

Determination and Analysis of Certain Chemical and Eco-Pedological Indicators within the "Suior Amelioration Perimeter", Baia Sprie Forest Division, Maramures Forestry Department

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Abstract: An accurate determination and analysis of certain chemical and eco-pedological soil indicators within the „Suior amelioration perimeter” allows us to conclude whether forest vegetation may be installed, artificially or naturally, on these types of soil, using the technical options offered by forestry, by means of ecological reconstruction of exhausted – barren land, for the purpose of reintroducing these non-productive lands into the forestry, ecological and environmental circuit.

Keywords: mine dumps, ecological reconstruction, chemical and eco-pedological indicators

1. Introduction

Every year, the surface extractive industry affects large areas of land which are eliminated from the agricultural and/or forestry circuit and are mainly exhausted. For the purpose of surface exploitations uncovering processes are carried out. Unfortunately, placing these layers back involves high costs and in case of incorrect execution, the land loses many of its initial properties [5].

The cities *Rivulus Dominarum*=Ladies' River (today Baia Mare) and *Mons Medio*=Middle Mountain (Baia Sprie) have been integrated since early times into the Hungarian Feudal State, as the Hungarian kings wished to explore the gold and silver from this hollow in the Crown's interest.

Throughout the years, the extractive mining industry in the area has encouraged the development of certain non-ferrous metal-chemical processing capacities, the consequences of which have a strong impact on all environmental components: air, water, soil, vegetation, animals and last but not least, the population in the area.

The exhausted terrains within the „Suior amelioration perimeter” with a total surface of 24.00 ha resulted from surface mining carried out in the past in sub-lots 37D and 39N1, Production Unit II Suior within the Baia Sprie Forest Division. The lands mentioned consist of destructured slopes, mainly covered with sterile material, consisting of pyritic andesite and weathered tufa or in the process of weathering, which in contact with water disintegrates into small up to powder-like particles, which under heavy precipitation become pasty. These exhausted lands are crossed by ravines and gullies which create an outlet in the main stream of Suior; their existence has led to the onset of surface and deep erosion, accompanied by massive transports of alluvia [6].

An accurate study and analysis of the chemical and eco-pedological components of these types of land may offer extremely useful information concerning the capacity of mine dumps to offer favourable conditions for the growth and development of forest and/or herbal vegetation.

2. Experimental

For the purpose of determining the chemical and eco-pedological soil indicators within the „Suior amelioration perimeter”, 9 main soil profiles have been carried out, in compliance with the current methodology (STAS 7184/1-84). Samples from the pedological profiles were gathered on genetic horizons (in this case two horizons). The profile was 1 m deep and 60 cm wide. The soil samples were gathered from the main wall (the one in the front).

The actual soil sampling was carried out using a knife, cleaned after each sample in order to avoid sample contamination from one horizon to the other and from one profile to the other.

The quantity of soil gathered from each profile horizon amounted to 0.3-0.5 kg, appropriately labelled, packed in plastic bags and sent for analysis to the Maramures Pedological and Agrochemical Studies Office (O.S.P.A. Maramures) which issued, upon request, the Analysis Report under O.S.P.A. Maramures no. 360/12.07.2010.

Soil analyses include the determination of the following chemical and eco-pedological indicators: pH, humus percentage, total nitrogen percentage, presence of phosphorus and potassium, carbonates, total exchange capacity and the saturation level in bases [2].

The humus determination has been carried out using the Walkley-Black method modified by Gogoasa.

The calcium carbonate determination has been carried out using the gas volumetric method (Scheibler method).

In order to determine the nitrogen supply level, both direct and indirect methods have been used. In the group of direct methods the determination of the total nitrogen content, the Kjeldahl method, is included. This method implies soil mineralization through boiling with concentrated sulphuric acid in the presence of catalyst.

The presence of phosphorous in the soil profiles carried out was determined using the Egner-Riehm-Domingo method with molybdenum blue.

3. Results and Discussion

The analysis report of the soil profiles from the "Suior amelioration perimeter" is presented in figure 1. In the surface horizon (the first 20 cm) the soil reaction is from excessively acid (profile 1, 2, 3) to highly acid (profile 8), moderately acid (profile 4, 5, 7), slightly acid (profile 6) up to moderately alkaline (profile 9).

As a general view of the pH in the superior horizons of the profiles within the "Suior amelioration perimeter", the soil reaction is classified as *moderately acid*, with an average value of 5.1.

In horizon B, the soil reaction is from extremely acid (profile 8), to excessively acid (profile 2, 3), highly acid (profile 1, 5, 6, 7), moderately acid (profile 4) up to moderately alkaline (profile 9).

As a general view of the pH in the inferior horizons of the profiles carried out, the soil reaction is classified as *highly acid*, with an average value of 4.7.

Humification, a slow and gradual transformation process of the organic matter, which however does not reach mineralization, but is finalized with the generation of a new re-synthesis product called *humus*, consisting of transformed organic matter, represents an extremely important eco-pedological indicator in soil assessment, in respect of the success in their reintroduction into the forestry circuit, through the regeneration of the wood and/or herbal vegetation.

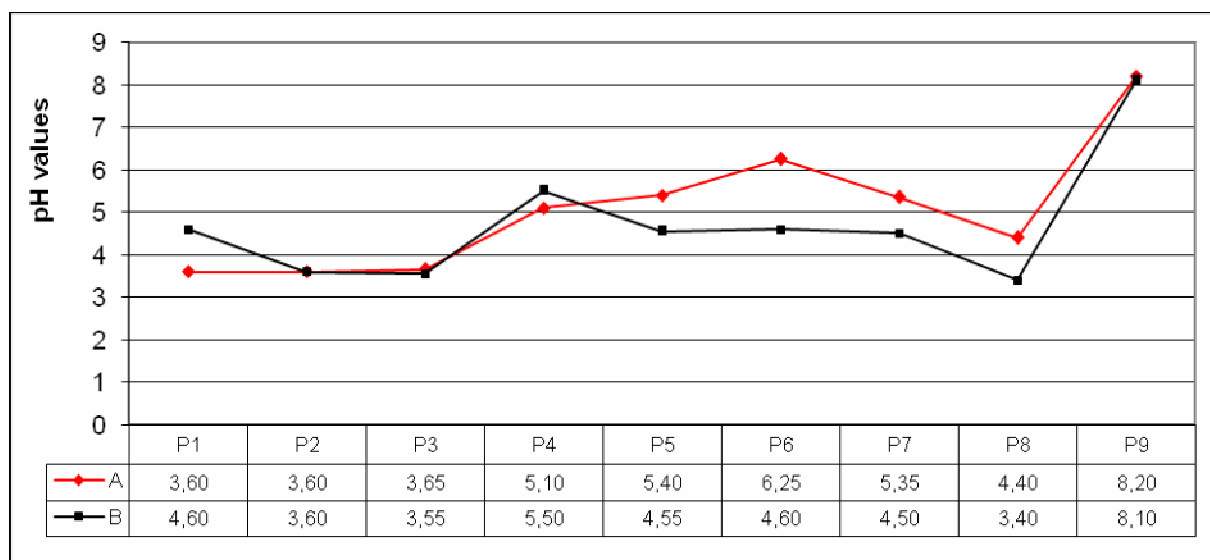


Figure 1. pH values in the two diagnostic horizons

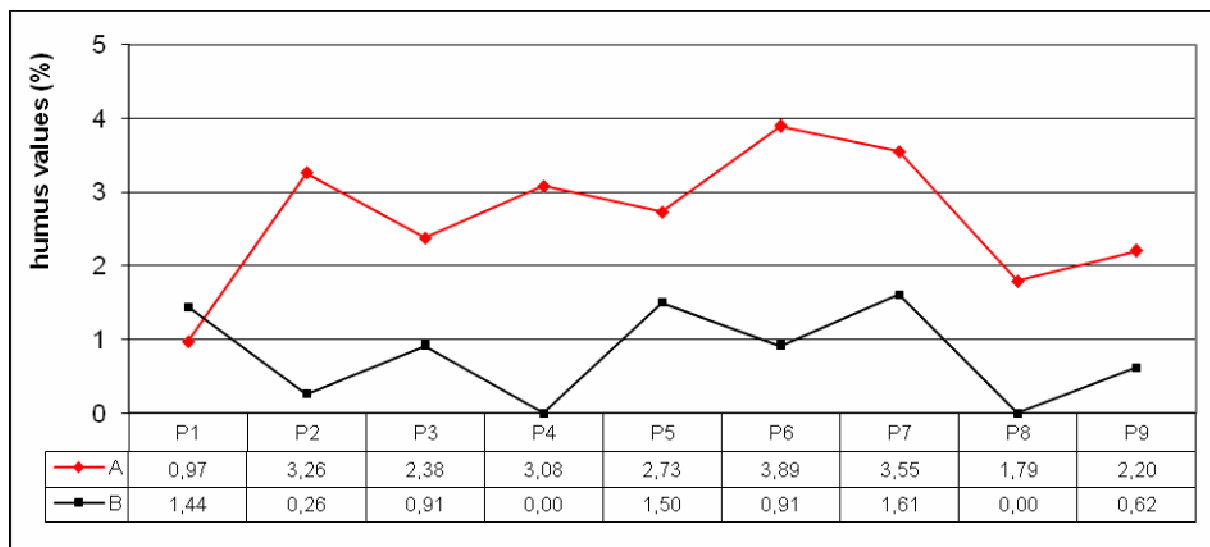


Figure 2. Humus values in the two diagnostic horizons

Figure 2 presents the humus values for both soil horizons within the Suior amelioration perimeter. In the surface horizon (first 20 cm), in most profiles (profile 2, 4, 6 and 7, with a maximum value of 3.89% humus in profile 6), the humus content is situated within the normal limits of a forestry station considered healthy from the perspective of humification. There are also profiles, in which the soils are considered poor in humus (profile 3, 5, 8 and 9, with a minimal value of 1.79 % in profile 8). In profile 1, the humus content is 0.97 % which indicates a very poor soil.

As a general view of the humus value in the superior horizons of the profiles carried out in the "Suior amelioration perimeter", the studied soil reactions are classified as *poor in humus*, with an average value of 2.65 %.

In horizon B, the humus percentage is lower than in the superior horizon, the soils being classified as poor (profiles 1, 5 and 7) and very poor in all the other profiles carried out, even with zero values in profiles 4 and 8.

As a general view of the humus value in the inferior horizons of the profiles carried out, the studied soil reactions are classified as *very poor in humus*, with an average value of 0.81 %.

Calcium carbonate has low solubility ($0.0131 \text{ g}\cdot\text{L}^{-1}$ at 18°C) and it does not present very alkaline reactions. As CaCO_3 is leigated from the soil, pH decreases.

In debasified soils, the reaction becomes more and more acid in relation to the debasification level of the absorption complex. In strongly debasified soils, the pH value decreases also because of the presence of certain organic and mineral acids due to which it reaches 4.0 or less than 4.0. On the other hand, there is close interdependence between the pH value and the saturation level in bases. If $V = 100\%$, the reaction is neutral ($\text{pH} = 7$) and in lower values, initially it decreases suddenly, then in a slower pace and when it reaches values which are lower than 25 %, pH values drop very fast again.

The only soil profile with carbonate content is profile 9, with a very high content of calcium carbonate of 26.42 % in the superior horizon and an average calcium

carbonate content of 6.54 % in the inferior horizon, being in direct and close correlation with the high pH value within the same profile (8.2 in horizon A and 8.1 in horizon B).

The total cation exchange capacity (T) represents the total cations absorbed in the complex and it is expressed as m.e. per 100 g of soil, dried at 105°C . The total cation exchange capacity calculation was carried out by adding up the exchange capacities for bases and the exchange capacity for hydrogen ($T = S_B + \text{SH}$). The total cation exchange capacity values are higher if the soil is rich in clay and humus.

As indicated in figure 3, the maximum values in the superior horizons of the analysed profiles are found in profiles 6 and 7, in direct relation to the maximum humus value within the same profiles. Profile 6 has a percentage of 41.05 % total exchange capacity with a humus percentage of 3.89 % and profile 7 has a percentage of 58.51 % total exchange capacity with a humus percentage of 3.55 %.

The total exchange capacity values decrease with depth, being directly related to the fact that the humus percentage is smaller in the inferior horizons than in the superior horizons.

The degree of base saturation ($V\%$) indicates the saturation percentage of the soil absorption complex in base cations. It is calculated as $V\% = \frac{S_B}{T} \cdot 100$. Depending

on the degree of base saturation, the soils have been classified in the following categories of mineral trophicity: extremely oligobasic ($V\% < 10\%$), oligobasic ($V\% = 10 - 30\%$), oligomesobasic ($V\% = 30 - 55\%$), mesobasic ($V\% = 55 - 75\%$) and eubasic ($V\% > 75\%$).

There is a close interdependence between the pH value and the degree of base saturation. Thus, if $V = 100\%$, the reaction is neutral ($\text{pH}=7$) and with lower values, initially it decreases suddenly, then in a slower pace and when it reaches values which are lower than 25 %, pH values drop very fast again.

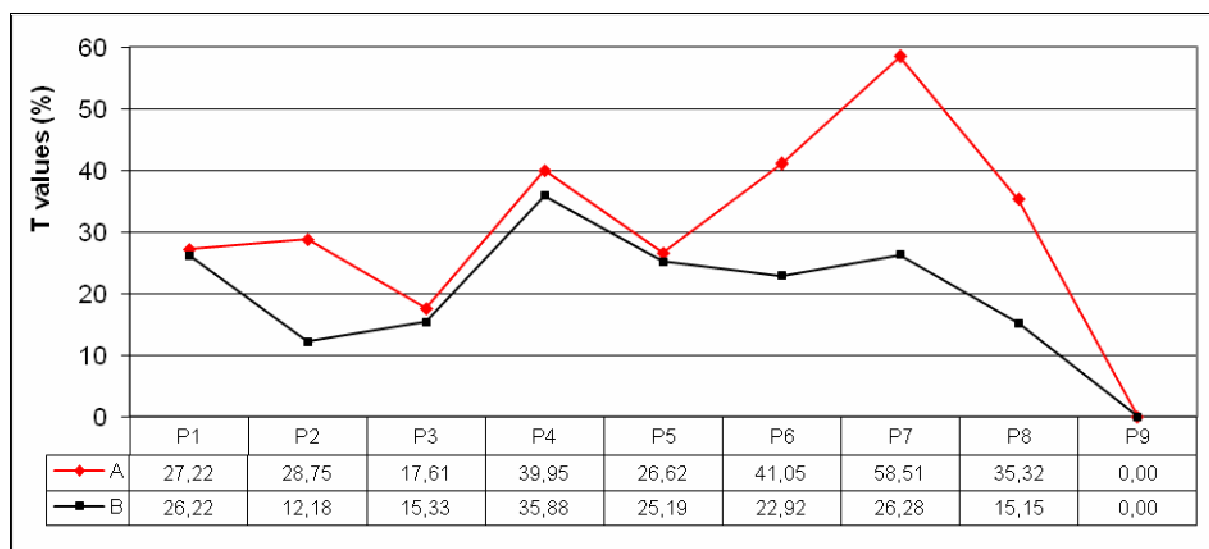


Figure 3. Total exchange capacity in the two diagnostic horizons

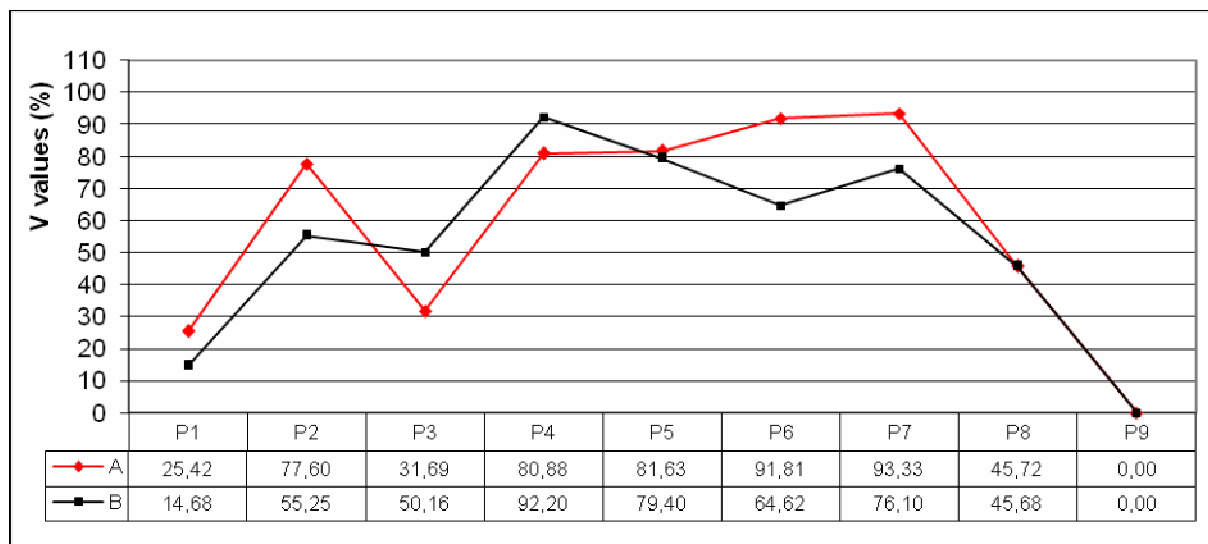


Figure 4. Saturation level in bases in the two diagnostic horizons

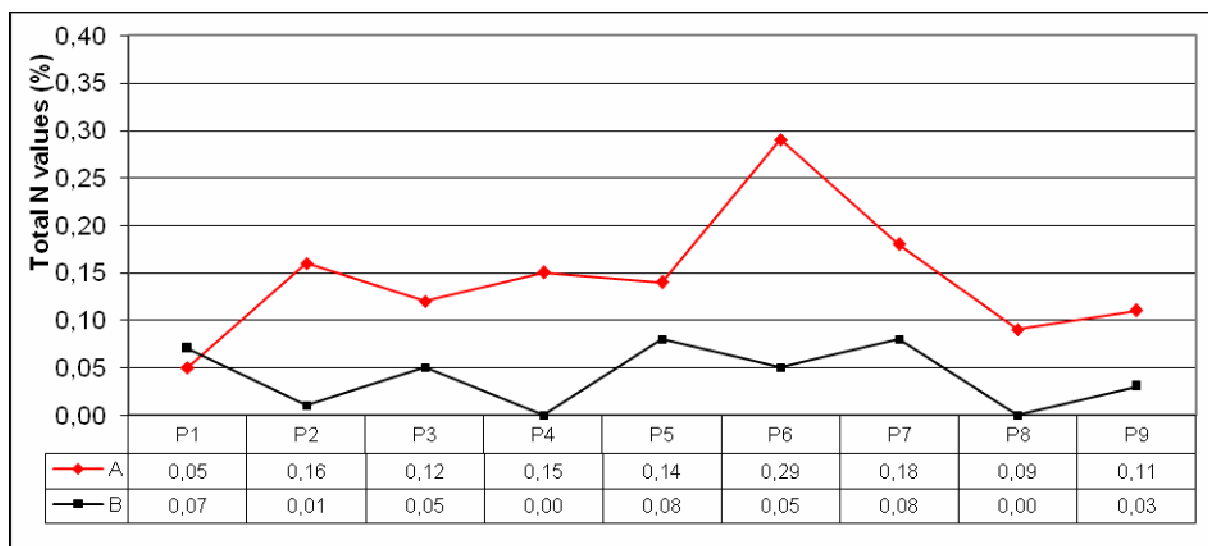


Figure 5. Total nitrogen values in the two diagnostic horizons

As indicated in figure 4, the highest degree of base saturation, in horizons A of the profiles carried out in the "Suior amelioration perimeter", are found in profiles 4, 5, 6 and 7 in close relation to the highest pH values within the same profile and the same horizon (profile 4: $V = 80.88\%$, $pH = 5.1$; profile 5: $V = 81.63\%$, $pH = 5.4$ %, profile 6: $V = 91.81\%$, $pH = 6.25$ and profile 7: $V = 93.33\%$, $pH = 5.35$).

Profile 1 indicates that it has the lowest degree of base saturation (both in horizon A and B), in perfect correspondence with the lowest pH values in the profiles carried out (Horizon A: $V = 25.42\%$, $pH = 3.6$, Horizon B: $V = 14.68\%$, $pH = 4.6$). Also, profile 1 has the lowest level of humus percentage recorded from all the profiles, this being only 0.97% in horizon A.

Nitrogen is the nutrient element from the soil used mainly in the composition of the plant body and for vegetal growth. It is found in the soil as organic and mineral combinations, usually representing 2-3 % from the total amount of nitrogen in the soil. Over 95 % of the nitrogen in

the soil is bound in organic matter and that is why, the supply of nitrogen to plants depends on the decomposition rhythm of organic substances and humus. The presence of nitrogen is determined in m.e. per 100 g/soil.

As also indicated in figure 5, in the superior horizons (horizons A) of the studied profiles, the presence of nitrogen is generally low, with very small content (profile 1 – 0.05 % and profile 8 – 0.09 %), small content (profile 3 – 0.12 %, profile 5 – 0.14 % and profile 9 – 0.11 %), average content (profile 2 – 0.16 %, profile 4 – 0.15 % and profile 7 – 0.18 %) variations and high content only in profile 6. The average value of the nitrogen content in the superior horizons is 0.14 %, which indicates a small up to medium total nitrogen average content.

In the inferior horizons (horizons B) of the studied profiles, the total nitrogen content decreases with depth, with a very low nitrogen content in most of the profiles, even null in certain profiles (profiles 4 and 8), with an arithmetic mean of this indicator's value of 0.04 % - very low content of nitrogen.

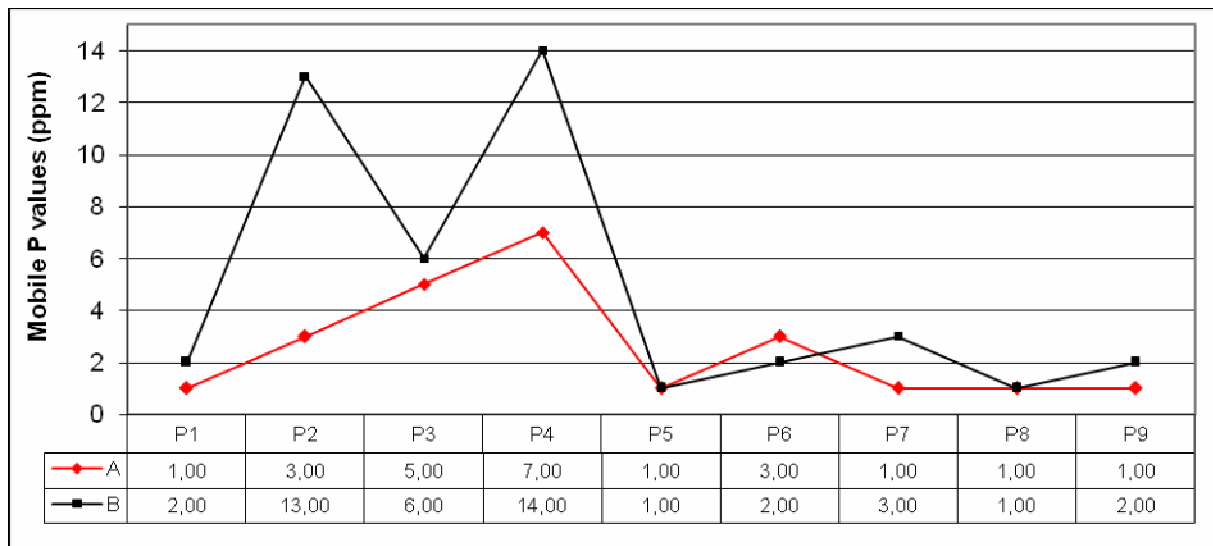


Figure 6. Mobile phosphorous values in the two diagnostic horizons

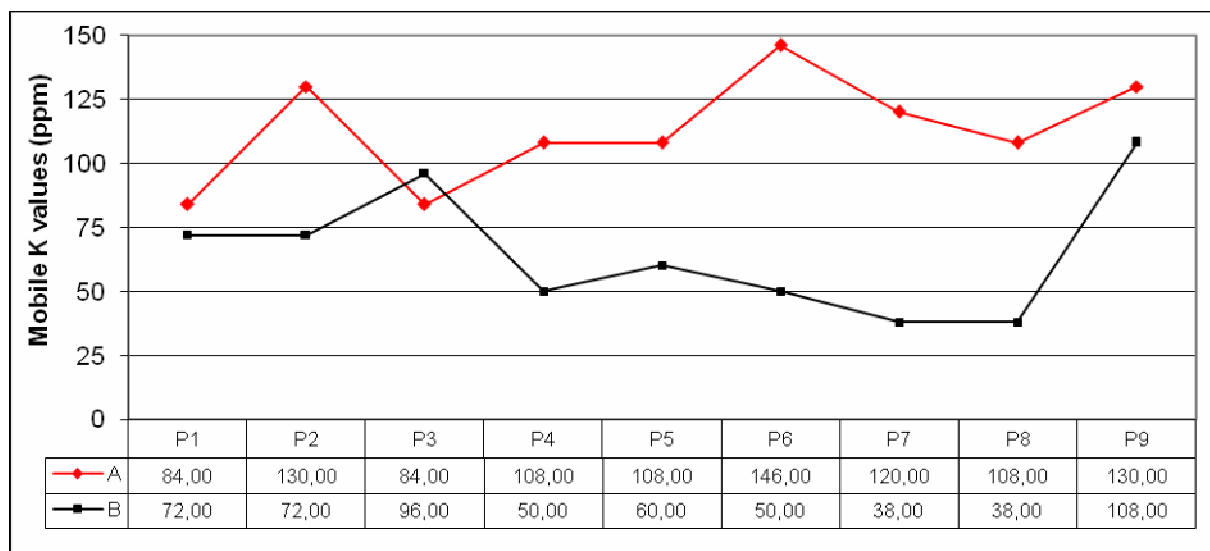


Figure 7. Display of mobile potassium values in the two diagnostic horizons

Even though phosphorus participates in much smaller quantities in the plants' compositions, it is especially important for their life, as it is one of the main components of the organic compounds (phosphoproteins, phospholipids) from the protoplasm in the nucleus, it is a compound of phytin, lecithin, nucleic acids and it is present in various organs and tissues and mineral phosphates. Phosphorus is present in seeds and young growing tissues, being used in the development process of flowers, fruit and seeds. It participates in the synthesis of proteins, in the formation of chlorophyll, breathing, in several enzyme processes, in the development of the root system.

Figure 6 indicates that in the superior horizons of the profiles from the "Suior amelioration perimeter" the average phosphorous content is 2.55 ppm, which generally denotes an extremely low content of phosphorous in most of the profiles, except for profiles 3 and 4, where the phosphorous content is very low (5 ppm in profile 3 and 7 ppm in profile 4).

In the inferior horizons the phosphorous content increases, in general, due to the levigation phenomenon, reaching an average of 4.88 ppm, with minimal values of 1 ppm in profiles 5 and 8 and maximum values of 6 ppm in profile 3, 13 ppm in profile 2 and 14 ppm in profile 4.

In general, soils contain between 0.2 and 4 % potassium, most of which is contained in primary minerals such as feldspars orthoclase (potassic), micas and secondary minerals such as lithium (over 98 %).

Potassium plays an important role in the synthesis of amino acids and proteins, in the synthesis of chlorophyll. It regulates the plant's relation to water, as good potassium concentrate increases the water absorption capacity. During drought years, a good supply of potassium increases the plant's resistance to low temperatures and draught, as well as to certain cryptogamic diseases. The insufficient supply of potassium to the plant determines the weakening of the photosynthetic process and vegetative growths.

Figure 7 shows that in the superior horizons of the profiles studied, the average value is 113 ppm, which generally denotes low potassium content. The minimum potassium content is found in profiles 1 and 3 with 84 ppm and the maximum in profile 6 with 146 ppm. Thus results medium potassium content.

In the inferior horizons, the potassium content decreases, reaching an average value of 64.8 ppm (very low content), with minimum values of 38 ppm in profiles 7 and 8 and maximum values of 108 ppm in profile 9.

4. Conclusions

Considering the extremely low eco-pedological conditions, based on the determination of the pedological indicators previously indicated, the ecological reconstruction of the Suior amelioration perimeter can be carried out through restocking works, with foregoing consolidation works concerning the dumps (with flank fences), soil chalking for the decrease of the pH value, chemical fertilizers applied for the improvement of the eco-pedological indicators and preparation works concerning the land.

In what the coating of the exhausted lands with forest vegetation is concerned, it is recommended to plant forest species which are resistant to such vegetation conditions, such as: spruce, black pine, larch, mountain ash, birch and others [3-4].

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