BIODEGRADATION OF PESTCIDES

M.Sc. 2nd Semester

Paper- 201

ICA/EC

Introduction

- A pesticide can be defined as any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest.
- Pesticides like insecticides, herbicides, fungicides, and various other substances are used to control or inhibit plant diseases and insect pests.
- The positive aspect of application of pesticides renders enhanced crop/food productivity and drastic reduction of vector-borne diseases.
- However excessive use of these chemicals leads to the microbial imbalance, environmental pollution and health hazards.
- Due to these problems, development of technologies that guarantee their elimination in a safe, efficient and economical way is important.

- Degradation of pesticides is very essential for controlling these problems.
- **Biodegradation** is a process by which a pesticide is transformed into a benign substance that is environmentally compatible with the site to which it was applied.
- The degradation or breakdown of pesticides can occur in plants, animals, and in the soil and water.
- However the most common type of degradation is carried out in the soil by microorganisms, especially fungi and bacteria that use pesticides as food source.
- The soil fumigant methyl bromide, the herbicide dalapon, and the fungicide chloroneb are examples of pesticides which are degraded by microorganisms.

Criteria for Biodegradation

- For successful biodegradation of pesticide in soil, following aspects must be taken into consideration.

1. Organisms must have necessary catabolic activity required for degradation of contaminant at fast rate to bring down the concentration of contaminant.
2. The target contaminant must be bioavailability.
3. Soil conditions must be congenial for microbial /plant growth and enzymatic activity.
4. Cost of bioremediation must be less than other technologies of removal of contaminants.

STRATEGIES FOR BIODEGRADATION

1. Passive/ intrinsic Bioremediation
2. Biostimulation
3. Bioventing
4. Bioaugmentation
5. Composting
6. Phytoremediation
7. Bioremediation
8. Mineralization

Passive/ intrinsic Bioremediation:

It is the natural bioremediation of contaminant by tile indigenous microorganisms and the rate of degradation is very slow.

Biostimulation:

Practice of addition of nitrogen and phosphorus to stimulate indigenous microorganisms in soil.

Bioventing:

Process/way of Biostimulation by which gases stimulants like oxygen and methane are added or forced into soil to stimulate microbial activity.

Bioaugmentation:

It is the inoculation/introduction of microorganisms in the contaminated site/soil to facilitate biodegradation

Composting:

Piles of contaminated soils are constructed and treated with aerobic thermophilic microorganisms to degrade contaminants.

Periodic physical mixing and moistening of piles are done to promote microbial activity.

Phytoremediation:

Can be achieved directly by planting plants which hyperaccumulate heavy metals or indirectly by plants stimulating microorganisms in the rhizosphere.

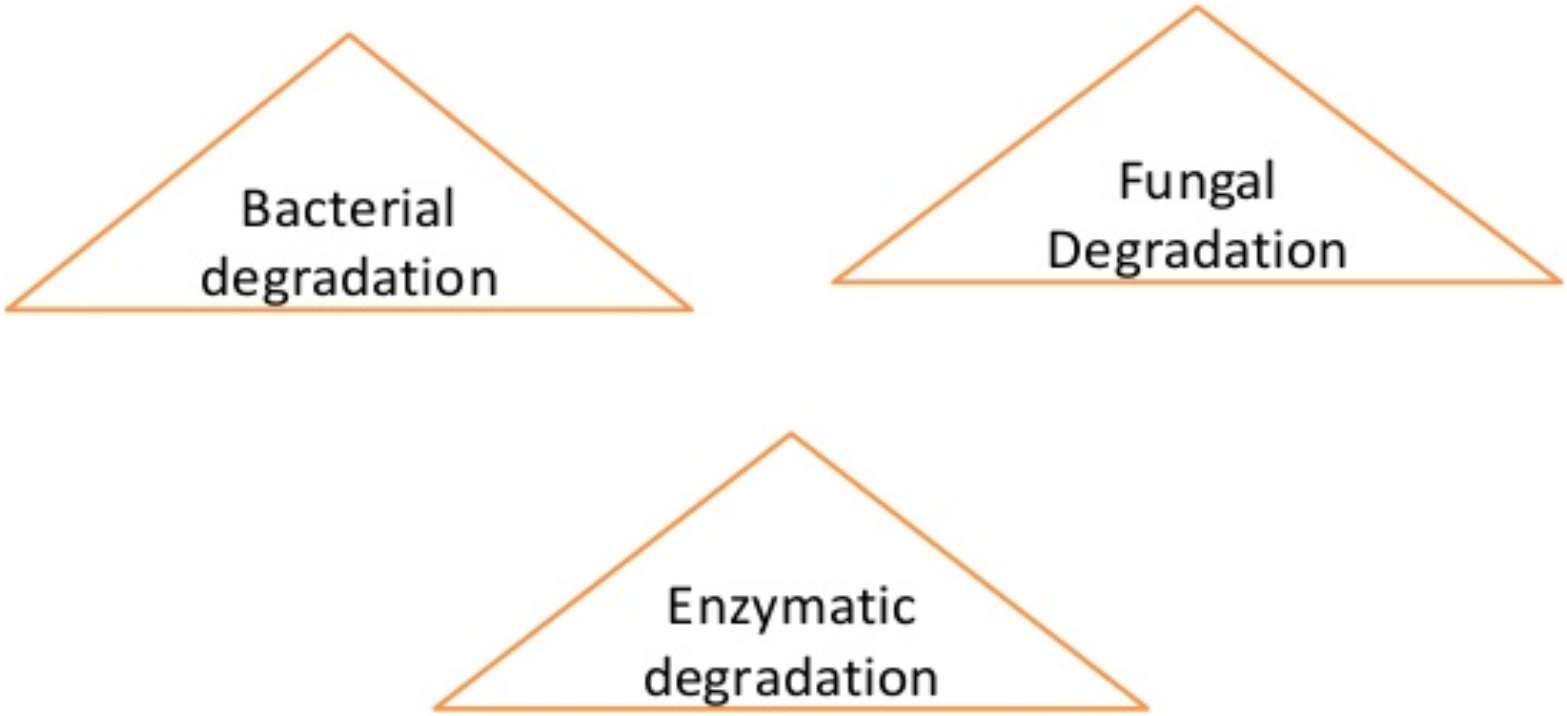
Bioremediation:

Process of detoxification of toxic/unwanted chemicals / contaminants in the soil and other environment by using microorganisms.

Mineralization:

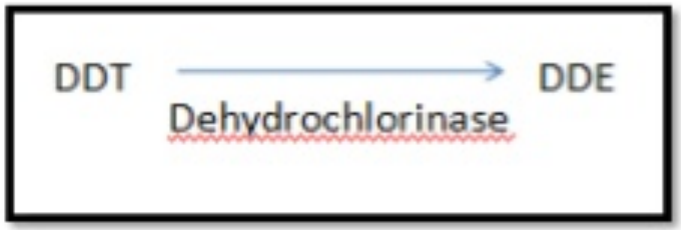
Complete conversion of an organic contaminant to its inorganic constituent by a species or group of microorganisms.

DIFFERENT APPROACHES FOR BIODEGRADATION



EXAMPLES OF MICROORGANISM INVOLVED IN BIODEGRADATION OF PESTICIDES

DDT



Degraded by:

- *Achromobacter*
- *Aerobacter*
- *Agrobacterium*
- *Bacillus*
- *Clostridium*
- *Escherichia*
- *Erwinia*
- *Kurthia*
- *Pseudomonas*
- *Streptococcus*

LINDANE :

Lindane → (Dehalogenation (chlorine removal)) → 2,3,4- pentachloro-1cyclo-hexane

Degraded by:
- *Clostridium*
- *Escherichia*

MALATHION:

- Organophosphate group
- Degraded by: *Torulopsis*
  Chlorella
  Pseudomonas
  Thiobacillus
  Trichoderma

HERBICIDES:

2,4-D

Phenoxyalkanoic acids or phenoxy herbicides

Degraded by: *Pseudomonas*
Achromobacter
Flavobacterium
Arthrobacter
Sporocytophaga

SIMAZINE AND ATRAZINE

Degraded by: *Aspergillus*
Rhizopus
Fusarium
Penicillium
Trichoderma

CHLOROPHAM:

Esters of carbamic acids (Carbamates or carbanilates)

Degraded by:

Pseudomonas
Achromobacter
Flavobacterium
Achromobacter

LINURAN:

Degraded by: Several bacteria especially *Aspergillus nidulans*

ACCELERATION OF BIODEGRADATION

1.Addition of surfactants

2.Supplementation with inorganic nutrients

3.Bioaugmentation

ADVANTAGES

- often less expensive and site disruption is minimal.
- it eliminates waste permanently.
- eliminates long-term liability.
- it can be coupled with other physical or chemical treatment methods.

DISADVANTAGES

- Treatment time is typically longer.
- Range of contaminants that can be effectively treated is limited to compounds that are biodegradable.
- The process is sensitive to the level of toxicity and environmental conditions in the ground.
- If the process is not controlled it is possible the organic contaminants may not be broken down fully resulting in toxic by-products that could be more mobile than the initial contamination

THANKS