Impact of Environmental Toxicants on Non-target Organisms

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Abstract

These substances, which are emitted by metropolitan areas, rural areas, and industrial properties, have been ingested by these ecosystems in significant proportions in recent decades. Leaching, irrigation, drainage, and surface runoff are some of the ways pesticides enter the aquatic environment. They are also easily ingested by non-target species including fish, mollusks, and other benthic creatures. These animals often go through bioaccumulation. By directly affecting certain cellular structures, including the lysosomal membrane, which is susceptible to degradation, exposure to these pesticides can result in a variety of physiological abnormalities. Additionally, they may react with nucleic acids, generating a variety of genetic damage and detrimental effects on the organism. Additional incentives are required to encourage the adoption of sustainable agroecological practises, together with a restriction on environmentally damaging active substances and stringent regulation by reputable environmental bodies.

Keywords: Toxicants, Pesticides, non-target organisms

Introduction

Pesticides are one of the key tools that drive the agricultural industry's productivity improvements. In the last several decades, with the modernization of technology and the consolidation of the modern inputs sector, agriculture has been increasing quickly. The indiscriminate use of these compounds, however, has readily spread to non-target creatures, and their consequences on the environment are diverse, ranging from the deterioration of air and food quality to the reduction in the quantity and quality of water, hurting human health. Additionally, it may negatively impact the cellular architecture of aquatic or terrestrial creatures, harming biodiversity [1].

Early in the 1960s, society started to worry about the risks that these pesticides presented to the environment and human health. Several nations have outlawed the manufacturing, distribution, and use of several of these substances, especially those that are classified as persistent organic pollutants (POPs), including organochlorines. After the Second World War, the use of carbamate and organophosphate pesticides increased due to the restriction on the majority of organochlorine chemicals, which are less hazardous but have a higher potential for bioaccumulation in the environment. Additionally, it became the most extensively used insecticide in the world due to its widespread usage in emerging nations with an agricultural-based economy. These poisonous compounds have the ability to harm non-target species in numerous biochemical and genetic ways. For instance, carbamates and organophosphates are powerful inhibitors of the acetylcholinesterase enzyme, harming an exposed organism's neurological system. The acetylcholine neurotransmitter is hydrolyzed by this enzyme in cholinergic synapses. The person may die as a result of cholinergic hyperstimulation if it is inhibited [2, 3].

Additionally, the mutagenic and carcinogenic properties of pesticides are well-known. They have harmful effects in the organism when they interact with nucleic acids. Since these chemicals are now a threat to both human health and the ecosystem, it is vital to monitor and limit their presence in the environment. These substances are categorised as insecticides, fungicides, herbicides, acaricides, rodenticides, molluscicides, and other terms depending on the dangerous species they are intended to eradicate. Insecticides make up 25% of all pesticides, followed by fungicides (22%), which account for the remaining 48%. They can be classified into pyrethroids, organochlorines, organophosphates, carbamates, benzoylureas, neonicotinoids, and other groups depending on the chemical type.

Figure 1 illustrates how spraying or runoff and leaching of precipitation, irrigation, and drainage may carry pesticides into the environment. Runoff and leaching are two of these processes that can affect lakes, rivers, and reservoirs. Additionally, they expose aquatic creatures to pesticide concentrations that can be hazardous to a wide range of species. Once present in the aquatic environment, these substances can enter living things through their skin, gills, and respiratory systems as well as dermally through the consumption of contaminated food.

These creatures often experience bioaccumulation. By directly affecting certain cellular structures, such as the lysosomal membrane, which may degrade or react with nucleic acids to generate multiple genetic lesions that have negative effects on the body, pesticide exposure can result in a variety of physiological alterations [4-6].

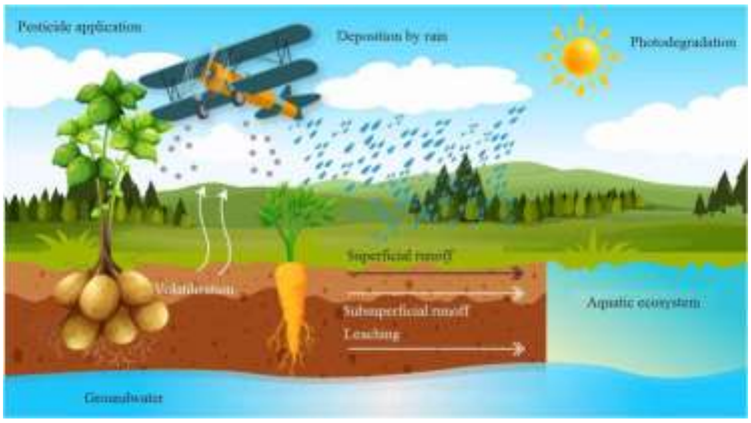

Figure 1. Pesticide paths to the aquatic environments.

Effect of Pesticides on Non-target Organisms in the Aquatic Environment

One of the key issues causing the poisoning of aquatic habitats has been the extensive use of pesticides in agricultural crops. The sensitivity of the organisms and the deposition and subsequent accumulation of these toxins in the environment are both to blame. Since pesticides can impact an aquatic organism's physiology and ability to survive, a growing number of studies are using fish, for instance, as markers of pesticide levels in the environment. These creatures are a source of molecules with biological activity. In the event that their physiological processes are compromised, genetic, biochemical, morphological, ecological, or behavioural alterations may result. These biomolecules are regarded as biomarkers, and biomonitoring programmes have employed their measurement to find harmful chemical exposure in aquatic environments. Through early detection, the presence of the toxin may be determined even before it significantly affects the exposed people's health [7].

Enzyme biomarkers, which are an alternative to exposure biomarkers for monitoring damaged aquatic ecosystems because of their high specificity and quick response to changes from target compounds, have drawn considerable interest in recent research. Enzymes are utilised as biomarkers because pollutants can impede or interfere with their catalytic activity. The majority of these harmful substances have a strong attraction for certain electron pairs, including sulfhydryl - SH groups and other functional groups from the catalytic site, that are present in the amino acids that make up the enzymes [8-10].

Genotoxic Effects of Pesticides

Since they interact chemically with genetic material and encourage alterations in the DNA molecule, pesticides are generally recognised to have genotoxic, mutagenic, and carcinogenic effect. These DNA changes in the organisms can have major effects since they harm cells and organs at the individual level and may even interfere with reproduction. The micronucleus (MN) test stands out among the most popular techniques for determining DNA damage in aquatic species because it enables rapid, easy, and less intrusive monitoring of macrolesions in the genome [11-12].

Conclusions

Agriculture crops now utilise more pesticides than ever before in an effort to increase output. Additionally, the uncontrolled use of these compounds has negatively impacted biodiversity, particularly in the aquatic ecosystem, by reaching non-target creatures. Diverse approaches have been utilised to find exposure to these harmful compounds in aquatic habitats in an effort to lessen these effects. Among these, the approaches discussed in this study that seek to assess the exposed organism at the biochemical and genetic levels perform effectively. It enables the early detection of the contaminant's existence even before it significantly alters the exposed person's health or before higher degrees of biological organisation are attained. It is important to note that pesticides found in aquatic environments may build up in creatures at all trophic levels, including humans, where they can reach significant amounts. Since these chemicals have turned into an issue for both human and environmental health, monitoring and regulating their presence in the environment is vital. In addition, there is a need for more regulation by reputable environmental bodies, increased incentives for the adoption of sustainable agroecological practises, and a ban on environmentally damaging active substances.

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