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EVALUATION OF Cu, Mn AND Zn CONTENT IN PLOUGHED SOIL LAYER

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Abstract

The paper aimed to present the micronutrients content of some soils from the West Region of Romania, in the north part of Semlac Plain. Micronutrients soil content is not usually analysed, sometimes being excluded by farmers in fertilisation process, by financial reasons. The soil types who were studied included in Luvisols class. Luvic phaeozems and Vertic luvisols are formed on clays and Stagnic luvisols is formed on loams. Soil was sampled up to 20 cm depth, on ploughed soil layer. It was analysed soil pH which is directly related to micronutrients (Cu, Mn, and Zn) availability for crops. Defining to this soil class is the acid reaction, fact identified after the analyses that we made. Soil copper content is inferior to that which is specific for Luvisols class, fact due to soil native clay content. This fact may cause disorders in crop nutrition and copper deficiency. Manganese and zinc soil amount is sufficient for crops demands. For the local farmers in the research area is important to be informed regarding the soil status in micronutrients, which are important to obtain quality yields. The soil method analyses were made according to national and international standards. The obtained results were compared with the other researches on this domain.

Key words: *micronutrients, piedmont plain, soil pH.*

INTRODUCTION

The concentration of trace elements in the Earth's crust is constant and their enrichment in one place causes depletion in others. The hazard of inorganic contaminants arises from their bioavailable concentrations and necessity for organisms. Cr, Cu, and Zn are essential micronutrients and are required in small quantities by living organisms, while As and Pb have not any known physiological function for plants or humans and even the smallest quantities can have adverse effects on organisms, (Kumpiene et al., 2008).

After Brady and Weil, 2002, soil quality is determined by a series of physical, chemical and biological indicators like texture, total organic soil matter, pH, extractable N, P and K but also the micronutrients such as Zn, Cu etc.

Stability of Cu in soil is strongly pH dependent, the mobility increases with decreasing pH. Carbonates, phosphates and clays can keep Cu mobility in soil low by chemosorption.

The mobility of Cu is usually the lowest at slightly alkaline pH but can increase in highly alkaline conditions (>10) due to the formation of OH^- complexes. (Kumpiene et al., 2008)

An increased amount of clay minerals in soil by 4% decreased Cu mobility by 77%, (Kumpiene et al., 2008).

The mobility of Zn is modified by the presence of P, Ca, Al, Mn and Fe oxides, and organic matter. Zn can precipitate with hydroxides, carbonates, phosphates, sulfides, molybdates and several other anions as well as form complexes with organic ligands, (Kumpiene et. all. 2008).

Cation exchange and complexation by organic ligands were suggested to be the main Zn mobility controlling mechanisms in acidic soils, while Al, Mn and Fe oxides were of less importance, (Kumpiene et al., 2008).

However, Zn is a rather mobile element and easily out-competed by other cations (such as Pb and Cu) for adsorption sites. A number of studies have been done attempting to stabilize Zn in soil by phosphorus amendments. Results indicated that Zn was immobilized as metal-phosphate precipitates with low solubility and high resistance to soil acidification (Kumpiene et al., 2008).

The pH of the soil solution is of considerable importance in controlling the solubility of trace elements in soils and might be depressed as a result of H^+ excretion by plant roots possibly resulting from cation uptake exceeding anion uptake, (Linehan et al., 1985).

Mn and Zn were among the first metals found to be essential for plants growth and development. Despite this knowledge, Mn and Zn deficiencies still remain common and are responsible for the most widespread crop micronutrient disorders throughout the world. This problem is more acute in acid sandy soils because these are characteristically low in organic matter and deficient in available plant nutrients. In acidic soils, fundamental chemical properties for plant nutrition (such as cation exchange and buffer capacity) are largely governed by organic matter content. (Obrador et al., 2007).

One of the major constraints for crop productivity in many countries of the world is the deficiency of micronutrients. Intensive cropping often leads to nutrients' imbalance in soils and may affect nutritional status of plants. The levels of Cu, Zn, Fe and Mn in soil decreases with increasing of pH, due to their adsorption/retention by soil particles. High pH soils may also indicate a problem of low micronutrients availability, but acidic ones are characterised most frequently by sufficient to excessive micronutrient supply, (Diatta et al., 2014).

Except in cases of natural catastrophes (volcanisms, flood,), high levels of heavy metals in the soil are of predominately anthropic origin, as they usually occur at very low concentrations in a terrestrial environment, typically at trace and ultra-trace levels, (Silva et al., 2012).

MATERIALS AND METHODS

Surface horizons (arable layer up to 20 cm) of three acidic soils located in a piedmont plain area (135-140 meters altitude), from the north part of the Semlac Plain (West Region of Romania) were used in this study. They were all taken from cultivated soils in which the dominant crops were cereals, colza and maize. The soil samples were air-dried and crushed to pass through a 2-mm sieve.

pH was determined by potentiometric method, in water extract 1:2.5 ratio.

A representative sample of each soil type was used for characterisation and analysed to determine the plant availability of the trace metals studied (Cu, Mn and Zn). Available forms of micronutrients in soil were determined by atomic absorption spectrophotometry after a previous solubilisation. The soil types of the research area were verified according to the Romanian Soil System Taxonomy (2012) and after the Soil Atlas of Europe.

RESULTS AND DISCUSSIONS

In the studied area were identified the following soil types: stagnic luvisols (formed on loams and having medium texture), vertic luvisols and luvic phaeozems formed on clays (which have mostly in their composition kaolinite and montmorillonite) with fine texture. Chemical changes and fate of micro-nutrients are strictly related to the following three factors: 1. soil buffering capacity mostly controlled by pH, clay and silt content and organic matter levels; 2. the total and available fractions of micronutrients; 3. crop plants and their requirements. All these factors usually affect the potential capacity of soil to supply micronutrients (quantitatively) as well as the concentrations and activity of the latter ones, (Diatta et al., 2014).

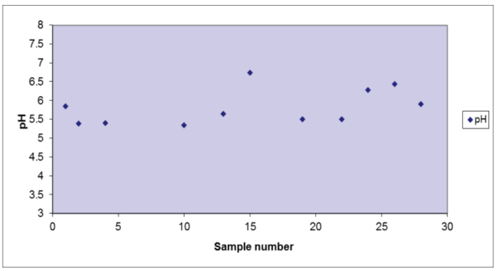

Figure 1. Soil pH values

Soil reaction is moderate acid in case of 5 samples (from 5.35 to 5.64 pH values). For 6 soil samples it was identified a weak acid reaction (5.85 to 6.74 pH values). This is an important indicator related to the availability of micronutrients for crops, as it shows in Figure 1.

Content in available Mn is estimated mostly between 5 and 50 ppm in romanian soils. For luvisols class the values are from 53 ppm to 196 ppm, (Rusu et al., 2005)
This manganese form depends on the total Mn content, on the pH and soil redox potential. Also, on acid soils this element achieve maximum concentrations, but manganese excess has phyto-toxical effects. Unlike other micronutrients Mn has a high affinity to form combinations with the soil organic matter.

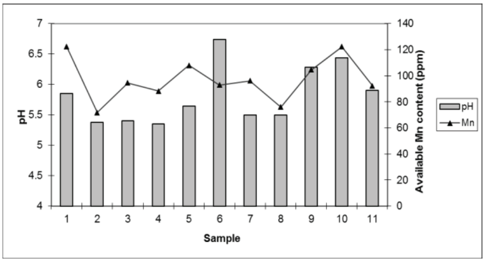

Figure 2. Relation between soil pH and available Mn.

Up to 15 ppm manganese, the soil has a sufficient amount in this element for crops. Our analyse results demonstrate a good supply on soil for this micronutrient.
Available copper content in soil depends on total copper, the one originated form the primary and secondary minerals, but also from the adsorbed forms on clays and humus. This form of copper in soil is depending on soil pH, nature of the clays and humus, (Rusu et al., 2005).
Unlike other micronutrients, copper has a high retention energy on clays and with the soil humified organic matter forms stable chemical compounds having reduced mobility.
In case of our studied soils we identified a specific normal copper content which varies between 3.5 ppm to 6.0 ppm.
In acid soil reaction cases, copper mobility and availability for crops is blocked by other ions such as: Al^{3+}, Fe^{2+}, Mn^{2+}. Copper deficiency for crops appears when the soil supply is less than 0.75 ppm.
Based on our obtained results we identified that only three samples have a medium supply (1.600 ppm-2.092 ppm) on this micronutrient the others being in the reduced supply category (from 0.477 ppm to 1.431 ppm), as it shows in Figure 3.

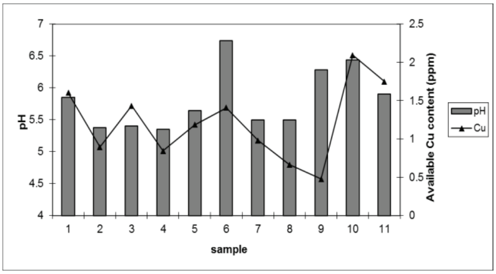

Figure 3. Relation between soil pH and available Cu.

Available Zn in soil is in function of total Zn content, pH and the compounds of the adsorbtion complex. Generally, the soils from our country contain 0.1 ppm to 8 ppm available Zn (Rusu et al., 2005).
Comparative to other micronutrients, Zn is find in reduced amounts, that may determine nutritional disorders for crops.
For luvisoils class available Zn varies between 1.8 ppm to 5.4 ppm, which means that under 1.8 ppm zinc deficiency occurs.
To the acid soil domaine, mobile zinc forms are to an optimum level, which mean that deficiency may occur on neutral or alkaline domaine.
In all the cases that we studied, soil available Zn level is well, except one sample which value is 4.18 ppm.

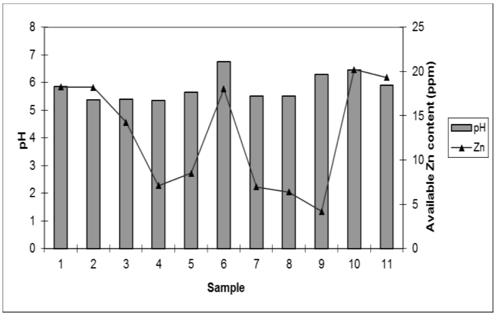

Figure 4. Relation between soil pH and available Zn

CONCLUSIONS

Researched area is located from the geographical point of view in piedmont plain, identified soils being part of the luvisols class.
These soils are formed on clays and loams, being characterized by fine and medium texture.

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Soils pH is moderate to weak acid, being an important indicator for micronutrients availability.

Manganese is identified in high amounts, fact due to the acid reaction, and the values are specific to the luvisols class.

Soil copper content is reduced to medium in some cases, being inferior to the standard values of this soil class. This might be caused to the high clay content specific for luvisols, copper retention on clay being well known.

All analysed soil samples have a zinc content superior to luvisols class standard.

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