IMPORTANCE OF SOIL LIVING ORGANISMS IN SUSTAINABLE AGRICULTURAL LAND MANAGEMENT

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Abstract

The paper deals with the soil biological research and its contribution to the changed cropping strategy and to the sustainable and environmentally friendly farming and management. The paper emphasizes the importance of biodiversity, as one of the most important ecological functions of soil. The organisms, populations and communities living in the soil play a key importance in the preservation of soil fertility.

The paper treats the activity of useful soil microorganisms in the soil-plant system; the possibilities to increase the soil biological activity, the methods for measuring the biological activity in the soil. Call the attention the presence of different bacterium and bio-preparations in the agricultural consumption. We have to prepare to examine the soil biological effectiveness of the more widely spread bio-preparations, bacterium preparations, and bioregulators. The prerequisites are the versatile knowledge of the biological state of soils and monitoring examination of the different effects soils had (including the mentioned preparations).

Keywords: sustainable management, environmentally friendly technologies, biodiversity, soil biota, bio-preparations

The soil is a remarkable proportion of the natural resources in Hungary (Várallyay, 1997). The important element of the sustainable management is the proper management and rational use of soil, which is particularly important in national economic and environmental protection point of view. The knowledge about processes taking part in soil is a very important element of the sustainable development and also a big challenge for the professionals.

Soil biological relations between the sustainability and environment-friendly agricultural technique

Soil quality is determined by physical and biological state of soil and harmony of fertility. If the consistency ceases, the living conditions of plant deteriorate too. The efforts for soil quality – amelioration, conservation, retain – coincide with the objectives of sustainable management.

In the sustainable management, the crop cultivation may be based such a cultivation methods that creates, saves and keeps favourable physical and biological condition of the soil (Birkás, 2005). The cultivation, through the protection of soil quality contributes to the harmony of environment and cropping systems.

In the context of the sustainable agricultural development, according to Németh (2005) such a land use strategies and applications should be established that make sufficient quantity and quality of products possible without the environment loading. The nutrient needs of a reasonably planning level of yield can be determined by the nutrient content and nutrient supplying capacity of soil. Without soil biota occurring in the soil-plan system, the soil could not play an important role in agricultural and environmental protection point of view (Biró, 2005).

The soil with their physical and chemical properties ensure the life conditions and functionality of living organisms, while the majority of these properties change in a smaller extent, the soil biological properties go through on a continuous changes as a result of dynamic processes. It follows that in contrast with the condition of soil environment, the soil biological properties have an increased susceptibility.

Soil quality has been defined as a sensible and dynamically changing property which responds to the use of soil and represents the soil state. In the further development of soil quality and evaluation the sustainability and the preservation of environmental quality have to be expressed (Szili-Kovács et al., 2011).

Functions of soil

In the last decades several author summarize the multifunctional role of the soils. Soils are the most significant – conditionally renewable – natural resources (Várallyay, 1994; 2005). More important function are: a.) reactor and transformer system, b.) medium for biomass production, c.) a major natural storage of heat, water, plant nutrients and others, d.) a natural filter and detoxication system, e.) soils represent a high capacity buffer medium, f.) a significant gene – reservoir of biosphere, an important element of biodiversity, g.) other functions are linking with „human activity".

Blum (1994) has set aside three ecological, and three technical, industrial, socio-economic functions of soil. The approach of the versatile functions of soil differs in the two authors, but regarding the content, it is almost the same. In both definitions the soil plays as a living place and one of the reservoirs of biosphere.

According to Blum (1999) sustainable management can be defined as spatial and/of temporal harmonization of all the six main uses land, minimizing irreversible ones, e.g. sealing, excavation, sedimentation, contamination or pollution, salinization, alkalinisation and others. Agricultural land management is only one of the several possible land uses and therefore depends on all other uses in a given area or region. In this definition the sustainability is not only determined by ecological but also by socio-economic and cultural factors.

Soil biota and fertility

The quantitative occurrences, species composition of the soil microorganism living in the soil are equally important. According to several authors only approximately 1% of the living microorganisms can be determined by the cultured techniques from the test sample. According to Szabó (1989) we can not determine the species composition of an only water or soil sample on substrate. There may be so microorganisms that their presence can be detected by electron microscopy, but can not be cultured in any medium. Among the cultured microorganisms there are several undetermined at present. The composition of the population dynamics of microorganisms during the year is also constantly changing. This could be the reason that we do not fully know exactly the bacterium population of soil types on species level.

The soil biomass producing capacity is the result of the soil physical, chemical and biological properties as well as their complex interaction.

Thus, the soil-plant system can continuously change due to the soil properties and climatic conditions, these multifactorial components influence the ecosystems, in which the proportion of each component can change (Biró 2005).

Among the physical properties the soil texture, pore conditions, moisture content, soil structure and temperature are the main environmental factors for the soil organisms. Among the chemical properties we have to emphasize the soil pH and parameters connecting to pH, so redox conditions, different concentration of nutrients, soil organic matter stock and colloid content.

The total living organisms in the soil is the soil biota, the biota with the changes of metabolism time to time implement the "biological dynamics" of the soil. The differences in the dynamics of soil types are the mineralisation processes, degradation of the soil organic material, intensity and nature of element cycles.

Occur of a greater amount of a particular soil organism's group does not necessarily indicate a greater biological activity. However, a higher biological activity also does not mean a stimulating effect on the soil fertility. Therefore, those attempts are doomed to failure, which connect the soil fertility to a soil biological parameter, e.g. intensity of cellulose decompose, the rate of nitrogen fixation (Szabó, 1989).

The multisided activities of soil living organisms

We can summarize the most important activities of soil microorganisms in the soil-plant environment as follows (Biró 2005):

- Conversation of organic material; the mineralisation and humification;
- Improvement the available plant nutrient with greater root surface and phosphorus mobilization;
- Biological nitrogen fixation;
- Hormone release of microorganisms helps plant growth (plant growth regulators (PGR));
- Enhancing drought tolerance by active water absorption of the greater root mass (mycorrhizal fungi and plant growth promoting rhizobacteria (PGPR));
- Biological plant protection, - biostatic, biocidal ferro-chelate agents, antagonist organisms, *Trichoderma sp.;*
- Micropollutants, partial or total breakdown of xenobiotics.
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In addition we point out the more general activities of living organisms in the soil:

- Certain groups of organism take part in the biological weathering processes of rock (algae, fungi and lichens);
- Improvement of soil structure (bacteria, fungi and worms);
- Ensure the cycle of elements between the living and non living environment;
- The symbiosis is very important among the organisms, mutualism, which is mutually beneficial for the individual organisms, the Rhizobium on the root of legumes and the ecto- and endo mycorrhizal fungi on the root of plants in higher order;
- Regulate and influence the composition of the atmospheric air.

Possibilities for increasing the soil biological activities

The soil physical, chemical properties and biological activity showed close correlation with soil fertility. The soil microbiological activities, the diversity within population and between species have been increased by the balanced water and nutrient supply.

By the optimal soil water regime favourable soil processes are formed, the following ways are possible to enhance the biological activity (Biró 2005):

- Detecting and controlling those soil degradation processes that decrease the soil biological activity;

- The nutrient supply to be controlled and conscious, taking into account the ability of nutrient exploration of microorganisms;
- In the knowledge of the spatial and time variability of soils the application of the precision approach and environmentally friendly cultivation methods;
- To increase the stock of organic matter, improvement the soil structure, and applying alternative agricultural crops;
- The reduction of the monoculture cultivation methods, extend the crop rotation and integrated crop management practices;
- Reduce the damaging effects of xenobiotics and pesticides on soil biota;
- Reduce the contamination of water resources;
- Extensive application of the environmental monitoring and advisory system, that takes the soil biological parameters into consideration.

Microbiological indication, test methods

The microorganisms are sensitive to the environmental changes, so the microbial indication methods are suitable for measuring the soil state and monitoring the soil quality (Szili-Kovács et al., 2011).

Depending on the purpose of the research, the methods are selected. Four method groups can be divided: to measure the microbial biomass, the microbial activity, the microbial diversity and examination for plant-microbe interactions. For and monitoring the soil fertility, the microbial biomass, soil respiration and the potential nitrogen mineralization may be sufficient. In the monitoring systems the soil physical, chemical and biological factors should be assessed on complex way (Kátai, 1992).

In our national Journal (Agricultural Chemistry and Soil Sciences) research results were published which approach the soil biological issues with new and modern molecular biological methods (examination the bacterial communities by phospholipids fatty acid method, identification of the microscopic fungi by PCR fragments, soil biological comparative evaluation of the Bt-endotoxin producing transgenic, as well as isogenic toxin is not producing maize rhisosphere (Kátai, 2012)).

Using microbial preparations

In Hungary has already appeared the so called "Bacteria fertilizer" in the 1960s which are used in the agricultural production. Those preparations proved to be effective which contain only one microorganism strain (*Rhizobium* sp., *Azotobacter* sp.). Their application is widespread in many countries (Manninger és Szegi, 1963).

The bacterial preparations that are mainly contained *Rhizobiu*m and *Azotobacter sp*. was named environment-friendly technologies, these preparations had positive effect on the soil inoculation, when the nutrient supply was optimal (Köves-Péchy et. al, 1989).
In recent years the different microbiological preparations, bacterium fertilizers have spread in the agricultural production (Biró, 2003). With the application of these products a variety of bacteria strains are allocated to the soil. Biró et al., (2000) also the combined, more useful microorganisms are proposed. To get more knowledge about the "new-generation" preparations (vaccines) is necessary for proper understanding of the sustainability and ensure the remediation of the soil-plant air system.
The distributors of these bacteria fertilizers promise that with the use of these preparations, the increased microbial activity, improving soil structure, more intensive breakdown of organic matter, modification of nutrients uptakeability (Solti, 2004).
In recent decades, in the Agrochemistry and Soil Science journal several soil biological papers were published and according to these papers (Kátai, 2012) the demand of research of sustainability, and the environment-friendly alternative nutrient supply, revival of the earlier "soil inoculation" methods. Bio-fertilizers and bacteria fertilizers have appeared in the agricultural use and to examine the efficiency of these products needs as well.

Recently, various microbial preparations have been in commercially available. The positive effect of the microbial preparations with different composition are supported by Hegde et al., (1999), El-Kramany et al., (2001), El-Sirafy et al., (2006), Elkoca et al., (2008), Kátai et al., (2008), Kincses et al., (2008), Tállai et al., (2008), Hegedűs et al., (2008), Schweinsberg-Mickan és Müller (2009), Leaungvutiviroj et al., (2010), Tállai (2010), Dadnia et al., (2010) with their research results.

In Hungary in 2012, according to the application area the following **yield increasing material** can be chosen for specialists:

- Fertilizers to supply the soil nutrient (organic and mineral fertilizers, leaf fertilizers, composts, worm humus, conditioners): 86
- Media for plant production: 8
- Soil amelioration materials: 44
- Soil conditioners: 6
- Preparations containing microorganisms: 34 (Erdős - Molnár, 2012).

In Hungry only those pesticides and yield increasing materials can be placed on the market, for which the licensing authority (National Food Chain

Safety Office, Soil and Agricultural Environment Protection Administration) issued the licence. On the bases of the appropriate examinations the authority gives permission for commercial release of products.
The quantity and quality of crop yield, confirm the users for the correct choice of preparations, therefore the preparations containing microorganisms may widely spread more and more.
At the same time very few information is available on the later life of microorganisms giving to the soil, their activity and mode of action. According to Szabó (1989) the "effective settling" of that microorganisms are influenced by several factors.

- First, the microorganisms must be present in the right place and right time, and have to survive in a shorter or longer period in an inactive state. The reproduction may only start, when all the essential nutrients are in available forms.
- They must have a high ecological tolerance, to tolerate the extreme physicochemical factors. The rapid growth and reproductive capacity can help overcome the biotic effects.
- The structural change of microbial population is rapid.
- In the soil the heterotrophic organisms make a degradation food chain, so besides the dead organic matter the body of the dead microbes is also take part in the mineralization process.

We have to prepare for measuring the effectiveness of the increasingly widespread bio-products, bacterial preparations, bioregulators, by soil biological examination methods. The first pre-requisite of it is to get more knowledge about the soil biological condition and the other prerequisite is to follow the various effects reaching the soil (including the bacterium preparations referred to) with monitoring.

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