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REVIEW ARTICLE

Pesticides and soil pollution: health risks that threaten to human life

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Abstract

Soil as a natural resource that acts as a medium for plant growth, soil provides nutrients, water, and physical support for plants. In addition, soil also functions as a carbon store, helping to regulate the climate by absorbing greenhouse gases. The process of soil formation involves complex interactions between minerals, organic matter, water, and living organisms. Soil pollution is increasingly having serious impacts on human health and ecosystems. Waste from human activities and the use of pesticides are the biggest causes of soil pollution. Some efforts that can be made to prevent soil pollution are bioremediation, monitoring pesticide use, phytoremediation techniques, and education. The use of pesticides in agriculture does have a significant impact on human health, both in the short and long term. Therefore, it is very important to implement effective control measures to reduce pesticide contamination and protect public health.

Keywords: Soil, Pollution, Health Risk.

INTRODUCTION

Soil is a natural resource that is essential for life on Earth. As a medium for plant growth, soil provides the nutrients, water, and physical support needed for plant roots to thrive. In addition, soil also functions as a carbon store, helping to regulate the climate by absorbing greenhouse gases. The process of soil formation involves complex interactions between minerals, organic matter, water, and living organisms, all of which contribute to soil fertility and health. However, soil faces various threats, such as pollution, erosion, and land conversion for settlement and intensive agriculture.

Soil pollution is an increasingly pressing environmental problem that can have serious impacts on human health, ecosystems, and agricultural sustainability. The main causes of soil pollution include industrial waste, excessive use of pesticides and herbicides in agricultural practices, and improper waste disposal. Hazardous chemicals such as heavy metals, hydrocarbons, and toxic organic matter can settle in the soil, damaging soil structure and reducing fertility. In addition, soil pollution can lead to groundwater contamination and affect the quality of food produced from contaminated land.

Soil pollution can be divided into several types based on the causes and sources. Pollution by waste is one of the main categories, where organic and inorganic waste from industrial, household, and agricultural activities pollute the soil. Organic waste, such as food waste, can decompose quickly but in large quantities can affect soil fertility. In contrast, inorganic waste, such as plastic and metal, is difficult to decompose and can damage soil structure in the long term. The use of pesticides and chemical fertilizers is also a significant cause of soil pollution; excessive use can damage the nutrient content of the soil and change the soil pH to be more acidic. In addition, pollution from industrial chemicals often occurs when waste from the production process is not managed properly, causing leakage of hazardous substances into the soil. Finally, pollution from poorly managed household waste also contributes to this problem, where the accumulation of waste can disrupt the soil ecosystem and the health of surrounding plants.

Excessive and inappropriate use of pesticides can result in the accumulation of hazardous residues in the soil, which in turn can contaminate crops and groundwater sources. Research shows that pesticides can disrupt soil microorganisms that are essential for fertility, as well as reduce agricultural productivity (Supriatna et al., 2021). Soil pollution is a serious environmental issue, which can be caused by various factors such as industrial waste, pesticide use, and mining activities. Research conducted in Wonocolo Village, East Java, revealed that the concentration of Total Petroleum Hydrocarbons (TPH) in polluted soil reached 124,265.75 mg/Kg, which shows a significant impact on soil quality (Madonna, 2024). In addition, research in Eka Jaya Village, Jambi City, showed that the use of pesticides that did not comply with established guidelines had resulted in soil contamination by carbamate compounds in two of the six sample locations taken (Supriatna et al., 2021). Another study in Brebes showed that the soil quality in shallot fields experienced mild to moderate damage, with low soil pH values due to pesticide use exceeding the limits (Ramadhan, 2018).

Exposure to pesticides can result in a number of health problems, including acute symptoms such as dizziness, nausea, and skin irritation, as well as more serious long-term effects, including cancer, genetic disorders, and reproductive disorders (Sinambela, 2024). Acute poisoning from pesticide exposure is also a common problem among farmers, with reports suggesting that up to 100 out of 223 farmers in one area experienced poisoning (Lusiana and Rozi, 2015). According to research, chronic poisoning caused by pesticides is often not identified until years later, and the risk increases with the frequency and dosage of inappropriate use (Yuantari et al., 2015). In addition, pesticide residues in food can cause the accumulation of toxins in the human body, which can cause serious diseases such as cancer and birth defects (Sinambela, 2024). the impact on the environment is also very concerning; soil and water pollution caused by excessive use of pesticides can damage the ecosystem and threaten the survival of non-target organism (Arif, 2015).

These findings highlight the importance of better management of chemical use and agricultural practices to prevent further soil pollution. Controlling soil pollution from pesticide use is critical to maintaining human and ecosystem health. Pesticides used in agriculture often contain hazardous chemicals that can leach into the soil, contaminate water resources, and enter the food chain. Long-term exposure to pesticide residues can lead to a variety of health problems, including hormonal disruption, respiratory disease, and even cancer.

The main objective of the research is to analyze the impact of pesticide pollution and efforts to control soil pollution caused by the use of pesticides which are expected to reduce pesticide residues in the soil. In addition, it aims to increase public awareness of the importance of wise pesticide management, so as to create a healthier and safer environment for future generations.

MATERIALS AND METHODS

This study utilizes a literature review of approaches. The main focus of this literature review is to identify the health risks caused by pesticides and soil pollution that threaten to human life.

RESULTS AND DISCUSSION

Pesticide pollution is a serious issue that has a major impact on the environment and human health. Excessive use of pesticides and not in accordance with applicable regulations can cause pollution to the environment, including soil and water. The use of pesticides in agriculture has a significant impact on human health, both acutely and chronically. Here are some important aspects related to the health impacts of pesticide use.

Exposure Mechanism

According toLusiana and Rozi, 2015 Causes of poisoning caused by pesticides are:

1. Pesticide Use: Acute pesticide poisoning is caused by pesticides entering the body. The majority of residents of agricultural villages such as Ponoragan Village are at risk of acute poisoning due to intensive agricultural activities.
2. Duration of Exposure: The time of direct contact with pesticides at one time (duration of exposure) also affects the risk of poisoning. However, research shows that there is no relationship between the duration of exposure and acute poisoning, although 72.4% of respondents experienced acute poisoning with a duration of exposure less than 3 hours/day.

Health Impact

In research conducted by Mahmudah et al., 2012 in Brebes Regency, it has been estimated that 19.25% of farmers experienced mild poisoning and 4.08% experienced moderate poisoning based on blood cholinesterase level examination data of farmers. Risk factors that influence poisoning are:

1. Agricultural Activities: Agricultural activities themselves are a major factor that increases the risk of poisoning. The process of mixing pesticides without PPE protection, such as not wearing gloves and masks, increases the risk of exposure.
2. Symptoms of Poisoning: Symptoms of pesticide poisoning include headaches, upset stomach, muscle aches, dizziness, blurred vision, diarrhea, and skin irritation. These are all due to the body's reaction to the harmful chemicals in pesticides (Sinambela, 2024).

Soil Pollution Control Efforts

Therefore, effective control measures need to be taken to reduce contamination and restore soil fertility. Here are some methods and approaches that can be taken to control pesticide pollution:

1. Bioremediation
   Bioremediation is a process that uses microorganisms, such as bacteria and fungi, to degrade harmful compounds in soil, including pesticide residues. These microorganisms can convert pesticides into less harmful compounds, such as carbon dioxide and water (Cintamulya and Putri, 2021).
2. Pesticide Use Supervision
   Strictly controlling pesticide use is essential. This includes following recommended doses and avoiding repeated applications in the near future to prevent accumulation of residues in the soil (Supriatna et al., 2021)
3. Phytoremediation Techniques
   Phytoremediation is the use of green plants to clean contaminated soil, sediment, or water (Laela and Ammurabi, 2024). Plants function as bioremediation agents that can reduce pesticide levels in the soil through various mechanisms, including accumulation and biodegradation.

4. Education and Awareness
   Increasing farmers' awareness of the health risks of pesticide use and the importance of using PPE can help reduce poisoning incidents. Using the right dosage and understanding how to apply it safely are also very important to protect the health of farmers and consumers (Tutu et al., 2022).

The following is previous research that uses bioremediation and phytoremediation methods in efforts to control pollution caused by pesticides:

Table 1. Previous studies utilized biremediation and phytoremediation

Method	Title	Result	References
Bioremediation	Bioremediation of Pesticide Contaminated Land by Composting in Batu Apple Plantation	From the results of the research that has been done pesticide residues in the control, as well as the C/N ratio of 40, C/N 35, and C/N 30 showed a decrease in concentration during the 28-day composting process with percentages of 48.3%, 86.2%, 89.7%, and 99.3% respectively. From these results, it can be concluded that the treatment with a C/N ratio of 30 has the highest pesticide degradation rate.	(Purnomo and Dhiningrum, 2023)
	Optimization of In Situ Bioremediation Process on Land Contaminated with Mancozeb Group Pesticides	Fertilization using mixed compost showed a bioremediation reaction that resulted in a pH change of 0.22 and occurred in neutral pH conditions. This allows microbes to be more effective in remediating pesticide residues. On the 35th day, pesticide residues from each spraying dose remained between 0.25% and 1.7%, which is equivalent to less than 0.003 ppm.	(Yohanes et al., 2011)
	Bioremediation of Metomil Pesticide by Pseudomonas Aeruginosa Bacteria	Pseudomonas sp. bacteria can grow on petri dishes containing Nutrient Agar (NA) medium and carbamyl pesticide solution. This shows that Pseudomonas sp. can degrade carbamyl pesticides and continue to grow on NA media containing carbamyl pesticides that are toxic to living things and have a bad impact on the environment.	(Pulungan, 2023)
	Remediation of Cobalt (Co) Contaminated Soil Using Bioremediator and Ameliorant	The results obtained showed that the Co levels in the soil decreased by 76% after treatment with bioremediator.	(Purbalisa and Dewi, 2019)
Phytoremediation	Removal of Tebuconazole Pesticide Waste with Phytoremediation System Using Water Hyacinth (Eichhornia Crassipes)	Water hyacinth plants have been proven effective in reducing the content of tebuconazole pesticide in wastewater, with a reduction percentage reaching 15.3%.	(Ajiningrum and Pramushinta, 2015)

Soil contamination has serious impacts on human health, both in the short and long term. In the short term, individuals exposed to contaminated soil may experience symptoms such as headaches, nausea, fatigue and eye irritation. This contamination is often caused by exposure to hazardous chemicals and heavy metals that can enter the body through inhalation or direct skin contact. In addition, skin diseases such as rashes can also result from contact with soil contaminated with certain chemicals. If left untreated, these short-term exposures can develop into more serious health problems.

In the long term, soil pollution can increase the risk of various chronic diseases. Repeated exposure to toxic substances such as arsenic and mercury has been shown to contribute to the development of cancer, including leukemia and other organ cancers. In addition, damage to vital organs such as the kidneys and liver may also result from the accumulation of heavy metals in the body. Disorders of

the nervous system, including neuromuscular blockages and nerve damage, pose a serious threat to public health, especially for children who are more vulnerable to the adverse effects of soil pollution. Thus, soil pollution is not only an environmental issue but also a major public health challenge that needs to be addressed urgently.

CONCLUSIONS

The use of pesticides in agriculture does have a significant impact on human health, both in the short and long term. Therefore, it is very important to implement effective control measures to reduce pesticide contamination and protect public health. In addition, efforts to restore soil fertility should also be a major focus, considering that the health of sustainable agricultural ecosystems contributes to the productivity and welfare of farmers. By integrating safer and more environmentally friendly agricultural practices, we can create a healthier environment for humans and nature, and ensure the sustainability of agricultural resources in the future.

Author contributions

Mimin Indriani Mulia: Conceptualization, analysis, writing draf, and editing.

Conflict of Interest

There is no conflict of interest in this study.

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Data availability

Data related to the findings of this study are available at the corresponding author.

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