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Update in pesticides in European agriculture: toxicity, persistence and ecosystemic risks

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A. INTRODUCTION & OBJECTIVE

To meet the global **demand for food** → Fast **population growth** → Widespread **use of pesticides** → **Modern** agriculture → In 2020, pesticide concentrations exceeded the threshold of concern at **22% of European river lake sampling points**; In 2022, **83%** of agricultural soils tested positive for pesticides → The use of **agrochemicals** is justified for:

(a) increased **production**,
(b) improved **crop quality**, and
(c) reduced labor and **energy consumption** in production.

Tang et al., (2021), found that **64% of the world's agricultural land** (roughly 24.5 million km²) **is at risk of pesticide contamination due to the presence of more than one active ingredient, and 31% is at high-risk zones**. This staggering figure emphasizes the need for heightened **safety measures** and **public awareness of pesticide use**.

The **extensive persistence** of these **inputs** results in their potential bioaccumulation in **non-target organisms**, resulting in their detection across diverse **biotic** matrices. Given the **interconnectedness** of organisms in **trophic networks**, these residues can spread through trophic transfer, affecting food webs and triggering human toxicity (**Figure 1**).

The greater the volume of pesticides applied on **land**, the greater the spread to the **aquatic ecosystem** through meteorological activities, creating serious **ecotoxicological risks**.

The aim of this systematic review is to investigate the **most widespread pesticide formulations used on crops, their acute** and **chronic toxicity, persistence and associated risks to human health.**

B. MAJOR PESTICIDES GROUPS

INSECTICIDES	RODENTICIDES	HERBICIDES	FUNGICIDES	MINERAL OILS
• Chlorinated hydrocarbons, • Organo-phosphates, • Carbamates–insecticides, • Pyrethroids	• Anti–coagulants, • Cyanide • Generators, • Hypercalcae-mics, • Narcotics	• Phenoxy hormone, • Triazines, • Amides, • Carbamates–herbicides, • Dinitroanilines, • Urea derivatives, • Bipiridils	• Inorganic, • Dithiocarbama-tes, • Benzimidazoles, • Triazoles • Diazoles, • Diazines • Morpholines	PLANT GROWTH REGULATORS

FAO (2024)

C. PREVALENT ACTIVE COMPOUNDS IN AGRICULTURE

The selected active substances were chosen from data provided by **EFSA (2023)** and **FAO (2024)** as the most frequently found pesticide residues in agricultural systems (**Figure 2**). Of these, four organophosphorus insecticides (**chlorpyrifos, diazinon, malathion,** and **parathion**) demonstrated acute neurotoxicity and high levels of environmental persistence. **Glyphosate**, an herbicide, is categorized as hazardous to long-term health despite low acute toxicity, and it is prevalent in over 30% of food samples scrutinized recently. Finally, **propiconazole**, a fungicide, is a concern due to its potential to disrupt the endocrine system and its ecological effects on aquatic organisms.

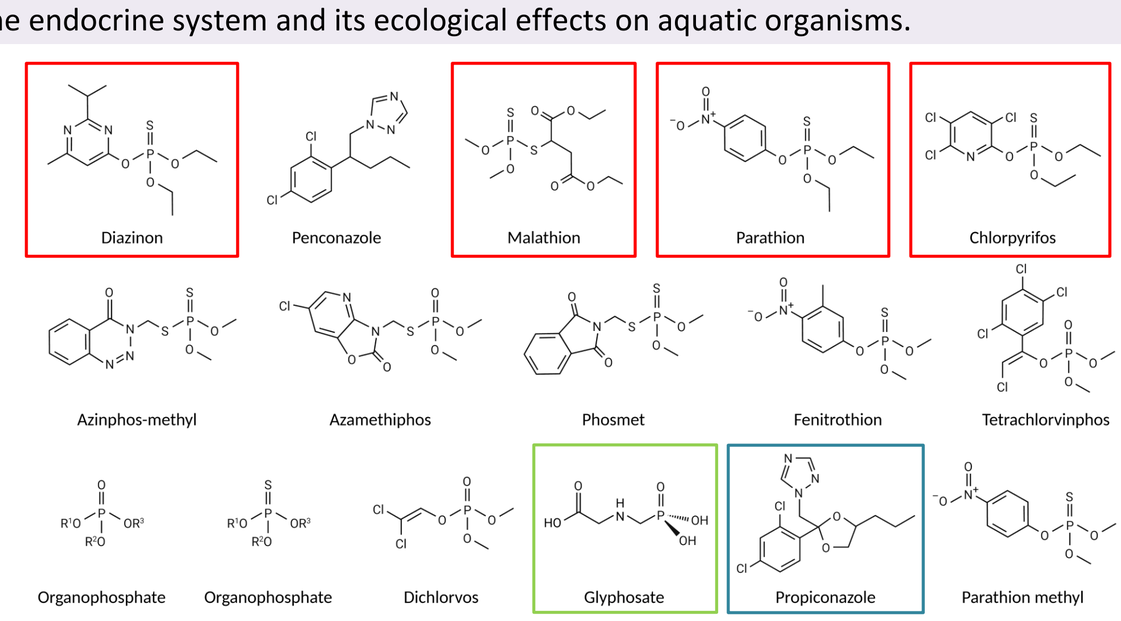

Figure 2: Active substances frequently found in pesticides used for land and crop production.

D. ACUTE & CHRONIC TOXICITY OF PESTICIDES

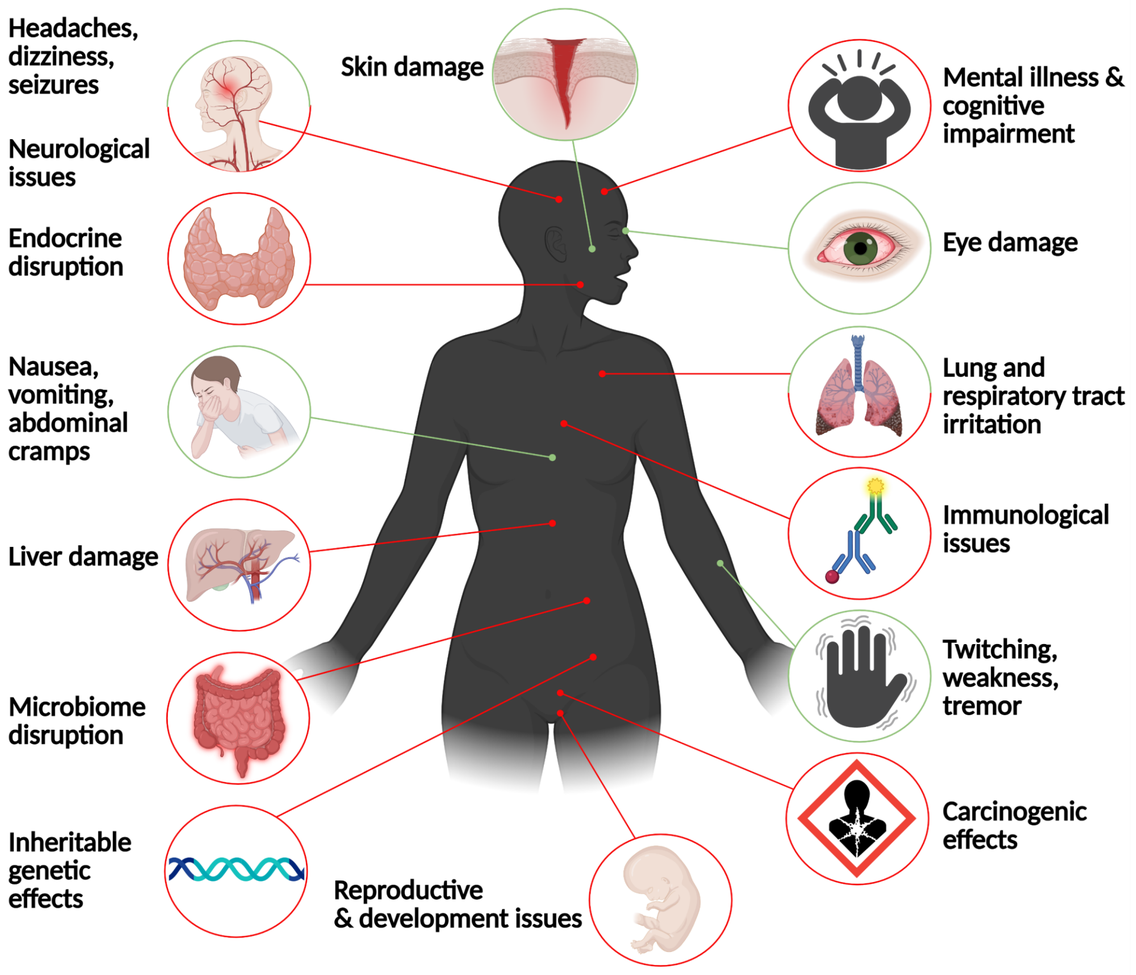

Figure 1: Deleterious effects of pesticides on human health, manifesting as acute (green) and chronic (red) toxicity.

E. PERSISTENCE OF PESTICIDES

Glyphosate and **propiconazole** have a **moderate to high** degree of environmental **persistence**. **Propiconazole** is extremely **resistant** to **breakdown** in soil and sludge. **Chlorpyrifos** has a longer half-life when incorporated into soil or in water. By contrast, **organophosphate insecticides**, degrade faster but remain **highly acutely toxic**. Such **persistence relies** on environmental factors, as **in microbial activity** or **heat.**

CONCLUSIONS

The use of pesticides negatively impacts **land fertility** by **affecting soil microbiota,** disrupting **biogeochemical cycles,** and leading to **long-term soil degradation**.

Recently, pesticides have received much attention because they are known to be **toxic** and **environmentally harmful**.

Going forward, more research should be conducted on using **biopesticides** and on understanding how the sector responds to **climate variability** and **regulatory barriers.**

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