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COMPARATIVE ASSESSMENT OF SOIL CHEMICAL PROPERTIES AND FERTILITY IN SÂNANDREI, ROMANIA

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Abstract: *This study aims to comparatively evaluate the chemical properties of two representative soils from Sânandrei area (Timiș County, Romania), namely molic preluvosol and eutric gleysol, in order to highlight their fertility status and agricultural suitability. The research was based on detailed pedological profiles, with chemical analyses performed on genetic horizons. The investigated parameters included soil reaction (pH), humus content, total nitrogen, mobile phosphorus and potassium, sum of exchangeable bases (SB), cation exchange capacity (CEC), and base saturation degree (V). Standard laboratory methods were applied, including potentiometric determination of pH, wet oxidation for humus, Kjeldahl method for total nitrogen, and extraction methods for mobile nutrients.*

The data were processed using descriptive and comparative statistical approaches, including range, mean values, and profile trends for each parameter. Results showed that molic preluvosol presents a wider pH range (5.80–8.40) and higher mean values of mobile nutrients, particularly phosphorus (12.3 ppm) and potassium (145.3 ppm), indicating a more balanced chemical fertility. In contrast, eutric gleysol is characterized by higher humus (up to 2.97%) and total nitrogen content (mean 0.116%), as well as greater cation exchange capacity (mean 31.06 me/100 g soil), but lower availability of mobile nutrients and a more acidic reaction in surface horizons.

Statistical comparison highlights that preluvosol is chemically more suitable for intensive agricultural use, while gleysol shows limitations related to nutrient availability and hydromorphic conditions. The findings emphasize the need for differentiated soil management strategies, including fertilization and drainage measures, to optimize agricultural productivity under local pedoclimatic conditions.

• Introduction

Soil is an essential component of terrestrial ecosystems, having a fundamental role in supporting agricultural production, regulating biogeochemical circuits and maintaining the global ecological balance (FAO, 2015; BRADY & WEIL, 2016; LAL, 2015).

Soil chemical properties, such as reaction (pH), humus content, total nitrogen, phosphorus, and mobile potassium, as well as cation exchange capacity, are key indicators of soil fertility and ability to support plant development (HILLEL, 2004; MIHUȚ ET AL., 2018; MONTANARELLA ET AL., 2016; GREGORY ET AL., 2016).

Globally, chemical soil degradation, manifested by acidification, salinization or nutrient depletion, is a major problem, affecting agricultural productivity and food security (FAO, 2015; LAL & STEWART, 2012; SMITH ET AL., 2016). In Europe, studies have shown significant variations in chemical properties depending on pedoclimatic conditions and land use, highlighting the role of agricultural management in maintaining fertility (JONES ET AL., 2012; TÓTH ET AL., 2017; PANAGOS ET AL., 2015; HORN ET AL., 2004; LAL & STEWART, 2012; DEXTER, 2004).

In Romania, soil research has shown that the chemical properties of soils are closely correlated with pedogenetic processes and parental material (FLOREA & MUNTEANU, 2012; FLOREA ET AL., 2014; BLAGA ET AL., 2005; BĂLTĂREȚU & BADEA, 2007). The soils of the Western Plain, including those in the Timișoara area, present a great diversity of chemical conditions, generated by the alternation of leaching, accumulation and hydromorphy processes (DUMITRU ET AL., 2011; IANOȘ ET AL., 1997; MIHUȚ ET AL., 2023; STROIA ET AL., 2025).

• Material and method

The study was carried out in the area of Sânandrei commune, located in the north-western part of Timiș County, in the vicinity of Timișoara, within the geomorphological unit of the Banat Plain. From a geographical point of view, the area is characterized by lowland relief, poorly fragmented, developed on loessoidal deposits and fluvials, which constitute the parent material for the analyzed soils. The climatic conditions are specific to a temperate-continental climate, with sub-Mediterranean influences, characterized by average annual temperatures of about 10–11°C and annual rainfall of 550–600 mm, which determines a variable water regime and, locally, conditions of excess humidity (MIRCOV ET AL., 2025).

From a pedological point of view, two representative types of soil were selected in the study, namely the soft preluvosol and the typical eutric gleiosol, which reflect the main conditions of formation and evolution of the soils in this region. The soft preluvosol is developed on loessoid deposits and presents a well-differentiated profile, characterized by clay-alluvial processes and accumulation of fine fractions in the subsurface horizons. The typical eutric gleiosol is formed on fluvial deposits and is influenced by the high level of groundwater, presenting obvious hydromorphic features, generated by glaciation processes.

The study material consisted of representative soil profiles for the two soil types, for which the chemical properties were determined on genetic horizons, according to the standard pedological methodology used in soil characterization studies in Romania. The analyses focused on the main chemical indicators of soil fertility, namely soil reaction (pH), humus content, total nitrogen, mobile phosphorus, mobile potassium, sum of exchangeable bases (SB), hydrolytic acidity (AH), total cation exchange capacity (CEC/T) and degree of saturation in bases (V%).

The determination of the soil reaction was performed potentiometrically, in soil-water suspension, expressed as pH in H_2O. The humus content was determined by the wet oxidation method, and the total nitrogen by the Kjeldahl method, widely used for the evaluation of the total nitrogen reserves in the soil. Mobile phosphorus and mobile potassium were determined by extraction with specific solutions (Egner-Riehm-Domingo method), the results being expressed in ppm, as an indicator of immediate availability for plants. The sum of the exchangeable bases was determined by the extraction of the basic cations (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}), and the total cation exchange capacity was calculated as the sum of the bases and hydrolytic acidity. The degree of saturation in the bases was determined as the percentage ratio between the sum of the bases and the total cation exchange capacity.

The data processing was carried out through descriptive and comparative statistical methods, in order to highlight the differences between the two types of soil and the variability on the profile. For each chemical indicator, the variation intervals (minimum–maximum), the average values and the evolution trends per profile were determined. The comparative analysis made it possible to identify significant differences between preluvosol and gleiosol in terms of soil reaction, organic matter content and mobile nutrient levels.

The graphical representation of the data was made using a series of real values for each analyzed horizon, the graphs being elaborated in English, according to the requirements of international scientific journals. These include representations of the variation of pH, humus, total nitrogen, phosphorus and mobile potassium, as well as indicators of the adsorbent complex, facilitating the visual interpretation of the differences between the two soils.

The methodology adopted allows for an integrated assessment of the chemical properties of the studied soils and provides the basis for interpreting the relationships between pedogenetic processes and chemical fertility, as well as for making recommendations on agricultural use and the necessary breeding measures.

• Results and discussions

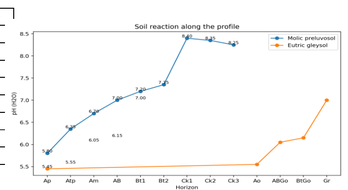
The analysis of the chemical properties of the soft preluvosol and the typical eutric gleiosol in the Sânandrei area highlights significant differences both in the distribution of the chemical indicators and in their agronomic functionality. Differences are closely related to the dominant pedogenetic processes, namely clay-dilution in the case of preluvosol and gleiation in the case of gleiosol (table 1).

In contrast, typical eutric gleiosol exhibits a more acidic reaction in the surface layer, with a slower growth towards neutrality at depth. This difference indicates a lower buffering capacity of the reaction in the agronomic active layer and may lead to limitations in the availability of some nutrients, in particular phosphorus.

The humus content, represented in Figure 2, highlights the fact that gleiosol has higher values in the upper horizons, reaching almost 3%, compared to about 2.4% in the preluvosol.

Comparative chemical properties of the soils of Sânandrei

Indicator	Preluvosol molic	Gleiosol tipic eutric
pH	5.80–8.40	5.45–7.00
Humus (%)	1.42–2.42	1.31–2.97
N total (%)	0.070–0.120	0.080–0.147
P mobil (ppm)	2.7–22.5	4.0–8.0
K mobil (ppm)	126–157	10–104
SB (me/100 g)	17.65–25.17	23.15–28.84
T (me/100 g)	22.59–27.87	29.76–32.32
V (%)	76.9–92.6	77.19–89.23



gure 1. Comparative chemical properties of molic preluvosol and eutric gleysol.

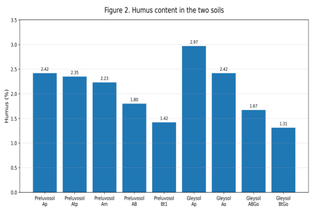


Figure 3. Total nitrogen content in the two soils

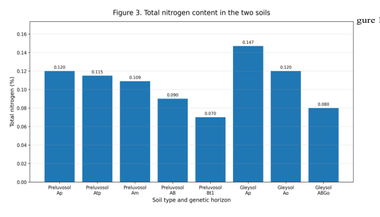


Figure 3. Total nitrogen content in the two soils

Figure 4. Mobile phosphorus in the two soils

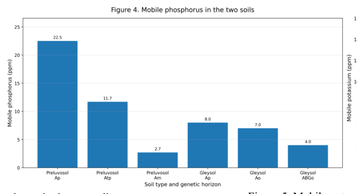


Figure 5. Mobile potassium in the two soils

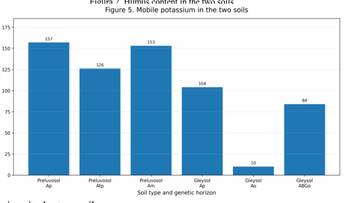


Figure 6. Exchange complex in molic preluvosol

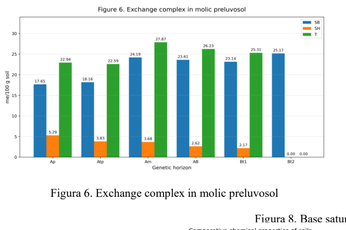


Figure 8. Base saturation degree in the two soils

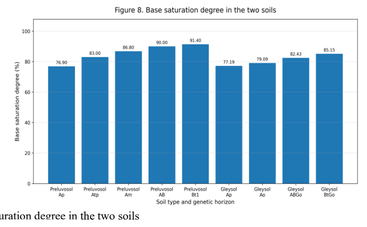


Figure 7. Exchange complex in eutric gleysol

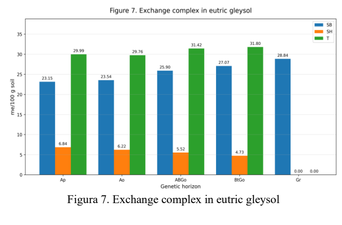
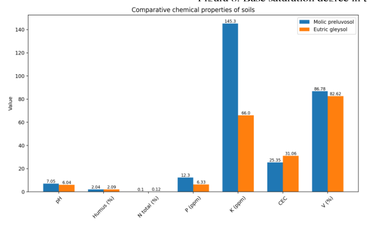


Figure 8. Base saturation degree in the two soils



Indicator	Preluvosol	Gleiosol
pH mediu	7.05	6.04
Humus mediu (%)	2.04	2.09
N total mediu (%)	0.101	0.116
P mobil mediu (ppm)	12.3	6.33
K mobil mediu (ppm)	145.3	66.0
SB mediu	21.99	25.70
T mediu	25.35	31.06
V mediu (%)	86.78	82.62

• Conclusions

The comparative analysis of the chemical properties of the soft preluvosol and the typical eutric gleiosol in the Sânandrei area revealed significant differences in terms of the level of fertility and agronomic functionality of the two types of soil. The results obtained show that soft preluvosol presents a more favorable reaction for most agricultural crops, characterized by an evolution from low acid in the surface layer to neutral and low alkaline in depth, which ensures a better availability of nutrients.

At the same time, preluvosol stands out for higher values of mobile phosphorus and potassium in the arable horizon, which gives it a clear agronomic advantage over gleiosol. The high degree of saturation in bases and the balanced distribution of nutrients indicate good chemical fertility and adequate capacity to sustain agricultural production.

Typical eutric gleiosol, on the other hand, exhibits a higher content of humus and total nitrogen in the surface layer, as well as a higher cation exchange capacity, reflecting a high chemical nutrient retention potential. However, this advantage is limited by the more acidic reaction in the upper horizons and the low levels of mobile phosphorus and potassium, as well as by the specific hydromorphic conditions, which affect the actual availability of nutrients and the biological activity of the soil.

The descriptive statistical analysis confirmed that the soft preluvosol presents more favorable average values for the indicators directly involved in plant nutrition, while gleiosol, although rich in organic matter and with a developed adsorptive complex, is less agronomically efficient. Overall, it can be concluded that soft preluvosol is better adapted for intensive agricultural use, while typical eutric gleiosol has limitations that require specific ameliorative interventions.

Based on the results obtained, it is necessary to adopt differentiated management measures for the two types of soil, in order to optimize fertility and agricultural use.