemical properties. When applying organic fertilization, the bulk density has the lowest values, between 1.09 g/cm^3 and 1.23 g/cm^3, for a cambic chernozem in Western Romania. In this case, the highest values were in variants in which NPK was applied in doses of $N_{150}P_{100}K_{50}$, which resulted in values between 1.46 g/cm^3 and 1.48 g/cm^3 (Mihuț & Rusu, 2007).

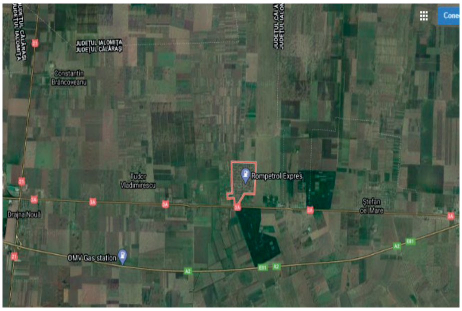

Figure 1. Perișoru, Călărași County

Soil structure can be expressed by the stability of soil structural aggregates (the ability of soil aggregates to resist decay by water).

Based on the experiments carried out, it was found that organic fertilization had a positive impact on the stability of structural aggregates, the aeration porosity being significantly higher at organic fertilization (9.6% on average), compared to unfertilized treatments (8.8 %).

The bulk density was significantly influenced by fertilization, according to the research conducted by Stehlik et al. (2019), where the bulk density recorded in fertilized plots was 1.31 g/cm^3, compared to 1.35 g/cm^3 in unfertilized plots.

The bulk density or volumetric weight correlates very well with the total porosity and compaction degree of the soil, being conditioned by the texture, content in organic matter and the agrotechnical works performed (Canarache, 1990). According to the literature, the root system develops optimally at bulk density values between 1.0-1.4 g/cm^3.

MATERIALS AND METHODS

The experiment was conducted in the Southeastern part of Romania, in Perișoru area, Călărași County, on a typical chernozem (Figure 1).

The placement of the soil profiles was made according to the complexity of the terrain and the soil cover, according to MESP, 1987 vol. I (Collection and systematization of pedological data).

It is a pedological study of Type B, category I of complexity. The density of soil profiles was established according to the current methodology (INCDPA Bucharest), but also according to the research purpose (technology applied for each studied area).

The description of each soil profile was carried out according to the guide for the field description of the soil profile and the specific environmental conditions, INCDPA Bucharest, (Munteanu & Florea, 2009).

Two series of profiles were carried out in the period April-May, 2019 (Figure 2) and in the period August-September, 2021 (Figure 3), after harvesting the crops.

Soil analysis

The samples were analyzed in the INCDPA 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, (Walkley-Black humidification method, STAS 7184/21-82);
- $CaCO_3$ (carbonates): gasometrical method (Scheibler calcimeter, SR ISO 10693: 1998, %);
- the nitrogen content, by calculation, based on the humus content and the degree of saturation with bases (IN = humus x V/100);
- mobile phosphorus content (Egner-Riehm-Domingo method and colorimetric molybdenum blue, Murphy-Riley method ascorbic acid reduction);
- mobile potassium content (Egner-Riehm-Domingo extraction and flame photometry);
- pH (potentiometric method in aqueous suspension at soil/water ratio of 1/2.5 - SR 7184 /13-2001);
- hydrolytic acidity, extraction with sodium acetate at pH 8.2;
- base saturation degree, V% (Kappen Schoffield method).

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/cm^3);
- total porosity (TP): by calculation (% by volume - % v/v);
- aeration porosity (PA): by calculation (% volume -% v/v);
- degree of compaction (DC): by calculation (% 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 (HC): 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);
- wilting coefficient (WC, %, g/g), calculated based on hygroscopicity coefficient;
- field water capacity (FWC, % w/w), calculated based on Dumitru et al. (2009) formula, considering clay content (%), silt content (%), bulk density (g/cm^3), and layer depth (cm);
- useful water capacity (UWC, % w/w) is calculated as the difference between field capacity (% w/w) and wilting coefficient (% w/w);
- total water capacity (TC, % w/w) is determined as the ratio between total porosity (% v/v) and bulk density (g/cm^3).

RESULTS AND DISCUSSIONS

Profile 1 - Typical chernozem

Coordinates: *$44^0$453 252 - N & $27^0$501 395 - E*
Landscape: plain
Use: arable
Parent material: loessoid deposits
Groundwater: >10 m

Figure 2. Typical chernozem (2019)

Morphological characterization

Horizon Am (0-32 cm), dusty clay, dark brown, (10 YR 2/1 to wet and 10 YR 3/2 to dry) moderately developed glomerular structure, porous, permeable, frequent fine roots from cultivated vegetation, weak effervescence, gradual transition to the lower horizon;

Horizon AC (32-57 cm), medium clay, yellowish-brown, (10 YR 4/3 to wet and 10 YR 5/4 to dry), poorly developed glomerular structure in the upper half of the transition horizon, slightly friable, loose, accumulations of carbonates in the form of pseudomycelia, moderate effervescence;

Horizon Cca (>57 cm), dusty sandy clay, yellowish (10 YR 5/4 in wet and 10 YR 6/4 in dry) unstructured, friable, loose, with accumulations of carbonates in the form of pseudomycelia and small crumbly concretions, strong effervescence.

Profile 2 - Typical chernozem

Coordinates: *44^0 26' 05" - N & 27^0 30' 03" - E*

Landscape: plain

Use: arable

Parent material: loessoid deposits

Groundwater: >10 m

Figure 3. Typical chernozem, CL (2021)

Morphological characterization

Horizon Am (0-34 cm), dusty clay, dark brown (10 YR 2/1 to wet and 10 YR 3/3 to dry), well-formed glomerular structure, rough, porous, loose, non-plastic, non-adhesive, frequent fine roots, does not effervescence, wavy gradual transition;

Horizon AC (34-62 cm), medium clay, light brown (10 YR 3/3 to wet and 10 YR 4/4 to dry), moderately developed glomerular structure, rough, porous, loose, non-plastic, non-adhesive, frequent fine roots, weak effervescence, wavy gradual transition;

Horizon Cca (62-115 cm), sandy clay loam, yellowish (10 YR 4/3 to wet and 10 YR 5/4 to dry), poorly structured in the upper half, very friable, porous, loose, non-plastic, non-adhesive, rare fine roots, strong effervescence, clear straight passage.

Variation of chemical characteristics (pH and humus content) for this type of soil is shown in Figure 4. Based on the graph, it can be seen that the value of the soil reaction is 7.8 (weakly alkaline) at the surface and it increases to over 8.5 at the base of the profile. The humus content varies inversely to the soil reaction, from 4.6 in the bioaccumulative horizon to 1.8 at the base of the soil profile.

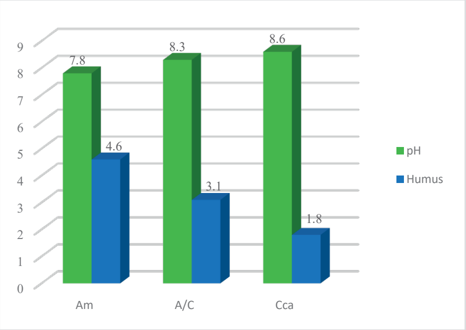

Figure 4. Variation of chemical characteristics

On the typical chernozem from Perişoru, due to the medium and undifferentiated texture on the depth of the profile, but also due to the good quality agrotechnical works, the bulk density values are the most favorable during the three years, 2019-2021 (Figure 5).

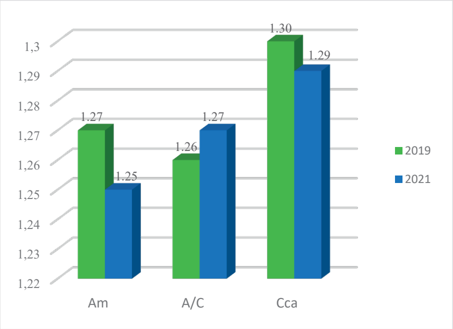

Figure 5. Bulk density (2019-2021)

The total porosity values correlate with the bulk density, due to the agrotechnical works performed, in conjunction with the clay texture and moderately developed soil structure (Figure 6).

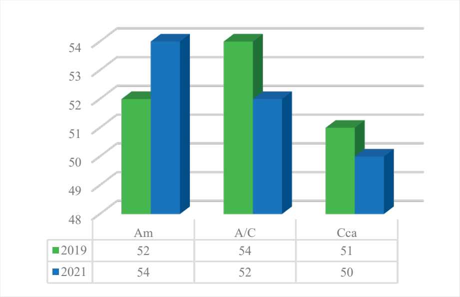

Figure 6. Total porosity (2019-2021)

The perfect correlation between total porosity and bulk density is reflected on the degree of subsidence, with almost parallel values between 2019 and 2021 (Figure 7).

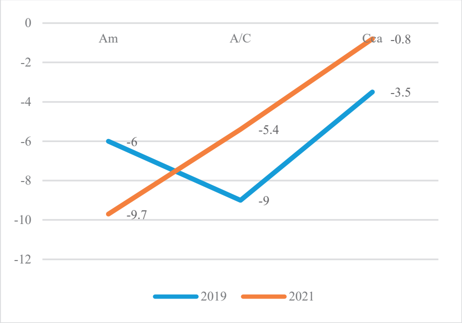

Figure 7. Compaction degree (2019-2021)

The results obtained show the most favorable characteristics, usually encountered in soils with loamy texture (medium), undifferentiated on the profile but also due to the applied technology.

The studied land is classified in the second grade of quality for arable lands, with 66 points, due to the poor climatic conditions and the groundwater level below 10 m. The graphic representation of the land evaluation marks, by crops is shown in Figure 8.

The economic efficiency by crops, during the three years of research (2019-2021) is presented in Figures 9, 10 and 11.

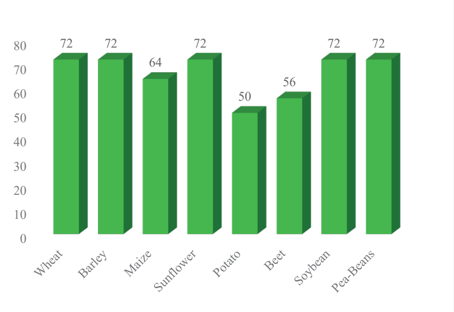

Figure 8. Land evaluation marks, by crops

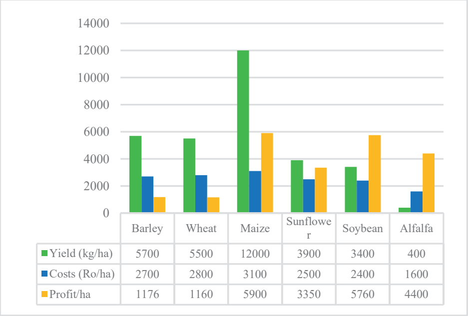

Figure 9. Economic efficiency (2018-2019)

Based on the graphic results, it can be shown that in the first year of research, profit was obtained for all crops in rotation, as a result of the superior technology applied, but also due to the productive potential of the soil.

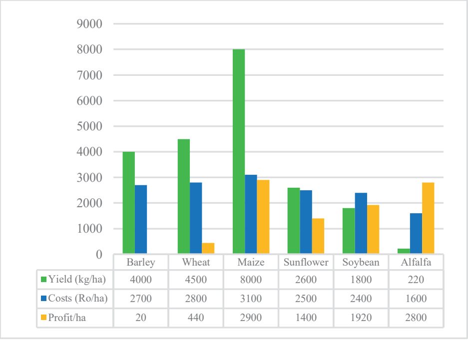

Figure 10. Economic efficiency (2019-2020)

In the second year of research, the economic situation is repeated, but with a lower profit, obtained on the basis of the resulting productions. The technology was the same, but there were less favorable climatic conditions.

Figure 11. Economic efficiency (2020-2021**)**

In the third year of research, the economic situation was the most beneficial, both in terms of climate and in terms of soil potential and applied superior technology.

CONCLUSIONS

In the conditions of the typical, vermic chernozem, formed in the steppe zone, on loessoid deposits, with groundwater found at over 10 m, in temperate climate, the following were found:

- the soil works were applied in a controlled, systematized way, at adequate humidity, were of good quality and alternated the classical system with the conservative one;
- under these conditions, the yields obtained were very good, with a substantial profit being obtained, both due to the potential of the soil and the applied technology;
- a large part of the area is equipped for irrigation, especially for the maize and soybean crops, and 3-4 waterings were applied with norms of 500 m^3/ha;
- application of chemical root fertilizers, was performed according to a rigorous plan, since agrochemical mapping is carried out once every 4 years.
- the production obtained for the main crops in the investigated period was at an average level, with relatively low expenses and with a substantial profit for each crop;
- in the case of maize for grains, the production reached the level of 12000 kg/ha, primarily due to the type of soil well-supplied with nutrients, with favorable physico-chemical characteristics, to which the applied technology is associated;
- due to the high productive potential of the soil type and the top technology applied, the soybean crop recorded a production of about 3.5 tons/ha, thus generating a profit of over 5700 lei/ha.

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