Hort4EUGreen

Strategic Partnership No. 2020-1-RO01-KA203-080398

SUSTAINABLE USE OF PESTICIDES AND THEIR RESIDUES MONITORING

Hazard classification related to pesticides

Volume 2

University of Agronomic Sciences and Veterinary Medicine of Bucharest

ЛЕСОТЕХНИЧЕСКИ УНИВЕРСИТЕТ

MATE

EDITURA EX TERRA AURUM · U.S.A.M.V. BUCUREŞTI

Erasmus+

Bucharest, 2025

Hort4EUGreen

Strategic Partnership No. 2020-1-RO01-KA203-080398

CONTRIBUTORS

USAMV

University of Agronomic Sciences and Veterinary Medicine of Bucharest

Liliana BĂDULESCU
Roxana CICEOI
Monica BADEA
Ionuț Silviu BEIA
Oana-Crina BUJOR
Violeta Alexandra ION
Marian MUȘAT

Editing
Oana VENAT
Elena IVAN

University of Forestry

ЛЕСОТЕХНИЧЕСКИ УНИВЕРСИТЕТ

Rumen TOMOV

ISBN 978-606-072-468-1
ISBN 978-606-072-470-4

Bucharest, 2025

Hort4EUGreen

Strategic Partnership No. 2020-1-RO01-KA203-080398

"Enhancing practical skills of horticulture specialists to better address the demands of the European Green Deal"

Bucharest, 2025

Table of Content

Volume 2.
Introduction

Pesticides, encompassing a broad spectrum of chemical and biological agents such as herbicides, insecticides, fungicides, and rodenticides, are crucial in modern agriculture and public health. Their primary purpose is to control various pests and diseases that affect crops and, by extension, food security and public health. However, the extensive use of pesticides raises significant concerns regarding their impact on human health and the environment.

The diverse chemical properties and modes of action of pesticides necessitate a comprehensive understanding of their potential hazards. Hazard classification of pesticides is a critical process that evaluates the risks posed by these chemicals to humans and the environment. This classification is pivotal for the safe handling, use, and regulation of pesticides.

The need for hazard classification is underscored by the dual nature of pesticides as both beneficial for pest control and potentially harmful. The World Health Organization (WHO) and other regulatory bodies have established criteria for classifying pesticides based on their toxicity levels, environmental persistence, and potential for bioaccumulation (World Health Organization, 2009).

These criteria play a vital role in guiding regulatory actions and informing users about the risks associated with different pesticides.

The growing awareness of the adverse effects of pesticides, such as acute and chronic toxicity, ecological disruption, and the development of pesticide resistance, has led to the evolution of regulatory frameworks and safety standards globally. This includes initiatives like the Stockholm Convention on Persistent Organic Pollutants, which aim to eliminate or restrict the production and use of the most hazardous pesticides (Stockholm Convention, 2001).

This chapter aims to delve into the principles of hazard classification, types of pesticide hazards, acute and chronic toxicity, classification by hazard or risk, exposure, pesticide residues in food and occupational safety. It seeks to provide a comprehensive understanding of how pesticides are classified based on their hazards and the global efforts to manage these risks for the safety of both humans and the environment.

Learning outcome descriptors

By the end of the module, the trainees should be able to prove their knowledge on hazard classification, types of pesticide hazards, acute and chronic toxicity, classification by hazard or risk, exposure, pesticide residues in food and occupational safety.

General and transferable skills

1	Analyzing and evaluating different hazards related to pesticides
2	Understanding the notions and importance of acute and chronic toxicity
3	Continually updating knowledge and skills in manipulating the pesticides safely both for the operator and for the produced food
4	Understand the guidelines to minimize health risks and ensure a safe working environment for individuals who work with pesticides.

Knowledge, understanding and professional skills

1	Understanding various risks related to pesticides exposure
2	Ability to make informed decisions regarding the choice of pesticide products and their active substances according to the destination of treated crop and national and international regulations
3	Deep understanding of the importance of knowing classes of pesticides and their mode of action

Unit 2.1 Acute and chronic toxicity

Liliana Bădulescu, Roxana Ciceoi,
Violeta Alexandra Ion, Oana-Crina Bujor

In the current agricultural landscape, pesticides play a critical role in ensuring crop protection and enhancing food security. However, their usage is accompanied by potential risks to human health and the environment. The importance of understanding pesticide hazards, therefore, cannot be overstated, as it is crucial for the development of safe agricultural practices and effective environmental policies. While pesticides primary function is to increase agricultural productivity, the inadvertent consequences of their use have raised significant concerns. Pesticides can have acute and chronic effects on human health, including respiratory problems, neurological disorders, and even carcinogenic risks (Alavanja, 2009). Moreover, pesticides can negatively impact non-target species, leading to biodiversity loss and ecological imbalances (Pimentel, 2005). The toxicological assessment of pesticides involves understanding their mechanism of action, dose-response relationships, and exposure pathways. Pesticides can exhibit varying degrees of toxicity depending on their chemical structure and the target organism. For instance, organophosphate insecticides inhibit acetylcholinesterase, leading to neurological dysfunction (Costa, 2018). Assessing these risks requires comprehensive toxicological studies, including both in vivo and in vitro models, to establish safe exposure levels.

The environmental impact of pesticides extends beyond the target pests. Pesticides can persist in the environment, contaminating soil and water bodies, and thereby affecting a wide range of non-target organisms. The phenomenon of bioaccumulation, where pesticides accumulate in the tissues of organisms, can lead to detrimental effects up the food chain (Ray & Shaju 2023). The authors noted that pesticides applied to crops often migrate to aquatic ecosystems, where they are commonly broken down and accumulate in the food chains of these environments, eventually making their way to human consumers. These substances, absorbed by fish, ascend through the food chain, leading to detrimental health effects in humans upon ingestion. The drift of pesticides into aquatic habitats results in chemical pollution, leading to persistent adverse impacts. Exposure to pesticides and synthetic chemicals in humans has been associated with various health issues, including cancer, obesity, endocrine disruption, and other disorders (Ray & Shaju 2023).

Globally, every year, approximately 3 billion kg of pesticides are used which budgets around 40 billion USD.

Additionally, the widespread use of pesticides has been linked to the decline of pollinator populations, which are crucial for ecosystem health and agriculture (Goulson, 2014).

Acute toxicity of pesticides

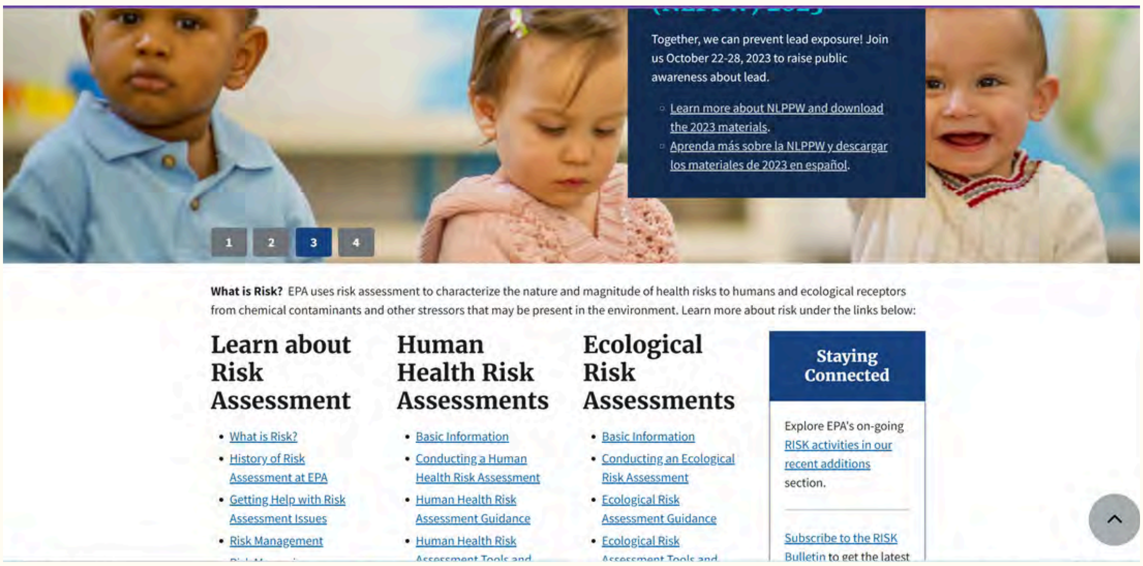
Acute toxicity refers to the adverse effects that occur following ***a single exposure or multiple exposures to a pesticide over a short period***. These effects are often immediate or appear within hours or days after exposure. The severity of acute toxicity depends on the dose and the inherent toxicity of the pesticide. Common symptoms include skin and eye irritation, nausea, dizziness, and in severe cases, respiratory distress or death. Organophosphate pesticides, for example, can cause acute neurotoxic effects due to their mechanism of action on the nervous system (Eddleston et al., 2008).

Chronic toxicity of pesticides

Chronic toxicity results from prolonged or repeated exposure to a pesticide over a longer period, typically months or years. This type of toxicity can lead to long-term health effects that may not be immediately apparent. Chronic exposure to certain pesticides has been linked to serious health issues, including cancer, endocrine disruption, reproductive and developmental problems, and neurological disorders (Alavanja et al., 2004). Unlike acute toxicity, the effects of chronic exposure are subtle and often require epidemiological studies to establish causation.

Understanding and differentiating between acute and chronic toxicity is crucial for risk assessment and regulatory decision-making. Regulatory agencies like the Environmental Protection Agency (EPA) in the United States establish safety standards for pesticide use, taking into account both acute and chronic toxicity levels (EPA, 2017). These standards are designed to protect public health by ensuring that the exposure to pesticides does not pose significant ***risks***, either in the short or long term. EPA defines the ***risk*** as the probability of adverse effects on human health or ecological systems due to exposure to environmental *stressors*.

A *stressor* refers to any biological, chemical, or physical factor that can cause negative impacts on human health or ecosystems. These stressors can harm specific natural resources or entire ecosystems, encompassing flora, fauna, and their surrounding environments.



Learn more about EPA Risk Assessment

The distinction between acute and chronic toxicity in pesticide exposure underscores the complexity of assessing and managing the risks associated with pesticide use. Both types of toxicity present significant health risks, necessitating careful consideration in the regulation and application of pesticides. Ongoing research and vigilance are essential to protect public health and ensure that the benefits of pesticide use in agriculture do not come at an unacceptable cost to human health.

Acute toxicity it is a critical aspect of pesticide safety and regulation, as it helps in understanding the immediate health risks associated with pesticide exposure. Usually, the *measurement* of the acute effect is done by assessing **LD 50** (lethal dose, 50%), which is the dose required to kill half the members of a tested population after a specified test duration.

Pesticide that induce acute toxicity have several specific mechanisms of action:

*Neurotoxicity***.** Many pesticides, such as organophosphates and carbamates, exert toxic effects by disrupting the normal function of the nervous system. For instance, they may inhibit acetylcholinesterase, an enzyme essential for nerve function.

Respiratory and dermal toxicity. Pesticides can cause irritation or damage to the respiratory tract and skin upon inhalation or direct contact.

The symptoms of acute pesticide poisoning are immediate, including dizziness, nausea, headaches, skin and eye irritation, and respiratory distress. In severe cases, acute toxicity can lead to convulsions, unconsciousness, and in extreme cases, death.

Among the factors influencing acute toxicity, the most important are the chemical nature of the pesticide, the route of exposure and the dose and duration of exposure. The higher doses and prolonged exposures increase the severity of the toxic effect.

The main routes of exposure for acute toxicity are:

- inhalation,
- ingestion,
- dermal contact.

The prevention and treatment of such effect is best done by a safe handling and usage. The indications are usually on the label and must be strictly followed. For those using such substances, the personal protective equipment can reduce the risk of acute exposure. In case of poisoning, the treatment involves immediate medical attention, with treatments specific to the type of pesticide and exposure.

On the other side, the chronic pesticide poisoning, that results from prolonged or repeated exposure to pesticides over an extended period, manifests through a diverse array of symptoms affecting various organ systems. The clinical presentation is often nonspecific, making diagnosis challenging.

Chronic toxicity refers to the adverse health after an exposure at low or sub-lethal levels. This fact is crucial in the field of pesticide regulation as it addresses the potential long-term health risks that may not be immediately apparent after short-term or acute exposure.

The *measurement* of chronic toxicity is a long a laborious process and may consist of:
(1) toxicological studies, that involve long-term animal studies, consisting in exposing animals to a pesticide over a significant portion of their lifespan to observe adverse effects.
(2) exposure biomarkers can include alterations in blood chemistry, hormone levels, or enzyme activities and they are used to assess exposure levels and early biological effects.
(3) epidemiological studies consist in observing different populations with long-term pesticide exposure, in order link the exposure patterns to health outcomes over time.
(4) Threshold Limit Values (TLVs) are used by the regulatory agencies to specify the level of exposure that is believed to be safe over a working lifetime.

(5) No-Observed-Adverse-Effect Level (NOAEL) and Lowest-Observed-Adverse-Effect Level (LOAEL) are determined from animal studies. NOAEL is the highest dose at which no adverse effects are observed, while LOAEL is the lowest dose at which adverse effects are observed. These values are critical for risk assessment and setting regulatory limits.

All these measurements are extremely important in pesticide safety and regulation for:
-risk assessment and regulation, as the chronic toxicity data are vital for regulatory agencies in setting safety standards, including permissible exposure limits, to protect public health and the environment. This data helps in determining the acceptable daily intake (ADI) levels for various pesticides.
-labeling and usage guidelines, in order to develop appropriate labeling and usage instructions that keep the users away and aware of potential long-term risks.
-environmental impact assessments, that shows the long-term effects of pesticides on non-target species and ecosystems.

The key symptoms associated with chronic toxicity can be:
(1) *neurological*, especially in the case of organophosphates and organochlorines. Symptoms may include neuropathies, characterized by tingling, numbness, and weakness in extremities, as well as neurobehavioral changes such as memory loss, mood disorders, and decreased cognitive function, which are often irreversible (Costa, 2015; Colosio et al., 2003).

(2) *respiratory,* like chronic bronchitis, reactive airway disease, and impaired pulmonary function. The respiratory effects are primarily due to the inhalation of pesticide aerosols, dust, or vapors, leading to irritation or damage to the respiratory tract (Hoppin et al., 2017).

(3) *dermatological, as* dermatitis, eczema, and photosensitivity. Pesticides can act as irritants or sensitizers, leading to allergic reactions or chronic skin disorders (Damalas et al., 2016).

(4) *gastrointestinal*, as chronic gastrointestinal disturbances, which may include nausea, chronic gastritis, and disruptions in bowel habits. Pesticides may disrupt the gut microbiota, leading to gastrointestinal symptoms (Giambo et al, 2021; Gama et al., 2022; FAO, 2023, Abou Diwan et al, 2023).

(5) *reproductive and endocrine disruption*, inducing reduced fertility, menstrual disorders, and adverse pregnancy outcomes. Pesticides can mimic or block hormones, leading to endocrine disruption (Mostafalou et al., 2018).

(6) *immunological effects*, as increased susceptibility to infections and possibly autoimmune diseases. The immunotoxic effects of pesticides include altered immune function and hypersensitivity reactions (Corsini et al., 2013).

(7) oncological risks, with increased risk of certain cancers, such as leukemia, lymphoma, and prostate cancer. The carcinogenic potential of pesticides is a subject of ongoing research, with evidence suggesting that some pesticides can act as carcinogens or tumor promoters (Bassil et al., 2007).

(8) *psychiatric*, as depression and anxiety (Parrón et al., 2014).

REFERENCES

Abou Diwan M, Lahimer M, Bach V, Gosselet F, Khorsi-Cauet H, Candela P. Impact of Pesticide Residues on the Gut-Microbiota–Blood–Brain Barrier Axis: A Narrative Review. International Journal of Molecular Sciences. 2023; 24(7):6147. https://doi.org/10.3390/ijms24076147

Alavanja M. C. (2009). Introduction: pesticides use and exposure extensive worldwide. Reviews on environmental health, 24(4), 303–309. https://doi.org/10.1515/reveh.2009.24.4.303,

Alavanja, M. C., Hoppin, J. A., & Kamel, F. (2004). Health effects of chronic pesticide exposure: cancer and neurotoxicity. Annual review of public health, 25, 155–197. https://doi.org/10.1146/annurev.publhealth.25.101802.123020,

Bassil, K. L., Vakil, C., Sanborn, M., Cole, D. C., Kaur, J. S., & Kerr, K. J. (2007). Cancer health effects of pesticides: systematic review. Canadian family physician Medecin de famille canadien, 53(10), 1704–1711.

Costa L. G. (2006). Current issues in organophosphate toxicology. Clinica chimica acta; international journal of clinical chemistry, 366(1-2), 1–13. https://doi.org/10.1016/j.cca.2005.10.008

Costa L. G. (2018). Organophosphorus Compounds at 80: Some Old and New Issues. Toxicological sciences : an official journal of the Society of Toxicology, 162(1), 24–35. https://doi.org/10.1093/toxsci/kfx266,

Colosio, C., Tiramani, M., & Maroni, M. (2003). Neurobehavioral effects of pesticides: state of the art. Neurotoxicology, 24(4-5), 577–591. https://doi.org/10.1016/S0161-813X(03)00055-X,

Corsini, E., Sokooti, M., Galli, C. L., Moretto, A., & Colosio, C. (2013). Pesticide induced immunotoxicity in humans: a comprehensive review of the existing evidence. Toxicology, 307, 123–135. https://doi.org/10.1016/j.tox.2012.10.009

Damalas CA, Koutroubas SD. Farmers' Exposure to Pesticides: Toxicity Types and Ways of Prevention. Toxics. 2016; 4(1):1. https://doi.org/10.3390/toxics4010001

EPA, (2017). Pesticide Registration Manual: Chapter 13 – Risk Assessment.

Eddleston, M., Buckley, N. A., Eyer, P., & Dawson, A. H. (2008). Management of acute organophosphorus pesticide poisoning. The Lancet, 371(9612), 597–607. doi:10.1016/s0140-6736(07)61202-1,

FAO. 2023. The impact of pesticide residues on the gut microbiome and human health – A food safety perspective. Food Safety and Quality Series, No. 19. Rome. https://doi.org/10.4060/cc5306en,

Gama, J., Neves, B., & Pereira, A. (2022). Chronic Effects of Dietary Pesticides on the Gut Microbiome and Neurodevelopment. Frontiers in microbiology, 13, 931440. https://doi.org/10.3389/fmicb.2022.931440,3), Giambò, F., Teodoro, M., Costa, C., & Fenga, C. (2021). Toxicology and Microbiota: How Do Pesticides Influence Gut Microbiota? A Review. International journal of environmental research and public health, 18(11), 5510. https://doi.org/10.3390/ijerph18115510

Goulson D. (2014). Ecology: Pesticides linked to bird declines. Nature, 511(7509), 295–296. https://doi.org/10.1038/nature13642,

Hoppin, J. A., Umbach, D. M., Long, S., Rinsky, J. L., Henneberger, P. K., Salo, P. M., Zeldin, D. C., London, S. J., Alavanja, M. C., Blair, A., Beane Freeman, L. E., & Sandler, D. P. (2014). Respiratory disease in United States farmers. Occupational and environmental medicine, 71(7), 484–491. https://doi.org/10.1136/oemed-2013-101983

Pimentel, D. (2005). Environmental and Economic Costs of the Application of Pesticides Primarily in the United States. Environ Dev Sustain 7, 229–252, . https://doi.org/10.1007/s10668-005-7314-2,

Mostafalou, S., & Abdollahi, M. (2013). Pesticides and human chronic diseases: evidences, mechanisms, and perspectives. Toxicology and applied pharmacology, 268(2), 157–177. https://doi.org/10.1016/j.taap.2013.01.025

Ray, S., & Shaju, S. T. (2023). Bioaccumulation of pesticides in fish resulting toxicities in humans through food chain and forensic aspects. Environmental analysis, health and toxicology, 38(3), e2023017. https://doi.org/10.5620/eaht.2023017

Giambò, F., Teodoro, M., Costa, C., & Fenga, C. (2021). Toxicology and Microbiota: How Do Pesticides Influence Gut Microbiota? A Review. International journal of environmental research and public health, 18(11), 5510. https://doi.org/10.3390/ijerph18115510

Unit 2.2 Classification by hazard or risk

Roxana Ciceoi, Liliana Bădulescu,
Marian Mușat

Pesticides are classified according to their hazard or risk, to ensure safe usage and minimize environmental impact. This classification is vital for understanding the potential dangers associated with different pesticides and for implementing appropriate safety measures.

Hazard vs. Risk Classification

The classification of pesticides by hazard refers to the inherent properties of a pesticide that could cause harm, such as toxicity, flammability, or environmental persistence. This classification is based on the chemical's physical, chemical, and toxicological properties.
The classification of pesticides by risk considers the likelihood of these hazards causing harm under specific conditions of use. This includes factors like exposure levels, application methods, and environmental considerations.

``EFSA is the keystone of EU risk assessment regarding food and feed safety. In close collaboration with national authorities and in open consultation with its stakeholders, EFSA provides independent scientific advice and clear communication on existing and emerging risks.``

A shark in the seas is a

Swimming with a shark is a

See more on www.efsa.europa.eu/en/discover/infographics/hazard-vs-risk

Toxicity Classifications

One common method of classifying pesticides is by their *level of toxicity to humans and non-target organisms*.

The World Health Organization (WHO) and the Environmental Protection Agency (EPA) categorize pesticides into different classes based on acute toxicity levels. For example, Class I pesticides are extremely or highly hazardous, requiring stringent safety measures, while Class IV includes those that are slightly hazardous.

Pesticides are also classified based on their *environmental impact*. This includes their potential for bioaccumulation, persistence in the environment, and effects on non-target species like bees, fish, and birds. Pesticides that are highly persistent and bioaccumulative are considered more hazardous to the environment.

Another classification system is based on the *mode of action*, which describes how the pesticide affects the target pest. Grouping pesticides by their mode of action helps in managing pesticide resistance as it allows for effective rotation and combination of pesticides to prevent pests from developing resistance.

Regulatory agencies classify pesticides to determine their registration, labeling, and usage requirements. This classification often **combines aspects of toxicity, environmental impact, and usage** patterns.

For example, restricted-use pesticides are those deemed to have a higher risk and their purchase and application are limited to certified applicators or those under their direct supervision. They are classified by regulatory authorities like the U.S. Environmental Protection Agency (EPA) or by the European Food Safety Authority (EFSA) and the European Chemicals Agency (ECHA), in collaboration with national regulatory authorities of member states in Europe.
Examples vary based on the jurisdiction and specific regulatory criteria, but some common examples include:

Paraquat, a highly toxic herbicide used for weed and grass control. Due to its acute toxicity and potential for causing severe health problems upon ingestion or exposure. Poisoning by paraquat herbicide is still (Jayavardhan et al, 2023) a major medical problem in parts of Asia, leading to pneumonitis and lung fibrosis and renal and liver injury (Gawarammana and Buckley 2011).

Atrazine, is an herbicide used primarily for weed control in corn crops. Atrazine is restricted due to concerns about its potential to contaminate groundwater and its possible endocrine-disrupting effects. Recently it was found that even adding stable manure, atrazine was added within agricultural soils (Tuncel et al., 2023).

Methomyl is a carbamate insecticide used on a variety of crops, still found in vegetables (Almutiriy et al., 2023). It is highly toxic to humans, wildlife, and bees, necessitating its classification as a restricted-use pesticide.

Aldicarb: A systemic insecticide and nematicide known for its high toxicity to humans and wildlife, particularly through groundwater contamination.

2,4-Dichlorophenoxyacetic acid (2,4-D): While many formulations of 2,4-D are available for general use, certain formulations with higher concentrations or specific application methods are classified as restricted-use to mitigate risks of drift and non-target exposure.

Chlorpyrifos: An organophosphate insecticide used on various crops, turf, and in non-agricultural settings. Its use is restricted due to concerns about neurological effects, especially in children.

Mancozeb: A fungicide used in agriculture. Some formulations are restricted due to concerns about its role as a potential carcinogen and its environmental impact.

It's important to note that the classification and availability of these pesticides can change based on ongoing regulatory reviews and emerging scientific evidence. Always refer to the latest guidelines and regulations from relevant authorities in your region for up-to-date information. Certified applicators are trained to handle these substances safely, understanding the risks and necessary precautions associated with their use.

Classification by hazard

Pesticides are classified by hazard to assess and communicate the risks they pose to human health, non-target organisms, and the environment.

The most common hazards includes:

(1) **Toxicity levels,** determined through laboratory tests, which can be acute or chronic (see previous). The World Health Organization (WHO) and the Environmental Protection Agency (EPA) categorize pesticides into different toxicity classes, from extremely hazardous to slightly hazardous. The WHO Recommended Classification of Pesticides by Hazard and the guidelines to classification ar available at https://www.who.int/publications/i/item/9789240005662 (WHO, 2019).

(2) **Carcinogenicity**, according to the he International Agency for Research on Cancer (IARC) and the EPA recommendations.

(3) **Teratogenicity** and reproductive effects, determine other classification, crucial for pregnant women and those of reproductive age.

(4) **Environmental impact** determine the classification according to the potential for bioaccumulation, persistence in the environment, and toxicity to non-target species like beneficial insects, birds, fish, and other wildlife. Pesticides with high environmental risks are classified as more hazardous.

(5) **Physical hazards**, for the pesticides that are flammable, explosive, or reactive.

F(6) **Mode of action, r**efers to how they affect target pests, for example, as neurotoxins, growth regulators, or respiratory inhibitors. Understanding the mode of action is important for managing resistance and for safety considerations.

(7) C**hemical family:** depends on chemical structure (family), such as organophosphates, carbamates, or pyrethroids, Different chemical families often have similar properties, toxicity profiles, and antidotes in case of poisoning.

On pesticide labels, signal words like "Danger," "Warning," or "Caution" are used based on the product's acute toxicity. "Danger" indicates the highest toxicity level, while "Caution" represents the lowest.

Classification by risk

The classification of pesticides by risk involves evaluating the likelihood and severity of harm occurring under specific conditions of use. This risk-based approach considers both the inherent hazards of the pesticide and the exposure to it.

Key factors in risk classification include:

(1) **Exposure level** according to the frequency, duration, and concentration of exposure to the pesticide. This includes occupational exposure for farmers or applicators, as well as potential exposure to consumers through residues in food.

(2) **Environmental exposure**, referring to the potential for a pesticide to contaminate soil, water, and air, as well as its impact on non-target organisms, including beneficial insects, birds, and aquatic life.

(3) **Usage patterns,** referring to where a pesticide is used , fact that significantly affects its risk profile. For example, a pesticide used in large-scale agricultural settings may have a different risk classification than when used in home gardens.

(4) **Vulnerability of populations**, as children, pregnant women, the elderly, and those with compromised immune systems, might be more vulnerable to pesticide exposure. The risk classification considers these sensitivities.

(5) **Mitigation measures** may lead to a different categorization, such as protective equipment, application methods, and buffer zones.

(6) **Residue levels** in food, based on the quantity of pesticide residues found in food and their compliance with established safety standards.

(7) **Cumulative and synergistic effects**, as these interactions, can alter the overall risk profile.

(8) **Resistance development** can lead high attention regarding the increased use of chemicals or the need for more potent alternatives.

This risk-based approach ensures that pesticides are used safely and effectively, minimizing potential harm to human health and the environment.

The classification of pesticides by hazard and risk is crucial for ensuring their safe and effective use. It assists in the appropriate selection and application of pesticides, the protection of human health, and the minimization of environmental impact. As our understanding of pesticides and their impacts evolves, these classification systems are continually refined to reflect the latest scientific knowledge and regulatory standards. Understanding these classifications is essential for everyone involved in pesticide use, from manufacturers and regulators to applicators and farmers.

References

Gawarammana, I. B., & Buckley, N. A. (2011). Medical management of paraquat ingestion. British journal of clinical pharmacology, 72(5), 745–757. https://doi.org/10.1111/j.1365-2125.2011.04026.x

Korukonda Jayavardhan, M.Shanthi, C.Ganesh, Divya.V.C, Somana Boyana Vyshnavi, Shreya Gupta, (2023). Deadly Weed Killer: A Case Report . (2023). Boletin De Literatura Oral - The Literary Journal, 10(1), 3661-3666, https://www.boletindeliteraturaoral.com/index.php/bdlo/article/view/725,

Tuncel M.E., Umit Yildiz, Yusuf Uras, Gokce Akyol, Cafer Ozkul & Nihat Hakan Akyol (2023). Sorption and transport of atrazine for stable manure-amended agricultural soil from Kahramanmaraş, Turkey, Soil and Sediment Contamination: An International Journal, DOI: 10.1080/15320383.2023.2296527,

Almutiriy, R.S., Alnajeebi, A.M., Elhalwagy, M.E.A. et al. Investigation of pesticide residues level on commonly consumed leafy vegetables picked from the central market in Jeddah, Saudi Arabia. Environ Sci Pollut Res (2023). https://doi.org/10.1007/s11356-023-31694-z

Hort4EUGreen

Unit 2.3 Exposure

Liliana Bădulescu, Roxana Ciceoi,
Rumen Tomov

Exposure to pesticides refers to the contact that occurs between a person or an environment and a pesticide.

Exposure to pesticides is a critical public health and environmental issue, given the widespread use of these chemicals in agriculture, pest control, and various other settings. Understanding the nature, routes, and impacts of pesticide exposure, as well as strategies for risk mitigation, is essential for ensuring safety and minimizing potential hazards.

An analysis of the chemical registers from 19 countries and regions indicates that approximately 350,000 chemical substances have been documented for large-scale production and usage in the last three to four decades. Each year, around 700 new chemicals are formally incorporated into the inventory of the US Toxic Substances Control Act (TSCA). Concurrently, since 2009, the European Chemicals Agency has been registering roughly 1700 chemicals annually, encompassing both new and existing substances, under the framework of Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) (Derek et al, 2023).
The primary routes of exposure are dermal (skin contact), inhalation, ingestion, and ocular (eye contact) (WHO, 2019).

Each route poses different risks and necessitates distinct protective measures. For instance, dermal exposure, the most common route, can occur through handling pesticides or contacting treated surfaces (National Pesticide Information Center, 2020).

Farmers, agricultural workers, and pest control professionals are particularly at risk due to their close and frequent contact with pesticides. Studies have shown that occupational exposure can lead to acute health effects like skin irritation, respiratory problems, and neurotoxic symptoms (Alavanja et al., 2004). Beyond occupational settings, individuals can be exposed to pesticides in their homes or communities, particularly in agricultural areas where pesticides might drift from fields or contaminate water sources (U.S. Environmental Protection Agency, 2020). Residues on fruits and vegetables also present ingestion exposure risks (Pesticide Action Network North America, 2019).

Dermal absorption

Contact with the skin is the most common path of toxic substance exposure, by three skin layers.

The epidermis, particularly its outer stratum corneum, plays a key role in determining absorption rates. For instance, Malathion rapidly penetrates this layer and is quickly absorbed into the bloodstream, unlike DDT, which absorbs more slowly.

The dermis, or inner skin layer, provides nutrients to the epidermis and contains hair follicles and glands, which minimally contribute to absorption.

The subcutaneous fatty tissue acts as a cushion and allows skin flexibility.

The factors influencing the skin's absorption of toxic substances include the skin's condition, the chemical properties of the substance, and the concentration and duration of exposure. An unbroken stratum corneum acts as a barrier, but damaged skin allows easier penetration. Inorganic substances and water-based organic chemicals are poorly absorbed by intact skin, while organic solvents are more readily absorbed. Higher concentrations of a toxic substance or prolonged exposure generally increase absorption rates.

Absorption by inhalation

Contact by inhalation is a very quick and efficient way for toxic substances to enter the body, as the respiratory tract's lining doesn't effectively block absorption. The respiratory system, including the nasal passages, trachea, larynx, and lungs, plays a crucial role in this process. Factors influencing inhalation toxicity include the air's toxic substance concentration, the substance's solubility in blood and tissue, the rate of breathing, exposure duration, the respiratory tract's condition, and the size of the toxic particles.

Absorption by ingestion

Ingestion of pesticides is often accidental, involves consuming toxic substances through the digestive system, which includes the mouth, esophagus, stomach, and intestines. This system's main role is to digest and absorb food. The absorption of toxins is influenced by the body's structure and how long the substance stays in the system. Once absorbed, a chemical's effects are determined by its concentration in organs, its form, metabolic changes it undergoes, and its duration in tissues. After entering the bloodstream, it can be distributed throughout the body, moved between tissues (translocation), or transformed into a new compound (biotransformation).

Other types of exposure are by **the eye**, especially the ***cornea***, is a frequent site for toxic substance contact. Acids and bases typically cause damage, with the cornea's ability to self-repair depending on the extent of harm. Eye compartments contain aqueous and vitreous humor, vital for nutrient and oxygen diffusion to the cornea for tissue repair.

Injections are also a notable exposure route, in laboratory studies on animals.

Exposure types, depending on the time period includes:

(1) Acute (exposure to a chemical for no more than 24 hours),

(2) Chronic (exposure for over 3 months),

(3) Sub-acute (exposure up to 1 month),

(4) Sub-chronic (exposure lasting 1 to 3 months).

Excretion of toxins

The rate at which toxins are excreted from the body is crucial in determining their toxic effect. Toxins that linger longer in the body pose a greater risk of causing damage.

The primary excretion route is through *urine*, facilitated mainly by the kidneys. The kidneys play the most significant role in toxin elimination.

Additionally, the *lungs* expel gaseous substances like carbon dioxide, while the *liver* processes and eliminates substances such as lead or DDT into bile, which eventually leaves the body via feces.

Other minor excretion pathways include the *skin, hair*, and *breast milk*, although they are less significant compared to the primary organs of excretion.

In a case study using carbaryl, a commonly used carbamic insecticide that inhibits acetylcholinesterase, it was found that during biotransformation, the pathway that highlights how carbaryl is excreted from the human body, the carbaryl's metabolites are more toxic than the pesticide itself, particularly in causing acute oral, reproductive, and mitochondrial damage, while fewer metabolites were nephrotoxic, hepatotoxic, and carcinogenic, but none showed higher mutagenicity than carbaryl itself (Hernández-Valdez, 2023).

Alavanja, M. C., Hoppin, J. A., & Kamel, F. (2004). Health effects of chronic pesticide exposure: cancer and neurotoxicity. Annual review of public health, 25, 155–197. https://doi.org/10.1146/annurev.publhealth.25.101802.123020,

Hernández-Valdez, Jazmín and Sánchez-Meza, Juan Carlos and Velázquez-Zepeda, Aldo, In Silico Analysis of the Degradation Metabolites Toxicity and Biotransformation Pathway of Carbaryl in Humans. Available at SSRN: https://ssrn.com/abstract=4487402 or http://dx.doi.org/10.2139/ssrn.4487402

Unit 2.4 Pesticide residues in food

Liliana Bădulescu, Oana-Crina Bujor, Violeta Alexandra Ion, Monica Badea, Ionuț Silviu Beia

Pesticide residues in food are a significant concern due to their potential impact on human health. These residues result from the use of pesticides in agriculture to control pests and diseases in crops. The levels and types of residues found in food depend on factors like the pesticide's properties, application methods, and environmental conditions. Regulatory bodies worldwide, such as the US Environmental Protection Agency (EPA) and the European Food Safety Authority (EFSA), set maximum residue limits (MRLs) to ensure food safety. Studies have shown that long-term exposure to certain pesticide residues can pose health risks, including developmental and neurological effects.

A maximum residue level (MRL) is the highest level of a pesticide residue that is legally tolerated in or on food or feed when pesticides are applied correctly, following the good agricultural practice. This standard ensures that any pesticide residues present in food items are within safe limits for consumption, protecting consumer health. MRLs are established based on thorough scientific evaluation and are a key aspect of food safety regulations.

Hort4EUGreen

Under European Union legislation (Article 32, Regulation (EC) No 396/2005), the EFSA provides an annual report which examines pesticide residue levels in foods on the European market. This report is based on data from the official national control activities carried out by EU Member States, Iceland and Norway and includes a subset of data from the EU-coordinated control programme, which uses a randomised sampling strategy.

For 2020, 94.9% of the overall 88,141 samples analysed fell below the maximum residue level (MRL), 5.1% exceeded this level, of which 3.6% were non-compliant, i.e. samples exceeding the MRL after taking the measurement uncertainty into account. For the subset of 12,077 samples analysed as part of the EU-coordinated multiannual control programme, 1.7% exceeded the MRL and 0.9% were non-compliant.

"Take a look at the report! Your health is at stake!"

SCIENTIFIC REPORT

EFSA Journal

ADOPTED: 24 February 2022

doi: 10.2903/j.efsa.2022.7215

The 2020 European Union report on pesticide residues in food

European Food Safety Authority (EFSA),
Luis Carrasco Cabrera and Paula Medina Pastor

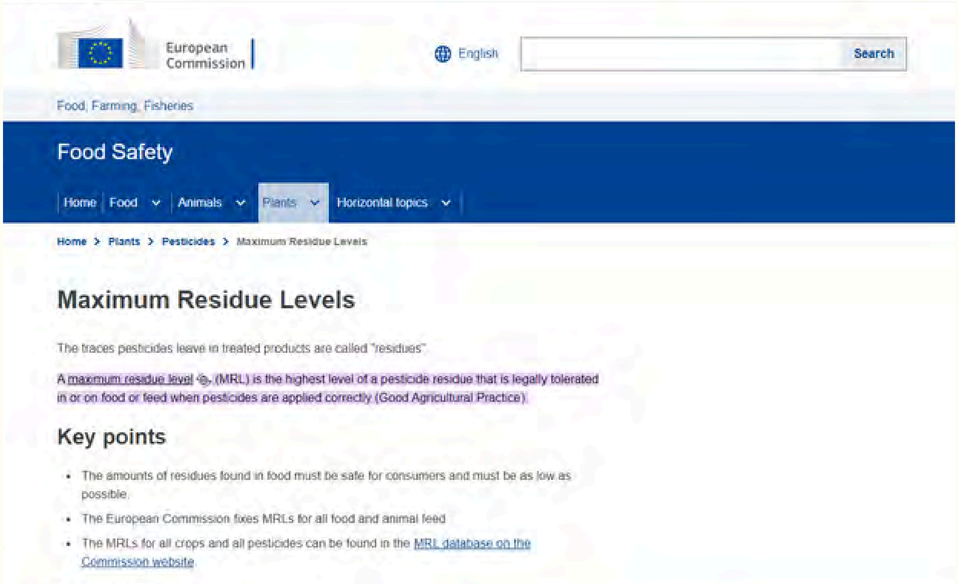
Abstract

Under European Union legislation (Article 32, Regulation (EC) No 396/2005), the EFSA provides an annual report which examines pesticide residue levels in foods on the European market. This report is based on data from the official national control activities carried out by EU Member States, Iceland and Norway and includes a subset of data from the EU-coordinated control programme, which uses a

To assess acute and chronic risk to consumer health, dietary exposure to pesticide residues is estimated and compared with health-based guidance values. Dietary exposure to pesticides for which health-based guidance values were available is unlikely to pose a risk to EU consumer health. In the rare cases where dietary exposure for a specific pesticide/product combination was calculated to exceed the health-based guidance value, and for those pesticides for which no health-based guidance value could be established, the competent authorities took appropriate and proportionate corrective measures to address potential risks to consumers.
Recommendations are proposed to increase the effectiveness of European control systems, thereby continuing to ensure a high level of consumer protection throughout the EU.

Key points:

- The amounts of residues found in food must be safe for consumers and must be as low as possible.
- The European Commission fixes MRLs for all food and animal feed
- The MRLs for all crops and all pesticides can be found in the MRL database on the Commission website.


European Commission

English Search

Food, Farming, Fisheries

Food Safety

Home | Food | Animals | Plants | Horizontal topics

Home > Plants > Pesticides > Maximum Residue Levels

Maximum Residue Levels

The traces pesticides leave in treated products are called "residues".

A maximum residue level (MRL) is the highest level of a pesticide residue that is legally tolerated in or on food or feed when pesticides are applied correctly (Good Agricultural Practice).

Key points

- The amounts of residues found in food must be safe for consumers and must be as low as possible.
- The European Commission fixes MRLs for all food and animal feed.
- The MRLs for all crops and all pesticides can be found in the MRL database on the Commission website.

Visit Food, Farming, Fisheries Commission for more on MRL!

Source here

Source here

Ways to avoid residues in food

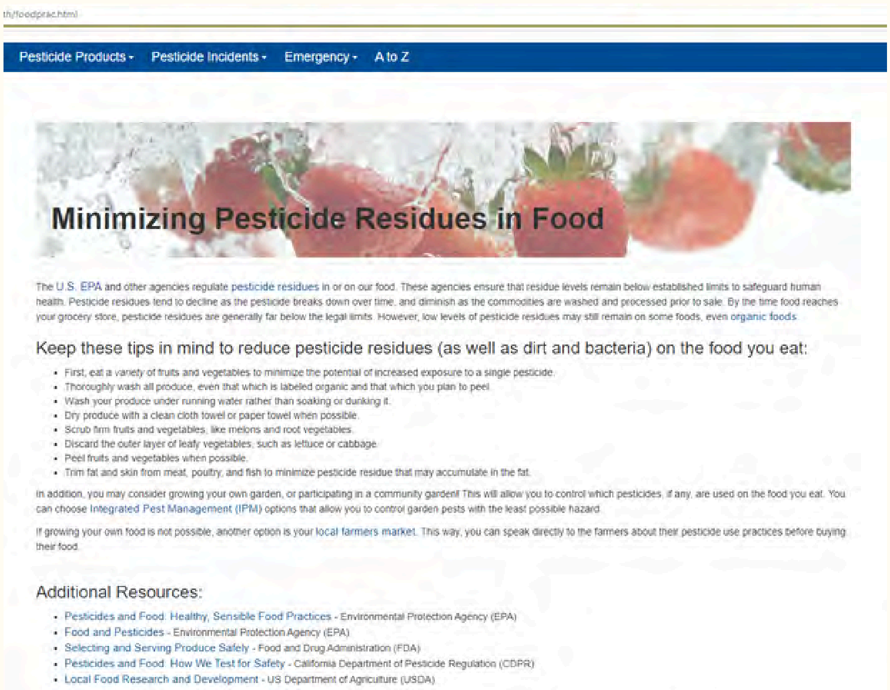
The information available on how to avoid residues is abundant, and sometime controversary.

Always stay alert and informed!

Consumers are advised to wash and peel fruits and vegetables to reduce pesticide residue intake, as not all pesticide residues can be removed by washing. Peeling fruits and vegetables to reduce dirt, bacteria, and pesticides, and discarding the outer leaves of leafy vegetables increase the chances of safer food.

Trimming fat from meat and skin from poultry and fish is also advisable, because some pesticides residues collect in fat.

Organic farming practices, which limit or exclude synthetic pesticide use, may offer an alternative approach to reduce these residues in food.



th/foodprac.html

Pesticide Products ▾ Pesticide Incidents ▾ Emergency ▾ A to Z

Minimizing Pesticide Residues in Food

The U.S. EPA and other agencies regulate pesticide residues in or on our food. These agencies ensure that residue levels remain below established limits to safeguard human health. Pesticide residues tend to decline as the pesticide breaks down over time, and diminish as the commodities are washed and processed prior to sale. By the time food reaches your grocery store, pesticide residues are generally far below the legal limits. However, low levels of pesticide residues may still remain on some foods, even organic foods.

Keep these tips in mind to reduce pesticide residues (as well as dirt and bacteria) on the food you eat:

- First, eat a variety of fruits and vegetables to minimize the potential of increased exposure to a single pesticide.
- Thoroughly wash all produce, even that which is labeled organic and that which you plan to peel.
- Wash your produce under running water rather than soaking or dunking it.
- Dry produce with a clean cloth towel or paper towel when possible.
- Scrub firm fruits and vegetables, like melons and root vegetables.
- Discard the outer layer of leafy vegetables, such as lettuce or cabbage.
- Peel fruits and vegetables when possible.
- Trim fat and skin from meat, poultry, and fish to minimize pesticide residue that may accumulate in the fat.

In addition, you may consider growing your own garden, or participating in a community garden! This will allow you to control which pesticides, if any, are used on the food you eat. You can choose Integrated Pest Management (IPM) options that allow you to control garden pests with the least possible hazard.

If growing your own food is not possible, another option is your local farmers market. This way, you can speak directly to the farmers about their pesticide use practices before buying their food.

Additional Resources:

- Pesticides and Food: Healthy, Sensible Food Practices - Environmental Protection Agency (EPA)
- Food and Pesticides - Environmental Protection Agency (EPA)
- Selecting and Serving Produce Safely - Food and Drug Administration (FDA)
- Pesticides and Food: How We Test for Safety - California Department of Pesticide Regulation (CDPR)
- Local Food Research and Development - US Department of Agriculture (USDA)

Good practices in avoiding or reducing pesticides residues

Choose Organic: Organic produce is grown without synthetic pesticides.

Wash and Scrub: Thoroughly washing and scrubbing fruits and vegetables under running water helps remove residues.

Peel and Trim: Peeling fruits and trimming outer layers of vegetables can reduce pesticide levels.

Diversify Your Diet: Eating a variety of foods limits exposure to any single type of pesticide.

Grow Your Own: Home gardening allows control over what pesticides, if any, are used.

Buy Local and In-Season: Local and in-season produce often has fewer pesticides.

Use a Baking Soda Soak: Soaking produce in a baking soda solution can help remove some pesticides.

Check Pesticide Residue Data: Refer to resources like the Environmental Working Group's "Dirty Dozen" and "Clean Fifteen" lists.

Cook Your Food: Cooking can reduce pesticide levels in some foods.

Discard Cooking Water: For some vegetables, boiling and discarding the cooking water can reduce pesticide residues.

Unit 2.5 Occupational safety related to pesticide

Liliana Bădulescu,
Ionuț Silviu Beia

Occupational safety related to pesticides refers to the practices and regulations designed to protect workers who handle and apply pesticides from potential health risks. This includes using personal protective equipment, adhering to safe handling and application procedures, understanding and complying with pesticide labels and safety data sheets, and undergoing proper training. The goal is to minimize exposure and prevent pesticide-related illnesses and accidents in the workplace.

Identifying risks associated with pesticide handling and application in the workplace, including exposure routes such as inhalation, skin contact, and ingestion allows to elaborate safety measures such as the use of Personal Protective Equipment (PPE), proper storage and handling procedures, and emergency response protocols for pesticide exposure.
Another important factor is training and education for workers, emphasizing the importance of understanding pesticide labels and safety data sheets.

In Europe, occupational safety related to pesticide use is primarily regulated by the European Agency for Safety and Health at Work (EU-OSHA) and the European Chemicals Agency (ECHA). These agencies work within the framework of EU legislation, such as the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) and the Classification, Labelling and Packaging (CLP) Regulation, to ensure safe handling and use of chemicals, including pesticides, in the workplace. They set standards, guidelines, and requirements for protective measures, training, and reporting to safeguard workers' health and safety.

Personal Protective Equipment (PPE) for pesticide users typically includes items such as gloves, goggles, face shields, respirators, protective clothing, and boots. These are designed to protect the skin, eyes, respiratory system, and body from direct exposure to pesticides. Gloves made of nitrile or other chemical-resistant materials are important for hand protection. Protective clothing can include coveralls or aprons. Respirators are essential when there is a risk of inhaling pesticide vapors or dust. The selection of PPE depends on the type of pesticide, method of application, and duration of exposure. Proper fit and maintenance of PPE are also crucial for effective protection.

PPE is essential for safeguarding against pesticide exposure. It's crucial to read and understand the pesticide label before use, as it provides vital safety, usage, and handling information. Legal compliance with label instructions is mandatory. The required PPE varies with different pesticide products. Proper use and understanding of PPE principles are fundamental to ensure the health and safety of individuals involved in pesticide handling. For example, a glove material resistant to one pesticide may not protect against another. Similarly, respirators suitable for one task may not be effective for others. Similarly, respirators suitable for one task may not be effective for others. Regular inspection of PPE for damage and understanding the distinctions between “water-resistant” and “chemical-resistant” materials is important.

Aprons

When necessary, aprons should be constructed from material that resists chemicals and should extend from the mid-chest area to the knees. It is advisable to wear an apron during the mixing or loading of chemicals, or while cleaning spray equipment, even in instances where the pesticide label does not explicitly require it.

Coveralls

Coveralls, which are either one-piece or two-piece loose garments, at the very least, cover the entire body except for the head, neck, hands, and feet. The label on the pesticide might indicate that these coveralls should be donned over another layer of clothing. Typically, coveralls are crafted from materials like cotton or a blend of cotton and polyester, and they do not resist chemicals.

There are materials that are laminated or coated to offer water resistance and some protection against solvents.

Eye protections

Requirements for eye protection can include shielded safety glasses, goggles, a face shield, or a full-face respirator. Shielded safety glasses are equipped with a brow cover and side shields. When using a half-mask respirator or prescription glasses, specialized goggles are necessary. The straps of eye protection gear should be positioned beneath any mandatory protective headgear. It's crucial to distinguish between chemical goggles and regular safety goggles. Chemical goggles are designed with a baffled airway to prevent direct splashes from entering the goggles, a feature that ordinary safety goggles lack.

Chemical goggles are designed with a baffled airway to prevent direct splashes from entering the goggles, a feature that ordinary safety goggles lack.

Footwear

Footwear options encompass waterproof boots, or boots or shoe coverings resistant to chemicals, which are to be worn over standard shoes or boots. It is essential to select footwear that will not soak up the spray. The pant legs should always be worn over the outside of the footwear to avert the spray from trickling down the leg and into the footwear. Duct tape may be utilized as a temporary solution to seal the junction between the boots and pants. Footwear exposed to these conditions should be thoroughly cleaned after each day's usage and should not be worn inside buildings.

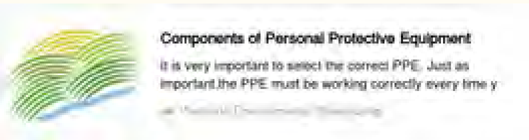
Gloves

The protective capabilities of glove materials and their duration of effectiveness after exposure to a specific pesticide vary. This level of protection also differs based on the type of contact, whether it be with diluted sprays, splashes of concentrated products, granules, or powders.
It is important to closely observe the types of gloves recommended on the pesticide label. Nitrile, neoprene, and butyl rubber are among the more frequently used materials for chemical-resistant gloves. Waterproof gloves offer substantial protection primarily for dry and water-based formulations. Typically, pesticide labels will provide "examples" of appropriate types of gloves.

Butyl Rubber glove

Barrier Laminate

Nitrile glove



Headgear options consist of chemical-resistant hoods and hats with a broad brim that are also resistant to chemicals. When selecting headgear, as required by some product labels, it is important to choose items that will not absorb the spray.

Respirators

When handling pesticides, respirator requirements specified on the pesticide labels are quite precise. For comprehensive information, refer to the Respirators module on this website. Utilize only those respirators that have been approved by the National Institute for Occupational Safety and Health (NIOSH). Also, consult the OSHA Respiratory Protection Regulation (29 CFR).

A preliminary medical evaluation is mandated by law if the pesticide label stipulates the use of a respirator.

Respirators such as self-contained, canister, and cartridge style require a snug fit to the face and must undergo fit testing prior to use. This fit testing should be conducted annually, whenever the type of respirator is altered, or if there are significant changes in weight or facial structure.

Fit testing should be performed solely by a trained individual or safety professional, adhering to the instructions provided with the respirator or other specific fit test protocols for the model. Respirators that require a tight seal must not be used by individuals with facial hair (like beards), jewelry, or any other obstruction at the point where the respirator contacts the face.

A respirator seal check, which is distinct from a fit test, assesses the seal's effectiveness between the respirator and the skin and should be conducted every time the respirator is used. Follow the PPE instructions for performing a correct seal check.

Replace filters, canisters, cartridges, etc., in accordance with the pesticide label or PPE instructions, whichever is more frequent, and whenever there is damage to the equipment, increased breathing resistance, presence of odor, taste, irritation, or soiling. Adhering to PPE instructions for replacement is vital, as other indicators may not always be reliable. For instance, the ability to detect an odor varies based on the product, individual, and weather conditions, and the mere detection of an odor does not necessarily imply potential harm.

REFERENCES

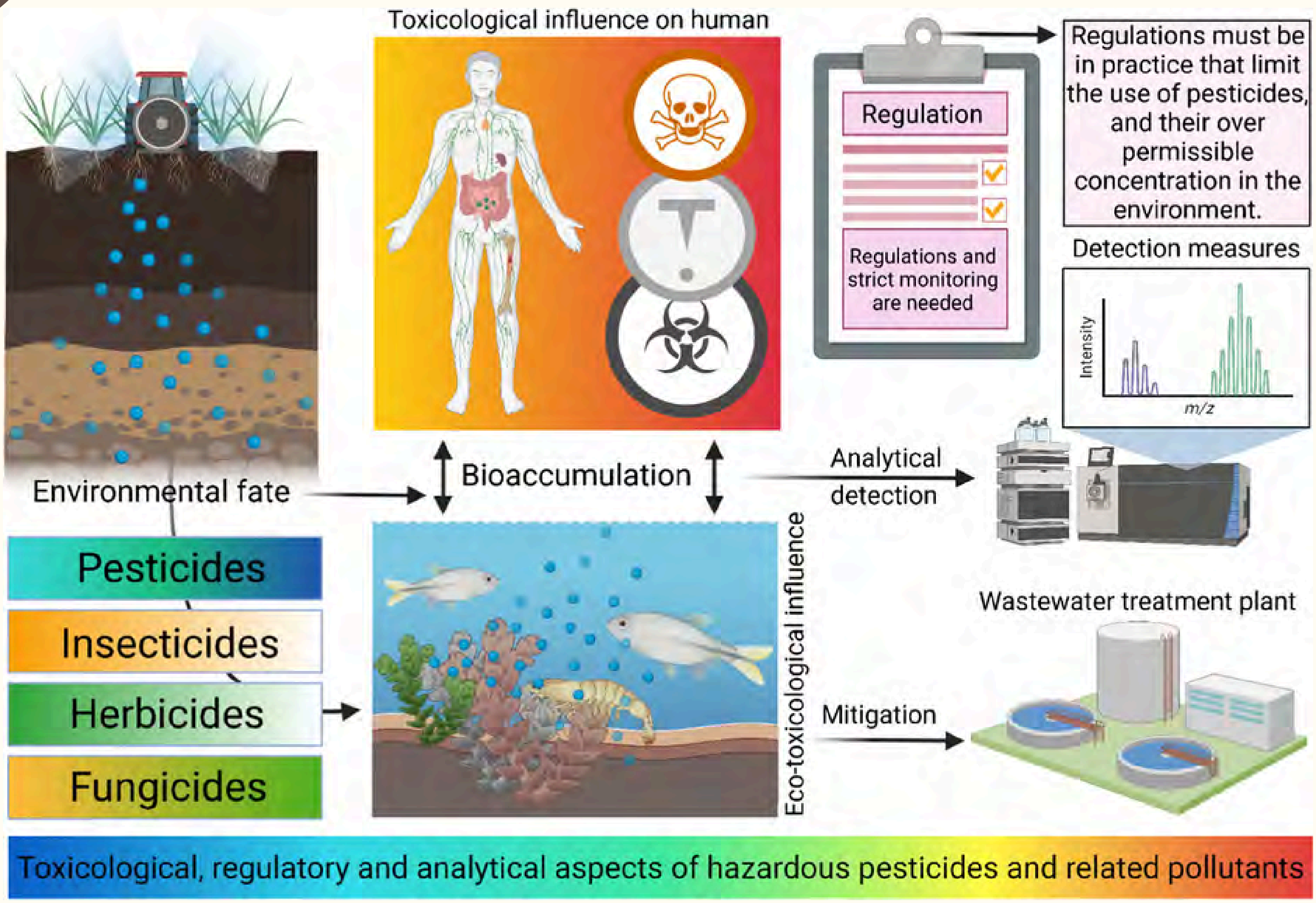
Derek C. G. Muir, Gordon J. Getzinger, Matt McBride & P. Lee Ferguson
Environmental Science & Technology 2023 57 (25), 9119-9129
DOI: 10.1021/acs.est.2c09353


Expert Insights: What is pesticide poisoning?
Copy link
What is
PESTICIDE
poisoning?
Watch on YouTube

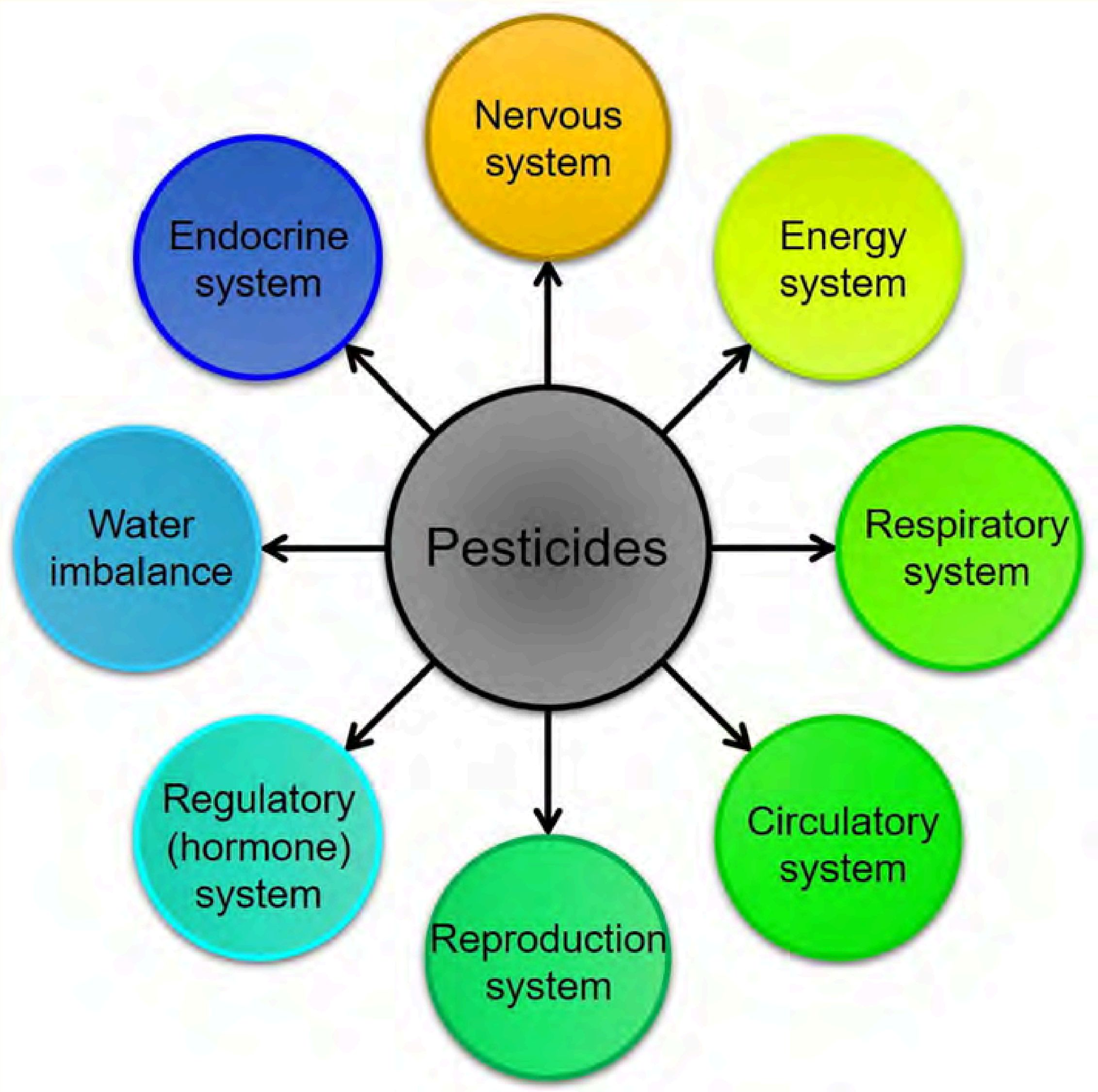
Source here


Can we feed our population without synthetic pesticides?
Climate change · Climate change refers to long-term shifts in temperatures and...
Copy link
End of Pesticides?
Watch on YouTube

Source here


Toxicological influence on human
Regulation
Regulations and strict monitoring are needed
Regulations must be in practice that limit the use of pesticides, and their over permissible concentration in the environment.
Detection measures
Intensity
m/z
Environmental fate
Bioaccumulation
Analytical detection
Pesticides
Insecticides
Herbicides
Fungicides
Eco-toxicological influence
Wastewater treatment plant
Mitigation
Toxicological, regulatory and analytical aspects of hazardous pesticides and related pollutants

Source here



Toxicological effects of pesticides on living organisms.
Reprinted from Ref. (Bilal et al., 2019) with permission from Elsevier.
License Number: 5176320561958.

Source here

Hort4EUGreen

Highly Hazardous Pesticides

The information of each molecule was retrieved from the PubChem database (https://pubchem.ncbi.nlm.nih.gov).

Pesticides	Used as	Hazard statements code	Global harmonized system
Chlordane	Insecticide	H302, H312, H351, H400, H410	GHS07, GHS08, GHS09
Heptachlor	Insecticide	H301, H311, H351, H373, H400, H410	GHS06, GHS08, GHS09
Lindane	Insecticides, Rodenticides	H301, H312, H332, H362, H373, H400, H410	GHS06, GHS07, GHS08, GHS09
Dieldrin	Insecticide	H301, H310, H351, H372, H400, H410	GHS06, GHS08, GHS09
Pentachlorophenol	Herbicides	H301, H311, H315, H319, H330, H335, H351, H400, H410	GHS06, GHS07, GHS08, GHS09
Endrin	Insecticide	H301, H310, H351, H372, H400, H410	GHS06, GHS08, GHS09
Pentachloronitrobenzene	Fungicide	H317, H400, H410	GHS07, GHS09
Clofentezine	Miticide, Acaricides	H312, H400, H412	GHS07, GHS09
Hexachlorophene	Microbiocide, Fungicides	H301, H311, H400, H410	GHS06, GHS09
Hexachlorobenzene	Fungicide	H350, H372, H400, H410	GHS08, GHS09
Hexachlorobenzene	Fungicide	H350, H372, H400, H410	GHS08, GHS09
Mirex	Insecticide	H302, H312, H351, H362, H400, H410	GHS07, GHS08, GHS09
Ditalimfos	Fungicide	H315, H317	GHS07

Highly Hazardous Pesticides

The information of each molecule was retrieved from the PubChem database (https://pubchem.ncbi.nlm.nih.gov).

Edifenphos	Fungicide	H301, H312, H317, H331, H400, H410	GHS07, GHS09, GHS06
Pyrazophos	Fungicide	H302, H332, H400, H410	GHS07, GHS09
Anilofos	Herbicide	H302	GHS07
Bensulide	Herbicide	H302, H400, H410	GHS07, GHS09
Butamifos	Herbicide	H302, H400, H410	GHS07, GHS09
Glyphosate	Herbicide	H318, H411	GHS05, GHS09
Chlorpyrifos	Insecticide	H301, H400, H410	GHS07, GHS09
Bromophos	Insecticide	H302, H400, H410	GHS07, GHS09
Etrimfos	Insecticide	H302, H400, H410	GHS07, GHS09
Fenitrothion	Insecticide	H302, H400, H410	GHS07, GHS09
Phoxim	Insecticide	H302, H317, H400, H410	GHS07, GHS09, GHS08
Sulprofos	Insecticide	H301, H311, H330, H400, H410	GHS06, GHS09
Parathion	Insecticide, acaricide	H300, H311, H330 - H400 - H410	GHS06, GHS08, GHS09
Malathion	Insecticide, acaricide	H302, H317, H400, H410	GHS09, GHS07
Phosphamidon	Insecticide, acaricide	H300, H311, H341, H400, H410	GHS06, GHS08, GHS09

Highly Hazardous Pesticides

The information of each molecule was retrieved from the PubChem database (https://pubchem.ncbi.nlm.nih.gov).

Dichlorvos	Insecticide, acaricide	H301, H311, H317, H330, H400	GHS06, GHS07, GHS09
Omethoate	Insecticide, acaricide	H301, H312, H400	GHS06, GHS07, GHS09
Sulfotep	Insecticide, acaricide	H300, H310, H400, H410	GHS06, GHS09
Thiometon	Insecticide, acaricide	H301, H312	GHS06, GHS07
Vamidothion	Insecticide, acaricide	H301, H312, H400	GHS06, GHS07, GHS09
Triazophos	Insecticide, acaricide	H301, H312, H331, H400, H410	GHS06, GHS07, GHS09
Naled	Insecticide, acaricide	H302, H312, H315, H319, H400	GHS07, GHS09
Fenitrothion	Insecticide, Acaricides	H302, H400, H410	GHS07, GHS09
Terbufos	Insecticide, nematicide	H300, H310, H400, H410	GHS06, GHS09
Fenamiphos	Nematicide	H300, H310, H330, H319, H400, H410	GHS06, GHS07, GHS09

Hort4EUGreen

Remain In Touch

UNIVERSITY
OF AGRONOMIC SCIENCES
AND VETERINARY MEDICINE
OF BUCHAREST

021 318 2266

https://hortgreen.com

Address: Bulevardul Mărăști 59, București 011464

ISBN 978-606-072-468-1
ISBN 978-606-072-470-4