



Pesticides and Environmental Health; A Review

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Review

Pesticides reach the environment primarily during preparation and application. Application can take place via different techniques, depending on factors such as the formulation type, the controlled pest and, the application timing. In agriculture, it is possible to apply pesticides to the crop or to the soil. Liquids sprays are commonly used in crops; for example, boom sprayers, tunnel sprayers, or aerial application. Systemic pesticides can also be employed. As for soils, pesticides can be applied as granules, injected as a fumigant, or sprayed onto the soil surface, which is possibly followed by pesticide incorporation into the soil top layer. Seeds are sometimes treated with pesticides prior to planting [1]. After application, pesticides can be taken up by target organisms, degraded, or transported to the groundwater; they can also enter the surface water bodies, volatilize to atmosphere, or reach non-target organisms by ingestion, for example. The physical and chemical properties of the pesticide, soil, site conditions, and management practices influence the behavior and fate of pesticides. Concerning the physical and chemical properties of pesticides, their solubility determines their transport in surface runoff and their leaching to groundwater [2]. The higher the solubility, the greater the carrying and leaching. The partition coefficient also affects the behavior of pesticides, and many chemicals do not leach because soil particles adsorb them.

Adsorption depends on the chemical and also on the soil type. The volatility of pesticides indicates their tendency to become a gas; the higher the volatility (high vapor pressure), the larger their loss to the atmosphere. Environmental conditions such as temperature and humidity impact volatility, which can occur from soil, plants, or surface water, and may continue for several days or weeks after pesticide application. In the atmosphere, the chemicals can be transported over long distances. Subsequent atmospheric deposition can contribute to surface water pollution. Finally, the degradation of pesticides that also determines the behavior and fate of these compounds in the environment [2]. Degradation (their break down into other chemical forms) can occur by photo decomposition, microorganisms, and a variety of chemical and

physical reactions. Pesticides with low biodegradation are called persistent, they can remain in the environment for a long time. Soil properties can also affect the movement of pesticides. In relation to the soil texture, coarse textured sands and gravels have high infiltration capacities, and water tends to percolate through the soil and reach groundwater. Fine-textured soils such as clays generally have low infiltration capacities, so water tends to run off, reaching streams and lakes. Moreover, soil containing more clay in its composition bears larger surface area to adsorb pesticides. Regarding permeability, highly permeable soils allow water to move easily. This water may contain dissolved pesticides, which will reach groundwater. Texture influences soil permeability. Ultimately, soils with high organic matter content can adsorb pesticides and retain water with dissolved chemicals.

Moreover, these soils possess a larger population of microorganisms that can degrade the pesticides. The site conditions that can determine pesticide behavior in the environment are depth until the groundwater, geological conditions, topography, and climate. In the case of shallow groundwater, the soil filters smaller amount of water with chemicals and adsorbs and degrades lower quantities of pesticides, so contamination is a major concern. Regarding the geological conditions, the presence of wells, sinkholes, and highly permeable materials, such as gravel deposits, facilitates groundwater contamination [1]. On the other hand, the existence of drainage ditches, streams, ponds, and lakes increases the probability that rainfall or irrigation runoff will contaminate surface water. In relation to topography, flat landscapes, areas with closed drainage systems where water drains toward the center of a basin, and especially sinkhole areas, are more susceptible to groundwater contamination. As for climate, large rainfall or irrigation may culminate in large amounts of water percolating through the soil, to reach groundwater. Rainfall can also carry pesticides to surface waters, contaminating rivers, lakes, and seas, and taking these chemicals to distant places.

Finally, management practices can affect the movement of pesticides. With respect to the application methods, pesticides

injected or incorporated into the soil are more available for leaching and reaching groundwater, whereas pesticides sprayed onto crops are more susceptible to volatilization and surface runoff, reaching surface waters and the atmosphere. Concerning the application rates and timing, the use of larger amounts of a pesticide during rainfall or irrigation facilitates the assess of the chemical to groundwater. With respect to handling practices, correct storage and disposal of the pesticides containers impact environmental contamination [3].

The fact that a contaminant is present in the environment does not necessarily mean that it will reach an organism. The contaminant and the organism must overlap in time and space for exposure to occur. Contact can be dermal or oral or even via inhalation, gills, and, more rarely, injection. Once pesticides reach non-target organisms, they may undergo biotransformation via reactions like hydrolysis, oxidation, reduction, or conjugation catalyzed by liver enzymes. biotransformation is an effort of the organism to detoxify and eliminate xenobiotics, but this process can also produce metabolites that are more toxic than their parent compound, a phenomenon called bio activation. An example of bio activation is the biotransformation of DDT, which is not highly toxic to birds, into DDE, which causes thinning of eggshells because it disrupts calcium metabolism. In organisms, the absorption of a pesticide with high lipid solubility and low elimination rate can lead to bioaccumulation of this chemical in the fatty tissue, and the final concentration of the chemical in the organism will be higher than its concentration in the environment. When the bio accumulated chemical passes from lower to higher trophic levels through the food chain, successively greater pesticide concentrations emerge in animals of higher trophic level.

This phenomena is called bio magnification. The offspring of top predators can also become contaminated, mainly in the case of marine mammals, because they can consume milk with extremely high fat and pesticides content. Application of pesticide involves not only the active ingredient but also the whole formulation. Therefore, the environment and the human are exposed to both the active and inert ingredients. Although inert ingredients have no pesticidal activity, facilitate application of the pesticides – they enhance the active compound penetration into the target organism as well as the toxic action. Hence, the inert ingredients raise the formulation toxicity even in non-target organisms. One example is the formulation of glyphosate, which is an active ingredient. It contributes a little to the total toxicity of the formulated product, particularly in the case of aquatic organisms, which are more sensitive to surface-active substances.

The categorization of pesticides commonly relies on their persistence in the environment. Organochlorine pesticides are persistent, whereas organophosphates, carbamates, phenoxyacid derivatives, chloroacetanilides, pyrethroids, and others are non-persistent. Compared with persistent pesticides, non-persistent chemicals have much shorter environmental half-lives and do not tend to bioaccumulate. Nevertheless, because of the heavy agricultural use of these chemicals, exists concern about their

presence in the environment. The non-persistent pesticides organophosphorus and carbamates act on acetylcholinesterase. The presence of this enzyme in insects, birds, fish, and all mammals allows these pesticides to reach both target and non-target organisms. Pesticides such as organophosphorus and carbamates can affect numerous teleost behaviors. The pesticides that inhibit acetylcholinesterase are polar and water soluble. Moreover, their metabolism in the body is fast, and their degradation in the environment is relatively rapid. Therefore, organophosphorus and carbamates do not tend to bioaccumulate in aquatic species. However, the accumulation of these compounds in fish and invertebrates was reported long ago.

Organophosphorus compounds do not persist in the environment. However, their large-scale use and their decomposition rates in the environment cause these compounds to accumulate in soils, from where they subsequently enter groundwater and rivers. A recent study detected the organothiophosphate insecticide chlorpyrifos in air and seawater in the Arctic, which demonstrated the long-range transport of this chemical. Diazinon, another organophosphorus compound, frequently occurs in point sources (wastewater treatment plant effluent) and non-point sources (storm water runoff) in urban and agricultural areas. This pesticide is extremely toxic to birds and the aquatic life. Organophosphorus compounds are acutely toxic, broad-spectrum pesticides. In the environment, secondary poisoning can occur when predators consume animals poisoned by these chemicals. Examples of contamination by organophosphorus are numerous [4]. In Argentina in 1995-1996, approximately 6000 wintering Swainson's hawks (*Buteo swainsoni*) became poisoned after they fed on grasshoppers sprayed with the organophosphorus insecticide monocrotophos.

An example of carbamate contamination occurred with the pesticide, aldicarb, which polluted groundwater in the United States. Other carbamates such as carbaryl and its degradation product 1-naphthol have emerged in surface waters. The metabolite 1-naphthol is more toxic than its parent compound, and it has arisen in India. Methomyl, carbaryl and carbofuran, commonly used carbamates, have appeared in the aquatic environment. Carbofuran has commonly been associated with wildlife pesticide poisoning events when applied in the granular form. Apparently, birds mistake them for seeds. Organochlorines have long environmental half-lives and tend to bio accumulate and bio magnify in organisms. A series of evaporation and deposition steps as well as migration of animals containing bio accumulated organochlorines can transport these compounds through the environment, carrying it to animals in higher levels of the food chain. These persistent chemicals thus occur thousands of miles away from their origin. The properties of organochlorines like aldrin and dieldrin result in direct mortality of predatory birds, such as sparrow hawks and kestrels.

These chemicals have intensive use in agricultural and industrial activities, so they emerge across the world, including the deserted plateau and the polar zone [5]. The organochlorine chlorothalonil is a fungicide that has arisen in seawater and air in the Arctic as well as in snow cores in Arctic Canada. Endosulfan, an organochlorine

insecticide, has appeared in animals from Greenland like marine fish and mammals. Despite the ban on many organochlorine compounds in the 1970s, some countries still fabricate and use chemicals such as DDT to control vector disease. Other countries have replaced organochlorines with the less persistent and more effective organophosphorus compounds. Pyrethrins and Pyrethroids are non-persistent pesticides used worldwide as insecticides in agriculture, forestry, households, public health and stored products. Therefore, urban and peri-urban populations are potentially chronically exposed to these compounds.

Pyrethrins and Pyrethroids act on sodium channels in the nervous system of numerous phyla, such as arthropods and chordates. Pyrethrins and Pyrethroids present low acute toxicity to mammals and birds and constitute one of the safest insecticides to man [4]. However, at low concentrations these chemicals are acutely toxic to a wide range of aquatic organisms and insects. Pyrethrins are natural compounds extracted from chrysanthemum flowers; pyrethroids are synthetic compounds whose structure resembles the structure of pyrethrins. Light degrades these chemicals [3]. Modification of pyrethroids over the years has enhanced their insecticidal activity and persistence in the environment [6]. Compared with pyrethrins, pyrethroids are more stable under light, which incurs increased environmental risks associated with their use. Pyrethrins and Pyrethroids display high selectivity and easy degradability in the environment as compared with other pesticides, been a favored replacement for organophosphorus compounds. Pyrethroids strongly adsorb to soil particles, but they can move in runoff with soil particles and reach sediments, consequently entering aquatic ecosystems and affecting aquatic organisms like invertebrates and fish. Fish are highly sensitive to pyrethrin and pyrethroid products, and contamination of lakes, streams, ponds, or any aquatic habitat is a concern. Moreover, some formulations contain additional insecticides, insect repellents, and solvents such as alcohol and petroleum, which increase pesticide toxicity [5].

Triazines basically consist of herbicide compounds, are relatively persistent and migrate easily through the soil into surface and ground waters. In soil, they undergo degradation mainly in a microbial action, but the role of photo degradation is still significant. Residues of triazines have emerged in soil, surface waters, and groundwater in areas where the application of agrochemicals has taken place. Herbicides are often benign with regard to impacts on animals; however, these compounds can have toxic effects at concentrations found in the environment [4].

Furthermore, indiscriminate use of this herbicide, careless handling, accidental spillage, or discharge of untreated effluents into natural water ways can harm the fish population and other aquatic organisms and may contribute to long-term effects in the environment. Atrazine, a triazine herbicide, is one of the most often detected pesticides in streams, rivers, ponds, reservoirs, and groundwater [3]. Phenoxy derivatives basically consist of compounds with herbicide action. They are soluble in water and can pollute surface and ground waters. Phenoxy derivatives display

moderate toxicity, but some chlorinated metabolites can be toxic to human and aquatic organisms. In addition, the metabolites may have mutagenic and carcinogenic properties. 2, 4-D and MCPA, which are also phenoxy herbicides, can undergo degradation by biotic and abiotic mechanisms. However, these processes may not suffice to reduce the concentrations of chlorinated phenoxy derivatives on many sites. Regarding dipyrindyl derivatives, the best-known compounds are diquat and paraquat, developed as herbicides and desiccants. Diquat is water soluble and persistent in the aquatic system. However, it can bind to soil, which reduces its mobility in the environment.

Although herbicides are usually little toxic to animals, diquat is toxic to some aquatic organisms. Soil adsorbs paraquat, which presents its leaching to ground water; soil microorganisms and photolysis degrade this herbicide [3]. The herbicide glyphosate bears glycine, which adsorbs to soil, undergoes degradation by bacteria, and has low potential for runoff [1]. However, is it highly water soluble and emerges in surface waters. Glyphosate is little toxic to mammals, but the surfactants present in some formulations rise the toxicity of this chemical. Hence, some formulations, mainly those intended for aquatic vegetation control, can kill amphibians. Many authors have demonstrated that glyphosate formulations can cause genetic damage in fish. Dithiocarbamates (DTC) function mainly as fungicides that protect crops, but they also work as rodent repellents. The intensive use of dithiocarbamates in agriculture often contaminates water bodies. Ziram, one of the best-known dithiocarbamates, is toxic to aquatic organisms [3]. Other examples of chemical classes of pesticides exist. Alachlor and metolachlor belong to the group of chloroacetanilides. These herbicides and their degradation products have arisen in surface and groundwater [6]. Diuron, a urea derivative, can pollute freshwaters by leaching through the soil. It has appeared in marinas and coastal areas. Additionally, trifluralin, adinitroanilin, has emerged in Arctic air and seawater [1]. Therefore, a huge amount and variety of pesticides exist in the environment. Many chemicals that exist at low concentrations may not cause acute detectable effects in organisms, but they may induce other kinds of damage, like genetic disorders and physiological alterations that, in the long run, reduce the organism's life span [7-12].

References

1. Vorkamp K, Rig t FF (2014) A review of new and current-use contaminants in the Arctic environment: Evidence of long-range transport and indications of bioaccumulation. *Chemosphere* 111: 379-395.
2. Roberts T R, Dyson JS, Lane MCG (2002) Deactivation of the Biological Activity of Paraquat in the Soil Environment: a Review of Long-Term Environmental Fate. *J Agric Food Chem* 50(13): 3623-3631.
3. Padhye LP, Kim JH, Huang CH (2013) Oxidation of dithiocarbamates to yield N-nitrosamines by water disinfection oxidants. *Water Res* 47(2): 725-736.
4. Kubrak OI, Atamaniuk TM, Husak VV, Drohomiretska I Z, Storey JM, et al. (2012) Oxidative stress responses in blood and gills of *Carassius auratus* exposed to the mancozeb-containing carbamate fungicide Tattoo. *Ecotoxicol Environ Saf* 85: 37-43.

5. Bedos C, Cellier P, Calvet R, Barriuso E, Gabrielle B (2002) Mass transfer of pesticides into the atmosphere by volatilization from soils and plants: overview. *Agronomie* 22: 21-33.
6. Sirotkina M, Lyagin I, Efremenko E (2012) Hydrolysis of organophosphorus pesticides in soil: New opportunities with eco compatible immobilized His6-OPH. *International Bio deterioration & Biodegradation* 68: 18-23.
7. Berg VF, Kubiak R, Benjey WG, Majewski MS, Yates SR, et al. (1999) Emission of pesticides into the air. *Water, Air & Soil Pollution* 115(1): 195-218.
8. Lourencetti C, Marchi MRR, Ribeiro, ML (2008) Determination of sugar cane herbicides in soil and soil treated with sugar cane vinasse by solid-phase extraction and HPLCUV. *Talanta* 77(2): 701-709.
9. Agriculture and Natural Resources. Water quality: Controlling Nonpoint Source (NPS) Pollution. *Pesticide Management to Protect Water Quality*.
10. Durmaz H, Sevgiler Y, Üner N (2006) Tissue-specific anti oxidative and neurotoxic responses to diazinon in *Oreochromis niloticus*. *Pesticide Biochemistry and Physiology* 84: 215-226.
11. Van Wezel AP, Vlaardingen VP (2004) Environmental risk limits for antifouling substances. *Aquatic Toxicology* 66(4): 427-444.
12. Osano O, Admiraal W, Klamerc HJC, Pastor D, Bleeker EAJ (2002) Comparative toxic and genotoxic effects of chloroacetanilides, formamidines and their degradation products on *Vibrio fischeri* and *Chironomus riparius*. *Environmental Pollution* 119: 195-192.



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