FERTILITY LEVEL OF SOILS IN HUNGARY – ROMANIAN BORDER AREA

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Abstract: *The most important property of soil is to be living environment for plants and to make it possible for crops to yield. He has the ability to ensure plant`s growth and fruiting. This is because of the essential quality of soil to be a physical, chemical and biological dynamic environment, giving a set of necessary conditions for growth and development of natural and cultivated vegetation. Soil is the most favorable support for plant root development, a source of nutrients and water. Because soil is a much more complex system than air and water, pollution is affecting its properties, including the level of fertility. In addition, pollutants in soil can pass into plants, water or air, and remediation is a difficult process, sometimes untenable. The aim of this paper is to determine fertility level of soil on both sides of Hungary- Romanian border. 10-10 HU-RO test sites were selected. Seven test sites include wheat fields with intensive cultivation, while 1 site was selected from an organic wheat cultivation field. Test sites including a pasture field and a forest were included as controls. Samples were taken according to the soil sampling guidelines, on two depths: 0-20 cm and 20-40 cm. Analized parameters were: pH-ul, carbonate content, humus content, available phosphorus and potassium. All analysis methods were according to ISO standards. Soil pH is probably the most commonly measured soil chemical property and is also one of the more informative. Soil pH has a profound influence on plant growth. Compared with soils in Hungary, where the pH is uniform, slightly alkaline, soils in Romania have pH values contained in a much wider area. Humus is a colloidal substance, and increases the soil's cation exchange capacity, hence its ability to store nutrients by chelating. Most soils in Hungary, humus content between 2 -4%, which means a reduced supply. Phosphorus (P) is a naturally occurring element that exists in minerals, soil, living organisms and water. Phosphorus is essential for early root development and hastens plant maturity. In terms of soil phosphorus content is observed in Hungary a good and very good supply in this main macronutrient. Phosphorus content of soils in Romania is very varied, ranging between 5 and 150 ppm. Available soil potassium supply in both countries range from low to very good. In Hungary, the largest quantities of potassium were determined on soils rich in organic matter.*

Key words: *fertility, soil, humus, fertilizers, crops*

INTRODUCTION

The most important property of soil is to be living environment for plants and to make it possible for crops to yield. It has the ability to ensure plant`s growth and fruiting. This is because of the essential quality of soil to be a physical, chemical and biological dynamic environment, giving a set of necessary conditions for growth and development of natural and cultivated vegetation. Soil is the most favorable support for plant root development, a source of nutrients and water.

Soils are being degraded worldwide through processes of erosion, anaerobiosis, salinization, compaction and hard-setting, organic matter depletion, and nutrient imbalance. Measuring soil fertility should serve as an indicator of the soil's capacity to produce safe and nutritious food, enhance human and animal health, and overcome degradative processes (PAPENDICK AND PARR, 1992).

Fertility is soil property to provide to plants water and nutrients in sufficient quantities for their growth and development. Maintaining and enhancing soil fertility is essential for obtaining for long-term high, stable and quality yields. Natural reserves of soil nutrients are limited. Without restoring soil nutrients removed from crops by fertilization with mineral and organic fertilizers, soil reserves fall and with them, decreases crop yields. Therefore maintaining and enhancing soil fertility under certain conditions, are of fundamental importance. There are three main components of soil fertility - physical, chemical and biological (Abbott and Murphy, 2003). The level of soil fertility results from the inherent characteristics of the soil and the interactions that occur between these three components.

Basic soil indicators like soil texture and depth are useful for comparing soil quality among soil types, and within a soil type before and after some management practice has been imposed. Soil texture is the most fundamental qualitative soil physical property controlling water, nutrient, and oxygen exchange, retention, and uptake. It is a master soil property that influences most other properties and processes. Soil depth is a quantitative property influencing the amount of resources available to plants per unit area. The relative thickness of soil horizons could also be a sensitive indicator of several soil functions (Schoenholtz et.al., 2000).

The other most important factors affecting soil fertility include the presence of the right quantities and forms of essential nutrients; the availability of moisture and the stability of its level; good aeration, which is important for the development of the root system and for the life processes of microorganisms that break down organic matter and store nutrients in a form available to higher plants; the presence of toxic substances; and the pH (Arshad and Coen, 1992). The sum of these properties determines the cultivability of the soil.

Knowing fertility level of soils in Hungary – Romania border area is important for the protection and sustainable use of soil in cross – border region (Csongrad – Timis county area), preserving its functions and preventing soil degradation. Most important direct beneficiaries of the research are local farmers and indirect beneficiaries are those, who are living in the region and their local communities. Furthermore both countries can be considered indirect beneficiaries, because the results of the research provide possibility to enhance the fertility level of the soil in the Csongrad – Timis region.

MATERIAL AND METHOD

Soil samples were taken from the 10 sites along the Hungarian side and from 10 sites along the Romanian side of the HU – RO border. Seven sites include wheat fields with intensive cultivation, while 1 site was selected from an organic wheat cultivation field. Sites including a grassland and a forest were included as controls. Samples were taken according to the soil sampling guidelines. Planned dates of sample collections were April 2011, August 2011 and October 2011.

Soil samples were colected on 0-20 cm and 20 – 40 cm depth. Soil was air-dried and passed through a 2 mm sieve. Soil reaction was measured potentiometrically using a combined electrode expressed in pH units.

Determination method of soil humus content: Organic carbon is oxidized anhydride dichromate ($Cr_2O_7^{2-}$) in excess, in presence of sulfuric acid, oxidation facilitated by heat produced by diluting a volume of normal solution of bichromate of potash with two volumes of concentrated sulfuric acid and maintaining the sample at a temperature of 100° C for 30 minutes. Organic carbon content is calculated as the amount of dichromate consumed for

oxidation of anhydride. Excess of dichromate anhydride is titrated with a 0,2 N solution of Mohr salt in the presence of diphenylamine.

Mobile phosphorus determination: phosphates are extracted from soil sample with a solution of ammonium acetate-lactate at pH = 3,75. Phosphate anion extracted by any method, is determined colorimetrically.

The amount of available potassium was determined trough Egner – Rhiem – Domingo method (AL – K). After extraction, potassium content of soil samples was determined by flame atomic absorption spectrometry (F-AAS, VARIAN SpectrAA-300)

Total Elements (Zinc, Manganese, Iron, Copper, Cadmium, Lead And Nickel) were determined by extraction with nitric acid/chlorhidric acid mixture. This method determines the concentration of Zn, Mn, Fe, Cu, Cd, Pb, Ni, as requested utilizing a nitric acid/chlorhidric acid closed vessel microwave digestion. Analysis is by Atomic Absorption Spectrometry (AAS). The approximate method detection limit is 1mg/kg for all elements except phosphorus (0.001%).

RESULTS AND DISCUSSIONS

Soil pH is probably the most commonly measured soil chemical property and is also one of the more informative. Soil pH has a profound influence on plant growth. Soil pH affects the quantity, activity, and types of microorganisms in soils which in turn influence decomposition of crop residues, manures, sludges and other organics. It also affects other nutrient transformations and the solubility, or plant availability, of many plant essential nutrients. Compared with soils in Hungary (figure 1), where the pH is uniform, slightly alkaline soils, in Romania soils have pH values contained in a much wider area

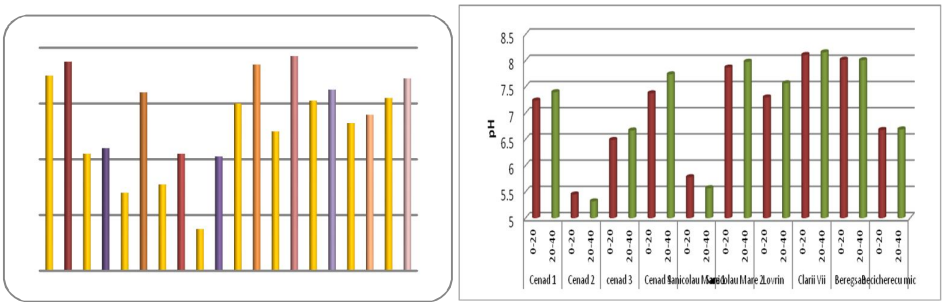

Fig.1. Soil pH values

Humus is a colloidal substance, and increases the soil's cation exchange capacity, hence its ability to store nutrients by chelating; thus, while these nutrient cations are accessible to plants, they are held in the soil safe from being leached by rain or irrigation. Humus can hold the equivalent of 80–90% of its weight in moisture, and therefore increases the soil's capacity to withstand drought conditions. Most soils in Hungary, humus content between 2 -4%, which means a reduced supply. Only soil samples harvested from forest soil has higher content of humus, located in the medium supply. The lowest values were determined in soil with ecological system. Humus content of soils in Romania are generally ranged between 1.97 – 4.73%, with highest value determined on forest, 4.73%, and grassland soils, 4.38% (fig.2).

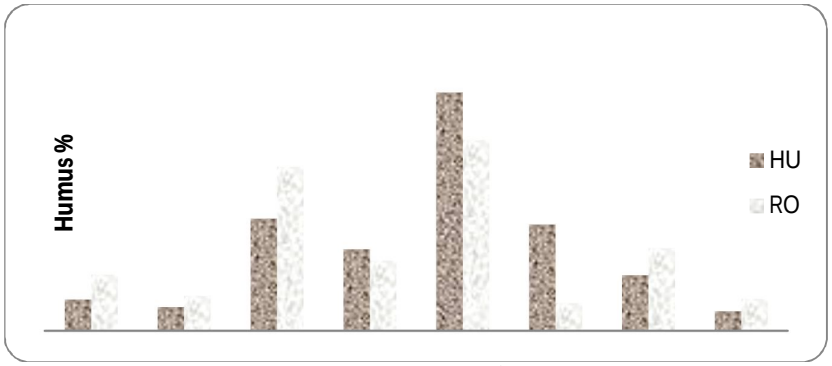

Fig. 2. Humus conten of soils

Phosphorus (P) is a naturally occurring element that exists in minerals, soil, living organisms and water. Plant growth and development requires phosphorus, like nitrogen, in large amounts. Phosphorus is essential for early root development and hastens plant maturity. Mobile phosphorus sometimes called available inorganic phosphorus. It can include small amounts of organic phosphorus, as well as orthophosphate, the form taken up by plants. It also is the form subject to loss by dissolution in runoff and to a lesser extent, leaching. The soluble form accounts for the smallest proportion of the total phosphorus in most soils. When fertilizer or manure (both containing mostly soluble phosphorus) are added to soil, the soil's pool of soluble phosphorus increases. With time, soluble phosphorus is transformed slowly to less soluble (less plant available) forms. In terms of soil phosphorus content is observed in Hungary a good and very good supply in this main macronutrient (figure 3). On these soils was determined a high content of organic matter and it is likely that the high content of phosphorus come from the decomposition of organic matter. Phosphorus content of soils in Romania is very varied, ranging between 9 and 88 ppm. Values of mobile phosphorus content in soil greater than 70 ppm is a very good supply.

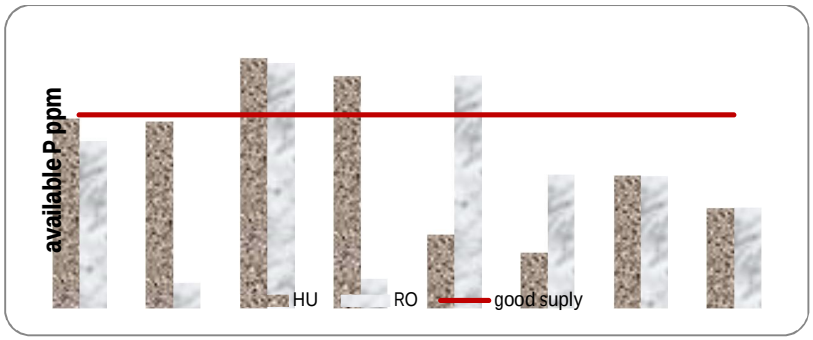

Fig.3 Phosphorus soil content

Potassium is an essential nutrient for plant growth. Potassium is involved in many plant metabolism reactions, ranging from lignin and cellulose used for formation of cellular

structural components, to regulation of photosynthesis and production of plant sugars that are used for various plant metabolic needs. It controls water loss from plants and is involved in overall plant health. Soils that have adequate potassium allow plants to develop rapidly and outgrow plant disease, insect damage and protect against winter freeze damage. Available soil potassium supply in both countries range from good to very good. In Hungary, the largest quantities of potassium were determined on soils rich in organic matter. Highest potassium content was determined in Romanian forest soils, 812 ppm (figure 4). Although potassium is released into the soil by decomposing organic matter, it has the ability to retain potassium fertilizer applied as cation exchange and release it as needed in the soil solution.

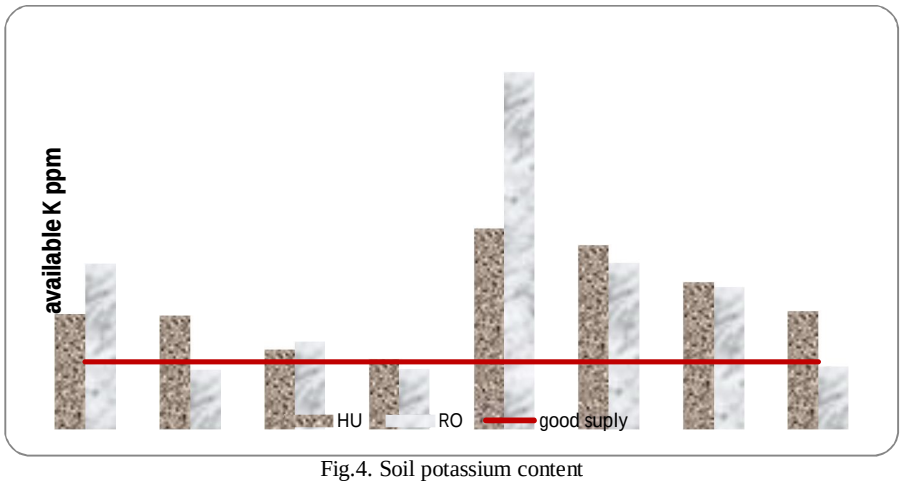

Fig.4. Soil potassium content

The availability of zinc, cooper, nikel, cadmium, manganese, iron and lead to growing plants is very dependent on soil pH and organic matter content. The availability of most metals increases as the soil pH decreases (becomes more acidic). Availability decreases as the soil pH increases (becomes more alkaline). Organic matter or humus will often chelate (form complexes with) these metals, which generally tends to increase or maintain their availability to plants, even at higher pH levels.

Total zinc content in soil is ranged between 40 ppm and 140 ppm in Hungary, and between 30 ppm and 75 ppm in Romania. Copper content in soils vary in a large domain, being ranged between 20 ppm and 130 ppm for Hungary, and respectively 71 ppm for Romania. Highest manganese content was determined in Romanian soils, maximum value was 967 ppm. Hungarian soils are richer in nickel, highest value being determined in soil with intensive system, 50,1 ppm.

Soils from Hungary – Romania border area have a low cadmium content, non of the values exced maximum admitance levels. Lead content of Romanian soils are relatively low (2 – 30 ppm), but in Hungary in intensive system and forest soils, at depth of 0 -20 cm, lead content exceded admitance level of 50 ppm.

CONCLUSIONS

On the Hungarian border side soils are slightly alkaline, while in Romanian side of the border they vary from acid to alkaline soils. Humus content of soil in Hungary – Romania border area is ranged between 2% and 4 %. Grassland soils have the highest phosphorus content in both countries, followed by forest soil in Romania and soil with ecological system in Hungary. Available soil potassium supply in both countries range from good to very good. Highest potassium content was determined in Romanian forest soils, 812 ppm. Among heavy metals only lead content excedes admitance leve,l in Hungarian soils.

Considering all determined chemical indicators, we can conclude that the soils of the Hungary - Romania are quality soil, with pH from acid to slightly alkaline, medium humus content and well supplied with phosphorus and potassium.

To maintain quality in terms of soil chemistry, is required: to enhance organic matter, to manage nutrients and pests efficiently, to prevent soil compaction and to diversify cropping systems .

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