DYNAMICS OF THE MAIN AGROCHEMICAL INDICATORS ON A CROPLAND WITH DIFFERENT SLOPES IN THE MOLDAVIAN SUB-CARPATHIANS

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Abstract

Assessment, protection and restoration of soil properties are the main directions to follow in farmland management, both for the long-term conservation of this natural resource and for increasing crop quality and yield. This study aimed to determine the soil agrochemical state and to estimate the variation of its main chemical properties induced by the irregular land surface. Agrochemical soil sampling was carried out at a depth of 0-25 cm in autumn 2022, the land was previously cultivated with oilseed rape. The specific soil of the area is phaeozem argic and the land parcel studied is tilled in conventional system. Soil reaction values, essential nutrients (N, P, K), and humus content were determined by standard methods. The results reveal a good to very good mobile potassium supply (132-308 ppm) and a low to medium mobile phosphorus content (9-22 ppm). The nitrogen index in relation to humus content (5.2%) reflected an average concentration of this element (3.6%). The pH values indicate a strong to moderate soil acidity response (4.7-5.2), caused by leaching of surface horizons by water erosion. By correlating the data obtained, it can be concluded that the soil fertility status is good and can be maintained and improved by applying appropriate tillage practices.

Key words: farmland, nutrients, potassium supply, fertility

Agricultural soils are influenced by the long-term history of cultivation practices and current management decisions of the farmer (Engell I. *et al*, 2022). Differences in inherent soil characteristics can result in variations in soil health that influence crop yields and environmental quality (Veum K.S. *et al*, 2021).

Soil chemical properties are mostly used to measure soil fertility and health compared to physical and biological properties due to their rapid measurement, applicability to field conditions, accessible to producers, dynamic nature, and ability to capture a wide range of soil functions (Brejda J.J. *et al*, 2000; Veum K.S. *et al*, 2021).

The chemical properties of the soil undergo important changes in time, being considerably influenced by the soil tillage system (Chetan F. *et al*, 2019) and the long term use of mineral fertilizers (Marin N. *et al*, 2021). Research has also shown that local soil conditions and soil morphology control the lateral and vertical movement of solutes (Yoder R.E. *et al*, 2001).

Because of the important role they play in nutrient availability, plant growth and development and ultimately yield, pH, N, P, K and humus are the main indices to consider when assessing soil fertility.

Soil pH is a key index of soil properties, which was considered as one of the main variables influencing other soil properties (Bolan and Kandaswamy, 2005). Studies have shown that soil pH can influence crop yields, soil nutrient release, and soil microbial activity to a large extent (Zhang L. *et al*, 2019).

Nitrogen (N) is an essential element for the functioning of terrestrial ecosystems and is often the primary limiting resource for the productivity of many terrestrial ecosystems (Xiao A. *et al*, 2018). Soil nitrogen transformations underpin plant growth and are fundamental to healthy ecosystem functioning (Girkin T.N. *et al*, 2022). It is an important source of nutrients, and its dynamic change is influenced by several factors, in particular by soil conditions and ground cover plants (Kang J. *et al*, 2023).

Phosphorus (P) being a key element in DNA, RNA as well as ATP and phospholipids is essential for the growth, functioning and reproduction of all life on earth (Alewell C. *et al*, 2020). Phosphorus (P) moves slowly in the soil, is easily fixed, and is usually enriched in the surface layer. If stratified, most of the soil P in the surface layer is easily washed off by rainfall runoff (Lv L. *et al*, 2023).

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A low content of potassium in the soil limits the yields of agricultural crops, and agrochemical analysis provides useful information for possible improvement of soil fertility and proper fertilization (Kovačević V. *et al*, 2005). Understanding of soil potassium dynamics is essential for sustainable crop production and bioavailability of potassium depends on forms and distribution within the soil profile (Butt R.H. *et al*, 2017).

Humus is a part of the soil that performs one of the main functions in creating the necessary conditions for the growth and development of plants. It contains plant nutrition elements that are formed in the soil during mineralization (Zamyatin S.A. *et al*, 2020).

On sloping cultivated land there are fluctuations in the degree of soil nutrient supply caused by differences in the intensity of soil erosion between different slope positions.

Based on these considerations, in 2022, an agrochemical study was conducted on a farmland with different slopes to determine nutrient dynamics in relation to slope variation, in order to implement the necessary practices to maintain and improve soil fertility.

MATERIAL AND METHOD

The studied land is placed near Dobreni village and belongs to Berardi Prod Ltd, located in the north-eastern part of Romania, in Neamt County.

Physically and geographically, land parcel number 2277 (LP 2277) (*figure 1*) is located in the Moldavian sub-Carpathians, and the area is known as Hatasului Coast (47°00`26`` N, 26°23`13`` E). The climate is characterised by an average annual temperature of 7.6ºC and precipitation of 545 mm. According to Vasiliniuc *et al,* (2021), the soil in the area is of phaeozem argic type.

The sampled field is 57 ha, conventionally tilled and previously cultivated with oilseed rape.

Figure 1 **Land parcel *2277* under study**

In order to obtain representative data, the land parcel was divided into 10 soil sampling points (from 945 to 954) based on slope and relief. Soil samples 953 and 954 were collected from the plateau, around which slopes vary between 6-15%.

In the fall of 2022, 20-25 agrochemical subsamples were collected in the 0-25 cm range, using an auger attached to the Honda ATV (Wintex 1000), resulting a composite sample for each plot.

The collected soil samples were transported under appropriate conditions, dried, ground and analysed in the soil chemistry laboratory of the Research Institute for Agriculture and Environment Iasi (RIAE).

The contents of nitrogen, phosphorus, potassium, humus and soil pH were determined by standard methods of analysis and characterised by the limits summarised in *table 1.*

Table 1

The methods used to determine soil chemical properties and characterisation limits

Indicators	**Methods**	**Characterisation limits** (ICPA Bucuresti, 1981)	
Soil reaction (pH)	potentiometric method in aqueous suspension in the ratio 1:2.5 soil:distilled water	≤ 5.0	*strongly acid*
		5.01 – 5.80	*moderately acid*
		5.81 – 6.80	*slightly acid*
		6.81 – 7.20	*neutral*
		7.21 – 8.40	*slightly alkaline*
		> 8.40	*strongly alkaline*
Humus (H%)	titrimetric dosing with Walkley - Black method in Gogoasa modification	≤1.0	*extremely low*
		1.1 - 2.0	*low*
		2.1 - 4.0	*medium*
		4.1 - 8.0	*high*
		> 8.0	*very high*

Indicators	Methods	Characterisation limits (ICPA Bucuresti, 1981)	
Nitrogen index (NI%)	NI = H*BS/100, H (%) - humus content; BS (%) - base saturation.	≤ 2,0 2,1 - 4,0 4,1 - 6,0 > 6.0	*low* *medium* *good* *very good*
Mobile phosphorus (P ppm)	Egner – Riehm - Domingo method consisting of extraction with ammonium acetate lactate solution at pH 3.75; colorimetric determination with molybdenum blue by the Murphy - Riley method - reduction with ascorbic acid (STAS 7184/19-82);	< 8.0 8.1 – 18.0 18.1 – 36.0 36.1 – 72.0 72.0 – 144.0	*very low* *low* *medium* *good* *very good*
Mobile potassium (K ppm)	in ammonium lactate acetate and determined by the Egner – Riehm - Domingo method using the atomic absorption apparatus, flame technique - CONTR AA 700 (STAS 7184/18-80)	< 66.0 66.1 – 132.0 132.1 – 200.0 200.1 – 265.0	*low* *medium* *good* *very good*

RESULTS AND DISCUSSIONS

The results of agrochemical mapping are represented as a cartogram (*figure 2*).

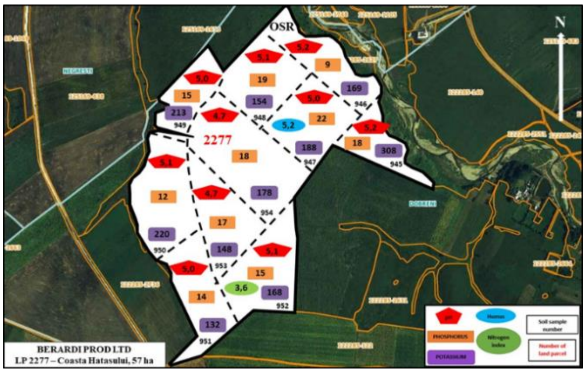

Figure 2 **Cartogram of the *2277* land parcel**

In terms of soil reaction, the lowest pH value reported is 4.7 in the plateau area and the highest is 5.2, thus the studied plot is classified as strongly acid and moderately acid, but the differences between the samples were relatively small (*figure 3*).

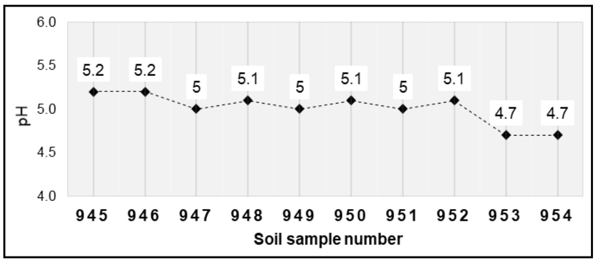

Figure 3 **Soil reaction values on analysed soil samples**

Determination of humus was carried out from three points (945, 950, 954). The values obtained indicate a high humus content in the soil over the whole area, with 5.48% in sample 950, indicating a better conservation of organic matter compared to sample 945 with 5.04%. NI calculation results revealed a medium soil nitrogen supply of 3.66-3.91% and a land parcel average of 3.6% (*figure 4*).

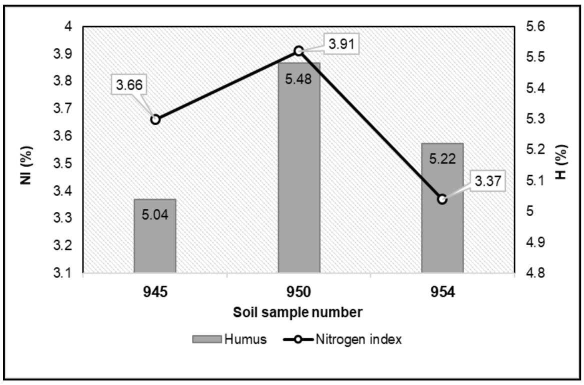

Figure 4 **Nitrogen index values correlated with soil humus content**

Regarding the P content, *figure 5* shows that the lowest value is 9 ppm and the highest is 22 ppm, and about half of the agrochemical mapped land area is low supplied and the other half has a medium P content. The supply of this nutrient was found to decrease with increasing land slope due to leaching by erosion.

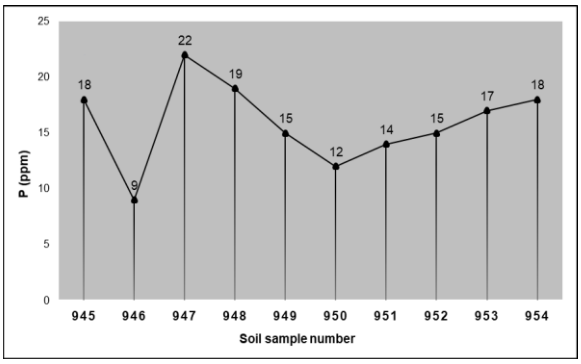

Figure 5 **Mobile phosphorus content**

According to the characterization limits, the analysed samples report a good and very good supply of mobile K, with some remarkable differences between the soil samples, the lowest value being 132 ppm and the highest 308 ppm (*figure 6*). Also, for this nutrient, there is a tendency for its concentration to depend on the slope of the land, with a lower content in areas with higher slopes.

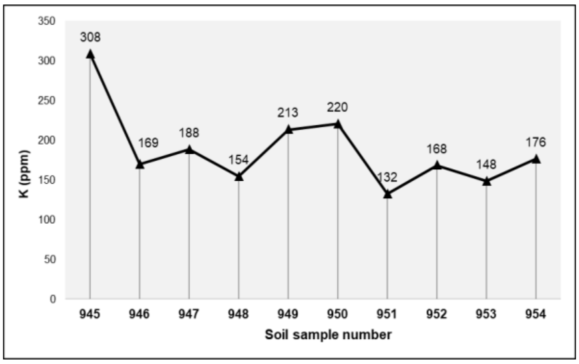

Figure 6 **Mobile potassium supply**

CONCLUSIONS

The soil chemical properties analysed in this research (pH, NI, humus, K and P) are related differently to other properties, so they represent only a small number of those that determine soil fertility and crop yield.

Soil acid reaction is the result of rainfall runoff and leaching of surface layers. The high humus content (5.2%) of the LP 2277 is due to the process of bioaccumulation in the soil surface horizon, which specific to the phaeozem argic soil. The P and K supply depends on the slope of the land, and their oscillations can be prevented by tilling the soil along level curves.

Crop-specific application of fertilizers and amendments, proper tillage and implementation of erosion prevention and control measures are some of the solutions to be implemented in the study area.

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