



## A Review On The Impact Of Chemical Pesticides On Aquatic Ecosystems

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### Abstract:

Pesticides are mostly used in agriculture intended for preventing, repelling, destroying or mitigating any pest. Herbicides, insecticides, fungicides, nematocides etc. are the pesticides widely used in agriculture. Despite their benefits, pesticide can have undesirable effects on humans and the natural environment. Countless chemicals are stable in environment. Prone to bioaccumulation and toxic as some pesticides are persist in the environment, hence they can stay freely in environment. When these pesticides are added to the aquatic ecosystems such as ponds, rivers, they affect the life cycle of aquatic animals mainly the fishes. This review focuses on the effect of pesticides on aquatic ecosystem and aquatic animals. Different types of pesticide chemicals and their toxicity on different fish species are discussed.

**Keywords-** Pesticides, affect, negative impact, herbicides, insecticides, eliminate.

### Introduction:

A pesticide is a chemical substances that are intentionally released in the agricultural fields in order to avert, deter or control and kill population of insects, weeds, rodents, fungi or other harmful pests. Pest can be defined as the plants or animals that jeopardize our food, comfort and health (Isra Mohammad et al, 2016). According to Food and agriculture organization (FAO) pesticides are defined as a substance or mixture of substances attended for controlling, preventing, destroying any pest, animals or human disease causing vectors, undesirable plants or animal species affecting food production, managing, selling, storage and transportation. They include insecticides, herbicides, nematocides, fungicides, rodenticides etc (Zhan et al, 2020; Bhatt et al; 2021a; Zhan et al; 2022). Some of the most important properties of pesticides that helps to predict the environmental fate are-half life, soil sorption coefficient, water solubility and vapor pressure. (E.A kerle et al, 2007) The use of pesticides has been increasing many folds over the past few decades, an approx 5.2 billion pounds of pesticides are used worldwide per year. The pesticides are not only used in agricultural fields but also it is used in the home as sprays, poisons, powders for controlling Cockroach, mosquitoes, rats, fleas and other harmful bugs. Pesticides can contain active ingredient with inert substances, contaminants and occasionally impurities. Once released into the Environment pesticides break down into simpler substances called as metabolites that are more toxic to active ingredients in some situations. pesticides help in the effective mitigation of harmful bugs but unfortunately the risk associated with it surpassed their beneficial effects.

### Importance of pesticide use:-

Pesticides have both primary as well as secondary benefits. Pesticides protects about a third of all agricultural foods globally, although their uncontrolled usage has negative consequences for ecosystem (Zhang et al, 2011). Primary benefits observed after direct usage of pesticides such as killing of insects and other pests that feed on crops. 40 % of crops lost due to disease and weeds and pest collectively worldwide but if there is no pesticides then the quantity of loss will be more than the usual. These pesticides not only saving crops from damage rendered by pest but they also increase the productivity of crops. According to studies, there is a significant increase in crops yield due to pesticides usage and economic losses will be greater if there is

no pesticides. Crops production will be decline which will ultimately leads to shortage of foods.

Pesticides also protect crops from disease outbreak through the control of rodent and insect vector and thus contribute to human health. Pesticides also protect forest and wildlife habitat from the attack of invasive species of plants and non-native species of insects.

### Negative Impacts of Environment-

Risk associated with pesticide is more than the beneficial effects. Population growth and climate change contribute to the increasing use of pesticides which leads to higher global pesticide production in future. Pesticides reach the environment primarily during application and preparation. Application can takes place via different technique depending on the factor like formulation type, the controlled pest and the application timing. After application, pesticides can be taken up by target organisms, it can degrade or transported to the ground water and also these can enter the surface

water bodies, volatilize to atmosphere or reach non-target organisms by ingestion. Depending on the physical and chemical properties of pesticides, their solubility determines the transport in surface runoff and their leaching to groundwater. The higher the level of solubility, greater the carrying and leaching (Mariana furio Franco Bernardes, 2015). Pesticides have drastic effects on non target species and effect animal and plant biodiversity, terrestrial as well as aquatic food webs and ecosystem. According to Majewski and Capel (1995), approx, 80-90 % of the applied pesticides can volatilize within a few days of application. This volatilize pesticides evaporates into the air and subsequently may cause harm to non-target organisms. e.g. herbicides also provide harmful effects to the other plants. An uncontrolled use of pesticides can lead to the reduction of several terrestrial and aquatic plant species. Pesticides also threatened the rare species like Bold Eagle, Peregrine falcon and Osprey (Helfrich et al, 2009). Amongst all the categories of pesticides, insecticides are considered to be most toxic whereas fungicides and herbicides are the second. Pesticides enter the natural ecosystem by the two different means depending on the solubility. Water soluble pesticides get dissolve in water and enter ground water, rivers and lakes hence causing harm to non-targeted species. On the other hand, fat soluble pesticides enters the bodies of animals by a process known as 'Bioamplification' and thus get absorbable in the fatty tissues of animals.

Effects of pesticides on environment-

1. Small concentration of pesticides enter the bodies of animals which are in low level trophic .
2. Secondary consumer eat many primary consumer species and therefore the concentration of pesticides will increase in the bodies.
3. When the high level predator such as Owls eats Shrews and other prey, the pesticides concentration eventually increases many folds in the body.

**Threats to Biodiversity due to use of pesticides-**

The accumulation of pesticides in the food chains is of greatest concern as it directly effects the predators and raptors but also pesticides indirectly reduce the quantity of shrubs, herbs and insects. Excessive or uncontrolled used of pesticides leads to destruction of biodiversity.

**Threats to aquatic biodiversity-**

Many research showed that pesticides are entered in to the ground and surface water by direct application for the control of aquatic weeds and aquatic insects. Ground water is polluted when pesticides leach from the treated fields, mixing and washing sites, surface water system like lakes, rivers, streams, reservoirs etc. Pesticide mobility in water results in pesticides contamination of water sources. Both surface water and ground water caused by pesticides are very serious and urgent issues in freshwater and coastal ecosystems. Pesticide creating contamination in ground water can cause major change in water quality. Even after controlled use, traces are also found in drinking water which can be source of human exposure to pesticides (Macneale et al, 2010). Water is the fundamental need of life which is rapidly polluted due to natural and anthropogenic activities (Hussain and Asi, 2008). Toxicity of Pesticides depend on the factor like exposure level, immune response, immunological essay, stress limit etc. (Banerjee, 1999).

Persistence organic Pesticides and CUP Pesticides enter into the water bodies through different ways like atmospheric precipitation, chemical or Pesticides manufacturing industries releasing unprocessed chemical waste into water bodies and resulting in negative impact on aquatic ecosystem. (Socorro et al;2016).Pesticides can enter the soil through the process of waterdrift, runoff, leaching or can directly enter into the surface water. Water contaminated with pesticides can damage the life of aquatic organisms. It can effects the aquatic plant, decreased dissolved oxygen in the water and cause physiological and behavioral changes in fish population. Pesticides which are applied to land drift to aquatic ecosystem are not only toxic to themeselves but also interact with the stressors which includes algal bloom. With the uncontrolled use of pesticides, a decline in fish population observed (Scholz et al 2012 ) Oxygen level of water also reduce to killing of aquatic plants which leads to suffocation of fish and thus reduce productivity (Helfrich et al, 2009). Level of pesticides is more in surface water than the ground water due to run off from farmland and contamination by spray gift. Amphibians are mostly effected due to pesticides contamination. Carbonyl has been found toxic for amphibian species whereas herbicides glyphosate cause high mortality of tadpole (Relyea, 2005) Small concentration of malathion can cause abundance and composition of plankton and periphyton. The reproduction potential of plant also decreased due to pesticides use.

Table1: *The toxicity of pesticides on the basis of concentration.*

<b>Hazard rating</b>	<b>Dose (mg/L)</b>
Toxicity	LC50
Minimal	>100
Slight	10-100
Moderate	1-10
High	0.01-0.1
Extreme	0.01-0.1
Super	<0.01

Table2: *The acute toxicity (LC50) of some pesticides against certain fish species(Pradip Kumar Maurya et al. (2019)*

<b>Name of pesticide</b>	<b>Fish species</b>	<b>Duration of exposure</b>
DDT	Rainbow trout	96 hrs-8.7 µg/l
Akton	Channel catfish	96 hrs-400 µg/l
Acephate	Feathed M.	96hrs>1000 µg/l
Alachlor	Rainbow trout	96hrs 2.4 µg/l
Endosulfan	Channel catfish	96hrs 1.5 µg/l
Malathion	Labeorohita	96hrs 15 µg/l
Malathion	Heteropneustesfossils	96hrs 0.98 ppm
Methyl parathion	Catlacatla	96hrs 4.8 ppm
Roger	Pontius stigma	96hrs 7.1 and 7.8 ppm

Table3: *Acute toxicity of some insecticides against certain fish species (Source: Hanazato, 2011).*

<b>Insecticides</b>	<b>Fish species</b>	<b>96hLC50</b>
Azodrin	Rainbow trout(RT), bluegill (BG), Channel catfish, Feath-ered minnows (FM)	4.9-50 ppm
Aldrin	FM, Chinook Salmon, RT, blue head, bluegill	2.5-53 ppm
Carbaryl	Coho salmon, Chinook salmon, RT, green sunfish, largemouth bass, yellow perch, and black crap-pie	0.9-39 ppm
Carbofuran	Walked catfish, Chubs	0.22-23 ppm
Chlordane	Coho salmon, cutthroat, RT, FM, Channel catfish	0.72-11.9
Chlorpyrifos	Nile tilapia (NT), Bluegill , FM, RT, Goldfish	0.72-11.9 ppm
DDT	Coho salmon, cutthroat, RT, FM, Channel catfish	1.5-21.5 ppb
Diazinon	Guppies, Channapunctatus	0.9-2.6 ppm
Dieldrin	Coho salmon, Chinook salmon, RT, green sunfish, large-mouth bass, yellow perch and black crappie, Cutthroat	1.2-19 ppb
Diflubenzuron	FM, Brook trout, Yellow perch, RT and Cutthroat	25-240 ppm
Dinitroceresol	RT and bluegill	66-360 ppb
Dioxathion	Cutthroat, Largemouth bass	22-110 ppb
Disulfoton	Coho salmon, Chinook salmon, RT,	60-4700 ppb

### **Threats to terrestrial ecosystem-**

The capacity of soil to filter, degrade and detoxify of pesticides is a function of quality of soil. The degradation of pesticides leads to the production of residues

that persist and transform in aquatic system and terrestrial system. Soil and sediment contamination by pesticides has been a widespread problem in terrestrial areas that cause adverse impacts on the quality of food and agricultural sustainability. Pesticides play major effects on the terrestrial ecosystem, its soil properties and its fauna. When pesticides applied on agriculture it accumulates on the soil and interact with the soil microorganisms which changes microbial diversity, biochemical properties and enzymes activities. Pesticide can damage and reduce soil biomass and decline the soil fertility (Zhou et al, 2006). In terrestrial areas as the soil reveals a large retention capacity of pesticides in their structure by adsorption but also remit old organic pollutant into the atmosphere, groundwater and living organisms etc. Soil is the principal reservoir of environmental pesticides which play important role in global distribution and fate of contamination. Uncontrolled use of pesticides can also affect sublethal effects on terrestrial ecosystem in addition to killing non-targeted plant species. Drifting or volatilization of phenoxy herbicides can damage nearby land plants. Herbicides glyphosate can increase the susceptibility of plants to diseases and reduce seed quality. Population of beneficial insects like bees and beetles can significantly decrease due to use of pesticides like carbamates, herbicides also cause damage to the fungal species which are known to inhibit symbiotic association.

**Effect of Pesticides on plant growth and development-** Chemically treated seeds are exposed to greater chemical concentration than the mature plants during cultivation, so these plants are faced by greater range of phytotoxicity. Pesticides involve a variety of enzymatic and non-enzymatic alternation in chemical and physiological antioxidants that have initial effect on plant growth from germination which leads to reduction in plant yield (Choudhury, 2019).

The excessive use of pesticides can cause oxidative stress due to the formation of Reactive Oxygen Species (ROS) which can finally lead to growth deficiency and reduced the efficiency of photosynthesis in plants. (Vinay Mohan Pathak et al;2022).

**Effects of pesticides on pollinators-**In addition to soil and aquatic ecosystem, pesticides also affect the pollinator. Pollinators are the biological agent of pollination process. Some of the pollinators are honeybees, beetles and fruit flies etc. Pesticides affect the activity of pollinators like colony mortality, foraging and pollen collecting efficiency.

### **Ecological aspects of pesticides-**

Pesticides are included in a broad range of pollutants that have ecological impacts. Different types of pesticides have different types of effect on the ecology. Two processes through which water gets contaminated are-

**Bioconcentration-** This is the process through which movement of a chemical from the surrounding media to the organisms occurs.

**Biomagnification** - This is the process of increasing the concentration of a chemical as food energy is transformed within the food chain. As smaller organisms are eaten by larger organisms, the concentration of pesticides are increasingly magnified in tissues and other organs.

### **Natural factor that degrade pesticides -**

In addition to chemical and photochemical reactions, another two mechanisms that cause degradation of pesticides are-

1. Microbial process in soil and water.

2. Metabolism of pesticides that are ingested by organisms as a part of food.

Through these two processes have beneficial effect in reducing toxicity but it also has adverse effects.

### **Degradation of pesticides in soil-**

Many of these pesticides dissipate rapidly in soils and the process is called mineralization and it results in the conversion of the pesticides into simpler compounds like CO<sub>2</sub>, H<sub>2</sub>O and NH<sub>3</sub>. Some of the processes are the results of chemical reactions such as hydrolysis and photolysis, catabolism and metabolism.

### **Ways through which can minimize the impact of pesticide-**

There are different practices that reduce the potential for pesticides to cause environmental damage or water contamination. Some of the important practices are –

#### **1.Integrated pest management (IPM) -**

Integrated pest management (IPM) does not solely rely on chemicals for the control of pests. Biological control, timely chemical and cultural practices are used to obtain necessary level of control. Pesticides are last line of defense and used only when pest levels are causing sufficient damage to offset the expense of the application.

#### **2.Consider weather and irrigation plans-**

If pesticides are applied before rainfall or irrigation, they may result in reduced efficacy as pesticide is washed off the target crop which results into the need of reapplying the pesticide. Heavy rainfall can also cause pesticide contamination

runoff at the site of application.

### **3.Pesticide use and storage-**

It is necessary to read and follow the directions written in the pesticide container. Pesticide should not mix near wells or other sources of water

### **4.Dispose of pesticide and chemical wastes safely**

Excess chemical and pesticide should dispose in accordance with the label directions.

### **5.Reduce off target drift-**

It should not begin application when wind and temperature favors pesticide drift to an off target area.

### **Remediation technologies for pesticides removal-**

With increasing range of pesticides, it is very important concern to remove pesticides from environment. Many techniques have been discovered to remove pesticides including air, water, soil and food. The instant method of removing pesticides from food are washing, peeling, cooking and blacing but it is impossible to remove complete pesticides due to the persistence and stability. Biological and chemical methods are suitable for pesticides recovery.

Contaminant-immobilization technology (CIT) is an in-situ approach used for very low cost effective for restoration of soil polluted by pesticides. In this technique, adsorption takes place which remove toxicity from non-targeted organisms. Fenton advanced oxidation process also used or remove organochloride pesticides

Including DDT. DDT is highly persistence and high bioaccumulation which is hazardous to environment. Degradation by microbial activity is also an important biological method which is very less cost effective, eco friendly and best technique for pesticide removal (Gavrilescu, 2005). Bacteria can degrade pesticides at good rate isolated at different ecosystem. This is an important method which does not cause any damage to environment. In this technique, microbes degrade pesticides for nutrient and release c02 And water.(Huang et al, 2008). Degradation of pesticides by microbes also depends on the available environmental factor.

### **Conclusion and recommendation-**

Pesticides are mostly used in agricultural sector for the purpose of controlling unwanted organisms which can cause damage to crops. Although pesticides have many benefits for crops but also create severe impacts on the environment. They can cause damage to our natural environment by contaminating it and cause several health issues. Studies observed that pesticides not only damage agriculture lanmd but also national parks and other land.

For the purpose of our healthy life, a healthy environment is necessary .Recently, removal of pesticides pollutant become a topic of concern worldwide. Many techniques have been developed for their safe removal. Pesticides are removed from soil, environment, and water by using plants, animals and different chemicals. By controlled use of pesticides, environment can be saved which is necessary to achieve our sustainable development goals.

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