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SOIL CONTAMINATION AND ITS PRECLUSION THROUGH MICROORGANISMS

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ABSTRACT

Uncontrolled usage of chemical fertilizers will eventually cause the soil to lose its natural fertility, turning it into a wasteland and generating soil pollution. Pesticides, insecticides, herbicides, etc., operate in the similar manner. Microorganisms act as "natural soil engineers," crucial in soil formation and ecology. Microorganisms can be employed to degrade dangerous chemicals; they break down dead and decaying plant and animal materials into simpler components that other plants and animals then consume. They control the flow of nutrients to plants, support nitrogen fixation, and ultimately encourage the detoxification of naturally occurring inorganic and organic pollutants in soil and finally help to clean up the environment.

INTRODUCTION

The concentration of any metal or chemical in the soil or atmosphere exceeds normal, it is called pollution. Most land pollution is spreading from industrial units. In this context, chemical fertilizers and sugar factories, textile manufacturing units, graphite, thermal power plants, cement factories, soap and oil factories, metal manufacturing plants, and other factories release chemicals and gases in large quantities that affect animals, organisms, plants, soil, etc. The use of unbalanced chemical fertilizers and other agricultural chemicals (insecticides, weedicides, etc.) and the release of chemicals and other heavy metals under various industrial activities are causing serious adverse effects on the health of the soil and environment. Growing crops, vegetables, fruits, etc. in contaminated soil, the plants absorb more heavy metals than at the normal level. These harmful pollutants enter the human body through the food chain. Soil pollution affects soil organisms and soil organic matter.

MAJOR CAUSES OF SOIL POLLUTANTS

Soil pollution can have various causes, including:

1. *INDUSTRIAL ACTIVITIES:* Chemical spills, dumping of hazardous waste, and inappropriate disposal of industrial waste can contaminate soil.
2. *AGRICULTURAL PRACTICES:* Using pesticides, herbicides, and fertilizers can lead to soil pollution. These chemicals can accumulate in the soil over time, harming human health and the environment.
3. *LANDFILLS:* Improper disposal of household and municipal waste in landfills can release toxic substances into the soil.
4. *MINING:* Mining activities can disturb the soil and release heavy metals and other pollutants.
5. *CONSTRUCTION ACTIVITIES:* Construction activities, such as demolition and excavation, can release chemicals and pollutants into the soil.
6. *TRANSPORTATION:* Vehicle emissions from cars and trucks can lead to the deposition of pollutants onto the soil.
7. *OIL SPILLS:* Oil spills can contaminate soil, making it unsuitable for plant growth and other uses.

Overall, soil pollution can have significant environmental and health impacts and requires measures to prevent and remediate contaminated sites.

A view of contaminated field

ROLE OF MICROORGANISMS IN THE REMOVAL OF SOIL CONTAMINATION

Microorganisms play a crucial role in the removal of soil contaminants through a process known as bioremediation. Bioremediation uses microorganisms to break down and degrade pollutants in soil, water,

and other environments. Microorganisms, such as bacteria and fungi, can transform contaminants into less harmful forms or even completely mineralize them into non-toxic substances. They do this by using the pollutants as a source of energy and carbon, breaking down the chemical structure of the contaminant through a range of biochemical pathways.

Table 1: Major Soil pollutants with their sources and toxic effect on human health

S.NO.	Major soil pollutant	Source	Toxic effects on human health
1.	Lead	Paint, food grains, vehicle smoke, agricultural chemicals, etc.	Effects on the nervous system, memory and general development
2.	Mercury	Food grains, processing, storage and medical sources of plants, vegetables and other food grains	• Burning, pain, side effects on brain and kidney • high blood pressure • Loss of hair, teeth, nails, etc.
3.	Arsenic	Coal mines, power industry, agrochemical etc.	Cancers related to the kidney, gall bladder, tongue, etc., Poor digestion, diarrhoea, etc.,
4.	Other metals (Manganese, Cadmium, Copper, Zinc, Nickel, etc.)	Food grains, chemical fertilizers, industrial waste etc.	Different effects of different metals
5.	Polyaromatic Hydrocarbons	From coal mines, vehicle exhaust, accumulation in plants and vegetables, burning of crop waste, wood etc.	• Effects on the skin • Eye irritation • Adverse effects on kidney and liver • Cancer in the skin, tongue, gall bladder etc. • Skin-related diseases etc.

The use of microorganisms in bioremediation can be natural or enhanced. In natural bioremediation, indigenous microorganisms present in the soil are stimulated to degrade the contaminants. In enhanced bioremediation, specific microorganisms are introduced into the contaminated soil to accelerate the degradation process.

Microorganisms have been successfully used in the bioremediation of various soil contaminants, including petroleum hydrocarbons, heavy metals, pesticides, and chlorinated solvents. However, the effectiveness of bioremediation depends on several factors, such as the type and concentration of the contaminant, the microbial community present in the soil, and environmental factors, such as temperature, pH, and nutrient availability.

MANAGEMENT OF SOIL MICROORGANISMS FOR REMOVAL OF SOIL CONTAMINATION

There are several strategies for managing soil microorganisms to enhance the removal of soil contaminants through bioremediation. Here are some common approaches:

1. *NUTRIENT MANAGEMENT:* Microorganisms require nutrients to thrive and carry out bioremediation. Adding nutrients such as nitrogen, phosphorus, and carbon to the soil can enhance the growth and activity of microorganisms. This can be done by adding organic amendments, such as compost, manure, or inorganic fertilizers.
2. *BIOAUGMENTATION:* Bioaugmentation involves the addition of specific microbial strains that are known to degrade the target contaminant. This approach can be effective when the indigenous microbial community is not well-suited to degrade the contaminant.
3. *BIOSTIMULATION:* Biostimulation involves the addition of substances that stimulate the growth and activity of indigenous microorganisms without adding specific strains. Common biostimulants include oxygen, electron donors, and surfactants that help to solubilize contaminants.
4. *PHYTOREMEDIATION:* Phytoremediation is the use of plants to enhance bioremediation by stimulating the growth and activity of microorganisms in the root zone. Plants can release organic compounds through their roots that can serve as a food source for microorganisms or absorb and translocate contaminants, making them available for microbial degradation.
5. *MONITORING:* Monitoring is an important aspect of bioremediation management to assess the approach's effectiveness and adjustment as needed. Monitoring can involve measuring contaminant concentrations, microbial populations, and soil properties such as pH and nutrient availability.

Overall, managing soil microorganisms for bioremediation requires carefully assessing the site conditions and selecting an appropriate approach based on the soil's contaminant and microbial community.

CONCLUSION

Uncontrolled usage of chemical fertilizers will eventually cause the soil to lose its natural fertility, turning it into a wasteland and generating soil pollution. Pesticides, insecticides, herbicides, etc., operate in the similar manner. Microorganisms act as "natural soil engineers," crucial in soil formation and ecology. Microorganisms can be employed to degrade dangerous chemicals; they break down dead and decaying plant and animal materials into simpler components that other plants and animals then consume. They control the flow of nutrients to plants, support nitrogen fixation, and ultimately encourage the detoxification of naturally occurring inorganic and organic pollutants in soil and finally help to clean up the environment.

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