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UTILITY OF SOIL MICROORGANISMS FOR SUSTAINABLE AGRICULTURE

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The role of soil microorganisms in sustainable agriculture

Modern agriculture practices largely rely on high inputs of mineral fertilizers to achieve high yields and include applications of chemical pesticides to protect crops against pathogens and pests. These practices are now being reevaluated and are coming under increased scrutiny as a result of our awareness of potential health and environmental consequences of excessive mineral fertilizer and chemical pesticides application. It is widely recognized that application of mineral fertilizers, especially nitrogen, can result in groundwater contamination by nitrates leaching through the soil profile. Under certain soil conditions denitrification of applied nitrogen fertilizer can give rise to gaseous nitrogenous compounds that volatilize them from soil into the atmosphere. Some of them are thought to contribute to the greenhouse effect and/or the alteration of the ozone layer. Similarly, use of chemical pesticides has raised concern about their possible presence and their residues in the food chain and in the environment. These problems led to strong interest in alternative strategies to ensure competitive yields and protection of crops. This new approach to farming, often referred as sustainable agriculture, seeks to introduce agricultural practices that are more friendly to the environment and that maintain the long-term ecological balance of the soil ecosystem. In this context, use of microbial inoculants in

agriculture, such as biofertilizers, phytostimulators and biopesticides, represents an attractive environmentally-friendly alternative to further applications of mineral fertilizers and chemical pesticides. A continued exploration of the natural biodiversity of soil microorganisms and the optimization and manipulation of microbial interactions in the rhizosphere of crops represents a prerequisite step to develop more efficient microbial inoculants.

Potential benefit of soil microorganisms for agriculture

Unique properties of soil microorganisms and their biosynthetic capabilities have made them likely candidates for solving particularly difficult problems of life sciences. Recently microbial technologies have been successfully applied to various agricultural and environmental problems such as crop productivity, biocontrol of soil-borne diseases, soil and water pollution, utilization of organic wastes. However they have not been widely accepted by the scientific community because it was difficult constantly to reproduce their beneficial effect. Biopreparations are effective when they meet proper environmental conditions like available water, nutrients supply, pH and temperature. Other important step for establishing of beneficial soil microorganisms in modern agriculture is to combine them with existing conventional technologies. Meanwhile, now the biopreparations developed on the basis of natural non- genetically modified microorganisms are widely applied in organic agriculture. For developing new biopreparations researchers usually use beneficial microorganisms. We can define beneficial microorganisms as those which can fix molecular nitrogen, dissolve rock phosphates, suppress soil-borne phytopathogens, decompose organic wastes and residues and produce bioactive compounds such as vitamins, hormones and enzymes that stimulate plant growth.

Use of biopreparations for agriculture in Russia

A range of biopreparations for modern agriculture has been developed in ARRIAM (All-Russia Research Institute for Agricultural Microbiology,

St.Petersburg, Russia).

Rhizotorphin brand name of group of biopreparations for legumes. Selected effective strains of nodule bacteria (*Rhizobium*) have been used for manufacturing of Rhizotorphin. ARRIAM possesses National *Rhizobium* Collection comprising about 900 strains for all types of legumes. The practice showed that application of Rhizotorphin can fully replace nitrogen fertilizers for cultivation such legumes as soybean, alfalfa, clover, galega. The importance of legumes for crop rotation to restore soil fertility is very well known.

Extrasol brand name of biopreparations for non-legumes. Extrasol is a preparation of plant growth-promoting and nitrogen-fixing bacteria inhabiting plant roots intended to improve nutrition of vegetable, grain and industrial crops, as well as to enhance their productivity. Extrasol increases germinating power of seeds, improves the absorption of nutrient elements by plants, intensifies their development, and increases their resistance to the phytopathogens affection, all of which increases substantially the plants' productivity. Bacteria which naturally inhibit rhizoplane of healthy plants were isolated, selected and used for production of Extrasol preparation. Their inherent features are quick growth and the ability to colonize the roots or rhizosphere of cultivated plants, thus ousting the microorganisms inhibiting the plants' growth. All of the above bacteria are capable, to a greater or less extent, of synthesizing the growth hormones and fix molecular nitrogen, which affects the roots' absorbing capacity and the general productivity of crops. The field tests in various regions of Russia and other countries showed that application of Extrasol can fully replace seed treatment with chemical means against root rot diseases and partly replace chemicals for foliar diseases.

Bitoxybacilline, Bacicol, Actinine biopreparations for pest control. Effective strains of bacteria and actinomyces have been used for production of these biopreparations. The field tests in various regions of Russia have been showed high efficiency of biopreparations for pest control comparable with chemicals. Biopesticides are effective against wide range of pests. Certain technologies for

proper application of each biopreparation have been developed.

Bamil,Omug,Okud,Pudret microbial fertilizers after transformation of organic wastes from animal production. Microbial fertilizers combining advantages of both chemical fertilizer and organic manure help to utilize organic wastes and improve crop productivity. Application of microbial fertilizers improves soil fertility, suppresses soil-borne phytopathogens and increases yield by 70-80%. The technologies for production of microbial fertilizers have been developed according to the type of organic wastes.

Researchers from ARRIAM are developing now the technologies for integrated use of various types of biopreparations in conventional, sustainable and organic agriculture. The main goal is to replace fully or partly the use of chemicals to reduce soil and ground water pollution, soil degradation and preserve natural biodiversity.

Extension of beneficial microorganisms for 21 century agriculture

Concerning 21 century agriculture it is important to define future priorities. Undoubtedly, future agriculture should produce food on a long-term sustainable basis, maintaining human health, be beneficial for both producers and consumers, actively preserve and protect the environment. On the other hand, agricultural economy is based on market system that demands a stable supply of food and it becomes necessary to use farmland for its full productive potential throughout the year. To reach this it is necessary to breed cultivars with improved capabilities such as great yield potential, disease stress resistance, nutritional quality, high level of environmental competitiveness and compatibility with beneficial soil microorganisms. Beneficial soil microorganisms can enhance the growth of plants, suppress soil-borne phytopathogens and improve crop quality. So, in 21 century the best soil and crop management practices to achieve more sustainable environmentally friendly agriculture should imply the application of selected types of biopreparations and biotechnologies.