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Role of Microbes In Environmental Sustainability

Biological Science

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ABSTRACT

Microbial world, a treasure in itself, if exploited judiciously, can contribute to the sustainable development. Environmental protection has the foremost importance in the present day life of mankind. Scientists have been researching for technologies naturally available for enhancement of agriculture, management of agricultural waste, etc. This paper attempts to highlight the role of indigenous microbes in environmental sustainability through their various applications in agriculture such as bio-fertilizers, bio-pesticides, bio-herbicides, bio-insecticides etc.

KEYWORDS:

Indigenous microorganisms, bio-fertilizers, bio-pesticides, bio-herbicides, bio-insecticides, sustainable agriculture.

INTRODUCTION

Microbes are everywhere and often in very large numbers. One can think of microbes beyond the world in which we all live (i.e., from earth to space). Microbes are an integral part of biogeochemical cycles which are important for our sustenance. A large number of these microbes are beneficial to plants, animals and humans in one form or the other but some are harmful as well.

"Microbes generate more than half of the oxygen we breathe". It is not an exaggeration to state that life originated with microbes and all life is derived from microbes. Life without higher organisms is possible, but life without microbes is not. The microbiota of an ecosystem has the capability to keep its environment clean, provided it's not overloaded with the pollutants.

Indigenous Microorganisms as Environment Protectors

Environmental protection has the foremost importance in the present day life of mankind. Scientists have been researching for technologies naturally available for enhancement of agriculture, management of agricultural waste, etc. Indigenous Microorganisms (IMO's)-based technology is one such great technology which is applied in the eastern part of world for the extraction of minerals, enhancement of agriculture and waste management. Indigenous microorganisms are a group of innate microbial consortium that inhabits the soil and the surfaces of all living things inside and outside which have the potentiality in biodegradation, bioleaching, bio composting, nitrogen fixation, improving soil fertility and as well in the production of plant growth hormones. Without these microbes, the life will be wretched and melancholic on this lively planet for the survival of human race. That is why, environmental restoration and safeguarding target via the indigenous microbes in a native manner to turn out the good-for-nothing and useless waste into productive bio resources is the primary concern of this review. Based on the collection sites, the process of collection and isolation methods are different as they may vary from place to place. Ultimately, in this way to a meaningful and significant extent, we can bridge the gap between the horrifying environmental distress and the hostile activities that have been constantly provoked by human kind—by getting these indigenous microorganisms into action.

Applications in Agriculture

Micro-organisms found in the soil improve agricultural productivity. Men use naturally occurring organisms to develop bio fertilizers and bio-pesticides to assist plant growth and control weeds, pests, and diseases.

Micro-organisms that live in the soil actually help plants to absorb more nutrients. Plants and these friendly microbes are involved in "nutrient recycling". The microbes help the plant to "take up" essential energy sources. In return, plants donate their waste by-products for the microbes to use for food. Scientists use these friendly micro-organisms to develop biofertilizers.

Bio-fertilizers

Phosphate and nitrogen are important for the growth of plants. These compounds exist naturally in the environment but plants have a limited ability to extract them. Phosphate plays an important role in crop stress tolerance, maturity, quality and directly or indirectly, in nitrogen fixation. A fungus, *Penicillium bilaii* helps to unlock phosphate from the soil. It makes an organic acid, which dissolves the phosphate in the soil so that the roots can use it. Bio-fertilizers made from this organism are applied by either coating seeds with the fungus as inoculation, or putting it directly into the ground.

Rhizobium is a bacteria used to make biofertilizers. This bacterium lives on the plant's roots in cell collections called nodules. The nodules are biological factories that can take nitrogen out of the air and convert it into an organic form that the plant can use. This fertilization method has been designed by nature. With a large population of the friendly bacteria on its roots, the legume can use naturally-occurring nitrogen instead of the expensive traditional nitrogen fertilizer.

Bio-fertilizers help plants use all of the food available in the soil and air, thus allowing farmers to reduce the amount of chemical fertilizers they use. This helps preserve the environment for the generations to come.

Bio -Pesticides

Microorganisms found in the soil are all not so friendly to plants. These pathogens can cause disease or damage the plant. Scientists developed biological "tools," which use these disease-causing microbes to control weeds and pests naturally.

Bio-Herbicides

Weeds are the problem for farmers. They not only compete with crops for water, nutrients, sunlight, and space but also harbor insect and disease pests; clog irrigation and drainage systems; undermine crop quality; and deposit weed seeds into crop harvests.

Bio-herbicides are another way of controlling weeds without environmental hazards posed by synthetic herbicides. The microbes possess invasive genes that can attack the defense genes of the weeds, thereby killing it.

The benefit of using bio-herbicides is that it can survive in the environment long enough for the next growing season where there will be more weeds to infect. It is cheaper than synthetic pesticides thus could essentially reduce farming expenses if managed properly. Further, it is not harmful to the environment compared to conventional herbicides and will not affect non-target organisms.

Bio-insecticides

Biotechnology can also help in developing alternative controls to synthetic insecticides to fight against insect pests. Micro-organisms in the soil that will attack fungi, viruses or bacteria, which cause root diseases. Formulas for coatings on the seed (inoculants) which carry these beneficial organisms can be developed to protect the plant during the critical seedling stage.

Bio-insecticides do not persist long in the environment and have shorter shelf lives; they are effective in small quantities, safer to humans and animals compared to synthetic insecticides; they are very specific, often affecting only a single species of insect and have a very specific mode of action; slow in action and the timing of their application is relatively critical.

Microbes in Sustainable Agriculture

Now increasing attention has been paid to the development of sustainable agriculture in which the high productivities of plants and animals are ensured using their natural adaptive potentials, with a minimal disturbance of the environment. The most promising strategy to reach this goal is to substitute hazardous agrochemicals (mineral fertilizers, pesticides) with environment-friendly preparations of symbiotic microbes, which could improve the nutrition of crops and livestock, as well as their protection from biotic (pathogens, pests) and abiotic (including pollution and climatic change) stresses.

The broad application of microbes in sustainable agriculture is due to the genetic dependency of plants on the beneficial functions provided by symbiotic cohabitants. The agronomic potential of plant–microbial symbioses proceeds from the analysis of their ecological impacts, which have been best studied for N_2 fixing. This analysis has been based on 'applied co-evolutionary research', addressing the ecological and molecular mechanisms for mutual adaptation and parallel speciation of plant and microbial partners. For plant–fungal interactions, it has been demonstrated that the host genotype represents the leading factor in the biogeographic distribution of mycobionts and for their evolution within the mutualist↔antagonist and specialist↔generalist continua.

An increased knowledge of microbe-based symbioses in plants could provide effective ways of developing sustainable agriculture in order to ensure human and animal food production with a minimal disturbance of the environment. The effective management of symbiotic microbial communities is possible using molecular approaches based on the continuity of microbial pools which are circulating regularly among soil- plant- and animal-provided niches in natural and agricultural ecosystems. Analysis of this circulation could enable the creation of highly productive microbe-based sustainable agricultural system, while addressing the ecological and genetic consequences of the broad application of microbes in agricultural practice.

Conclusion

With recent advances in biology, materials, computing, and engineering, environmental biotechnologists now are able to use microbial communities for a wealth of services to society. These include detoxifying contaminated water, wastewater, sludge, sediment, or soil; capturing renewable energy from biomass; sensing contaminants or pathogens; and protecting the public from dangerous exposure to pathogens.

The uniqueness of microorganisms and their often unpredictable nature and biosynthetic capabilities, given a specific set of environmental and cultural conditions, have made them likely for solving particularly difficult problems in life sciences and other fields as well. The responsible use of microorganisms to get economic, social and environmental benefits is inherently attractive and determines a spectacular evolution of research from traditional technologies to modern techniques to provide an efficient way to protect our environment.

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