

Chemical Pesticides and their Adverse Effects

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Abstract

Pesticides are substances that are mainly used in agricultural lands, human health programs and urban green lands in order to protect plants and humans from various diseases. The industrialization and widespread use of pesticides by farmers, pest control operators and even general public can lead to significant risk to human health and environmental issues. Although they have several benefits, yet they have known ability to cause numerous negative health and environmental effects. Pesticides are toxic substances- they are biocides, designed to get rid of weeds, rodents, fungi and other organisms that can threaten public health and economy.

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Description

Pesticides are agrochemicals that are mainly used in agriculture or in human health programs, to protect plants from pests, weeds or diseases and protect humans from vector borne diseases such as dengue fever, malaria, lyme disease and schistosomiasis [1]. Pesticides include insecticides, herbicides rodenticides bactericides, fungicides, herbicides. These products are, moreover used for other purposes such as improvement and maintenance of nonagricultural areas like public urban green areas and field as well as sports fields [2]. These are also used in chemical substances such as building materials, pet shampoos and sometimes in boat bottoms to eliminate the presence of unwanted insects or other species.

Pesticides can be grouped according to types of pests they kill:

- **Herbicides:** These are chemicals used to kill weeds (i.e. unwanted plants) E.g. Borax, Nitrofen.
- **Insecticides:** These are used to kill insects. E.g. DDT, BHC.
- **Rodenticides:** These are used to kill rodents. E.g. Walfrin, Zinc phosphide.
- **Nematocides:** These are used to kill nematodes. E.g. DBCP, Phorate.
- **Molluscicides:** These are used to kill molluscs. E.g. Sodium pentachlorophenate.

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Fungicides: These are used to kill fungus. E.g. Bordeaux mixture.

Algaecides: These are used to kill algae. E.g. Copper sulphate, Endothall.

Bactericides: These are used to kill bacteria. E.g. Dichlorophen, Oxalinic acid.

Piscicides: These are used to kill fishes. E.g. Trifluoro Methylnitrophenol (TFM).

Classification of pesticides

Organochlorides (Chlorinated hydrocarbons)

- They belong to group of chlorinated hydrocarbon derivatives.
- These are synthetic pesticides.
- These pesticides cause neurological damage, endocrine disorder and have acute and chronic health effects.
- Non-biodegradable and persistent in soil for a long time.
- High tendency of bioaccumulation.

E.g. Lindane, methoxychlor, DDT, DDE, DDD, aldrin, dieldrin, Benzene Hexachloride (BHC), kepone.

Organophosphates

- These are esters of alcohols with phosphoric acid or with some other acids.
- These are very toxic acetylcholinesterase inhibitors as a result of which the breakdown of acetylcholine stops. The accumulation of acetylcholine results in convulsion paralysis and death.

E.g. Malathion, parathion, chloropyrifos, diazinon, monocrotophos.

Carbamates

- These are organic compounds derived from carbonic acids.
- Short lived but highly toxic.
- Block transport of ions (Na^+ , K^+ , Ca^{2+}) across nerve membrane or block acetylcholinesterase.

E.g. Carbaryl (sevin), aldicarb (timic), methomyl, carbofuran, bendicarb, propoxur.

Pyrethroids

- Group of manmade pesticides similar to the natural pesticide pyrethrum, which is produced by Chrysanthemum flower.
- These are toxic to insects and aquatic organisms.
- Disruption of endocrine activity.

E.g. Deltamethrin, cyfluthrin, bifenthrin, lambda-cyhalothrin, permethrin.

Dermal entry

Entry of insecticides through the skin. Pesticides that enter via this route are known as contact poisons. Dermal entry can happen when

- Aerosol spray droplets hit or strike the insect
- Insects anyhow come into contact with powder or granule form of insecticide. As they walk over or during their flight.

Oral entry

Entry of insecticides through the mouth when the insect eats it. Pesticides that enter via this route are known as ingested poison. The insecticides may be ingested by the insect:

- As a poison bait (a food to which insecticide has been added).
- When it grooms or cleans itself after the poison comes into contact with its body.

Respiratory entry

Entry of insecticides when breathed in by the insect. Insects breathe through spiracles. Pesticides that enter via this route are known as inhaled poisons.

Benefits of pesticides

- Crop protection
- Food preservation
- Material preservation
- Disease Control (mosquitoes, lice, scabies)
- Fleas or ticks on pets.

Risks of chemical pesticides

They may induce adverse health effects including cancer, effect on reproduction, immune or nervous systems. Moreover, skin, eyes and lung irritation, hormone disruptions, blood disorders, nerve disorders, birth defects, toxicity to foetus, etc. (Figure 1).

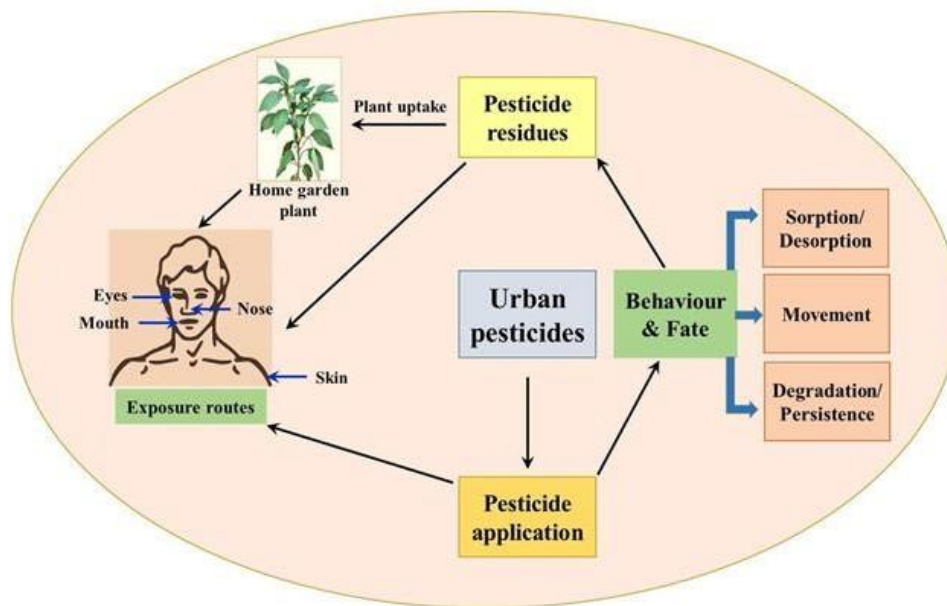


FIG. 1. Toxic to humans.

Impact on environment and ecosystems

Air

- Respirable particles contaminated with pesticides
- Respirable aerosols during spraying
- Vapour from volatile residues of pesticides

Soil: Crawling and hand to mouth behavior of children facilitate exposure.

Water

- Pesticides may contaminate the water for drinking and bathing.
- They may contaminate nearby groundwater and surface water.

Food

- Routinely sprayed on crops (vegetables, fruits and grains).

- Bioaccumulation in animals and products (fish, meat, egg, dairy).

Fate and transport of pesticides

Pesticides are easily diffused to the atmosphere during application, and shortly thereafter they are lost from the soil through gaseous diffusion. Some highly volatile pesticides, however, may also pass downward into aquifers (Figure 2).

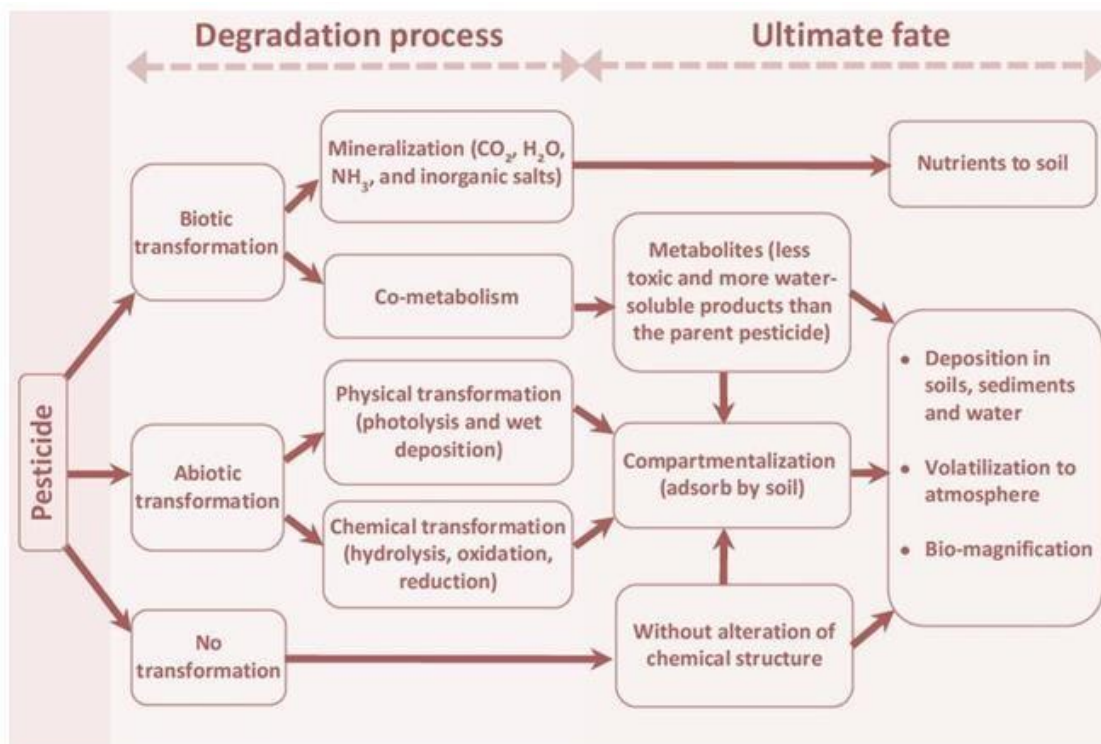


FIG. 2. Fate and transport of pesticides.

Pesticides may be occluded to soil particles, particularly the clays and soil organic matter. Strongly sorbed pesticides do not readily leach through the soil profile but may be bound to the sediments discharged from croplands [3]. Pesticides may be degraded (transformed) by chemical and biological processes. Chemical degradation occurs through such reactions as hydrolysis (reaction with water), oxidation, photolysis (photochemical degradation) and reduction. Biological degradation may also occur as soil microbes breakdown or consume pesticides. These microbes are widespread in the top several centimeters of soil. The extent of degradation may range from the formation of metabolites to the formation of inorganic decomposition products. Thus, there is an urgent need for a new concept in agriculture and an alternative to chemical pesticides.

Alternatives to chemical pesticides

The replacement of hazardous pesticides with safer alternatives can be done by means of sustainable practices and achieved in a cost-effective manner. Examples of approaches to pesticide risk reduction include:

Integrated Pest Management

Integrated Pest Management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment.

Conservation agriculture

Conservation Agriculture is a farming system that promotes minimum soil disturbance, maintenance of a permanent soil cover,

and diversification of plant species [4]. It magnify biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and to improved and sustained crop production (Figure 3).



FIG. 3. Three principles of conservation agriculture.

Organic agriculture

Organic farming is an agricultural approach that supports healthy products free from components that may harm humans and nature. It considers potential environmental and social impacts by knocking out the use of synthetic inputs, such as synthetic fertilizers and pesticides, veterinary drugs, genetically modified seeds and breeds, preservatives, additives and irradiation. These are replaced with site-specific management practices that maintain and increase long-term soil fertility and prevent pest and diseases.

Agroecology

Agroecology is a holistic and integrated approach that simultaneously applies ecological and social concepts and principles to the design and management of sustainable agriculture and food systems [5]. It seeks to optimize the interactions between plants, animals, humans and the environment while also addressing the need for socially equitable food systems within which people can exercise choice over what they eat and how and where it is produced.

Biological pesticides

Biopesticides, also known as biological pesticides, are pesticides derived from natural materials such as animals, plants, bacteria, and certain minerals. Typically, biopesticides have unique modes of action and are considered reduced-risk pesticides.

Biological pest control

Biological control involves the mass-production and release of natural enemies such as parasitoids and predators to control pest insects in an environmentally sound manner. Radiation is used to increase the applicability, cost-effectiveness and safety of rearing, shipping and deploying such natural enemies.

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