THE ANALYSIS OF THE HEAVY METALS IN THE CORN AGRICULTURAL ECOSYSTEM IN THE AXENTE SEVER-COPŞA MICĂ AREA (SIBIU COUNTY)

ANTONIE Iuliana[1], PAVEL Petronela[2]

Lucian Blaga University of Sibiu,

Abstract

The invertebrates constitute important indicators in the appreciation of the soil. A first step in this respect is constituted by the analysis of the heavy metals in the corn fields in the Axente Sever and Copşa Mică Area. Methods of researching: collecting the samples in the soil by using the agricultural drill; the determination of the heavy metals by spectroscopy of atomic absorption, using the spectrometer of atomic absorption ContrAA 700. As a result of the researches the average concentration of lead and cadmium in the soil of the agricultural ecosystems from the studied area is still high.

Key words: *soil, heavy metal*

JEL classification: *Q01*

1. Introduction

Our researches are a part of a more ample study: "Researches regarding the biodiversity of the agricultural entomologic fauna in the soil of the corn culture, its importance upon the pedological ecological genesis and the economical ecology in the Sibiu County" and which final goal is to find a biologic index in order to express the equilibrium or non-equilibrium status between the invertebrates fauna useful for the ecological genesis of the soil

[1] *Lecturer Ph.D. , iuliana_antonie@yahoo.com*
[2] *Assistant professor, Ph.D. student, , ptrpetro@yahoo.com*

and the pest one. We approached this theme because the soil is a dynamic vital system for the human activities and for maintaining the ecosystems. The main function of the soil is that it represents the fundament for practicing the agriculture in the main goal of assuring the food security and safety of the population. Its role is due to the physical and chemical properties of the soil. From the point of view of quality index of the soil the invertebrates were quite neglected. The biological properties of the soil are still weakly understood although their relations with the physical and chemical properties, with the health of the plants and the food quality are obviously important: the invertebrates play a vital role in the decomposition of the organic matter, in the cycle of the nutritive elements and it could constitute important indicators in the appreciation of the soil; the changes in the invertebrates biodiversity can give us indexes of the deterioration or rehabilitation of the soil. The novelty of the project stands in introducing in the equation of the parameters that assure the proper ecological genesis of the soil, the invertebrates' biodiversity in the corn culture soil. The study has a character of national novelty and "primum movens" in the corn culture in Sibiu County. Being a novelty it asks for an original methodology, all leading in the end to obtaining a biologic index.

2. Material and method

The researches took place in the agricultural ecosystem Axente Sever/Copşa Mică. We made our opinion in choosing the latter agricultural ecosystem because there we are dealing with two major problems: the excessive pollution of the soil and the presence in the corn culture of two important pests: *Tanymecus dilaticollis* (corn weevil) and the migrating locust (*Locusta migratoria).*

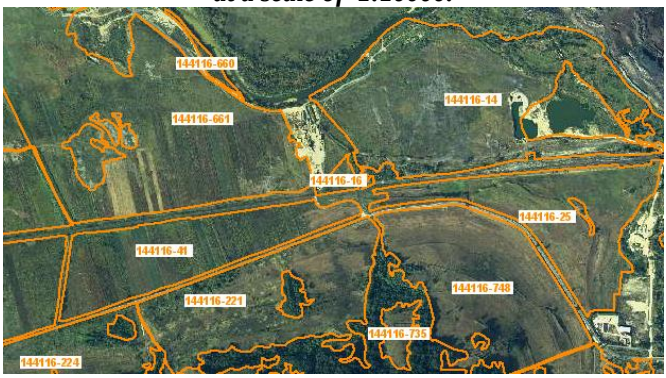
Mapping: three types of maps for each researched agricultural ecosystem:

1. Google Earth maps, general and detailed view;

2. Maps LPIS (cadastral maps) – map of APIA (photo plan) at a scale of 1:2500, 1:5000 and 1:10000. The researched place can be recognized after the number of the physic block 661 for Axente Sever and 144116-14 for Copşa Mică;

3. Administrative plans of the agricultural plots from the local City Hall. The part called "Şesul zavoi" is the part in Axente Sever adjacent to that in Copşa Mică.

Figure 1: Axente Sever - Maps LPIS (cadastral maps) – map of APIA (photo plan) at a scale of 1:10000.



Source: *APIA*

Collecting the samples in the soil from the researched agricultural ecosystems

Figure 2: *Collecting the samples in the soil from Axente Sever*

Source: *original photo*

Determination of the heavy metals by spectroscopy of atomic absorption is relatively new technique characterized by rapidity, sensibility and the possibility of analyzing the metallic ions from complex mixtures

without being necessary the previous separation of these. These types of analyses were done in the labs of the Faculty of Agricultural Sciences, Food Industry and Protection of the Environment in Sibiu.

The spectrophotometry of atomic absorption is a method of analysis which is based on the property of an atom, which being in a fundamental electronic state of absorbing the radiant energy corresponding to the wave length of one of its resonance radiations.

In the case of absorption of the radiation an element brought in the gas state (atomized) can be passed into an energetic high state if it is introduced in a field with electric and magnetic field. The electrons are transferred from the external stratum to a superior energetic level and the atoms pass into an excited state. The radiation is absorbed by the atoms and the reduction of the intensity of the incident radiation is in a close bound with the number of atoms which absorb; in this way is determined the concentration of the element in the sample.

The basic principle for the quantitative evaluation of the absorbed spectrum is based on the Lambert-Beer Law, with the mention that the relation between the absorbed and the concentration is a linearly one only for the reduced concentrations. In the case of raising the concentration this property disappears.

In order of determining the heavy metals from the soil samples taken from the soils in Axente Sever/Copşa Mică we used the apparatus contra 700, a spectrometer for the atomic absorption with a continue source of high resolution (Figure 3).

Figure 3: The spectrometer of atomic absorption ContrAA 700

Source: *original photo*

For determining the content of heavy metals the soil samples were left to dry at the room temperature, then dried at a temperature of 105^0 C in the drying stove for 3 hours. After drying the soil samples were grinded with the Fritch Pulverissette equipment 0 (Figure 4)

Figure 4: Grinding mill for soil

Source: *original photo*

Besides drying and grinding the soil samples didn't require any other preparation phase.

3. Results and discussions

Collecting the soil samples from the researched agricultural ecosystems represent a first important phase in the study of the agricultural entomological fauna being available for Romania by STAS 7184/1-84 "Harvesting of the samples for the pedological and agricultural chemical studies". The configuration of the studied plots was rectangular – rectangle. As results we obtain from each studied plot an average sample, constituted in its turn from 40 elementary soil samples (round 20 for each hectare), the surface of the plot being walked in zigzag. The soil samples for the agricultural chemical maps were taken from a depth of 30cm with the drill. The elementary samples were introduced in collecting bags corresponding to each plot. These bags were numbered and dated. For unloading the drill of the soil sample from its channel was used a tool with a beak that slides on channel evacuating the sample in the bag. The samples were taken to the lab of agricultural analyzes of The Faculty of Agricultural Sciences and Protection of the Environment in the idea of drying and grinding them.

The phase in the lab comprises the operations of unpacking of the samples, their labeling, numbering, drying and grinding. The samples from the bags of soil collecting were dried at the room temperature for 2 days and then were grinded. After grinding the sample was put through a sieve having the diameter of an eye of 2mm, drifted and afterwards there was going to determine the heavy metals from the agricultural ecosystem.

The determination of the heavy metals by spectroscopy of atomic absorption

As a result of reaching on the soil of heavy metals contained in powders the level of pollution of the soil is still very high in the area. During the time the state of the soil was monitoring by The Agency of Protection of the Environment in Sibiu. The average concentrations of lead and cadmium in the soil are continuously high in this area (Table 1).

Table 1. Average samples of lead and cadmium in the soil of corn culture in the agricultural ecosystem in Axente Sever and Copşa Mică

Number	Collecting samples location	Cd (mg/kg) average sample	Pb (mg/kg) average sample
1	**Axente Sever**	19,10	558,45
2	**Copşa Mică**	18,85	950,30

Comparing these data with the reference values regarding the concentration of some heavy metals (total forms in the soil) published by The Official Monitor (Order nr. 756/1997 of M.A.P.P.M. first part, nr. 303/1997) come to support this fact (Table 2).

Table 2: Reference values regarding the concentration of some heavy metal (total forms in the soil)

	Pb	Zn	Cu	Cd
	($mg \cdot kg^{-1}$ s.u.)			
N.C. (normal Content)	‹20	‹100	‹20	‹1
Alarm Limit				
Sensitive use	50	300	100	3
Less sensitive use	250	700	250	5
Intervention limit				
Sensitive use	100	600	200	5
Less sensitive use	1000	1500	500	10
Charging class				
Weak	21-40	101-150	21-40	1.1-2.0
Moderate	41-100	151-300	41-100	2.1-3.0
Strong	101-300	301-700	101-200	3.1-7.0
Very strong	301-1000	701-1500	201-400	7.1-20.0
Excessive	›1000	›1500	›400	›20
Source: The Official Monitor - Order nr. 756/1997 of M.A.P.P.M. first part, nr. 303/1997				

A thoroughly research of the soil from a pedologic, physical and chemical point of view as well as of its pollution and the correlation with productivity was done in 2000 by Professor Micu Mircea in his Ph.D. thesis in 2001 having the title "The Influence of Pollution upon the Soils in Copşa Mică Area and Its Ecologic Implications", being a reference document in this field (Barbu, 2006). One of the general observations of this study mentions the lack of homogeneity of the level of development of the same vegetable species on the same under type of soil. This fact was also noticed by us through the

researches done in the analyzed corn agricultural ecosystems. The vegetation, represented by grain corn, was presented quite not uniformly, so some parts were covered with fully developed plants and some parts with week plants or even without plants. This fact assures a moderate level of productivity regarding the agricultural ecosystem. In this case the pollution with heavy metals is to be blamed for diminishing the productivity.

Another aspect that can't be over sighted is the effect of the black smoke that is present in the area. The deposits of black smoke lead to the closing up the stomas and prevent the getting in of the sun rays, affecting strongly the photosynthesis process and in this respect leading to the diminution of the corn production (Barbu, 2006). The accumulation of black smoke at the soil level leads to an excessive pigmentation of it. The modification of the color of the soil was noticed during the collecting the soil samples and the agricultural entomologic fauna in the area. Blacking was observed also at depth which outruns the limit of actions of the cars or the equipment for the mechanical works within the culture technologies.

The pollution of the environment in the Axente Sever and Copşa Mică area has a strong negative impact upon the invertebrates in the soil. The high level of contamination in the area with heavy metals had as a consequence the destruction of the ecologic equilibrium, reflected in the reduction of the invertebrates populations. In the rapport done by Vădineanu and coworkers in 1991 is drawn the alarm sign for the disappearing of the species of nematodes, enchiridia, lumbricides, and the number of species of oribates and collembolans was reduced with 11-95% given to non polluted areas. Our researches regarding the influence of the pollution with heavy metals upon the biodiversity of the agricultural entomologic fauna come to complete the studies already done in this field.

4. Conclusions

The average lead and cadmium concentrations in the soil of the corn agricultural ecosystem in Axente Sever/Copşa Mică area are still high.

The vegetation, represented by grain corn is presented quite non uniform in the studied plots. There are parts covered with full grown plants, other with weak plants and other without plants. This thing being a consequence of the pollution with heavy metals of the soil in the researched area.

The pollution with heavy metals, over the permitted limits, assures a level of moderated productivity at the level of the agricultural ecosystem, as a result of reduction of the photosynthesis process of the cultivated plants.

The corn cultivated on soils polluted with heavy metals extracts these metals that, finally can reach in the human or animal body, causing serious diseases.

The heavy metals from the soil are harmful for the invertebrates, affecting the capacity of forming the humus, so of the productivity of the soil.

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