Scientific Committee:

President:
- Academician Rudolf Kastori, Academy of Science and Art of Vojvodina, Novi Sad, Serbia and Hungarian Academy of Sciences, Budapest, Hungary

Vice-Presidents:
- Prof. dr Pavle Sekeruš, Vice-Chancellor for science at the University of Novi Sad
- Prof. dr Evgenij Ivanovich Koshkin, Vice-Chancellor for International Cooperation at the Russian State Agrarian University – MTAA, Moscow, Russian Federation
- Dr. Zvonko Nježić, Research Associate of the Institute for Food Technology in Novi Sad, Serbia
- Dr Dragana Miladinović, Assistant Director for Science at the Institute for Field and Vegetable Crops in Novi Sad, Serbia
- Stefano Ciafani, Vice-Presidente of Legambiente d’ Italy

Secretary:
- Ana Perenić, Professor of Ecology and Environment Protection, Vice-Director Ecological movement of Novi Sad, Serbia

Members:
- Academician Srbislav Denčić, Institute for Field and Vegetable Srops, Novi Sad, Serbia
- Academician Vaskrsija Janjić, University of Belgrade, Resident Professor at the Agricultural Faculty, Serbia
- Marjan Jošt, JOST Seed-Research, Križevci, Croatia
- Academician Branka Lazić, University of Novi Sad, Resident Professor at Agricultural Faculty, Serbia
- Prof. Dr. Desanka Božidarović, University of Novi Sad, Resident Professor at Agricultural Faculty, Serbia
- Prof. Dr. Biserka Dimiskovska, University “St. Cyril and Methodius”, Institute for Earthquake Engineering and Engineering Seismology (IZIIS), Skopje, Republic of Macedonia
- Prof. Dr. Miodrag Dimitrijević, University of Novi Sad, Resident Professor at Agricultural Faculty, Serbia
- Prof. Dr. Ivana Đujić, University of Belgrade, Resident Professor aof Food Chemistry and Biological Faculty, Serbia
- Prof. Dr. Slavko Filipović, University of Novi Sad, Resident Professor at the Technology Faculty, Serbia
- Prof. Dr. Vladimir Hadžić, University of Novi Sad, Resident Professor at Agricultural Faculty, Serbia
- Prof. Dr. Vlada Joldžić, Institute for Criminological and Sociological Research, University of Belgrade, Resident Professor at the Biological and Chemical Faculty, Serbia
- Prof. Dr. Kadar Imre, Research Institute for Soil Science and Agricultural Chemistry, Hungarian Academy of Sciences, Budapest, Hungary
- Prof. Dr. Borivoj Krstić, University of Novi Sad, Resident Professor at the Faculty of Science, Serbia
- Prof. Dr. Ivana Maksimović, University of Novi Sad, Resident Professor at Agricultural Faculty, Serbia
- Prof. Dr. Dragutin Mihajlović, University of Novi Sad, Resident Professor at Agricultural Faculty, Serbia
- Prof. Dr. Rodoljub Oljača, University of Banja Luka, Resident Professor at the Faculty of Forestry, Bosnia and Herzegovina
- Prof. Dr. Mihailo Peruničić, University of Novi Sad, Resident Professor at the Technology Faculty, Serbia
- Aleh Rodzkin, International Sakharov Environmental University, Minsk, R.. Belarus
- Prof. Dr. Atila Salvai, University of Novi Sad, Resident Professor at the Agricultural Faculty, Serbia
- Prof. Dr. Velibor Spalević, University of Montenegro, Research associate at the Biotechnical Faculty of Podgorica, Montenegro
- Prof. Dr. Ivan Šimurić, University of Zagreb, Resident Professor at the Agricultural Faculty, Croatia
- Prof. Dr. Marija Škrnjar, University of Novi Sad, Resident Professor at the Technology Faculty, Serbia
- Prof. Dr. Radmila Šovljanski, University of Novi Sad, Resident Professor at the Agricultural Faculty
- Prof. Dr. Ion C. Ungureanu, Resident Professor at the University of Agricultural Sciences and Veterinary Medicine, Bucharest, Romania
- Prof. Dr. Ljubo Vračar, University of Novi Sad, Resident Professor at the Technology Faculty, Serbia
- Prof. Dr. Momčilo Vukićević, Faculty of European Legal and Political Studies in Novi Sad, Serbia
- Prof. Dr. Victor Veniamnovič Zakrevski, North-Western State Medical University named after I.I. Mechnicov, Resident Professor, Sanct-Petersburg, Russian Federation
- Prof. Dr. Lu Zhongmei, Resident Professor at the Wu Han Law University, China
- Mr. Ivan Lullić, ing. polimer technology
Organizing Committee:

President:
- Nikola Aleksić, Director of the Ecological Movement of Novi Sad

Vice-president:
- Angelo Mancone, Co-ordinator Legambiente Veneto, Rovigo, Italy

Secretary:
- Ljubica Aleksić, Organizer of the Ecological Movement of Novi Sad

Members:
- Dr Vera Đekić, Center for Small Grains, Kragujevac
- MA Sladana Duranović, Professor of English language and literature
- Zoran Kovačević, Organizer of the Ecological Movement of Novi Sad
- Milenko Košutić, Engineer, Expert Assistant at the Institute for Food Technology (FINS)
- Slobodan Mišić, Organizer of the Ecological Movement of Novi Sad
- Bratimir Nešić, Translator and Lector of the Ecological Movement of Novi Sad
- Milanko Nešković, Organizer of the Ecological Movement of Novi Sad
- Dr. Đordr Okanović, Research Associate of the Institute for Food and Technology in Novi Sad
- Dr. Vera Popović, Institute for Field and Vegetable Crops, Novi Sad
- Marina Samsonov, Translator and Interpreter of the Ecological Movement of Novi Sad
- Prof. Dr. Milan Stanulović, Translator
- Željko Štrbac, Student of Faculty of Technical Sciences in Novi Sad
- Luka Vujasinović, Organizer of the Ecological Movement of Novi Sad
- Peta Vukić, Technical Director of the Ecological Movement of Novi Sad

Official water of the XVIII International Eco-Conference® 2014

- MINAQUA, NOVI SAD

Official host of the XVIII International Eco-Conference® 2014

- Institute for Nature Conservation of Vojvodina Province in Novi Sad
CONTENT

THE ECOLOGICAL MOVEMENT OF NOVI SAD: AN IMPORTANT DECISION OF ITS PROGRAMME COUNCIL ........................................15

FOREWORD ................................................................................................................................. 19

PRELIMINARY PAPERS

Marijan Jošt
BIOETHICS OF AGRICULTURE ........................................................................................................ 23
Jelena Filipović, Slavko Filipović, Šandor Kormanjoš, Vera Radović,
Zvonko Njezić, Dorde Okanović
INFLUENCE OF EXTRUSION PROCESS ON THE NUTRITIVE VALUE OF SOYBEAN ............35

CLIMATE AND PRODUCTION OF SAFE FOOD

Arion Tureșán, Éva Erdélyi
MODELLING THE EFFECTS OF CLIMATE CHANGE ON WINE PRODUCTION FOR KUNȘÂG REGION ................................................................. 49
Biserka Dimiskovska, Dragi Dojcinoivski, Vesela Radovic
AIR QUALITY IN R. MACEDONIA DEPENDING ON PRESENCE OF SULFUR DIOXIDE WITH REGARDS TO PRODUCING HEALTHY AND SAFE FOODS ............................................................. 59

SOIL AND WATER AS THE BASIS OF AGRICULTURAL PRODUCTION

Antonia Stojanova, Ivan Gospodinov, Svetla Kostadinova, Natalia Petrovska
EFFECT OF IRRIGATION AND FERTILIZATION ON MAIZE YIELD AND PROTEIN CONCENTRATION ............................................................ 71
Maksimović Ivana, Kastori Rudolf, Putnik-Delić Marina, Svjetlana Zeljković
RARE EARTH ELEMENTS IN THE ENVIRONMENT ........................................................................... 81
Branislav Leleš, Sonja Aćimović
POSSIBILITY FOR ALKALINITY OF SOIL IRRIGATED WITH DANUBE WATER ON THE BEZDAN PROFILE ........................................ 91
Sanja Mrazovac Kurilić, Vladanka Presburger Uliniković, Violeta Cibulić, Lidija Stamenković
ASSESSMENT OF POLLUTANT IMPACT ON NITRATE CONCENTRATION IN GROUNDWATER .................................................. 99
Livija Maksimović, Borivoj Pejic, Stanko Milic, Vladimir Sikora, Milka Brdar-Jokanovic, Vera Popovic
THE EFFECT OF DROUGHT ON SAFE FOOD PRODUCTION ........................................... 107
Vladimir Miladinovic, Vladan Ugrenovic, Vladimir Filipovic
METHODS OF PHYTOREMEDIATION OF SOIL ................................................................ 117
Miodrag Jelic, Jelena Milivojevic, Aleksandar Dikic, Vera Djekic, Goran Dugalic, Svetomir Stamenkovic
ALUMINUM TOXICITY IN ACIDIC SOILS IN SERBIA ........................................................ 127
Vera Dekic, Jelena Milivojevic, Miodrag Jelic, Snezana Brankovic, Vera Popovic, Vesna Perisic, Vladimir Perisic
STABILITY OF WHEAT YIELD ON ACID SOIL IN THE PRODUCTION OF SAFE FOOD ......................................................... 137
Zoran Dinić, Radmila Pivić, Dragana Jošić, Aleksandar Sebić, Aleksandra Stanjeković-Sebić
METALLURGICAL SLAG USE EFFECTS ON SOIL CHEMICAL, PHYSICAL AND MICROBIOLOGICAL PROPERTIES ........................................ 145
Srdan Šermencić, Jovica Vasin, Milorad Živanov, Stanko Milić, Dragiša Milosevic, Marinela Vasiljević
BIOCHAR APPLICATION: THE PROSPECTS OF SOIL PROPERTY IMPROVEMENT ........................................... 155

GENETICS, GENETIC RESOURCES, BREEDING AND GENETIC ENGINEERING IN THE FUNCTION OF PRODUCING SAFE FOOD

Vesna Samohor, Dijana Horvat, Z. Matotan
PRESERVING AND CONSERVATION OF OLD LOCAL VARIETIES AND VEGETABLE ECO POPULATIONS IN CROATIA ........................................ 165
Kristina Lukovic, Milivoje Milovanovic, Vladimir Perisic, Kamenko Bratkovic, Mirjana Staletic
VARIETY PERFECTA – ANOTHER CONTRIBUTION TO BIODIVERSITY OF WINTER WHEAT IN SERBIA ........................................... 173
Grozi Delchev, Iliyana Petrova
STABILITY VALUATION OF SOME STIMULATORS FOR THEIR INFLUENCE ON THE GRAIN YIELD OF TWO DURUM WHEAT CULTIVARS ........................................... 181
Fertilizers and Fertilization Practice in the Function of Producing Safe Food

Aleks Rodzkin, Sasa Orlovic, Borivoj Kljivic
The Perspective of Application of Ash From Willow Wood as a Mineral Fertilizer

Integrated Pest Management and Use of Biologicals

Milan Stojanovic
Review of the Most Important Mycotoxins in Food Safety

Marina Lazarevic, Violeta Mickovski Stefanovic, Dorde Glamočlija,
Vesna Perisic, Dušanka Indić, Vera Dekić, Vladimir Perisic, Jelena Milivojević
The Pesticides Residue in Vegetables Impact on Food Safety

Vesna Perisic, Dušanka Indić, Vera Dekić, Vladimir Perisic, Jelena Milivojević
Application of Protect-IT™ in Process of Integrated Pest Management of Stored Grains

Stojan Jevremović, Marina Lazarević, Miroslav Kostić
Application of Secondary Plant Metabolites in Control of Insect Pests

Agricultural Production in View of Sustainable Development

Tamás Tarján, Sándor Lőrincz, Éva Erdélyi
Development in the Agricultural Production of the Bordering European Countries and Regions of Serbia During the Last Decade

Imre Molnar
Future Cropping Systems for the Produktion of Safe Food
PRODUCTION OF FIELD AND VEGETABLE CROPS

Bojana Bekić, Vladimir Filipović, Vera Popović
FLOWERING PERIOD LENGTH AND SEED QUALITY
OF MEDICAL HONEY PLANTS ........................................... 273
Milka Brdar-Jokanović, Dušan Adamović, Livija Maksimović
CHAMOMILE AS A TRADITIONAL AND MODERN PLANT IN
SUSTAINABLE AGRICULTURE............................................. 281

PROCESSING OF AGRICULTURAL PRODUCTS IN THE
FRAMEWORK OF SAFE FOOD PRODUCTION

Ostrovskii V.E., Dr., Kadychevich E.A.
OPTIMAL NUTRITION AND CELLULAR LIFE PROLONATION
IN THE LOH-THEORY CONTEXT...................................... 293
Jelena Kneževič Milosević, Danijela Jasin Ljiljana Raskov Trifunjagic,
Aleksandra Suciurovic, Gordana Ludajic
MONITORING AND ENVIRONMENTAL PROTECTION IN THE OIL
INDUSTRY „DIJAMANT“ A.D, ZRENJANIN .......................... 303
V.V. Zakrevskii, S.N. Leleko
THE HEALTH RISKS CAUSED BY CONSUMING MEAT PRODUCTS
WHICH ARE CONTAMINATED BY NITROFURANS ............ 313
Dorde Alavuk, Časlav Kalinić
QUALITY OF GASTROLOGICAL PRODUCTS FROM THE ASPECT
OF THE TOURISM AND CATERING INDUSTRY .................... 323
Vanja G. Madjoska, Sonja D. Srbinovska, Sterja M. Sterjovski
IMPACT OF SERUM PROTEINS ON THE DEVELOPMENT
OF LACTIC ACID MICROORGANISMS IN YOGURT .................. 333
Olivera Šimurina, Bojana Filipčev, Marija Bodroža-Solarov,
Zvonko Nežić, Rada Jevtić Mučibaba, Jasmina Živković, Jelena Krulj
THE APPLICATION OF SELECTED ENZYMESTO IMPROVE
THE WHEAT FLOUR QUALITY ....................................... 345
Vid Stanulović, Milan Stanulović
BIOTECHNOLOGY IN PHARMACOTHERAPY ....................... 353

ECONOMIC ASPECTS AND MARKETING
AS SEGMENTS OF THE PRODUCTION OF SAFE FOOD

Qi Liao
THE FUTURE OF FOOD PRODUCTION .............................. 365
Ana Bukić
ECONOMIC ASPECTS OF ORGANIC FOOD
PRODUCTION AND MARKETING ................................. 371
FOOD STORAGE, TRANSPORTATION AND PACKAGING

Dragan D. Psodorov, Sonja D. Simić
BIOPOLYMERS AS A CONTEMPORARY PACKAGING MATERIALS IN ACCORDANCE WITH SUSTAINABLE DEVELOPMENT.......................... 381

NUTRITIONAL FOOD VALUE AND QUALITY NUTRITION

Veljko Đukić, Dorde Okanović
LANDAS A BASEHEALTHY FOOD PRODUCTIONIN THE MUNICIPALITY OF PRNJAVOR-REPUBLIC OF SRPSKA...................... 393
Karanyan Marietta
HEALTHY NUTRITION AS COMPONENT OF HEALTH BEHAVIOUR: AN ECOLOGICAL PERSPECTIVE........................................... 403
Agota Vitkai Kučera
INFLUENCE OF NUTRITION IN ELITE PROFESSIONAL VOICE USERS.......................................................... 411
Djordje Okanović, Dragan Palić
ROLE OF FAT IN NUTRITION OF ATHLETES............................................... 417
Bojana Vuković Mirković, Aleksandra Stanković, Maja Nikolić
CARBOHYDRATES IN COLLECTIVE NUTRITION OF CHILDREN AND YOUTH OF THE CITY OF NIS ................................................... 425
Nikola Vuksanović, Milijanko Portić, Dragan Teganski,
Bojana Kalenjuk, Darko Dragičević
THE SENSORY QUALITY ASSESSMENT OF ROASTED PIG IN THE RESTAURANTS IN BELGRADE .................................................. 431
Milica Stojnić, MA. Tamara Galonja Coghill
HEALTHY DIET AND EATING HABITS OF THE STUDENT POPULATION IN NOVI SAD................................................................. 441

LEGAL ASPECTS OF PROTECTING BRAND NAMES OF SAFE FOOD

Jožić Vladan
LAW-LOGICAL AND LEGAL PREROGATIVES FOR SAFE FOOD........... 451
Nenad Bingulac, Jelena Matijašević
SIGNIFICANCE OF LEGAL REGULATIONS OF FOOD SAFETY IN SERBIA................................................................... 465
ECOLOGICAL MODELS AND SOFTWARE IN PRODUCTION OF SAFE FOOD

Milorad Todorović, Milan Ivkovic
"GLOBAL G.A.P." – INTEGRATED FOOD SAFETY PROGRAMME................................................................. 477

NAME REGISTRY................................................................................................................................. 483
METHODS OF PHYTOREMEDIATION OF SOIL

Abstract

Land, as the basic resource for food production, is of paramount importance to the human population. The process of phytoremediation is what allows us the capability to preserve soil in case of contamination. This paper describes five techniques of soil purification. The process encompasses a number of different methods that can lead to the decomposition of contaminants (1) within the above-ground plant tissue, as is the case with the process of phytodegradation, or (2) in the root zone of plants, which is characteristic of the process of rhizodegradation, then, (3) it can bring about acquisition or absorption, which is characteristic of the processes of phytoextraction and phytovolatilisation, and, finally, (4) it can immobilise contaminants in the root zone, which occurs in the process of phytostabilisation.

Keywords: phytoremediation, soil, contamination.

INTRODUCTION

Intensive farming is increasingly being profiled by the use of synthetic agents such as fertilisers, pesticides and others (Ugrenović et al., 2012). Improper use of these agrochemicals leads to an increase in their content in the soil, frequently exceeding the prescribed permissible limits. This leads to a reduction in soil fertility and the destruction of biodiversity in an irreparable way. Soil biodiversity is the central part of our natural systems. But, it is also under ever growing pressure from human activities (Filipović and Ugrenović, 2012). One of the methods to purify soil and facilitate further improvement of soil biodiversity is the method of phytoremediation. The process represents a series of techniques that use the ability of plants, obtained naturally or
through the means of genetic engineering, to perform the decontamination of the environment (Flathman and Lanza, 1998). Phytoremediation is a clean, simple, economical and ecologically sustainable method (Wei et al., 2004); it is a green technology whose byproducts can have many positive impacts (Truong, 1999). By this method, we can carry out the decontamination of the soils contaminated with inorganic pollutants such as toluene, benzene, Polycyclic aromatic hydrocarbons (PAHs), ethylbenzene and many chlorinated solvents (US Environmental Protection Agency – U.S.EPA, 2000). The procedure can be performed in situ, i.e. exactly at the place of pollution, or ex situ. The ex situ method requires excavation, relocation and performing detoxification at another location, followed by the return of the treated soil to its original location. The difference between these methods is that the in situ one is considerably cheaper, but it takes a significantly longer period of time for the process to be carried out.

The success of phytoremediation depends on the potential of a plant to acquire and accumulate pollutants in its biomass, then, on the availability of contaminants to the root system of the plant, on the overall level of soil contamination and on the type of contaminant. It is necessary that phytoremediation plants be characterised by a high capacity for acquisition, translocation and tolerance towards a contaminant (the US Environmental Protection Agency – U.S.EPA, 2000). Large plant diversity is typical of organic agriculture, which, through various methods (multi-year crop rotations, intercropping, cover crops, insulating belts, etc.) makes possible the exercise of phytoremediation at different times and production conditions (Ugrenović and Filipović, 2012).

**PHYTOEXTRACTION**

*Phytoextraction* is a method that exploits the potential of higher vascular plants to perform the acquisition of contaminants from the soil. The process is performed by those plants that are able to acquire a contaminant through the root system, and pass it through the system of transpiration to the aerial parts (stems and leaves). The contaminants are displaced by cutting the above-ground biomass of plants once a certain stage of development has been reached. Phytoextraction is a technique that is most commonly used on soils contaminated with heavy metals and radionuclides. Apart from soil purification, phytoextraction is used for the remediation of sediments and sludge, and, to a lesser extent, for the treatment of contaminated water. According to the research so far (G.M. Pierzynski, 1994), the metals that are subject to the process of phytoextraction are: metals (Ag, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Zn), then, metalloids (As, Se) and radionuclides (90Sr, 137Cs, 239Pu, 238U, 234U).

Plants that expressly perform phytoextraction are called hyperaccumulators. Hyperaccumulators are able to absorb 50–100 times greater concentrations of heavy metals in relation to their own biomass, and, in relation to the plants which do not acquire heavy metals (Salt et al., 1995). To date, over 500 hyperaccumulative plant
species in over 45 plant families have been discovered (Sarma, 2011). Hyperaccumulators were found in the following plant families: Brassicaceae, Euphorbiaceae, Asteraceae, Lamiaceae and Scrophulariaceae (U.S.EPA, 2000). According to the research (Kumar, 1995), the plant species Brassica Junacea (Indian mustard), with great biomass, is able to accumulate Pb, Cr, Cd, Cu, Ni, Zn, Sr, B, and Se. Probably the most successful plant hiperaccumulator of metals from the family Brassicaceae is Thlaspi caerulescens. While the majority of plants display the symptoms of toxicity during the accumulation of zinc (Zn) at the concentration of 100 ppm, this plant is capable of accumulating 26000 ppm without any consequences (Brown et al., 1995). Hyperaccumulators are plants that are widely distributed in nature, and are most commonly found only in certain eco-habitats. The drawback of hyperaccumulators in the process of phytoextraction is that, in most cases, they are with a small growth and with little biomass. In addition to these shortcomings, hyperaccumulators also seek special conditions for their growth and development, and are not adaptable to a wide range of habitats. Furthermore, hyperaccumulators do not acquire a large amount of metals from the soil itself, as compared with the total amount of metals contained in the soil, and given the fact that there are no efficient hyperaccumulators for certain pollutants. Because of these reasons, it is necessary to carry out further research on the selection, genetic breeding and utilisation of plants with significantly greater biomass, more intensive growth and a more rapid development. Plants with these characteristics would, in relation to their biomass, absorb a lower concentration of pollutants, but would also acquire a higher total amount of metals from the soil. The research with large biomass plants was done with four types of sorghum, specifically, with broomcorn, sweet sorghum, Sudan grass and grain sorghum (Angelova et al., 2011). The soil that was examined was contaminated with lead, copper, zinc and cadmium. The results showed that Sudan grass and broomcorn have high potential for phytoextraction, because they acquired a considerably larger amount of metal in comparison with grain sorghum and sweet sorghum. In addition to sorghum, corn was another major biomass plant that showed good results in the phytoextraction of lead and cadmium (Mojira, 2011). Based on examinations (Oh et al., 2013), sunflower showed greater accumulation of lead, copper and cadmium in relation to corn, but also, a lower tolerance to metals absorbed.

PHYTOSTABILISATION

Phytostabilisation is a method by which a plant performs the reduction in mobility or the immobilization of a contaminant that is situated in the area of the root system of the plant. The plant excretes enzymes, which results in the change of chemical, biological and physical conditions in the soil, and leads to the retention of the contaminant in the rhizosphere zone. That is the reason why the contaminant remains immobilized. Its movement through the soil and the ecosystem, which can be caused by any kind of erosion or leaching in the soil, is prevented this way. The process
takes place through the means of microbiological or chemical mechanisms of the root zone itself, by which, changes occur to the chemism of the soil and/or the contaminating substance. What results is the change in the soil pH value, as an effect of the separation of root exudates. A pollutant can be reduced through the process of absorption and accumulation by roots, then, through the reduction of the valence of metals, lead, chromium and mercury in the soil (U.S.EPA, 1997). Beside the possibility of immobilisation of inorganic materials, primarily metals, according to research (Harms and Langebartels, 1986), there is the potential for the exercise of phytostabilisation of organic contaminants by associating an organic contaminant or its byproducts with the lignin within the plant tissue in its above-ground parts. This procedure is called phytolignification. For the process of phytostabilisation, the plants are needed that can grow in contaminated soil, with the roots that grow in the area of contamination and can perform changes in the biological, chemical and physiological conditions in the soil. The advantage of this method is that it is not necessary to do the dislocation of neither the soil nor the biomass from the site of contamination. Thus, the technology is not expensive. The primary disadvantage of this method of remediation is that a contaminant remains present in the soil at a given location, linked to parts of plant vegetation. There is also a risk, because it may come to an increase in the solubility of heavy metals and their subsequent washing towards the deeper layers outside the reach of the root system (Salt et al., 1995). The plant species that have shown great potential in the process of phytomobilisation are Indian mustard and hybrid Populus species (Pivetz, 2001).

PHYTODEGRADATION

Phytodegradation is a method of soil remediation, in which a plant performs the acquisition of contaminants from the soil, and then, through the biochemical processes performed within the plant tissue, the decomposition of contaminants is performed. This method is highly successful in the displacement of organic contaminants from the soil. In order to reach the process of phytodegradation, it is necessary that the plant adopt organic compounds that are supposed to carry out the degradation. Whether the plant will acquire a contaminant depends on the type of contamination, its concentration, plant species and soil conditions (Prasad, 2011). One study showed that more than 70 chemicals that comprised various components were acquired by 88 plants and tree species (Paterson et al., 1990). The acquisition of an organic contaminant depends on its hydrophobicity, solubility and polarity. Very soluble compounds will not be acquired and translocated into the plant (Schnoor et al., 1995). Also, phytodegradation takes place in the zone of the root system of the plant, wherein microbiological degradation of organic contaminants takes place, which occurs with the participation of the plant, that is, in a part of the rhizosphere. The plant produces enzymes which affect metabolic processes, and it comes to the decomposition of contaminants. Additionally, as a result of the respiration of microbiological
population, there comes to a reduction in oxygen content, that is, to the formation of reducing conditions in the surrounding environment, which contributes to more rapid decomposition of a contaminant. In either case, the degradation of organic molecules represents an enzymatic reaction. These enzymes include: dehalogenase, nitroreductase, peroxidase, lactase and nitratalase (Schnoor et al., 1995). Many of the plant enzymes are capable of metabolising several chemicals completely to carbon dioxide and water (Prasad, 2011). The enzymes are associated with the processes of transformation of organic contaminants such as: chlorine compounds, waste ammunition, phenols and herbicide residues (U.S.EPA, 2000).

Good results in the process of phytodegradation can be achieved on soils that do not have active microflora, and are thus unable to carry out the decomposition of contaminants. The deficiency lies in the possibility of the formation of toxic compounds and metabolic intermediates which may have the potential of adverse effects on the environment.

PHYTOVOLITISATION

Phytovolitisation is the process by which plant performs the absorption of contaminants from the soil, and transmits them through the transpiration system to a spot within the plant tissue where a chemical change is performed through metabolic processes. A harmful compound is thus converted into a less harmful form. After the change, the process of transpiration is carried out, and the plant releases the compounds into the atmosphere in a less toxic or non-toxic form. Current climatic conditions that the plant is exposed to in the course of phytovolitisation significantly affect the process. Temperature, wind, precipitation, insolation and air pressure can affect the success and the amount of a transpired contaminant. A disadvantage of this method is that, during the process, potentially harmful compounds can be assembled, which can have carcinogenic effects upon the emission. Another disadvantage is the possibility of the accumulation of harmful metabolites and intermediates in the plant tissues and fruits, in which case, they can enter the food chain.

Most of the research so far has dealt with the possibility of the acquisition of selenium, mercury and arsenic from the soil, their changes and the release into the atmosphere in a less toxic form. According to the research (Sakakibara et al., 2010), excellent results in the phytovolitisation of arsenic were achieved by the plant Pteris vittata, i.e., Chinese fern. An experiment showed that the plant had adopted about 90 percent of arsenic from the soil, and released it into the atmosphere. Excellent results in the phytovolitisation of selenium were achieved by Brassica junacea, i.e., Indian mustard (Banuelos et al., 1997b).
RIZODEGRADATION

Rhizodegradation is the process by which soil microorganisms carry out the decomposition of organic contaminant in the rhizosphere. Contaminants that are exposed to the process of decomposition in the soil are organic contaminants of high hydrophobicity, and, as such, cannot be acquired by a plant. Through the root, a plant indirectly stimulates the process of rhizodegradation. The root excretes exudates such as polysaccharides, amino acids, organic fatty acids, growth factors, sterol, nucleotides, flavonones, enzymes, and other compounds (Pivetz, 2001). The activity of root exudates contributes to higher growth and the reproduction of microorganisms. Thus, microorganisms rather significantly perform the decomposition of organic matter. Also, the effect of exudates can cause changes in the pH of the soil, which can result in a change in the transport of contaminants (Pivetz, 2001). Apart from producing exudates, root has a positive effect on the process rhizodegradation, because it increases aeration, water content in the soil, nutrient content, the transport of nutrients, soil structure, temperature. Given that the process of the decomposition of organic matter takes place in the soil, it is not necessary to carry out the cutting of aboveground residues, because the plant does not acquire contaminants. Therefore, there is no transfer of contaminants through a plant to the food chain. The above-mentioned reasons bring us to the conclusion that rhizodegradation stands for an inexpensive technology. The limiting factor in the process of rhizodegradation is the depth of the root of a plant, particularly, when it comes to plants with shallow root systems. Also, soil with severe compaction may limit deeper development of roots. A problem may occur if root exudates begin to stimulate the growth of microorganisms that do not perform the decomposition of organic matter (Pivetz, 2001), or if a plant begins to use organic contaminants as a source of organic matter instead of carbon, which would reduce the amount of a decomposed contaminant (Molina, 1995).

CONCLUSION

Phytoremediation represents a natural technology that exploits the ability of plants to perform soil remediation. It contributes to environmental protection. The technology is inexpensive and relatively easy to carry out. Depending on the applied method, remediation is performed of either organic or inorganic contaminants.

A lack of technology is that it is a time-consuming process compared with other methods of contamination displacement from the environment. It is applicable only to shallow soils. Phytoremediation is effective only with moderately hydrophobic compounds.

A threat to the health of humans and animals may occur if plants used in some of the methods of phytoremediation enter the food chain.
REFERENCE:


Vladimir Miladinović, Dr Vladan Ugrenović, Dr Vladimir Filipović

1Institut Tamiš, Pančevo, Srbija
2Institut za proučavanje lekovitog bilja ”Dr Josif Pančić”, Beograd, Srbija
miladinovic_vladimir@yahoo.com

NAČINI FITOREMIĐACIJE ZEMLJIŠTA

Apstrakt

Zemljište, kao osnovni resurs za proizvodnju hrane, od najvećeg je značaja za ljudsku populaciju. Proces fitoremedijacije su ono što nam daje mogućnost za očuvanje zemljišta usled zagađenja. U radu je prikazano pet tehnika prečišćavanja zemljišta. Postupak obuhvata više različitih metoda koje mogu dovesti do razgradnje zagađujuće materije (1) unutar nadzemnog tkiva biljke, što je slučaj kod procesa fitodegradacije, ili (2) u zoni korena biljke, što je karakteristično za rizodegradaciju, zatim, može da uzrokuje (3) usvajanje ili apsorpciju, što je karakteristika za fitoekstrakciju i fitovolitizaciju, i, najzad, (4) imobilizaciju zagađivača u zoni korena, što se dešava u procesu fitostabilizacije.

Ključne reči: fitoremedijacija, zemljište, zagađenje.
INTENATIONAL Eco-Conference (18 ; 2014 ; Novi Sad)
Safe food : proceedings / XVIII International
Eco-Conference, 24-27th September 2014, Novi Sad ;
[organizer Ecological Movement of Novi Sad ; project editor
Nikola Aleksić]. - Novi Sad : Ecological Movement of Novi
Sad, 2014 (Novi Sad : Album). - 486 str. : ilustr. ; 23 cm

Tiraž 500. - Bibliografija uz svaki rad. - Сажеци. -
Registar.

I. Ecological Movement of Novi Sad. - I. Ekološki pokret
grada Novog Sada v. Ecological Movement of Novi Sad
a) Здрава храна - Производња - Зборници b) Еколошка
пoљопривредa - Зборници
C0BISS.SR-ID 289561351