THE DEGREE OF SOIL FERTILITY IN THE DRAINAGE BASIN OF RÂUL ALB STREAM, DÂMBOVIŢA COUNTY, UP TO THE POINT IT MEETS BĂRBULEŢU STREAM, EXPRESSED THROUGH THE SOIL REACTION AND THE SUPPLY OF NUTRIENTS (ORGANIC MATTER, NITROGEN, PHOSPHORUS AND POTASSIUM)

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Abstract

The field research took place in the interval 2019-2020, in the higher drainage basin of Râul Alb stream, located in the north-western part of Dâmboviţa County, the analysis covering an area of 4034 ha. The research into the complex phenomena of erosion in the analyzed area was based on a pedological study, which consisted in performing 46 pedological profiles in representative areas of the analyzed region. After centralizing the results, it was noted that 59.42% of the entire analyzed area display a low alkaline reaction, at least at the level of the upper layer, because of its $CaCO_3$ content, which exacerbates the risk of landslide. From the point of view of the supply of nutrients (humus), most of the soils have a low and extremely low supply of these elements at the level of the upper layer, namely 73.42% of the analyzed area; as for the nitrogen supply, 26,68% of the entire surface of the drainage basin display severe shortages of this element. The situation is really serious in the case of the supply of mobile phosphorus in the soil, 3280.27 ha of the analyzed surface are low and very low in phosphorus, namely 76.20%, while the levels of potassium supply in the soils in the higher drainage basin of Râul Alb stream are mostly moderate and good, only 620.85 ha (14.42%) are extremely low and low in potassium supply.

Key words: drainage basin, organic matter, nitrogen, phosphorus, potassium

Fertility or the productive potential of the soil is the basic feature of the ground that ensures good plant growth and normal plant development through the simultaneous, continuous, and combined action of all factors forming part of its ecological complex. The fertility of the soil can be natural, where it is only due to environmental factors and cultural, induced by human action through various works (Puiu Şt. and Basarabă A., 2001). This fundamental characteristic is dependent, on the amount of humus contained in the soil, but also on its quality. Mull limestone humus is the best in quality and most suitable for plant growth and development (Dalal R.C. *et al*, 1996). Furthermore, the soil fertility picture is integrated by its reaction and the degree of supply of nutrients (nitrogen, phosphorus and potassium), but also by the ratio between them in the soil (Vintilă I. *et al*, 1984). Knowledge of all these aspects concerning the fertility status of the soils in the catchment areas of hill and mountain areas requires complex information, both of the pedological and the morphological nature of the investigated areas (Bucur N. and Lixandru Gh., 1997). Soil information is gathered by research into the natural environment in which soils are formed and evolved, soil sampling, chemical analysis, and interpretation according to the methodologies in effect. Morphodynamic information comes from the analysis of two groups of morphodynamic factors that can influence the fertility of the soils: the active factors (precipitation, temperature, wind, hydrographic network, anthropogenic activity) and the passive factors (geology of the area, landform, and degree of land cover with vegetation) (Loghin V., 1996). On slopes, the thickness of the fertile layer on the soil surface is directly influenced by the development of surface erosion processes, which evolve over time, deeply affecting the soils (Buckman H.O., Brady N.C., 1969).

The soil cover of a region, as well as that of the entire planet, is limited in quantity by those geographical limits, and if it's rationally exploited, it can increase its productive potential (Fitzpatrick E.A., 1977).

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LOCATION OF THE RESEARCHED AREA

The river basin of the Râul Alb is located in the central-southern part of Romania, on the territory of the Dâmboviţa County, more specifically in its north-western part. The research in this basin targeted its higher-up part until its confluence with the Bărbuleţu Valley, which stretches on 4 034 ha. The topography of the area is prevailed over by the Curvature Subcarpathians; the Râul Alb river basin is located at the western end, specifically in the Ialomița Subcarpathians. The northern part of the watercourse also includes the southern part of the Leaota Mountains its springs being in the Plaiul Găvana (*figure 1*). The maximum altitude in the north of the river basin is 1 044 m, reaching 433 m at the confluence with the Bărbuleţu Stream in its southern part. The outcome is an altitude amplitude of 611 m, which, combined with a length of the sector under investigation of 13.55 km, leads to an average slope of 4.5%. The Râul Alb is affluent on the left side of the Dâmboviţa River.

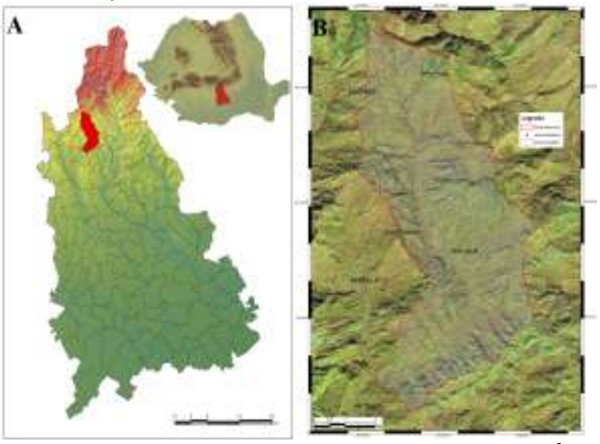

Figure 1 a, b **The location of the river basin of Râul Alb within the county of Dâmboviţa;** b. **Satellite map with the geographical boundaries of the river basin of the river Râul Alb, until confluence with the Bărbuleţu stream**

The 4 034 ha area of the catchment area, up to the point of the Barbuleţu spill, shall be divided into Land Administrative Units (L.A.U.) (*figure 2*):

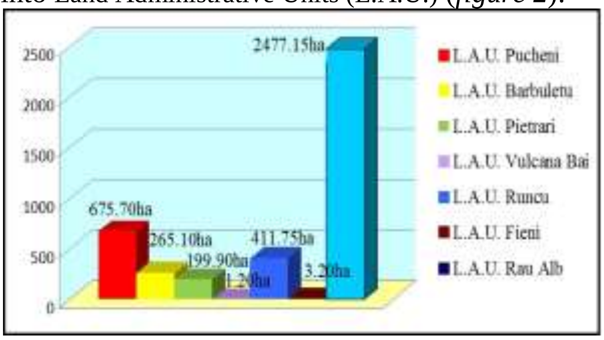

Figure 2 **The chart of L.A.U. s on which the river basin stretches, up to its confluence with Bărbuleţu stream**

- L.A.U. Pucheni – 675.70 ha;
- L.A.U. Bărbulețu – 265.10 ha;
- L.A.U. Pietrari – 199.90 ha;
- L.A.U. Vulcana Băi – 1.20 ha;
- L.A.U. Runcu – 411.75 ha;
- L.A.U. Fieni – 3.20 ha;
- L.A.U. Râu Alb – 2 477.15 ha.

MATERIALS AND METHODS

At the base of the data, regarding the reaction of soils in the Raul Alb river basin, to the confluence with the Bărbuleţu Stream and their supply with humus, nitrogen, phosphorus, and potassium, the soil study was carried out in 2019-2020, with the three-component phases: Field phase, laboratory phase, and office phase (Florea N., 1964; Duchaufour Ph., 1988). The aim of the research in the above basin is to estimate as closely as possible the risk of the occurrence of erosion processes through the GIS methods and how they influence soil fertility.

Forty-six representative soil profiles were executed, from which, 224 soil samples were embarked on diagnostic horizons.

The pedological study was conducted according to the „*Metodologia elaborării studiilor pedologice, volumele I, II, III, 1987*", and the definition of soil units and land classes according to S.R.T.S. 2012+.

Methods of chemical analysis

The soil samples were examined synthetically in the laboratory of the Dâmboviţa Office of Pedological and Agrochemical Studies. The following chemical analyzes have been worn out to determine the reaction of soils and the degree of supply of nutrients:

- the reaction (pH) of the soil by the potentiometric method in aqueous solution;
- the content of organic matter (humus) (%) by titrimetric determination (Walkley-Black method in Gogoașă modification);
- granulometric analysis or texture (5 fractions), through the Kacinski method;
- nitrogen content (nitrogen Index - I.N.) (%), resulting from calculation;
- mobile phosphorus content (ppm) by Egner - Riehm - Domingo method;
- mobile potassium content (ppm) by the method of extraction with ammonium chloride.

Creating the GIS database

To create the primary database, we started with the topographic maps 1:25 000 scales, and 5m equidistant, in which we scanned and georeferenced the Stereo 70 projection system. Furthermore, data on constructed areas (map of settlements, boundaries of administrative units –

built on *Open Street Map* applications) were also used.

By digitizing the level curves and the hydrographic network, we created the digital elevation model *(DEM*) with a 10 m resolution using the *ArcToolbox - Spatial analysis tools - Interconnection - Topo to Raster* of the *ArcGIS 10.6.1* software. For further research into the degradation of soil fertility due to erosion phenomena, morphometric maps (hypsometry, slope, relief, fragmentation – density and depth of fragmentation) and morphographic maps (slope orientation) were produced from DEM (*figure 3*). Also, the *DEM* was at the basis of making the slope shading map (*Hillshade*), which was the main tool for generating the other maps, all at a resolution of 10 meters.

To finally arrive at the analysis of the erosion risk in the river basin of the Râul Alb, we have chosen the weighted overlapping of thematic maps (*WOA*) method.

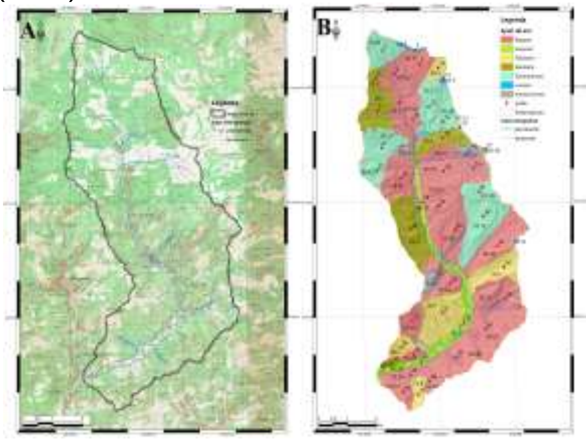

Figure 3 a. **The map of the level curves, scale 1:25.000 in the upper section of the Râul Alb river basin;** b. **The map of soil types in the stream basin of the Râul Alb to the confluence with the Bărbuleţu stream**

RESULTS AND DISCUSSIONS

Soil reaction (pH) in the upper horizon

At the level of the research area in the river basin of the river Râul Alb, the predominant is the low alkaline reaction of the soil in the upper horizon, followed by neutral (*figure 4*). The alkaline reaction of soils, caused by the presence of CaCO3, which is gravy on a clay texture of the parental material, encourages the activation and evolution of landslides.

The 4034 ha analyzed fall within the following soil reaction classes (pH):

- moderate acid reaction - 520.68 ha;
- low acid reaction - 487.31 ha;
- neutral reaction - 629.13 ha;
- low alkaline reaction - 2 396.88

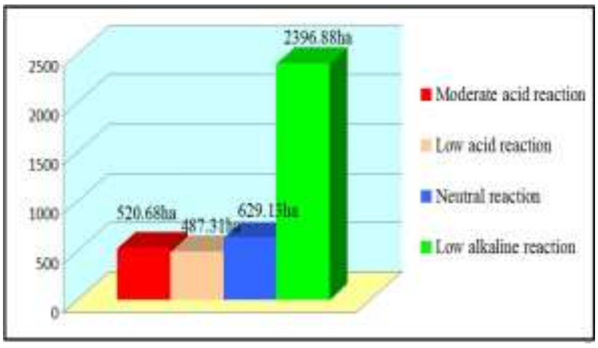

Figure 4 **Graph of soil reaction (pH) in the upper horizon according to indicator 63 of the „Metodologia elaborării studiilor pedologice, partea a III-a"(Florea N. *et.al*., 1987)**

The supply of organic matter (humus) to soils in the upper horizon

Dominance is in the upper horizon of the soils of the upper Basin of the Râul Alb the poor supply of organic material, and the middle supply is found in areas two times smaller than this. Poor humus supply results in low humus reserves in the first 50 cm and low soil fertility. The land areas of the basin under investigation are predominantly on moderate and strongly inclined slopes subjected to the erosion of surface and depth processes, which remove annually significant quantities of fertile material, thereby reducing the productive potential of agricultural land.

At basin level, the area of 4034 ha is hence, divided into soil supply classes of organic matter (humus) in the upper horizon (*figure 5*):

- extremely poor supply - 56.49 ha;
- very poor supply - 490.47 ha;
- low supply - 2414.99 ha;
- medium supply - 1072.05 ha.

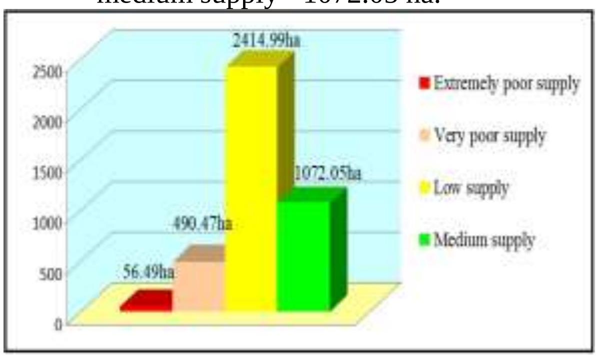

Figure 5 **Graph of soil supply of organic matter (humus) in the upper horizon according to indicator 70 of the „Metodologia elaborării studiilor pedologice, partea a III-a"(Florea N. *et.al*., 1987)**

The interpretation of soils humus content is made according to their texture in the first part of the pedological profiles. The more clayey the soil is, the bigger the quantity of organic matter has to be in order to have a satisfying supply of this element. Te sil texture, through the three elements that define it (clay, dust, sand), has a definitive role in land degradation through erosion located predominantly on slopes, which is also the case for the analyzed drainage basin, through the resistance that the soil might have to the erosive action of rain drops (*figure 6*).

At the drainage basin level, the medium-fine and fine textures are predominant, adding up to 3544.11 ha.

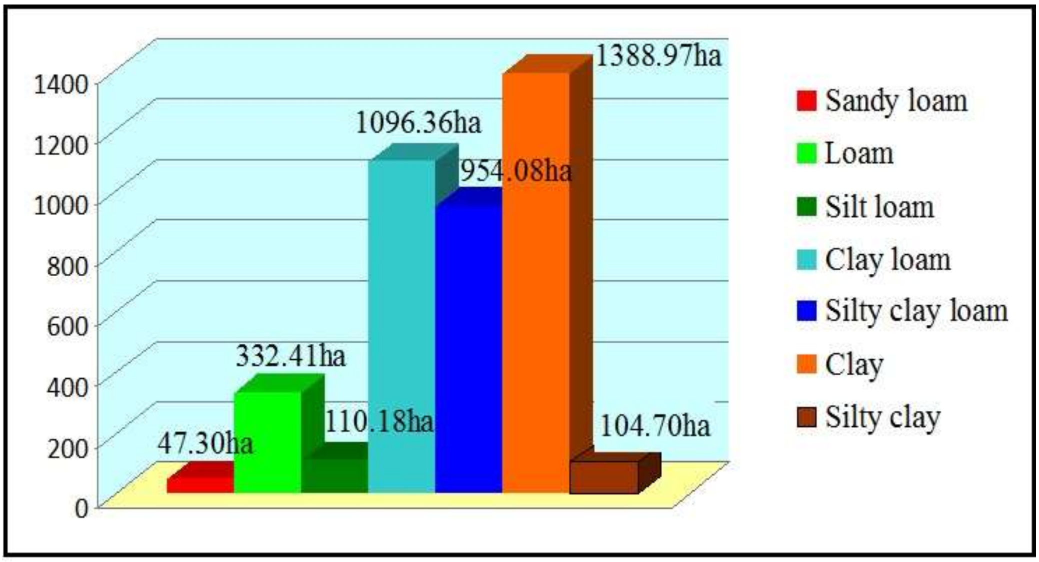

Figure 6 **Graph of soils texture in the upper horizon, according to indicator 23 of the „Metodologia elaborării studiilor pedologice, partea a III-a“ (Florea N., et.al., 1987)**

Nitrogen supply (I.N.) of soils in the upper horizon

The nitrogen supply status of soils has been determined by calculating the nitrogen (I.N.) index, starting from the supply of organic matter, by applying the formula:

$$I.N. = \frac{HUM \cdot VAh}{100}, \text{ where:}$$

- HUM = humus content (%);

Vah = the degree of saturation on bases calculated by hydrolytic acidity.

At the level of the researched hydrographic basin, the medium supply of nitrogen predominates in the first horizon of the soils, followed in value by the low supply, as follows (*figure 7*):

- low supply - 1076.00 ha;
- medium supply - 2340.01 ha;
- good supply - 617.99 ha.

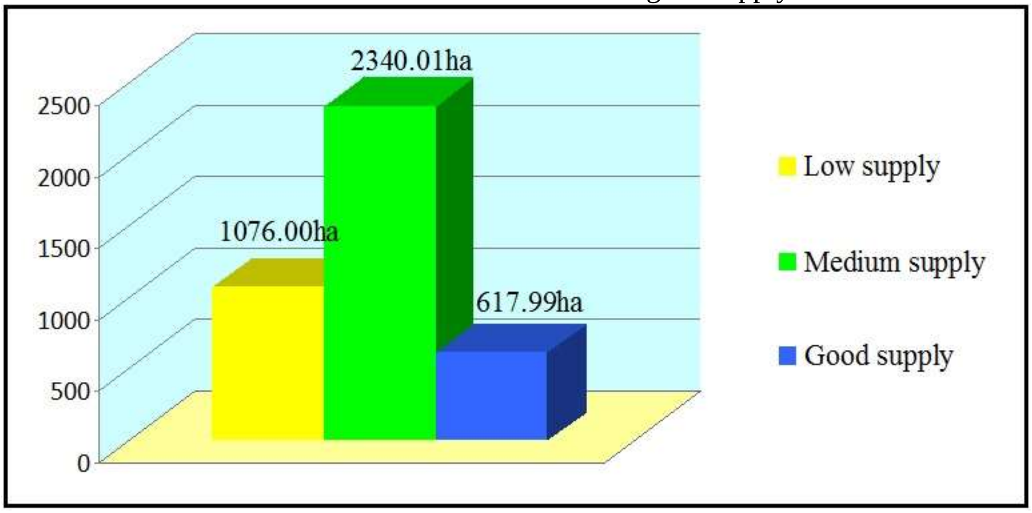

Figure 7 **Graph of nitrogen supply (I.N.) in the upper horizon according to indicator 142 of the „Metodologia elaborării studiilor pedologice, partea a III-a“(Florea N. *et.al.*, 1987)**

The supply of mobile phosphorus to soils in the upper horizon

The supply of mobile phosphorus at the level of the area under investigation is predominantly low and very low (3280.36 ha), with only 753.73 ha not affected by the weakness of this element. Te 4034 ha of the upper basin of the Râul Alb are hence grouped into mobile phosphorus supply classes in the upper horizon (*figure 8*):

- very poor supply - 1483.93 ha;

- low supply - 1796.34 ha;
- medium supply - 611.02 ha;
- good supply - 142.71 ha.

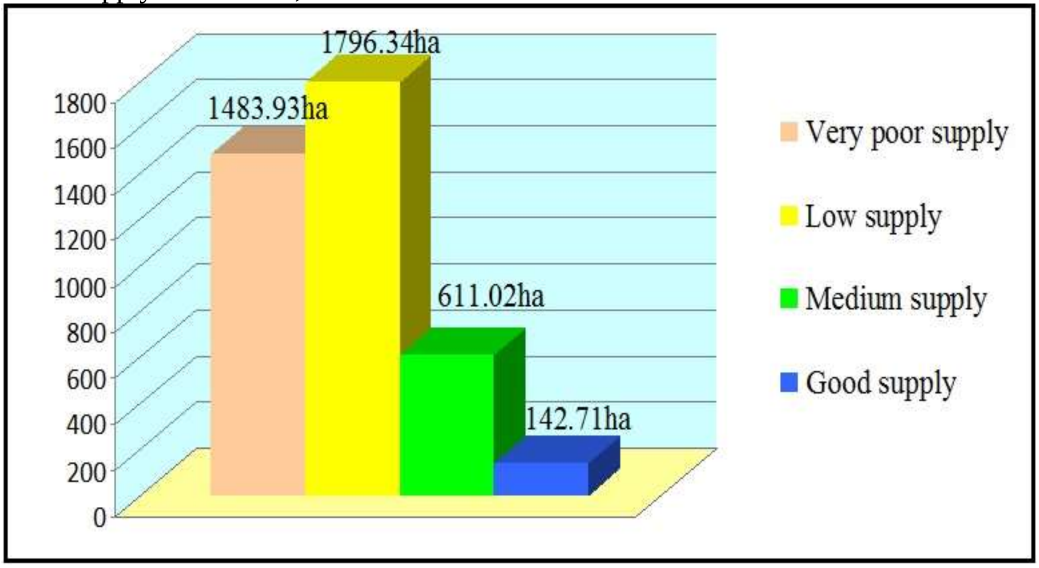

Figure 8 **Graph of the supply of mobile phosphorus to soils in the upper horizon according to indicator 72 of the „Metodologia elaborării studiilor pedologice, partea a III-a"(Florea N., *et.al*., 1987)**

The supply of mobile potassium to soils in the upper horizon

From the mobile potassium supply point of view, in the upper horizon, the soils of the hydrographic basin under consideration are good enough, 1977.15 ha of the total 4034 ha are good and very good supplied with this element. Only 620.85 ha suffer from potassium deficiency, the synthetic pool situation as follows (*figure 9*):

- extremely poor supply - 84.90 ha;
- very poor supply - 35.00 ha;
- low supply - 500.95 ha;
- medium supply - 1436.00 ha;
- good supply - 1564.43 ha;
- very good supply - 412.72 ha.

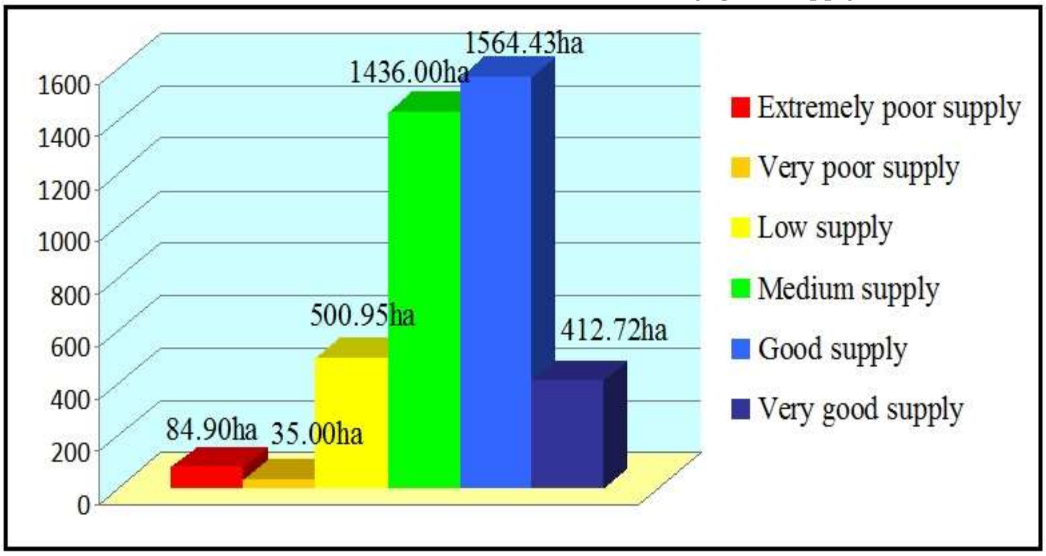

Figure 9 **Graph of the supply of mobile potassium soils in the upper horizon according to indicator 73 of the „Metodologia elaborării studiilor pedologice, partea a III-a" (Florea N. *et.al*, 1987)**

CONCLUSIONS

The soil cover in the Râul Alb hydrographic basin, up to the confluence with the Bărbulețu River, and its fertility rate is directly influenced by the terrain and climate conditions in which the soil forms and develops what makes it up. Through the erosion processes, both surface and depth, the soils on the moderate and strongly inclined slopes lose significant quantities of fertile material, which is accelerated by human activity, which inadequately exploits agricultural land or set up large areas to extend the built-up area. This makes these areas vulnerable to degradation through erosion and increases the risk of landslides, with the final effect of reducing the productive potential of the agricultural land affected.

By centralizing the results obtained from chemical analysis of soil samples taken from representative soil profiles, it has been found that of the 4034 ha of analyzed surface, 59.42 % have a low alkaline reaction at least in the upper horizon due to the $CaCO_3$ content, which increases the risk of landslides when soils are formed on the marls and the texture on the profile is fine. 520.68 ha have a moderate acid pH on the first soil horizon, requiring correction of the reaction by applying calcareous amendments.

Regarding organic matter (humus) supply, an element which is interpreted according to the texture of the first part of the soil profile, the biggest percentage belongs to soils with extremely poor – poor supply of this element in the superior horizon, meaning 73.42% of the mapped surface (2961.95 ha). Only 1072.05 ha of the drainage basin's total of 4034 ha have a moderate content of humus. 87.85% of the analyzed drainage basin's surface shows a medium-fine and fine texture in the first horizon.

The same is true for the nitrogen supply of the soil within the area under investigation. The values of this parameter (I.N.) are a result of the calculation based on the organic matter content. Thus, 2 958.00 ha of the 4034 ha that have been considered moderate and well supplied with nitrogen, which are 73,32%. The rest of the surface shows severe flair in the nitrogen content of the soil.

The situation is really acute regarding the supply of mobile phosphorus soils, with 3280.27 ha of the 76.21% of the mapped area having a highly small and low content of this element. The disadvantage of phosphorus poverty in the soil is a general one at the level of Dâmbovița County, how tends to become critical if it is not tackled by appropriate agro-technical measures.

In the case of potassium supply, the soils at the top of the river basin of the Râul Alb are much better, with only 620.85 ha (14.42%) being extremely low-supplied with this element, with 85.58% of the total 4034 ha investigated having middle of a high content of ground potassium.

ACKNOWLEGMENTS

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