EFFECTS OF PESTICIDES ON SOIL AND ITS HARMFUL EFFECTS

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Abstracts:

Uncontrolled application of pesticides can contaminate soil and may kill other nontarget organisms. Pesticides can damage soil biomass and microorganism such as bacteria, fungi, and earthworms. Microbial biomass is a labile component of soil organic matter and has an important role in soil nutrient element cycle. S. A. had studied earthworm biomass and cholinesterase activity affected by pesticides. The authors concluded that earthworms were affected detrimentally by the pesticides due to chronic (chlorpyrifos) and intermittent exposure (azinphos methyl). Other research also showed that malathion exposure gave the significant reduction in body weight and decreased sperm viability of Eisenia fetida adults species. The organism also had an adverse impact on growth and reproduction by the chlorpyrifos exposure, and the cypermethrin exposure also gave the significant reduction in cocoon production. Pesticides which are applied to the soil could have an impact on nontarget organisms and damage the local metabolism that is required by soil fertility and pesticide degradation itself. The large pesticides application and its impact can be identified in Indonesian shallot farming.

Introduction

A pesticide is any substance which is used to prevent, destroy or repel any pest from causing any damage. The term pest represents any living organism that may cause harm to human in respect to food competition, destruction of property and spread of disease. Pests include insects, rodents, microbes, fungi and weeds (unwanted plants), etc. of agricultural, medical and veterinary importance, and therefore, a pesticide can be an insecticide, an insect and plant growth regulator, a fungicide, an herbicide, a molluscicide, and an algaecide, etc. based on the target pest organism.

The major site of action for most pesticides are the nervous and endocrine systems and, therefore, are also potentially toxic to human with serious direct or indirect adverse health effects. Human beings are exposed to pesticides directly or indirectly. Direct exposure occurs during pesticide application process in agriculture, public health and livestock, and fumigation while indirect exposure involves ingestion of contaminated food and water, and inhalation of pesticides droplets from the drift. Children are more susceptible to pesticides than adults due to their physical makeup, behavior and physiology, and exposure to very low levels at early developmental stages can cause adverse health effects. Codex Alimentarius committee and the Pesticide Data Program of the United States Department of Agriculture have established pesticide maximum residue limits in edible food which must be followed to avoid any health risks.

Pesticide exposures have been linked to the elevated incidence of human diseases such as cancers, Alzheimer, Parkinson, amyotrophic lateral sclerosis, asthma, bronchitis, infertility,

birth defects, attention deficit hyperactivity disorder, autism, diabetes, and obesity, respiratory diseases, organ diseases and system failures. People who are exposed to pesticides are at a greater risk to develop various cancers including non-Hodgkin lymphoma (NHL), leukemia, brain tumors, and cancers of the breast, prostate, lung, stomach, colorectal, liver, and the urinary bladder.

Pesticides cause genetic and epigenetic changes by involving various processes at cellular levels. Pesticides may be involved in endocrine disruption and induction of inflammatory signals which result in production of reactive oxygen species (ROS) causing oxidative stress. ROS disrupt the cellular functions of mitochondria and endoplasmic reticulum.

This chapter covers different types, importance and modes of action of pesticides. Human exposure to pesticides and pesticide residues in food are also discussed. Finally, the impacts of pesticide exposure on human health with focus on the major chronic health effects (neurotoxic, genotoxic and carcinogenic, and reproductive effects) and recent findings regarding health effects associated with exposure to common types of pesticides, i.e., organochlorines, organophosphates, carbamates, pyrethroids and neonicotinoids insecticides, fungicides and herbicides are discussed.

The Dangers of Pesticides

One of my favorite foods in the world has to be a freshly picked apple. Whether I am eating a juicy, red Gala apple, or a green, tart Granny Smith apple, my taste buds explode with the goodness of each bite. Not only are apples delicious, but they are packed with the essential vitamins and minerals that your body needs to stay healthy. As I always say, "An apple a day keeps the doctor away," and I believe that is why I have not gotten sick since the 5th grade. Yet, lately I have been pondering over this question: Many fruits, such as apples, are sprayed with pesticides, and if pesticides can kill insects, what are the potential dangers they have on our body and the environment? This prompted me to dedicate a post about the dangers of pesticides, and my research surprised me.

As all of you know, most fruits and vegetables are grown of farms, and on farms, you can expect to find a lot of bugs, some of which have a strong liking for the crops. Farmers can not afford to lose their crops due to pesky little insects, so instead, some farmers spray chemicals, pesticides, on them which repel the insects. Pesticides can also prevent disease from spreading, so using pesticides lowers the risks of losing one's crop of the season.

Now, some of you may be wondering,"Do organic foods have pesticides?" The answer is yes, but these pesticides come from natural sources, such as certain types of plants, and they do not use synthetic pesticides. Organic farmers also tend to spray less pesticides on their produce than other farmers, and the pesticides are less dangerous for the environment. Also, if a product is certified organic, it has to abide by the national standards.

Not only are pesticides found in farms, but they are found in or around your home, too. Do you use insect repellent in the summer to avoid getting bitten by blood-sucking insects such

as mosquitoes? Well, insect repellent has the pesticide DEET in it. If you have a wooden deck on your house, then that probably contains that pesticide Chromated Copper Arsenate, (CCA), which helps in the aid to preserve the wood so it does not rot. Some other common items that contain pesticides are: bleach, certain types of paint, and even a few swimming pool chemicals. If you have a lawn, you might have weed killers, or herbicides, to prevent the growth of weeds. Some pesticides are also used on other animals besides insects, such as unwelcome rodents. (Rodenticides)

2.1 Types of pesticides

Pesticides can be classified based on chemical classes, functional groups, mode of action, and toxicity. The active ingredients of most pesticides are either organic (contain carbon) or inorganic (minerals e.g. copper sulfate, ferrous sulfate, copper, lime, sulfur, etc.). Organic pesticides are hydrophobic and more complex than those of inorganic pesticides. Organic pesticides can be natural (produced from naturally available sources) or synthetic (artificially produced by chemical synthesis in factories). The major types of pesticides used in agriculture, forestry, landscape, medical and veterinary sectors are listed in below table.

Type of pesticide	Active ingredient	Target pests
Insecticides	Natural and synthetic	Insect (6-legged) pests of agricultural, forestry, landscape, medical and veterinary importance
Miticides/acaricides	Natural and synthetic	Mites (8-legged) pests of agricultural, forest, landscape, medical and veterinary importance
Fungicides	Natural and synthetic	Fungal diseases (molds, mildews, rust) of agricultural, forestry and landscape importance
Herbicides	Natural and synthetic	Unwanted plants (weeds) of agricultural and landscape importance
Insect growth regulators	Synthetic	Disrupt the growth and reproduction of insect pests. IGR are species or genus specific.
Pheromones	Natural and synthetic	Attract and trap male insects and are often species-specific.
Plant growth regulators	Synthetic	Alter plants growth, e.g., induce or delay flowering
Algaecides	Natural and synthetic	Algae growing on different surfaces, e.g., patios

Type of pesticide	Active ingredient	Target pests
Molluscicides	Natural and synthetic	Slugs and snails of agricultural, forestry and landscape importance
Biopesticides	Natural	Can be insecticides, fungicides or herbicides
Antimicrobials	Synthetic	Microbes (mostly bacteria) of medical and veterinary importance
Rodenticides	Natural and synthetic	Rodents (mice, rats) in agriculture, landscape, building, storages and hospitals
Treated seeds	Synthetic	Seeds coated with an insecticide or fungicide or both to prevent damage from soil insect pests and fungus diseases
Wood preservatives	Synthetic	Pesticides to protect wood from insect pests, fungus and other diseases
Minimum risk pesticides	Natural and synthetic	Any pesticides which have been proven safe for human and are exempt from registration by any regulatory authorities

Table 1.
Major types of pesticides used in agriculture, forestry, landscape, medical and veterinary sectors. (adopted from: National Pesticides Information Center at http://npic.orst.edu/ingred/ptype/index.html).

Pesticides and the Environment

Even though pesticides are sprayed on land, many times, they can make their way into a water source, such as a river, ocean, or pond. For instance: Pesticides from an orchid may end up in a nearby stream due to runoff. If a body of water becomes contaminated with the chemicals, many fish and other animals may die and get sick. This can throw the whole ecosystem off balance.

Pesticides can also affect groundwater by a process known as leeching. Many people depend on groundwater for their drinking supply, yet, if that water has pesticides in it, it is unsanitary and harmful for the people to drink.

Another way pesticides can spread and cause potential harm is by volatilization. Volatilization occurs when a pesticide turns into a gas or vapor after it has been sprayed, allowing it to travel through the air and spread to different pieces of land. (Vapor Drift) This can be harmful for wildlife, such as frogs. Some scientists even believe that the pesticide,

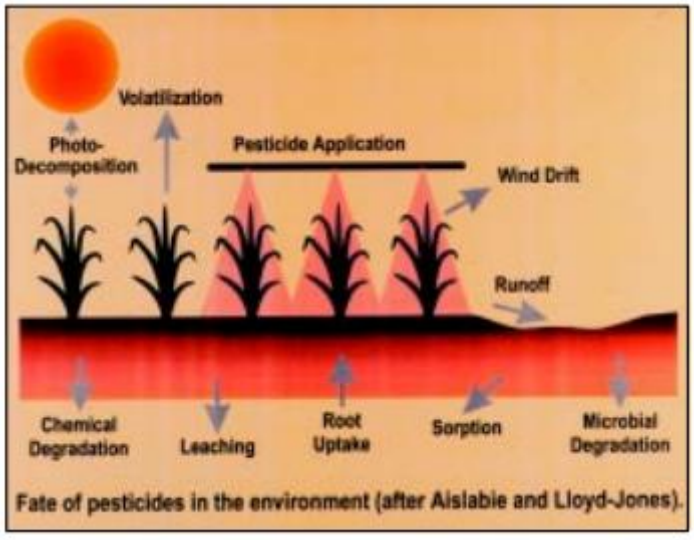
atrazine, causes reproductive problems in the frogs that affect the frog's biological goal, which is to survive to reproduce.

Retention of pesticides in the soil

Retention refers to the ability of the soil to hold a pesticide in place and not allow it to be transported. Adsorption is the primary process of how the soil retains a pesticide and is defined as the accumulation of a pesticide on the soil particle surfaces. Pesticide adsorption to soil depends on both the chemical properties of the pesticide (i.e., water solubility, polarity) and properties of the soil (i.e., organic matter and clay contents, pH, surface charge characteristics, permeability). For most pesticides, organic matter is the most important soil property controlling the degree of adsorption. For most pesticides, the degree of adsorption is described by an adsorption distribution coefficient (Kd), which is mathematically defined as the amount of pesticide in soil solution divided by the amount adsorbed to the soil.

Pesticide toxicity

The toxicity level of a pesticide depends on the deadliness of the chemical, the dose, the length of exposure, and the route of entry or absorption by the body. Pesticide degradation in soil generally results in a reduction in toxicity; however, some pesticides have breakdown products (metabolites) that are more toxic than the parent compound. Pesticides are classified according to their potential toxicity to humans and other animals and organisms, as restricted-use (can only be purchased and applied by certified persons who have had training in pesticide application), and general use (may be purchased and applied by any person).



Fate of pesticides in the environment (after Aislabie and Lloyd-Jones).

Use and application considerations

- Apply pesticides at the lowest effective level.
- Avoid unnecessary pesticide treatments.
- Use Integrated Pest Management.

• Follow all label instructions.

• Apply proper rates and times as label indicates.

• Calibrate application equipment.

• Apply formulations that minimize drift.

• Use safety equipment when handling.

• Store and dispose of pesticide containers properly.

• Use biological controls when appropriate.

• Alter farming or cropping systems to control pests.

• Use disease and insect resistant crop varieties.

Conclusion

Pesticides such as herbicides, fungicides, and insecticides vary in the amount of time they break down in the environment by the specific pesticide, the rate applied, and environmental conditions. We measure how long pesticides persist in the environment by a measure called half-life or how long it takes the original material to be reduced by 50%. Under most situations we would encounter in an agricultural setting, a pesticide half-life can range from a few hours to 4-5 years. Most pesticides are broken down by microbes in the soil, so environmental conditions that reduce microbial activity (cold, dry conditions) will extend pesticide remaining in the soil. In general, the trend is for the newer pesticides to last far less than those used decades ago (eg, DDT). In some parts of the world, copper-based fungicides are still used, and these will last forever in the soil, for all practical intents and purposes.

Reference:

1. F. Azam, S. Farooq, and A. Lodhi, "Microbial biomass in agricultural soils—determination, synthesis, dynamics and role in plant nutrition," *Pakistan Journal of Biological Sciences*, vol. 6, no. 7, pp. 629–639, 2003.
2. S. A. Reinecke and A. J. Reinecke, "The impact of organophosphate pesticides in orchards on earthworms in the Western Cape, South Africa," *Ecotoxicology and Environmental Safety*, vol. 66, no. 2, pp. 244–251, 2007.
3. S. Yasmin and D. D'Souza, "Effects of pesticides on the growth and reproduction of earthworm: a review," *Applied and Environmental Soil Science*, vol. 2010, Article ID 678360, 9 pages, 2010.
4. O. Espinoza-Navarro and E. Bustos-Obregón, "Effect of malathion on the male reproductive organs of earthworms, Eisenia foetida," *Asian Journal of Andrology*, vol. 7, no. 1, pp. 97–101, 2005.

5. S.-P. Zhou, C.-Q. Duan, H. Fu, Y.-H. Chen, X.-H. Wang, and Z.-F. Yu, "Toxicity assessment for chlorpyrifos-contaminated soil with three different earthworm test methods," *Journal of Environmental Sciences*, vol. 19, no. 7, pp. 854–858, 2007.

6. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052821.pdf

7. https://www.nature.com/scitable/blog/green-science/the_dangers_of_pesticides/