PEDOAGROCHEMICAL CHARACTERISTICS OF APPLE TREE GROWING SOILS FROM THE REGHIN REGION

Marilena MĂRGHITAŞ [1], Constantin TOADER[1], Mihaela MIHAI[1], Lavinia MOLDOVAN[1], Maria Hangan[1]

E-mail: mmarghitas@usamvcluj.ro

Abstract

The soil is considered the fundamental natural resource of the agricultural system, and is at the same time the essential support of life. It is known that over 90% of human and animal food is produced in or on the soil and the origin of all the living organisms on „Earth" is directly or indirectly connected to the soil. In contrast to other means of production, the soil layer of the Earth, of one country or one region is limited from a quantitative point of view and consequentially the attainment of increasingly higher crops is not to be done through extensive agriculture, but only by increasing the production per surface unit. Also, the soil is the result of the rock, the relief, clime and vegetation, being formed through the permanent and symultaneous action of the biosphere, the atmosphere and the hydrosphere on the litosphere and also of human activities. The purpose of our research is the description of the main pedoagrochemical characteristics of representative Reghin region soils, such as typical preluvosoil [SRTS-2003], brown argiloilluvial soil [SCRS-1980] and argic chernozem [SRTS-2003], and argiloilluvial chernosiem [SCRS-1980] destined for fruit tree plantations. It is a known fact that the favorability of soils for apple growing are closely related to the clay content of soils, as it was proved that these species grows normally at indicator values between 20 and 40% [Teaci et al., 1976]. The state of the research is given by rigorous experiments in a classic apple tree plantation performed on a typical preluvosoil and an argic chernozem from the Reghin region using the *Golden Delicious* and *Starkrimson* apple tree varieties that are representative for the region and are very popular both inside and outside Romania's borders. The studied territory lies at the Eastern edge of the Transylvanian Plain, northwest of the ciry of Reghin, where from a geological point of view, the sedimentary fragmentations are superposed, in an alternance of thin layers of clay marl, sandy marl and cohesive sands. This geological constitution favors both surface and profound erosion. The importance, originality and degree of novelty of these experiences is related to problems yet to be solved concerning the control of soil erosion on representative slopes from fruit tree plantations, and also the measures taken for the preservation and enhancement of organic matter content and the formation of humus in accordance with the climatic specificity of the Reghin region and the unfavorable repercussions of recent climatic anomalies.

Key words: soil, fertility, pedoagrochemical modifications, apple tree

Agricultural activity has in numerous ways made a major contribution in the sustainable development of the economy of a country, the most important component being the soil and its characteristics. Agriculture is not only the support of biomass production or the activity that ensures human food, but it also is the basis of the existence of life on „Earth". The people who perform agricultural acitivities have to assume the responsibility of protecting the soil and other resources of the environment that can be damaged through irrational exploitation. The fruit tree area of Reghin, an established region for apple tree plantations, where our research was conducted, has a moderate temperate climate, specific to the hill region with either sunny, or shadowed slopes that cause temperature differences. Also, the valleys favour frequent fog and the abrupt slopes run a high risk of erosion. Usually the soils from fruit tree plantations have physical, chemical and biological characteristics that are not proper for specific technologies and are many times detached from the requirements of fruit tree species. As a consequence, the accomplishment of production and productivity performance for these soils, one must take the pedoagrochemical characteristics into account, in order to assess and manage the eficient sustainment, enhancement and protection of the productive capacity of soils, especially their fertility. In this respect, this paper describes the main pedoagrochemical characteristics of soils that are representative for typical preluvosoils (brown argiloilluvial soil) and argic chernosem (argiloilluvial chernosem) from the established fruit tree area of Reghin, particularly, soils from the S. C. Heliantus Fruit Tree Farm, that was

[1] University of Agricultural Sciences and Veterinary Medicine, Faculty of Agriculture, Cluj-Napoca, Romania

created after the dissolution of the former State Agricultural Enterprise Reghin.

MATERIAL AND METHOD

Depending on the soils and landforms, throughout history, people of the Reghin area have been mostly grain growers, as well livestock and fruit-growing farmers, turned and used some of the agricultural land through biennial and triennial crop rotation, have established the right places to grow vines, fruit trees and hayfields or pastures for grazing animals. The location of experiments was decided on representative soils of the fruit-tree basin of Reghin, namely the typical argic chernozem and preluvosoil respectively, occupying large areas in this region, where classic and intensive fruit-tree plantations were established. This research relied on digging along soil profiles, study and describe their pedoagrochemical characteristics, performing analyses both in the field and the laboratory, to assess the fertility state and their favorability for apple culture in the fruit growing basin of Reghin. Soil profiles were conducted on a typical preluvosoil (*Figure 1*) and argic chernozem (*Figure 2*) representative of a classic apple plantation on S.C.Heliantus fruit growing farm S.C. Heliantus (from the former IAS Reghin), at the estern border of th Trasylvania Plain, north-west of Reghin, along National Road Reghin to Nasaud, neighboring villages are Sântu, Lunca Tecii and Dedrad. The surface area, where the farm is located, is characterized by an overall great diversity of relief, including small plates at an altitude of 400-500 meters, deep valleys, extensive slope processes across the entire slope caused by surface erosion but especially landslides, some very prominent, others not so severe making up small platforms of irregular configuration. To fight erosion and landslides, serious investments have been made before the Revolution, by setting up fruit plantations organized as farms, where agriculture is practiced correctly aiming at the production of great organic fruit both quantitatively and qualitatively that is required for export. Pedoagrochemical soil profile analyses were performed according to ICPA methodology for agrochemistry laboratories "Agrochemical analysis methodology to assess the fertilizer and amendment requirement" ICPA 1981 and description of soil profile according to SRTS - SRCS 2003 - 1980.

RESULTS AND DISCUSSIONS

a) **Typical_preluvosoils** (argillic brown) are known in literature under the names of argillic brown soils, brown soils and brown textural degraded soils.

For SRCS (1980), the argillic brown soil type is defined as exhibitig an argillic B horizon (Bt), of any color (other than the one mentioned for brown- reddish soils), and values greater than 3.5 wet, at least in structural elements and the first subhorizon. They are widespread soils in Romania, being found in the same area with luvic brown soils, albic luvisoils and planosoils. The typical preluvosoil, namely the typical argillic brown soil, is spread over an area of about 640.000 ha in agriculture, in theTransylvanian Plateau, Carpathian foothills. In terms of pedogenesis, we encounter grassy vegetation conditions (vernal species) as well as woody, with an extremely varied parental material. From a climate perspective, the average annual temperature and rainfall varies quite broadly, namely 6-9^{o}C temperature and 500-900 mm rainfall. Parent material is generally composed of rich calcium clays, marls, marly clays. Argillic brown soil genesis is specific: bioaccumulation is moderate, sometimes intense, forming mull type humus, where fulvic acids still predominate; alteration processes, dealkalinization, acidification, leaching and migration of colloids does not show to be too intense, only soluble salts are totally leached, $CaCO_3$ is also encountered in depth and by means of the migration and accumulation of clay, a clear differentiation of a Bt horizon is achieved, devoid of $CaCO_3$, where structural aggregates are covered by a thin film of clay. The typical preluvosoil has the following sequence of horizons on the profile [SRTS - 2003]: $\mathbf{A_0 - B_t - C_{Ca}}$

Reghin The pedoagrochemical characterisation of the typical prleuvosoil in Reghin:

Pedogenetic conditions *(figure 1):* Northern slopes are moderately inclined, on a 6^{o} slope, with north, north-eastern, western exposition, partially exhibiting old agriterraces, soil appearance: crust, parent material of marly clay, underground water depth > 10 m. Natural vegetation: *Stipa lessingiana , Festuca sulcata, Andropogon ischaemum, Artemisia campestris, Agrostis sp., Trifolium sp., Thymus glabrescens.* Used for conventional fruit tree plantation.

The typical preluvosoil (SRTS-2003), brown argillic (SRCS-1980), physically (according to the pedological profile) has a medium to heavy texture of clayey loam, with an obvious compact argillic horizon (Bt), which may jeopardize the airhydric regime and porosity at the depth explored by roots.

The pedoagrochemical characetristics of the typical preluvosoil in Reghin:

Pedoagrochimice soil analyses from conventional orchards are required every four years, as agro-chemical parameters of soil productivity condition soil productivity in fruit tree plantations and must be unconditionally correlated

with specific consumer requirements and necessary nutrients of apple varieties under question. The analysis of the main agrochemical indices of typical preluvosoil in Reghin (*table 1*) reveals the acidic, dealkalinized character of the soil in a the classic apple plantation, which requires, first, ameliorative measures to correct the reaction by means of calcareous amendments. It is average supplied in humus and nitrogen and low on phosphorus and potassium.

Profile make-up: Ao – A/B – Bt – C.

- Ao 0-22 cm, brown-gray granular structure, grainy destroyed, roots, and coprolites with a layer of smooth porous soil, compact, moist, loam-clay texture;
- A/B 22-41 cm, light rusty brown, polyhedral angular structure, loam clayey structure, plastic, adhesive, thick roots, coprolites, fine porous-porous, moderately compact, moist, gradual transition;
- Bt 41-58 cm, yellowish brown, gray, with average angular polyhedral structure, separation points, roots, and coprolites, finely porous, moderately compact-compact, moist, loam-clayey texture, gradual transition;
- C 58-120 cm, mottled with dark yellowish brown and whitish spots, rough, textured clay, and small bobovine and separation points, finely porous, compact, wet, waterproof.

Fig. 1. Morphologic traits for the typical preluvosoil in Reghin (2008)

Table 1

Physical and chemical analyses of the typical preluvosoil in the fruit-tree basin of Reghin (2008)

Horizon and depth (cm)		pH	Humus %	N total %	P_2O_5 mobile mg/100 gr sol	K_2O mobile mg/100gr sol	SH	V%	Mecanic analysis			Texture
									Coarse sand	Fine sand	Dust clay	
Ao	0-20	5.07	3.61	0.199	2.2	1.31	14.2	58,7	3.2	23.1	38.4	LA
A/B	25-40	4.86	3.51	0.188	1.0	7.9	14.2	58.7	3.2	24.3	36.2	LA
Bt	41-58	5.04	1.77	-	-	-	12.3	56.0	5.2	24.3	39.4	LA
C	70-90	5.27	-	-	-	-	12.6	65.6	4.0	25.6	53.6	A

Fertility and productivity of the soil are too low to support a plantation of apple during fruition in order to reach biological production potential. In this respect, organo-mineral fertilization is paramount, relying on a thorough agrochemical study to obtain quantitative and qualitative fruit production to ensure food safety and security.

The pedoagrochemical features of the typical preluvosoil in Reghin (*table 1*) are essential in setting technologies for rational fertilization in classic apple plantations, to obtain high yields of quality fruit and to prevent negative phenomena dof soil and environment degradation, to promote the harmonization of the environment and anthropogenic factors with the objectives of economic activities.

b) **Argic-chernozem-soil type** (argillic chernozem) is known in literature as the degraded chernozem or highly leached chernozem.

The SRCS-1980 argillic chernozem soil type is defined by a mollic horizon A (I), with chromes smaller than 2 and an argillic horizon B (Bt), having in the superior layer, smaller chromes and values under 3.5 wet and lower values than 5.5 dry.

According to SRTS-2003 argic chernozem is deemed as a part of that argic subtype of phaeosem and partly, part of the argic chernozem subtype, evidence that pedogenetic conditions are almost similar to those of the cambic chernozem.

There soils are widespread in Romania, occupying an area of about 590.000 ha, representing approximately 2.5% of the total land and are common in the most humid steppe area, near forest areas, of transition and in some sumountainous depressions, where one can encounter a rich herbaceous and woody vegetation.

Herbaceous vegetation is represented by different species of steppe: fescue (*Festuca vallesiaca*) stipa (*Stipa joannis*), bulbous bluegrass (*Poa bulbosa*), species of sedge (*Carex praecox*), wormwood (*Artemisia Austrian*) and other species.Woody vegetation is usually composed of mixtures of heaven, flasks, oaks, greyish oak, downy oak, oak, mixture of lime, ash and common maple.

From a climatic point of view, the mean annual temperature does not fall below 8.5 °C while mean annual precipitation is regularly 550 mm.

Parent material is generally composed of sedimentary rocks, loess, sand, clay and marl rich in $CaCO_3$.

Argillic chernozem soil genesis is specific: bioaccumulation is moderate, sometimes intense, forming mull humus type, humic acids are predominant, alteration processes, dealkalinization, acidification, leaching and migration of colloids are not too intense, only soluble salts are entirely leached, $CaCO_3$ is also active in depth and through the migration and accumulation of clay, a clear differentiation of a Bt horizon is achieved, without $CaCO_3$, where structural aggregates are covered by a thin film of clay. The argic chernozem, has the following sequence of horizons along the profile (SRTS - 2003): $\mathbf{A_m - B_t - C_{Ca}}$

Pedoagrochemical characterization of the argic chernozem in Reghin:

Pedogenetic conditions (figure 2): Northern slopes are moderately inclined, on a 6^o slope, with north, north-eastern, western exposition, partially exhibiting old agriterraces, soil appearance: crust, parent material of marly clay, underground water depth> 10 m. Natural vegetation*: Festuca sulcata, Agrostis sp., Trifolium sp.,* Used for conventional fruit tree plantation.

- Am 0-45 cm, dark brown or very dark brown when wet, glomerular structure that is more or less stable;
- Bt 45-120 cm, dark amber-brown to yellowish brown wet with prismatic structure, with structural elements covered by a thin film of clay;
- C 120-140 cm, yellow-whitish, with strong effervescence, when dry and brown-yellow when wet devoid of any structure.

Fig. 2. Morphologic traits for the argic chernozem in Reghin (2008)

The argic chernozem (SRTS-2003), argillic chernozem (SRCS-1980), physically (according to the pedological profile) has a medium to heavy texture of clayey loam, with an obvious compact argillic horizon (Bt), which may jeopardize the airhydric regime and porosity at the depth explored by roots.

Pedoagrochemical traits of the argic chernozem in Reghin:

Pedoagrochemical soil analyses from conventional orchards are required every four years, as fruit trees exploit the same substrate for agreat number of years, and the current concept of fertilizing fruit orchards correlates soil fertility agrochemical indices with differentiated requirements for specific consumption of the main nutitive elements.).

Table 2

Physical and chemical analyses of the typical preluvosoil in the fruit-tree basin of Reghin (2008)

Horizon and depth (cm)		pH	Humus %	N total %	P_2O_5 mobile mg/100gr soil	K_2O mobile mg/100gr soil	SH	V%	Mechanic analysis					Texture
									Coarse sand %	Fine sand %	ust%	clay%	D.a. g/cm^3	
Am	0-20	5.24	4.61	0.286	2.7	4.26	14.2	58.7	0.2	16.2	53.0	30.6	1.03	LA
	20-45	5.51	4.51	0.188	1.2	7.19	14.2	58.7	0.2	16.2	52.4	30.6	1.22	LA
Bt	45-120	5.60	1.77	0.073	-	-	12.3	59.0	0.2	15.0	52.0	34.4	1.45	LA
C	120-140	6.10	-	-	-	-	12.6	65.6	0.1	19.8	51.8	28.3	1.50	A

From a pedoagrochemical point of view, the argic chernozem in Reghin (Table 2), has a moderate acidic reaction. It has an average humus supply, as well as moderate in nitrogen and phosphorus, but exhibiting high potassium content. Fertility and productivity of the soil is good, but to support a plantation of apple to its full biologic production potential, rational fertilization technologies are necessary to obtain quantitative yields and higher quality fruit.

CONCLUSIONS

The typical preluvosoil of Reghin for fruit growing, shows the class and type pedological characteristics, including dealkalinization and acidification phenomena and accompanying clay and alkali eluviation towards the middle horizons of the profile. The pedoagrochemical chacterisation of the typical prelvosoil reveals that ecologically limiting factors are: high clayey structure of Bt and C horizons, dealkalinization of the adsorption complex, the average supply of humus and nitrogen and low phosphorus and potassium supply. It is clear that a technology that combines calcic amendment calcium, as well as mineral or organo-mineral fertilization are effective measures in increasing soil fertility. The argic chernozem of Reghin for fruit growing, has the typical class and type attributes and acquired, over time, as a consequence of technologies for multiannual and preponderantly mineral fertilization, those pedoagrochemical characteristics that are favorable to apple cultivation. Soil profiles presented show the influence of climate and heterogeneous parent materials on the physico-chemical properties of soils leading their grouping into categories such as those of acidic or moderately acidic soils with acidic and moderately acidic reaction and degraded texture, recommending growers in the area to aim at correct fertilizer application technologies in orchards in accordance with the requirements of specific and overall consumption of fruit species.

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