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FOR ENGINEERING AND SCIENCE

Pesticides

Description

An overview of pesticides pertaining to Rache Carson's "Silent Spring."

Body

Discovery

In 1942 Paul Hermann Muller of Switzerland discovered the insecticidal properties of a synthetic chlorinated organic chemical, dichlorodiphenyltrichloroethane (DDT) which had first been synthesized in 1874. In 1948 Muller received the Nobel Prize for Physiology or Medicine for his discovery.

DDT and Organochlorines

According to *Fundamentals of Pesticides*, DDT belongs to the chemical class of diphenyl aliphatics, which means that it consists of an aliphatic, or straight carbon chain, with two (di-) phenyl rings attached.

Pure DDT is made by the reaction of chloral with chlorobenzene in the presence of sulfuric acid. A colorless, crystalline solid, it melts at 109 degrees Celsius. The commercial product is 65% to 80% active compound. An amorphous powder, it has a lower melting point than the pure compound. DDT is applied as a dust or by spraying its aqueous suspension.

A persistent pesticide, DDT has many properties that are desireable in an insecticidal point of view. It is stable and so remains in soil and aquatic environments, and in animal and plant tissues. Microorganisms, enzymes, heat, or ultraviolet light do not readily break it down.

DDT is an organochlorine, one of four types of synthetic organic insecticides. Usually containing carbon, chlorine, and hydrogen, organochlorines are also known as "chlorinated organics," "chlorinated insecticides," or "chlorinated synthetics." Included are methoxychlor, lindane, toxaphane, and the closely related group of aldrin, dieldrin, chlordane, heptachlor, and endrin.

Effects

DDT affects the central nervous system. Both in insects and in mammals, DDT affects the normal transmission of nerve impulses. The neurons eventually send spontaneous impulses that cause the muscles to twitch; this may lead to death.

Soil, Water, and Bioconcentration

Large amounts of insecticide repeatedly sprayed on plants will eventually enter the soil, killing living matter there. These organisms include invisible bacteria, fungi, and algae which break down plant residues to release minerals, carbon, and nitrogen, insects which break down plant matter into new soil, and earthworms which dig tunnels that aerate the soil. Pesticides can cause the soil to become useless for

cultivation.

Chemicals sprayed on land can seep into rivers and streams. Some come in contact with groundwater, a major source of drinking water.

The major effect of environmental pollution is a process known as bioconcentration. Widely used insecticides affect the food chain because they degrade very slowly and are highly soluble in fat. After these chemicals are applied on land, they are washed by rains into streams, rivers, and lakes. There they are intaken by microscopic life forms, which are food for fish. The fish are then eaten by larger fish and aquatic birds. After animals ingest the pesticide through their prey, the compound is stored and concentrated in body fat. Repeated feeding causes high concentrations of the pesticide to build up. Thus, the higher up on the food chain an organism is, the more concentrated the intake of pesticide.

Birds and Mammals

The accumulation of DDT or its relatives in birds affects their ability to reproduce. DDT disrupts the formation of eggshells in the body of the female. Consequently, some species lay soft-shelled or shell-less eggs. Ospreys and bald eagles have been especially threatened as a result.

The effects of pesticides on mammals are not as obvious and are still being investigated. Some studies suggest that DDT can inhibit the productivity of plant plankton, upon which all other marine life depends.

Humans

How harmful a pesticide is to humans depends on the amount and susceptibility of the person. People with heavy exposure to chemicals during manufacture or use are most seriously affected. In the short term, there are severe reactions to touching or inhaling large quantities of pesticides. In the long term, the exposure to pesticides can cause adverse health effects such as cancers, birth defects, genetic damage, respiratory ailments, liver and kidney damage, neurological disorders, and reproductive problems.

Failure of Pesticides

Pest Resistance

Some insects are naturally more resistant to certain chemicals. As their susceptible members die, these survivors multiply, passing their resistance to the next generation. The pesticides no longer control at normally recommended rates. Some insects might develop cross-resistance, where resistance to one insecticide means resistance to a second with a similar mode of action as the first, or multiple resistance, where there is resistance to several classes. Depending on the type of resistance and the species of pest, resistance tends to last in the absence of the pesticide.

Pest Resurgence

Pest resurgence occurs when pests killed by insecticides return in larger numbers. This happens because the pesticides remove target insects and their natural enemies. Either the natural enemies are killed or they leave the area since their food is no longer available. There is an opportunity for the temporarily removed pests to reproduce before their natural enemies return.

Secondary Pests

A new species may become serious pests when their natural predators are killed. Spider mites, for example, caused havoc when DDT and other insecticides killed their predators.

Today's Usage

Because of the discovery of insect resistance, persistent residues in soil and in living tissue, accumulation in food chains, and harmful effects to wildlife, there has been a decline in the usage of organochlorines. They have been replace by the other three synthetic organics insecticides--organophosphates, carbamates, and synthetic pyrethroids.

Current insect control practice is done with an approach called Integrated Pest Management (IPM). This controls pests by combining methods such as chemicals, natural enemies, resistant plants, and cultural and mechanical controls. Biological controls include releasing predators, parasites, or pathogens of the pest species,

simulating the scent of female insects to lure males into traps, and releasing sterilized pests to disrupt the reproductive cycle. Farming techniques incorporate the planting of pest-resistant crops and frequent rotation of crops. The goal of IPM is to reduce the number of pests to a level not damaging to the economy. It also is used to maximize the good from controlling insects and to minimize the harm to the environment.

Rights

Resource Type

Case Study / Scenario