



Original article

Chemical pesticides: Their negative effects on the environment and ways to reduce them

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Abstract

We live in a globalized world in which the production, trade, and consumption of agricultural crops and other goods and services that use pesticides and fertilizers are shaped in large quantities by the needs and demands of a growing population and megatrends (such as urbanization and a growing global middle class). Unlike most industrial chemicals, both organic and inorganic pesticides and fertilizers are intentionally applied to the environment to provide specific beneficial functions. This leads to potential risks to the environment and health. However, despite numerous published scientific studies, there are data gaps and a lack of comprehensive knowledge regarding the adverse effects of pesticides and fertilizers on a global scale. Therefore, the current research highlights the role of chemical pesticides in increasing environmental pollution and its impact on all lifestyles, as well as the best approaches that can be used to address this degradation of the ecosystem.

Keywords: Harmful effects of fertilizers, Reducing the causes of water pollution, Environmental protection, Soil pollution.

Introduction

Chemical pesticides are widely used in agriculture to control pests, diseases, and weeds, with the goal of increasing crop productivity and quality. Despite their economic and agricultural benefits, excessive and unregulated use of pesticides leads to serious environmental and health problems, including soil and water pollution, decreased biodiversity, and the emergence of pest resistance (1). Although chemical pesticides have made significant contributions to increasing crop productivity and mitigating or eliminating many diseases transmitted to humans and animals, these chemical compounds have the potential to contaminate the air, water, soil, and food (2). Their presence alters the quality characteristics

of parts of the biosphere, resulting in harmful effects on humans, animals, and plants. Many international organizations, such as the World Health Organization (WHO), the US Environmental Protection Agency (EPA), and the Food and Agriculture Organization (FAO), have warned of the health risks that may result from the use of chemical pesticides (3). To be precise, it is important to distinguish between two terms: "coloring," which refers to the entry of relatively large quantities of pesticides into the environment of a particular area due to incorrect and excessive use. This is due to a lack of awareness and technical defects in the equipment used for pesticide control (4). The term "pollution," on the other hand, refers to the entry of

relatively small quantities of pesticides into the environment during the process of pesticide application, using currently available methods (5). The chemical industry provides valuable services to humanity, represented by the production of many different chemical substances essential to human life, as well as the production of some chemicals used in treatment. There are tens of thousands of chemicals used in industry and agriculture (6). Homes, hospitals, tanneries, animal farms, foundries, etc. The number of organic chemicals used in the countries of the region is estimated at about 50,000 compounds, and thousands of pesticides are used to eradicate weeds and insects. What makes it more difficult to address the issue of chemical pollutants in terms of research or treatment is the nature of these pollutants and their negative effects (7).

Historical development of the production and use of chemical pesticides:

Pesticides have been used since 1850. However, prior to 1940, their use was limited to small quantities, and their harmful effects on humans were negligible. Natural plant derivatives were often used, such as nicotine, extracted from chrysanthemum flowers, which are known as safe pesticides (8). In addition, some inorganic pesticides were used, such as copper sulfate and lime (known as Bordeaux mixture), and some preparations containing mercury, lead, zinc, and sulfur. These produce stable residues that accumulate in the soil and can be transferred to living resources, including fish, algae, and some aquatic organisms (9). After 1940, organic pesticides were introduced, which diffuse within living tissues and produce purifying effects. Insecticides were introduced to eliminate disease-carrying insects, and a single pesticide was no longer capable of eliminating all species, as each type of organism requires a specific pesticide (10). After the production and use of DDT pesticides and the proven great benefits of pesticides for humanity, during the years (1940-1950) AD, the compound

benzene hexachloride was used in England and France, and the production of other compounds such as dieldrin and others continued. These pesticides are known today as first-era pesticides and are among the main causes of environmental pollution in the world, due to their long period of survival in the environment and their relatively high toxicity (11).

Types of pesticides and their toxic effects on humans:

Pesticides are chemical or biological substances used to eliminate or reduce agricultural pests. Chemical pesticides are classified as toxic substances, and their toxicity ranges from very high toxicity to practically non-toxic substances. They were placed on this basis into five groups based on calculating the lethal dose Ld_{50} for half of the exposed experimental animals (mice, etc.). The LD_{50} value for very highly toxic substances ranges between (1-5) milligrams/kilogram of the exposed animal's body, while the LD_{50} value for the fifth group, which are practically non-toxic substances, ranges above 15 grams/kilogram of body weight. Between these two groups, there are highly toxic substances, moderately toxic substances, and low toxic substances (12).

There are several types of chemical pesticides, including:

- Insecticides
- Herbicides
- Fungicides
- Rodenticides
- Algicides
- Biocides
- Nematocides

Here is a detailed explanation of the most important types of pesticides:

Pesticides

Pesticides are chemicals that prevent insects, weeds, and fungi from damaging crops. They are used by farmers to increase the amount of crops they can

produce. Governments select and regulate pesticides, and product testing ensures that levels are low enough to not pose a risk to human health. However, many people believe pesticides are present in their food, so they resort to expensive organic foods (13). Pesticides are synthetic chemicals with lethal properties, usually classified as organic compounds. They are used to eliminate various pests, including insects, weeds, weedy plants, and many parasites that threaten human health, destroy crops, and are the primary cause of disease spread. Pesticides are living organisms that cause harm to humans, animals, and plants by transmitting pathogens or disrupting the ecosystem in the human-animal-plant cycle (14). Contamination by chemical pesticides, especially chlorinated hydrocarbon pesticides, can occur in areas where pesticides have been sprayed or when plant seeds are treated with pesticides. This formation can lead to the death of birds and some aquatic life. The danger of pesticides may spread to other areas through the food chain (15). The last years of this century have witnessed a significant increase in the production of pesticides worldwide, and they have become one of the technological inputs for increasing agricultural production and combating diseases that are harmful to humans and animals. Chemical pesticides are considered one of the modern means of increasing production. In addition to their significant role in reducing or eliminating a large number of pests that harm plants, they are also capable of eliminating disease-carrying insects (16).

Rodenticides or rodent poison:

This is a type of pesticide used to control rodent pests. It consists of toxic chemicals that have a direct effect, such as phosphides. However, this is accompanied by the risk of environmental pollution and a threat to human health (17).

Nematicides:

It is a type of chemical pesticide used to kill parasitic nematodes. It tends to be a broad-spectrum pesticide

with high volatility and other properties that promote migration through the soil. Human health and environmental concerns have led to the cancellation of the registration of the pesticide Dikar (hazardous) and many other general nematicides in agriculture (18).

Environmental Pollution

Every day, the environment in which humans live is exposed to numerous dangers that are not immediately apparent to anyone and do not require dedicated laboratories to detect them. Rather, we see them with the naked eye and experience them because they are numerous, clear, and have filled the Earth's surface. This has prompted dozens of scientific and research institutions, major associations, and civil society organizations to warn of these disasters and find a cure for them. Environmental issues have become a top priority for modern societies, given studies that daily indicate the relationship between environmental pollution and the emergence of diseases in humans and the deterioration of marine and terrestrial life on Earth. With the development of life and industrial and technological progress, the environment, with all its elements—air and soil—is now exposed to new pollutants that were previously unknown (19).

Forms of environmental pollution

Pollution takes many forms depending on the environmental context in which it occurs and the sources from which it results, which are often human activity. Pollution, as previously mentioned, is an expression of instability or chaos within an ecosystem. What concerns us here is understanding the impact of pollution on the environment in which we live and its impact on humans worldwide. Environmental pollution has many types, including all of the following:

First: Soil pollution

Pollution is defined as the deterioration or destruction of the earth's outer surfaces or the alteration of its components, most of which are

directly or indirectly the result of human activities and the misuse of land resources. Soil pollution occurs when humans do not dispose of waste from various activities properly. It can also occur when wells dump chemicals onto the soil through pesticides, insecticides, and fertilizers used in agricultural practices. Various human activities have also contributed to soil pollution and the destruction of the earth's outer surfaces. It is important to understand that soil is not just waste, although it is a large part of the problem. Soil pollution can occur as a result of the presence of many industries, including large oil refineries and chemical industries such as herbicides, insecticides, and all types of fertilizers used in agriculture. Therefore, many laws have been put in place to limit the illegal dumping of waste on the soil (20).

The most important damages resulting from soil pollution:

A/ Impact on human health: Soil pollution has serious consequences for human health. When crops and plants are grown on contaminated soil, they are transmitted to humans through the plants' sensitivity to these pollutants. This has led to a sudden increase in disease incidence. The entry of these pollutants into the human body can affect a person's genetic makeup, causing congenital diseases and chronic health problems (21).

B/ Impact on plant growth: The biological balance of any ecosystem is affected by widespread soil pollution. Most plants are unable to adapt when the soil composition changes within a short period of time. The fungi and bacteria present in the soil, which help mitigate the effects of climate change, begin to decline, leading to an additional problem: soil erosion and a slow decline in fertility, rendering the land unsuitable for agriculture. Consequently, native plants are unable to survive. **C/ Decrease in soil fertility:** The chemicals present in the soil can reduce soil fertility, which leads to a decrease in the percentage of agricultural crops, and the production of fruits and vegetables that lack high-quality

nutrients, which may contain some toxic substances that in turn cause serious health problems in people who consume them (22).

Second: Air pollution:

The need to control dangerous air pollutants in order to maintain human health, as air pollutants cause the death of about 50,000 people annually, which represents about 2% of the total percentage of other causes of death, and the most pollutants in this area are smoke emitted from tobacco, cigarettes, and tobacco. About 3 million people die annually, and air pollution means the presence of toxic substances in the air that harm human health in the first place (23).

Third: Water pollution:

Water occupies approximately 71% of the Earth's surface, with an estimated volume of approximately 296 million cubic miles. 98% of the world's water is in liquid form. Studies indicate that approximately 97% of this water is unfit for consumption due to its salinity. The remaining 3% is freshwater, but it is unavailable because it is either trapped in glaciers or in the form of groundwater (24).

Water pollution has many sources, the most important of which are the following:

A. Oil: This is one of the most widespread sources, and it forms point pollutants that are the most common colorants on coasts, seas, and oceans. Oil usually leaks into other bodies of water, either inadvertently or deliberately (25).

B. Industry: This is one of the most important and dangerous causes, especially discoloration caused by chemicals (such as acids, bases, and caustic soda), as these require three to four times more oxygen than other substances (26).

C. Urban sources of water: An example of this is sewage, which most cities resort to disposing of by discharging it into rivers or streams. There is no doubt that disposing of this water, contaminated with chemicals, microbes, viruses, and other substances,

can cause a health disaster due to the formation of microbial pollution that affects human health and agricultural production (27).

The Role of Chemical Pesticides in Environmental Pollution

Chemical pesticides are environmental pollutants. They are used to control pests on farms, fields, and homes. Despite their effectiveness and economic benefits, they have played a significant role in increasing environmental pollution through their harmful impact on human and animal health. Exposure to pesticides falls into two categories: acute exposure, which includes poisoning of animals as a result of inhaling pesticides or contact with the environment, or chronic exposure, which is long-term and leads to diseases such as cancer, liver and kidney disease, and nervous system disorders (28).

Types of Environmental Pollution Due to Chemical Pesticides:

There are many types of environmental degradation resulting from the incorrect and excessive use of chemical pesticides. The most important of these types are:

1- Soil Pollution by Pesticides:

Agricultural production is negatively affected by certain fungi and insects, which are largely responsible for reducing agricultural yields. Therefore, humans resort to using pesticides to eliminate these insects. Pesticides are used as powders, liquids, or sprayed as granules. This is done by ground equipment, aircraft, or by instilling them in the soil (29).

2- Air pollution by pesticides:

Chemical pesticides can contribute to air pollution. These pesticides are carried by winds as airborne particles to other areas, potentially contaminating them. Pesticides sprayed on crops can also be blown and carried by winds into neighboring areas, potentially posing a threat to wildlife. The spread of sprayed particles and exposure to them increases with increasing wind speed. Low relative humidity

and high temperature result in more aerosolization, so the amount of pesticides that can be inhaled in the outdoor environment depends largely on the season of treatment. Pesticide sprays may also be carried by winds to other areas (30).

3- Water pollution with pesticides:

It is a serious environmental problem that affects the health of humans, animals, and plants. This pollution occurs when pesticides are deposited in agricultural lands and enter the sources of life through surface runoff or drinking water into underground life. Water pollution with pesticides can lead to serious health problems such as nervous system disorders and cancer, which affect aquatic ecosystems and reduce water quality (31).

Ways to address the negative effects of chemical pesticides on the environment

The extensive use of pesticides causes strong and harmful effects on the biosphere represented by humans, animals, and plants, as genetic damage has been shown in humans, mammals, and higher plants, which necessitates research and study by humans to know the correct ways to avoid these damages. Despite the scientific and technical progress, the negative effects of pesticides still accompany the new types of pesticides and, in many cases, cause various diseases, especially kidney and liver failure; affect the nervous system, especially with phosphorus compounds; and may lead to complete failure and one of the cancerous diseases. In order to control the negative effects of using chemical pesticides, all of the following can be used (32).

1- Use the least possible amount of pesticides:

There are those who use large quantities of pesticides at close intervals, which is uneconomical on the one hand and polluting on the other. Therefore, it is necessary to be familiar with the rules of rinsing and limit the use to the amount necessary to achieve economic control. It is also possible to reduce the amount used by focusing the treatment on only the severely infected parts (33).

2- Development of pesticides:

The ideal pesticide should be highly effective for the type of harmful insects, but completely safe for all other forms of life, including beneficial insects, fish, wildlife, pets, and humans (34).

3- Exterminating continental insects before they spread:

Eradicating certain types of insects and removing them from a specific area is an important means of reducing the environmental impact of pesticides, as it eliminates the need for these materials. Moreover, eradicating harmful insects before they spread may not be very expensive compared to the damage caused by these insects and the expenses required to be inspected in subsequent years (35).

Methods for removing pesticides from the air include the following:

1. Pesticide vapors and particles can be removed from the air through chemical reactions and natural stabilization processes.
2. Photochemical reactions are among the most important reactions that occur in the air, as plants are exposed to sunlight in photochemical reactions.

Air stabilization processes remove residues through fog, rain, and dew, all of which help the residues reach the surface (36).

Treating water pollution with pesticides

Water pollution with chemical pesticides is a serious problem affecting the environment and human health. Several methods can be used to address this problem, as summarized in (37).

- 1- Physical treatment, which includes filtration using activated carbon filters or secondary filters to remove pesticides from water. Ion exchange treatment, which involves using ion exchange materials with pesticides, removing them overnight. It can also be achieved through sedimentation, which involves using chemicals to collect solid pesticides at the bottom of the water for easier removal.

- 2- Chemical treatment, which is done through coagulation, which involves using chemicals to collect pesticide molecules, creating larger clumps that can be easily removed, or through oxidation, which involves using chemicals to break down pesticides into less toxic substances, possibly through chlorination.

3- Biological treatment

This is done by using microorganisms, such as bacteria or fungi, to break down pesticides into harmless substances, or by using plants, as growing plants can lead to the absorption of pesticides from the soil (38).

Conclusions

- 1- Most pesticides used to eliminate agricultural pests and insects can cause cancer in the human body if their concentration in the body's tissues exceeds the naturally permissible limit.
- 2- The incidence of cancer increased significantly during the second half of the twentieth century, especially in developing countries. This is due to the widespread use of pesticides and toxic substances.
- 3- The negative effects of using pesticides are not limited to the area in which they are used, but rather they spread through the food chain to areas that may be very far away.
- 4- Animal meat, fish, and some chicken contain concentrations of pesticide residues that may cause harm to the human body if precautions are not taken when using such foodstuffs.
- 5- Environmental pollution from blood, air, and the organisms contained in these packaging knows no borders, but rather spreads throughout the world, as the remains of these pesticides can move from one country to another and from one continent to another as a result of certain natural conditions such as air, water, or the food chain via plant and animal food products.

6- There are still knowledge gaps that hinder a full understanding of some of the mechanisms and processes leading to the harmful effects of pesticides and fertilizers, in addition to the effectiveness of some control measures. However, the available evidence provides sufficient justification for additional action in both the public and private sectors to avoid or reduce potentially serious or irreversible adverse effects.

Recommendations

1. Adding easily decomposed organic materials to the soil. It has been observed that adding large quantities of organic fertilizers has helped accelerate the decomposition of some resistant pesticides, providing suitable conditions for the growth and activity of soil microbes.
2. Grow some plants that collect pesticides
3. Take transformative actions to address root causes and transform market demand, accompanied by supporting enabling measures.
4. Promote the professionalism of pesticide distribution and use and enforce relevant legislation.
5. Prioritize the development and availability of specialized pesticides and biocides.

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