

Role of Pesticides in Water Pollution

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ABSTRACT

Pesticides are some kind of chemicals which are used all over the world for controlling pests, weeds and diseases within crops and also for health care of animals and humans. These can be categorized as insecticides, rodenticides, herbicides, fungicides, nematocides, plant growth regulators and molluscicides. However, pesticides have proven beneficiary in crop yield and in reducing vector borne diseases, but they also poses various negative impacts on our environment. The irrelevant and uncontrolled uses of pesticides have caused serious threats to human health and ecosystems or whole environment. These can cause serious negative effects, even if used at a low amount. Water resources are being contaminated by the use of the pesticides. Water pollution is at rise due to persistent organic chemicals present in pesticides. Rainfall, drainage, microbial activity, application rate, soil temperature as well as mobility, solubility and half-life of pesticides are some of the factors which are responsible for the movement of pesticides residues to water. By using planned and safe dose, these risks can be minimized. We should protect our resources from contamination for their sustainable use in future; we should not only use these synthetic chemicals very carefully but also should be concerned about their metabolites and transformation products.

Keywords: Pesticides; Pesticide pollution; Water pollution; Health impacts; Environment problems

INTRODUCTION

Water is a basic requirement for everyone's life. At present time, our essence is in risk due to contamination of water that is increasing by development of current technologies. In India, the contaminated water is disturbed approximately 50% people in cities and 80% people in villages [1]. The technology is creating burden on the water reservoirs that isn't taken seriously. There are some regions where water is not secure for drinking purpose due to its high concentration of chemicals, metals, pesticides and bacteria [2].

Pesticides are one of the major pollutants that degrade water quality. Any substance or mixture of substances proposed for avoiding, killing, fighting or weaken any pest or weed is a pesticide. The pest can be unwanted plants, destructive insect, nematods, mammals, birds, fishes, microorganisms. These pests create competition for humans for foodstuff and harm resources, or increase diseases or cause irritation. Insecticides, herbicides, fungicides and rodenticides are generally used as pesticides. The other less well-known pesticides includes growth regulators, plant defoliant, surface disinfectants etc. Mostly, pesticides are used in

health management and crop fields. They are helpful in health protection of people as they destroy harmful pests like mosquitoes and also prevent agriculture land from diseases [3].

During last 40-50 years, the application of pesticides has raised rapidly. With increased use, concern about harmful effects on other organisms and humans has also increased [4]. The harmful effects of pesticide are the reason for fish kills, health problems in humans, and reproductive failure in birds. It has been concluded that the amount of pesticide which actually reaches to targeted pest is less than 0.1% and the rest get into the environment gradually and contaminates air, water and soil.

At the present time, water pollution by pesticides is a critical issue, especially in range of extensive agriculture where leaching of these harmful chemicals in water systems cause toxic effects on aquatic, animal and human health. There is a need of concern for Groundwater and surface water contamination as pesticides can make their approach to drinking water. Currently, various pesticides of different chemical composition are applied to agricultural land in whole world [5]. The toxic substance may runoff into streams, rivers or water bodies and results

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in water pollution. It is indicated in researches that irrelevant use of fertilizers pollute the water through leaching of nitrate from pesticides and nitrogenous fertilizers. It may also cause death of aquatic animals [6]. Although pesticides are used for beneficiary work, they have some limitations also. According to the Stockholm Convention on persistent Organic Pollutants, 10 of 12 most harmful and persistent organic chemical are pesticides [7].

There is a need for understanding of processes which cause harm to water resources to conserve hygienic quality of water. Though, the use of pesticides and fertilizers are in our hand, we can prevent water quality by using them properly. It is necessary to have knowledge about pesticide's nature for an easy understanding of the risks associated with them [8]. The presence of constant toxic chemicals in the environment raised a serious global concern as they have adverse effects on aquatic life, wildlife and human beings. So, we have to state the harmful effects of pesticides [9].

LITERATURE REVIEW

How pesticides came into existence (Key highlights from past to present)

- The history of the use of the pesticides is of very ancient time. It all started with the ancient Romans as they used Sulfur for destroying pests and ash and salts for weeds.
- The Arsenic (mixture of arsenic and honey) was started to use in 1600's to control pests. An impure form of Arsenic, Copper was used in 1867 for controlling the outburst of Colorado potato beetle in USA.
- The major use of pesticides came into existence around and after Second World War, when various efficient and cheap pesticides were produced. The discovery of Dichlorodiphenyl-trichloroethane (DDT), Aldrin, BHC, Dieldrin, 2, 4-D, Endrin has been related to this time period. The introduction of various

pesticides in different years has been illustrated in Table 1.

- Glyodin, Captan, Malathion, Fungicides were discovered between 1950 and 1955. The triazine herbicides were introduced between 1955 and 1960. In 1961, the use of pesticides was at peak. But after 1962, there was a sharp decline in the introduction of new pesticides due to environmental concerns. The book named 'Silent Spring' by the author 'Rachel Carson' has drawn the attention of people towards harmful effects of pesticides. Synthetic fungicides, Sulfonylureas, pyrethroids, Metaxyl were discovered in 1970-80s.

- DDT was banned completely in USA in 1972 followed by the ban on Dieldrin, Eldosulfan and Lindane. Then the list of restricted pesticides has increased ever since. Later in 2001, in Stockholm Conference, 179 nations signed to ban 12 POP's (Persistent Organic Pollutants) including DDT completely. The use of nicotinoid pesticides has been restricted by the European Union in 2013.

- At present, more focus is on biological control of pests or using bio controlling agents or bio-rational pesticides.

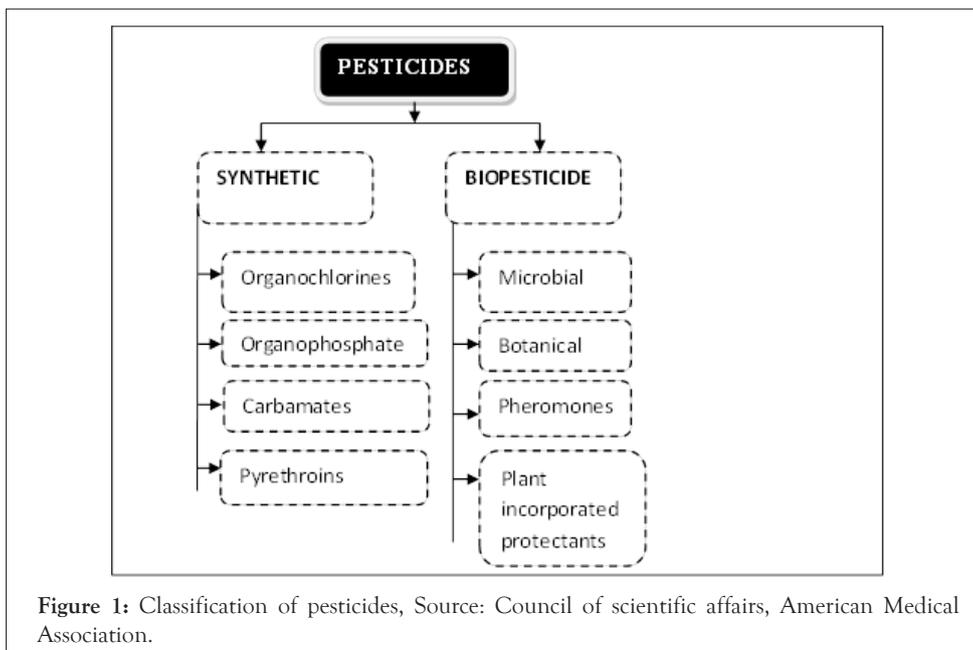
Classification of pesticides

Pesticides have different properties and characteristics. Pesticides can be characterized in different types. Generally they are classified according to their targeted pest species, their mode of action and chemical composition. Also, the Council on Scientific affairs, American Medical Association (1997) classified pesticides in two main categories, that is, synthetic pesticides and bio pesticides (Figure 1).

Classification based on the mode of action: In this type, pesticides are characterized into two types-systemic and non-systemic pesticides. Systemic pesticides enter in plant tissues and transported within plant vascular system for a desired effect. Non systemic pesticides don't enter into plant tissues and not transported in plant vascular system.

Table 1: History of pesticide development.

Time period	Chemicals discovered	Major events	References
1800-1920's	Early organics, Chlorophenols, Nitrophenols, Naphthalene, creosote,	In year 1867	(Paris Green), a form of copper arsenite- used to control Colorado potato beetle outbreak 10
1885-1892's		In year 1885	A copper mixture was invented to control Mildew by Professor Millardet 10
		In year 1892	Germany synthesized Potassium dinitro-2-cresylate 10
1935-1955	Chlorinated, cyclodienes, Chlorinated organics, DDT, HCH	In year 1939	A swiss chemist 'Paul Muller' discovered DDT; Phenoxyacetic herbicides and organophosphate insecticides were discovered 11
1950-1970	Organophosphorus compounds, cholinesterase inhibitors, Carbamates,	In year 1950	Production of glyodin, fungicides captan and insecticide malathion 12
		In year 1961-71	Agent orange was discovered 13
1970-1985	Synthetic pyrethroids, juvenile hormone mimics, avermectins, biological pesticides,	In year 1972	Official ban on DDT 14



Classification based on the targeted pest species: This is the most common type of classification. For example, herbicides target plants, insecticides target insects, and bactericides target bacteria. Some are fungicides, rodenticides, algacides, avicides and Ovicides. This type of classification is shown in Table 2.

Table 2: Pesticide classification by target pest.

Types of pests	Target pests	Example
Insecticides	Kill insects and arthropods	Aldicarb
Fungicides	Kill Fungi	Azoxystrobin
Bactericides	Kill Bacteria	Copper complexes
Herbicides	Kill weeds and other unwanted plants	Atrazine
Acaricides	Kill mites that feed on plants and animals	Bifenazate
Rodenticides	Control mice and other rodents	Warfarin
Algaecides	Control or kill growth of algae	Copper sulfate
Larvicides	Inhibits growth of larvae	Methoprene
Repellants	Repel pests by its taste or smell	Methiocarb
Ovicides	Inhibits growth of eggs of insects and mites	Benzoxazin
Virucides	Acts against viruses	Scytovirin
Molluscicides	Inhibits or kill mollusks	Metaldehyde
Nematicides	Kill nematods that act as parasites of plants	Aldicarb
Avicides	Kill birds	Avitrol
Piscicides	Act against fishes	Rotenone
Silvicides	Act against woody vegetation	Tebuthiuron
Termiticides	Kills termites	Fipronil

Classification based on the chemical composition: It is one of the most practical types of classification. Pesticides are classified according to their chemical ingredients. It is suitable for researchers in the field of environment and pesticides because it denotes the physical and chemical properties and the values of pesticides [10-14]. Classification based on chemical nature is

shown in Table 3.

Table 3: Pesticide classification by chemical composition.

Chemical group	Chemical names
Organochlorine	DDT,DDD, Eldrin, Dieldrin, Lindane, BHC, Toxaphene, Chlorobenzlate, Methoxycholro Aldrin, Chlordane, Heptachlor, Isodrin, Isobenzan, Cholro propylate
Organophosphates	Dimefox, Mipafox, Methyl Parathion, Ronnel, Bidrin, Enitothrion, Phorate, Fenthion, Abate, Dichorovas, Diptrex, Trichorofan, Dimethoate, Malathion, Demetox, Oxydemeton-methyl, Phosphomidon
Carbamates	Methyl Cabaryl, Carbanolate, Prupoxur,, Dimethan, Isolan, Carbofuran, pyrolan, Aminocarb, Aldicarb Thio Vernolate, Pebulate, Diallate, Monilate, Butylate, Trillate, Cycolate, Thiourea Dithio Methan, Thiram, Ferban, Amoban, Naban, Zineb, Maneb, Ziram Polyran, Dithane M-45
Pyrethroids	Allethrin, bonthrin, Dimethrin, Tetramethrin, Ptrethrin, Cyclethrin, Furethrin, Fenevelerate, Alphamethrin, Decamethrin, Cypermethrin,
Phenyl amides	Carbanllates, Acylanalld, Toluldines, Acetamide
Phenoxy Alkonates	2,4-D(2,4 Dichloro phenoxy acetic acid) 2,4 5 T(2,4 5 Trichloro phenoxy acetic acid) Dichloroprop, Mecoprop, Erbin, Sesone
Trazines	Atrazine, Simazine, Ametryn, Atraton, Chlorazine, Cynazine, Cyprazine, Metribuzin, propazine, Simeetryn
Benzoic acid	Dicamba, Dichlorobenil, Cholroambin, Tricamba, Neptalan, Bromoxynil
Phthallmides	Captan, Diflotan, Folpet
Dipyrids	Paraquat, Diaquat
Others	Pentachlorophenol, Floroacetate, Phenyl mercuric acetate, Ethyl mercuric phosphate, Methyl mercuric chloride, sodium arsenate, Calcium arsenate, Lead arsenate, Cacodylic acid, Aluminium phosphide, Zinc phosphide

Pesticide pollution

There are more than 500 different types of pesticides that are used in our environment. In the past few years the use of pesticides has increased as they enhanced the quality of food and crops.

Though, because of their high use, the concern about their dangerous effects on non-targeting organisms has also been increasing. Humans, birds and fishes indicated the effect of non-target pesticide poisoning. Some pesticides can persist in environment for long time, for example, organochlorine insecticides are still recorded in surface waters 30 years after their use and had been excluded [15]. They cause adverse effects on health as they collect in the tissues of organisms. Their formation as bioactive molecules to eliminate fungal, vegetal and animal species indicates that they can be harmful. Once these pesticides are applied to the crop fields, they can find different ways to reach aquatic systems depend on their water solubility and polarity. In surface waters, mostly pollutant enters from crop fields by runoff from irrigation or after precipitation [16]. In lakes, pesticide changes clean water into turbid water. As mentioned above, both point and non-point sources of pollution from pesticides are generally anthropogenic. So it is estimated that in surface water the toxic effects of these chemicals are caused due to anthropogenic activities that occur there. The distance between point or diffuse sources and water bodies is also relevant to the concentration of these chemicals in water bodies [17]. Pesticide persistence in the ecosystem is characterized by a number of phenomena occurring in different environmental chambers, such as plant, surface and groundwater, air and soil [18]. The uncontrolled and improper use of pesticides has become a typical cause of pollution. Though pesticides are directly sprayed to plants and soils, the amount of pesticide reached to target is less than 1%. An unintended delivery of pesticides because of spills, waste dumps, leaking pipes, and groundwater may cause them to live long in the environment. It is necessary to correctly evaluate the condition of contamination in water, soil and air for better management of pesticides [19].

Pesticides and water pollution

Pesticide residue in water is a major concern as they create harmful effects in living organisms. Pesticides can enter into water systems by several pathways like agriculture runoff, spillage, drifts, industrial effluents, washing of spray equipment, aerial sprays and transport from soils treated with pesticide. The most common movement of pesticides from land to water is by runoff or drainage [20]. The high concentration of pollutants could be found in river and groundwater than lakes because the detected concentrations of most pesticides follow a seasonal variation, with highest values occurring during the post spring and summer period followed by a decrease during winter [21-25]. Runoff from crop field is the most common way by which pesticides can enter in aquatic systems and pollute them. Pesticides are also applied in forested areas, golf courses, landscape areas and along roadsides [26]. The free and unsystematic use of pesticides has created serious issues for environment as it causes adverse effects in organisms. Some of the environment resistant and least biodegradable pesticides are high on use in many countries even though they are banned.

Pesticides may exert several toxic effects because they are fat soluble and can accumulate even at low concentrations that could

be predicted at molecular, behavioral and biochemical levels [27].

Currently in India organochlorine insecticides such as HCH and DDT comprise more than 70% of the pesticides. Reports from Bhopal, Delhi and some other cities and from some rural areas have indicated the availability of high level of pesticides in fresh water systems as well as in bottled drinking water samples.

One of the most shocking effects of pesticides contamination of groundwater was highlighted in 2002 when it was found that bottled water has contained pesticide residues. CSE recognized seventeen brands of bottled water with pesticide contamination which are commonly sold in areas of Delhi. The most common residues which were found in almost all samples are of organochlorine and organophosphates.

ERS conducted a research and calculated the total contribution of runoff in release of sediments and nutrients to streams and lakes. Total ninety nine watersheds were tested and it was found that forty eight had sediments and nutrients in excess levels. This research indicates that the main cause of nitrogen in 9 watersheds, sediments in 34 watersheds and phosphorus in 31 watersheds is agriculture. Another ERS study also investigated that excessive contamination in coastal waters is also by pesticides' runoff from agriculture land. In last few years the pollution level of many rivers were examined and it has been found that there was contamination due to continued runoff from crop lands along with industrial or domestic discharge.

The key users of pesticides are farmers as they use an enormous quantity of pesticides for protecting their crops or to increase crop yield. Also, a very huge quantity of insecticides is used by wood treatment industry for treating the raw material. Besides, the great usage of pesticides in urban areas majorly in home-gardening for controlling pests is a major source of pesticide pollution in water; insecticides are used very profoundly in urban areas [28].

Sources, entry and fate of pesticides into water

It has been investigated that source of pesticides into water has been depend on the behavior and pesticides' properties and the prevailing climatic conditions. Research has concentrated on understanding and observing the practices which conclude pesticide application to crop land. It is now increasingly accepted that there are also a number of other pathways by which pesticide can enter in water bodies. Usually there are two sources by which pesticides enter into water which are shown in Table 3. Pesticides can enter into water bodies by point and non-point sources.

Point sources: Point source belongs to the fixed sites and also includes chemical runoff during improper handling, storage and discharge. These can be little, simply recognized items or areas where concentration of pesticides is high as containers, spills or tanks. The spills of pesticides or direct movement of pesticides in groundwater is a point source kind of pollution. The use of insecticides in urban areas is typically point source pollution for surface water. These sources can be regarded as point sources as they can be related as a mathematical point to clarify study in mathematical modeling. Pollution point sources are similar to other point sources in chemistry, physics, optics and engineering. It is a single limited source of water, air, noise, light or thermal pollution. A point source has negligible extent which differentiates it from other pollution source configurations.

Diffuse sources: Diffuse sources or non-point sources are the

main cause of passage of pesticides in water. It is the movement of pesticides from large regions from the watersheds or from agriculture land to water systems by runoffs, erosion or leaching. It arises from unauthorized sources and diffused land-use activities. Fertilizers, sediments, gross pollutants soil erosion by pathogens, pesticides, salts, toxicants, acid sulfate soils in drained wetlands, etc. are the pollutants of diffused pollution sources.

Spray drift: Spray drift is the most possible route of entry of pesticide into surface water. Sometimes pesticides are applied to such lands which are near to surface water which causes spray drift. The data from a field showed the quantity of substances that creates drift in water. One such report indicated a drift discharge of the normal field extending from 0.3% to 3.5% by use of a pesticide in field.

Surface runoff: Some of the potential pollutants flow across the surface by irrigation, precipitation or some other source and mix up within a water body. Then it starts to percolate into the soil. The soils of elevated slope are more vulnerable to runoff.

Leaching: Leaching is a process in which a soluble chemical or mineral is drain away from a solid (ash, soil etc.) in a liquid. The residues of leaching may transport to underground water directly or it may transfer in a lateral way to surface water. When water

flows through fissures, cracks or by preferential flow, it flows quickly and the residues have very less chance to disperse and they cause great loss.

Drainage: Land drainage has an objective as it removes the extra water from surface. Several under drainage systems has been installed for improving the quality of water such as clay pipes, stone drains, horseshoe tiles, and slotted plastic pipes. These drains remove water from permeable soils effectively. When rainfall occurs, artificial drainage is responsible for the movement of considerable amount of dissolved pesticides which may cause loss of about 1%.

Fate of pesticides in water: To know the circulation of pesticides in biosphere, it is important to study the transport and fate of pesticides (Figure 2). After being applying on land, pesticides meet up with a range of fates. The part of pesticides which are not taken up by crops or land would be retain in soil or degrade to some other form. Pesticides which are soluble would be passed away by water molecules particularly during rainfall and percolate downward in the layers of soil and then reach to groundwater or else, the insoluble one will be bound to the particles of soil and get collected in the top most layer of the soil. These accumulated particles have a high tendency to contaminate surface water, streams, lakes and rivers by erosion or runoff [29].

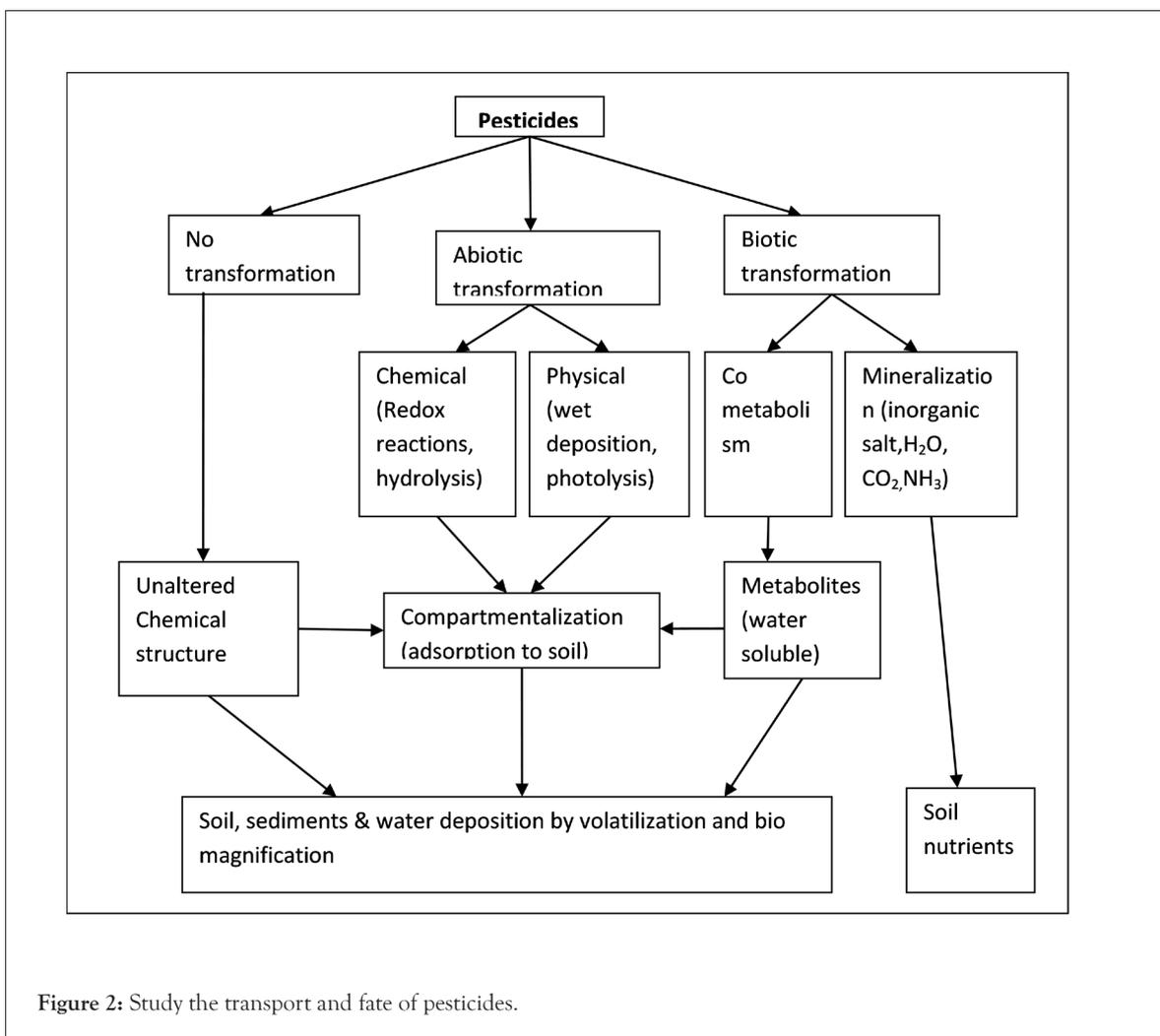


Figure 2: Study the transport and fate of pesticides.

The contamination of water from pesticides can also be contributed by volatilized pesticides in atmosphere. They can re-deposit during rain and then can enter to soil and surface water. Though, this pathway is irrelevant. Generally, the pesticides can enter the hydrological cycle specifically by surface loss and leaching. However, the extent of contamination of water is affected by the properties of pesticides, site conditions, soil characteristics and the way of application and practices of pesticide use [30].

As most of the pesticides are organic persistent compounds, they go through degradation by photochemical, microbial, and chemical reactions. In microbial decomposition, the pesticides degrade via mineralization process and break down into carbon dioxide and some other chemical form. In photo-chemical degradation, pesticides degrade through photolysis and break down by UV light. In chemical decomposition, the pesticides degrade by redox reactions and hydrolysis with water, air and other compounds of soil.

Factors affect mobility of pesticides in water:

There are various factors on which potential of pesticides to infect water depends:

- Solubility of pesticides in water
- Half-life of pesticides
- Environmental factors like season, soil, distance and weather
- Methods and processes linked with the use of pesticide.

The properties of pesticides like solubility, half-life and adsorption capacity determined the ability of leaching and surface loss. Those pesticides which have low degradation rate tend to have a long half-life period and ensure a longer period of time in environment and then pollute water resources.

In addition, metabolites as end products and transformers are produced from bio-degradation of pesticides. These may have either high or low toxicity than the parent pesticide. Additionally, the movement of pesticides is characterized by the solubility and adsorption capacity of the pesticides. Pesticides which can heavily adsorbed by soil are not as much in filter downward but can be taken away by erosion of soil particles by runoff and then get into surface water. The pesticides which have less adsorption capability in soil are highly soluble and can dissolve or leach in groundwater.

Groundwater pollution is in excess when there is a new crop or no crop. A crop which is mature or growing has the capability to decrease concentration of pesticides in a number of ways:

- Higher plants decrease the capability of pesticides to move in soils and their entry into water as they absorb more water from the soil.
- Higher plants can restrict runoff from an area by collecting rainfall.
- The enriched microbes in the soil increase the disintegration of the pesticides by bacteria.

Effects of pesticide' contaminated water

Although pesticides have beneficial effects in some areas, they have also some harmful effects on health and environment. Pesticides are exclusive pollutants as they have high active molecules and

have high poisonous effects. Many pesticides do not differentiate between their target and non-target organisms and cause harm to wildlife, birds, mankind, fishes and some other organisms. It is reported that there are about 5000-20,000 deaths per year due to pesticides and about 50 lakh to 1 million people get infected [31-33]. The sources of water became contaminated as pesticides contain persistent chemicals. The detectable amount of pesticides is present in groundwater and surface water which makes them unfit for use or cause severe health impacts.

Impact on human health: In spite of major advantages of pesticides to maintain better quality and protection of crops or raw materials, they pose a high threat to human health as they have tendency to accumulate in cell membranes.

There are two main health concerns caused by degrading water quality through pesticides. The first one is direct consumption of fishes which are contaminated by pesticides and second one is from the direct consumption of water polluted by pesticides.

Pesticide enters the human body through inhalation, ingestion, or by penetrating into skin. But mostly the people get poisoned by consuming pesticide contaminated water or food. They accumulate in human tissues or storage compartments. Even though the body of human can excrete the toxic chemicals but sometimes it absorbs them in the blood vascular system. When these toxins concentrate in large amount in the body, they show adverse effects. The exposure to pesticides can cause hormonal disturbances, reproductive disorders, immune-suppression, reducing intelligence and also cancer [34,35]. The harmful effect of pesticide on human health can become visible in sometime or few days or they can be long term effects which may appear in months or years. Acute and chronic effects of pesticide exposure on human health are discussed below [36-38].

Acute effects of pesticides: Instant reaction of pesticides show symptoms like itching, rashes, dizziness, headache, irritation in nose and throat, stinging of the eyes and skin, abdominal pain, diarrhea, vomiting, nausea, blindness, blurred vision and sometimes death. Acute effects of pesticide are not so harsh to look for medical help.

Chronic effects of pesticides: Chronic effects of pesticides may prove fatal and don't become visible for several years. These effects are life long and cause harm to more than one organ. Expose to pesticides for long periods have subsequent effects:

- The vulnerability to pesticides may affect neural health like vision problem, memory loss, loss of coordination, and problem in receiving motor signals.
- The long term contact to pesticide can damage immune system and may be the reason for hyper-sensitivity, allergy and asthma.
- Pesticide is known to cause cancer of testes, ovaries, breast and brain.
- Exposure to pesticides for a longer period alters the female and male reproductive hormones and affects their reproductive ability. As a result it causes birth defects, infertility, impulsive abortion and conceiving problems.
- The presence of pesticides in body for long time can cause blood disease, and may also destroy kidneys, lungs and liver.

Ecological effects of pesticides: Approximately, every part of

environment has been contaminated by pesticides. The residues of pesticides are found in soil, air, groundwater and surface water. The pesticide pollution has posed a serious threat to environment and non-targeted organisms that ranges from microorganism to insects, fishes, birds and plants. Pesticides have diverse ecological effects and are frequently interconnected. Effects at the ecological level are generally recognized as an early advice sign of adverse impacts on human health. These effects differ according to the type of pesticide used on an organism. Most of the ecological effects are long term and are not reported by researchers, so have issues for whole ecosystem. Following are some ecological effects:

- Reproductive failure
- Damage of immune system
- Tumors and cancers
- Damage of DNA
- Death
- Interruption of hormones
- Deprived health of fishes
- Mutations
- Some other physiological effects

These effects are associated with a combination of environmental stress and extent of exposure to pesticide. Ecological effects of pesticides expand further than an individual entity and may expand to entire environment.

Strategies to reduce pesticide loss to groundwater and surface water

The movement of pesticides to surface water or groundwater can be managed by applying some proper management strategies or techniques.

- **By preventing handling and storage loss:** Pesticide loss can be reduced by proper storage of pesticides, preventing accidents, assuring proper mixing, handling and disposal and by well-maintained construction.
- **By reducing the rate of product:** There is a direct relation between the quantity of pesticide that is applied and the amount which is lost to water. When there is a high rate, there is more loss. Split applications, banding, reducing application rate, foliar application; are some of the practices that can prevent loss of pesticide to water.
- **By reducing the potential of transportation to surface water:** Run-off and soil erosion or loss of sediments can transport pesticide to surface water. Any technique that can delay the onset after precipitation or lessen the amount of run-off can reduce the rate of pesticide loss by runoff.
- **By reducing the detachment properties to soil:** Techniques that can lessen the potential for detachment from soil can prevent contamination. One can select a pesticide that can be bound strongly to soil particles and hence reduce leaching loss.
- **By providing mechanism for deposition:** Grass waterways, filter strips, buffer zones etc, may reduce the run-off velocity and then help in increasing the infiltration of water, adsorption on soil or on vegetation. This can lessen the quantity of pesticide loss from a land.

DISCUSSION AND CONCLUSION

Pesticides have become very beneficial to farmers and to other people worldwide as they can increase crop yield and can provide a number of other benefits or advantages to everyone directly or indirectly. But due to hazards imposed by the pesticides on environment and human health; concerns are raised about its safety. The use of pesticides is causing serious health impacts. Even at less concentration, pesticides are a major threat to environment. The pesticides are contaminating water bodies and are causing water pollution. However, the hazards of pesticides can't be eliminated completely but they can circumvent in another way. We can minimize the harmful or unfavorable effects of pesticides by various ways like by applying alternative cropping techniques or through better spraying equipment's.

Formulation of safe, better and eco-friendly pesticides can lessen the adverse impacts related to use of pesticides. The risk of pesticides can be reduced if we use pesticides in suitable amount and use them only when necessary or required.

Many people or farmers are not aware of the toxicity or harmful effects of pesticides. They don't have any information related to type of pesticides, their hazards, level of poisoning and precautionary measures they have to take before use them. Because of these things, persistent or toxic chemicals are used to kill pests, weeds or for other use which can cause intentional or unintentional exposure. To minimize the use of toxic pesticides, it is necessary to create awareness among people.

Chemical pesticides can be used by combining them with natural remedies and treatments in future, which can cause more sustainable removal of insects or pests. The use of microbes or biological controlling agents would be a better alternative to use. There is a serious threat to aquatic ecosystems from pesticides. Now, it is the time to integrate the study of various disciplines involving environmental chemistry, toxicology, landscape ecology, conservation biology, population ecology, and community ecology; for understanding the direct or indirect impacts of pesticides.

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