What is a pesticide?

A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest. It is any toxic substance used to kill, animals, fungi or plants that cause economic damage to crop or ornamental plants or are hazardous to the health of domestic animals or humans. Pesticides are the important agrochemicals used in agricultural system for prevention of crops from pests. Pesticides are often applied several times during one crop season and a part always reaches the soil. The wide use of pesticides has created numerous problems, including the pollution of the environment. The influence of pesticides on soil microorganisms is dependent on physical, chemical and biochemical conditions, in addition to nature and concentration of the pesticides

Catabolism and detoxification metabolism occur when soil microorganism uses the pesticide as a carbon and energy source. Most pesticides work by poisoning pests. A systemic pesticide moves inside a plant following absorption by the plant.

Subclasses of pesticides include herbicides, insecticides, fungicides, rodenticides, fumigants, and biocides. Pesticides would pollute air, soil and water resources, contaminate the food chain and disrupt ecosystem balance.

The indiscriminate use of pesticides disturbs the soil environment by affecting flora and fauna including microflora of soil, and also the physicochemical properties of the soil like pH, salinity, alkalinity leading to infertility of soil. When pesticides are applied, the possibilities exist that these chemicals may have certain effects on non-target organisms, including soil microorganisms. Pesticides in the soil affect the non-target and beneficial microorganisms and their activities which are essential for maintaining soil fertility. The microbial biomass plays an important role in the soil ecosystem where they fulfil a crucial role in nutrient cycling and decomposition. The toxicity level of a pesticide depends on the deadlines of the chemical, the dose, the length of exposure, and the route of entry or absorption by the body.

Insecticides are being used extensively to control plant pests and vectors of human and live-stock diseases. Whatever may be the mode of application, and whether they are used in agriculture or in public health, insecticides never remain at the site of application and ultimately sink into the soil. In the soil, they come across the soil flora and fauna and the stage is set for their interaction with the soil ecosystem. The soil biota is a complex entity comprising several genera of bacteria, fungi, actinomycetes and algae, whose populations, always in dynamic equilibrium, continuously influence each other. These microorganisms are identified with a variety of basic ecological processes such as recycling of essential plant nutrients, trash decomposition and humus formation, soil structural stability, pathogen survival, pesticide degradation, formation of organic matter by chemo- and photosynthesis, nitrogen fixation, mineralization of carbon, nitrogen, phosphorus, and other elements. The efficient functioning of these processes is the result of a delicate equilibrium between microorganisms, soil, and plants. The balance between all these processes results in a state generally referred to as soil fertility. Consequently any interference in such microbe-mediated processes by insecticides may generally affect the soil fertility. Such chemical controls become self-defeating if the insecticides are applied without taking the complex microbiological systems into account.

Insecticides and soil microbial interactions span from inhibition to stimulation. In this range come the qualitative effects: stimulation or inhibition limited to a group of organisms; reversible inhibition where the organisms are first inhibited but later recover and sometimes reach levels higher than control and finally show no apparent effect.

Effects of pesticides on soil microorganisms

Due to rapidly growing human population, extensive pesticides have been utilized to maximize crop production. The extensive consumption of pesticides in cultivated soils leads to the pollution of the soil with harmful materials. The impact of different pesticides on the growth of soil microorganisms and its activity are difficult to expect. Even if the pesticides used in low concentration they effect chemical and biological properties, biochemical activity and soil microorganisms.

Pesticides in the soil impact the non- target and useful microorganisms and their activities. Beneficial soil microorganisms play essential role in soil fertility and productivity such as organic matter biodegradation, nutrients recycling, humus formation, Soil structural stability, nitrogen fixation, plant growth promotion, disease bio-control, and other biochemical transformation such as ammonification, nitrification phosphorus solubilizing. The effect of pesticides on soil microorganisms and their activity depend upon the type of pesticides used, quantities and soil conditions.

**Pesticides effects on soil microbial biomass:** Measurement of total soil microbial biomass (typically measured as carbon or nitrogen in biomass) is an extremely useful tool for interpreting soil biological quality. Specific soil microflora constituents can be ascertained based on abundance of specific cellular components. Microbial biomass is a part of organic matter in soil that constitutes living microorganisms smaller than 5-10 cubic micrometers and it is the fraction of soil organic matter that is sensitive to management practices and pollution. Soil microbial biomass is an important attribute of soil quality as well as crop ecology. Chemical pesticides had made a great contribution to the fight against pests and diseases. However, their widespread and long-term use resulted in insecticide resistance and bio-magnifications of insecticides, which in turn resulted in restrictions on their export. Problems, like soil and water contamination and dramatic increase of the harmful residues in many primary and derived agricultural products arose, which endangered both the general environment and human health. Microbial and biochemical parameters of soil are choice indicators of soil quality evaluations because of their early responses to soil disturbances than those of the physical and chemical parameters.

**Pesticides effects on soil fauna:** Soil fauna (e.g. earthworms, nematodes, microarthropods, protozoans) are important in organic matter (OM) transformations and soil structure formation, and are useful bio-indicators to study Xenobiotic ecotoxicity in soil.

**Effect of pesticides on soil enzyme**: Soil contains free enzymes, immobilized extracellular enzymes, and enzymes within microbial cells. They are indicator of biological equilibrium, fertility, quality, and changes in the biological status of soil due to pollution.

Negative impact of pesticides on soil enzymes like hydrolases, oxidoreductases and dehydrogenase activities has been widely reported in the literature. Nitrogenase is the enzyme used by organisms to fix atmospheric nitrogen gas (N2). Application of pesticides affects the efficiency and activity of nitrogenase enzyme. Adverse effects of pesticides have also been reported on nitrogenase activities of N2- fixing bacteria, purple non-sulfur bacteria, methylotrophic bacteria, and cyanobacteria. In contrary, repeated applications of pesticides significantly stimulated rhizosphere-associated nitrogenase activity.

**Effect of pesticides on carbon and nitrogen mineralization**: Carbon mineralization is an important parameter for assessing side effects of pesticides. Nitrogen mineralization processes, such as ammonification and nitrification, are also affected by the application of pesticides, with the former being inhibited less because it is carried out by a vast diversity of microflora.