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Research

BIOACCUMULATION OF XENOBIOTICS COMPOUND OF PESTICIDES IN RIVERINE SYSTEM AND ITS CONTROL TECHNIQUE: A CRITICAL REVIEW

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ABSTRACT

The intensive use of pesticides resulted in dispersal and persistence of pollutants throughout the global environment. Pesticides contamination in river fish, sediments and water ecosystem has become one of the most sensational issues due to their deleterious effect on public health and environment. In natural habitat, certain microbes are capable of metabolizing those persistent compounds or detoxify them which could be employed for bio-remediation. The direct use of different control technique of pesticides, like chemical, biological, mechanical, trapping, cultural and sanitation etc., such microorganisms are capable of degrading xenobiotics is also becoming a popular approach to safeguard the environment. The review paper focused on riverine ecosystem contamination and their control technique of the impacts and focus of the organocholorine pesticides in fish tissues.

INTRODUCTION

Pesticides contamination of aquatic ecosystem has emerged an environmental issue in the last few decades, and it is causing concern with respect to the risk for fresh and marine ecosystems. The different types of pesticides widely present in near the source of water body, as well as in bed sediments, has been well documented around the world. Concentration of pesticides residues higher in surface water through agricultural runoff, spray drift and domestic waste is majorly contributed. Several pesticides are adsorbed in the particulate matter and eventually are incorporated into the river sediments (Allan, 1986). Organochlorine pesticides (OCPs) are among the agricultural chemicals that used extensively for long periods. They have been used worldwide in agriculture as well as in mosquito, termite and tsetse fly, and insects control program (Guo, *et al.*, 2008). The behaviours of organochlorine pesticides are highly soluble in lipid results they have a potential accumulation in food chain posing toxicity a great threat of ecosystem and ultimately human health effects and the environment globally effected (Afful, *et al.*, 2010). OCPs are more stable compound in living tissues with long half-life of pesticides in environment (El-Mekkawi, *et al.*, 2009). It is a hydrophobic molecule which disrupts of ionic channels like pumping of neuronic cell membrane leading to automatic stimulate of neurons and involuntary contraction of muscles of aquatic life (Esmali and Sari, 2002).

Pesticides are regularly using for the protection of crop, vineyards and nursery plants. These pesticides can enter aquatic ecosystems, posing a threat to non-target species, including fish, mammals, birds, insects as well as humans (Fawell, 1991; Kuivila and Foe, 1995; Domagalski, *et al.*, 1997). Detection of potential cause of pesticide used an estimation of exposure which is usually based on predicted environmental concentrations (PEC) and their effects (Bascietto, *et al.*, 1990). However, it has also been pointed out that exposure assessment should rather be substantiated by measuring the real contamination in the field instead of using only modelling approaches (Solomon, 1996). Non-point source of pesticide pollution can enter streams and rivers via three main routes; leaching (Fawell, 1991), spray-drift and run-off (Merkle and Bovey, 1974; Fawell, 1991; Antonious and Byers, 1997; Everts, 1997), the studies regards runoff as the most important factor with regard to contamination of surface waters in arid areas. The runoff-related input usually leads to an increase of

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total suspended solids and pesticides which may enter the surface water as either water-dissolved or particle-associated chemicals (Wauchope, 1978; Malik, *et al.,* 2015).

The use of organochlorine residues has been restricted by most of the countries for their long-term persistence in the environment, their illegal use in agriculture field is uncommon and many countries still using the different health awareness programme (FAO/WHO 1978). Pesticide chemicals are introduced into aquatic ecosystem from agricultural runoff (Scott, *et al.* 1999). The presence of OC pesticides even at very low concentration in the water undesirable for long time consumption by river water ecosystem and may be toxic to fish. The toxic substances to aquatic life disturbed an increased by possible biomagnifications of the pesticides in aquatic organism (Murty, 1986).

Fishes are most important source of energy for the high-grade protein and they occupy an important position in the socio- economic condition of India. West Bengal is the famous for the largest producer of inland fish and consumes about 11.67 lakes tones annually. As a consequence, there is a likelihood of bioaccumulation of organic and inorganic pollutions like heavy metals and pesticides in fish and other aquatic organisms and without proper monitoring programme for the safety evaluation to consumers the situation may raise to an alarming level. (Amorastt, *et al.,* 1983; Jinha, *et al.,* 1993). Among a large number of man-made producing chemicals, organochlorine such as aldrin, dieldrin, dichloro diphenyl trichloro ethane (DDT) and its derivatives of dichloro diphenyl dichloro ethylene (DDE), hexachloro cyclohexane (HCH), benzene hexachloride (BHC), and polychlorinated biphenyls (PCBs) are of highly bio-accumulative nature and toxic biological effects. These chemicals are persistent in naturally in environmental component by the biomagnifications in the food web, and impose various toxic effects ultimately marine organisms (Tanabe, *et al.,* 1997). In the 12th Stockholm Convention, nine organochlorine pesticides, including aldrin, toxaphene, DDTs, chlordane, dieldrin, endrin, heptachlor and hexachlorobenzene, were controlled as persistent organic pollutants (POPs), different types of organic chemicals that a very harmful affects to the environment and the different ecosystem.

Classification of pesticides

Pesticides may be classified in a number of ways; these classifications can provide useful information about the pesticide chemistry, what they target. The some commonly target animals, plants and other classification. The pesticides were classified different categories on the basis of different uses of pest control shown in Table 1.

Table 1. Classification of pesticides and different uses

S.No.	Types of Pesticides	Use for
1	Fungicides	Kill fungi (including blights, mildews, molds, and rusts).
2	Fumigants	Produce gas or vapour intended to destroy pests in buildings or soil.
3	Herbicides	Kill weeds and other plants that grow where they are not wanted.
4	Insecticides	Kill insects and other arthropods.
5	Miticides (also called acaricides)	Kill mites that feed on plants and animals.
6	Microbial pesticides	Microorganisms that kill, inhibit, or out compete pests, including insects or other microorganisms.
7	Molluscicides	Kill snails and slugs.
8	Nematicides	Kill nematodes (microscopic, worm-like organisms that feed on plant roots).
9	Ovicides	Kill eggs of insects and mites.
10	Pheromones	Biochemicals used to disrupt the mating behaviour of insects.
11	Repellents	Repel pests, including insects (such as mosquitoes) and birds.
12	Rodenticides	Control mice and other rodents.
13	Defoliants	Cause leaves or other foliage to drop from a plant, usually to facilitate harvest.
14	Desiccants	Promote drying of living tissues, such as unwanted plant tops.
15	Insect growth regulators	Disrupt the molting, maturity from pupal stage to adult or other life processes of insects.
16	Plant growth regulators	Substances (excluding fertilizers or other plant nutrients) that alter the expected growth, flowering, or reproduction rate of plants.

Pesticides and environment

Residues of pesticides damages caused environment health of all living think, such as existence of pesticides make necessary of the development of technologies that guarantee their elimination in a safe, efficient in economic way. This kind of treatment has been approached from biotechnological point of view in order to be able to have a methodology that is safe and more economic than the conventional treatments, as well as avoiding additional damages to the environment. Biological processes have been used to treatment of wastes and polluted sites for the pesticides (Araya and Lakhi, 2004). In many cases, it has been reported that the microorganisms are very important in the degradation of xenobiotic compounds. Biological treatment can be applied to compounds whose chemical structure in the nature is infrequently or inexistent because they are synthesized artificially (Ortiz-Hernández, 2002). Additional use of pesticides from different way for preventing and controlling of pest, the biodegradation of these pesticides provides a cheap and efficient solution for their final disposal or for treatment of agricultural soils, contaminated water or polluted ecosystems. In 1973, the first bacteria with the capability of degrading organophosphorus compounds were described (Sethunathan, 1973; Sethunathan and Yoshida, 1973; Siddaramappa, *et al.*, 1973).

The use of pest control chemicals known as pesticides is well recognized in agricultural, non-agricultural and public health programme. Among the various classes of pesticides, herbicides are dominated in the world market while insecticides are leading the Indian marker (Aditya and chudhury, *et al.*, 1997).

Persistence of pesticides in river ecosystem

The process of bioaccumulation starts when pesticides applied to the agricultural land run off during storms into rivers streams, and eventually to the oceans. The pesticides become parts of the water column, and fish ingest the pesticides, usually through their gills, although sometimes through their fish scales. The pesticides inter their organs and fat tissue and are sequestered there. More and more pesticides are ingested and stored in organs and tissue, the running status of pesticides shown in Fig. 1. These pesticides accumulation up the food chain as big fish eat little fish and eventually as human eat the fish shown in Table 2.

The high level of toxic substances indicates the bioaccumulation of aquatic animals, indicated that the stress condition of toxic substances how much of effected by pollutant gets into each organism, the effectiveness of the elimination process of each organs, organism metabolic processes, organism fat content, and the solubility of the pollution. The accumulated pest for threats to humans, these types of information for each organism within the food chain must be obtained and added. The EPA has identified tolerance levels in which no harm to human health will take place.

Pesticide resistance

Pesticides resistance may be defined as a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species (IRAC, 2013). Resistant individuals tend to be rare in a normal population, but indiscriminate use of chemicals can eliminate normal susceptible populations and thereby providing the resistant individuals a selective advantage in the presence of a pesticide. Resistant individuals continue to multiply in the absence of competition and eventually become the dominant portion of the population over generations. As majority of the individuals of a population are resistant, the insecticide is no longer effective thus causing the appearance or development of insecticide resistance.

The intensive use of pesticides has led to the development of resistance in many targeted pest species around the globe (Tabashnik, *et al.*, 2009). Important crop pests, parasites of livestock, common urban pests and disease vectors in some cases have developed resistance to such an extent that their control has become exceedingly challenging (Van Leeuwen, *et al.*, 2010; Gondhalekar, *et al.*, 2011). However, many factors such as genetics, biology/ ecology and control operations influence the

Running and accumulation of the pesticides in the aquatic system

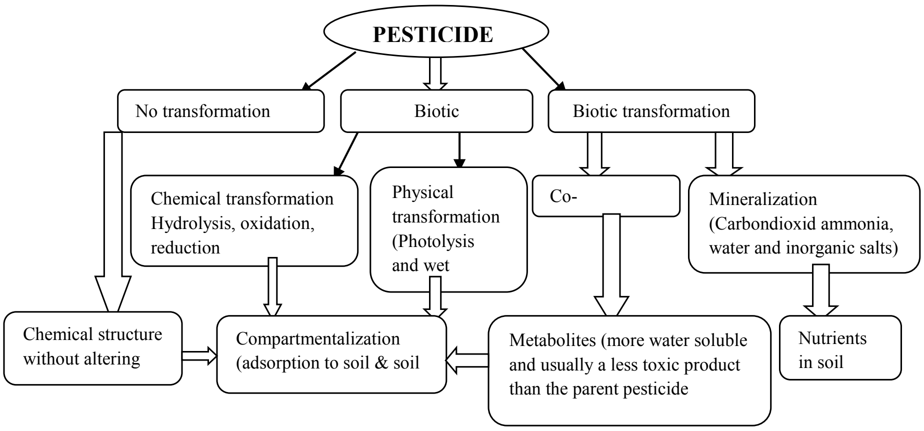

Fig. 1 Flow chart of the pesticides through the different routes in aquatic systems.

Table 2. Side effects of pesticides on abiotic and biotic components

Environmental component	Side effects
Abiotic	Residues in soil, water and air
Plant	Presence of residues, Phytotoxicity, Vegetation changes (due to the use of herbicides)
Animals, Birds, Insects	Residues, physiological effects, mortality in certain wild life species mortality of beneficial predators and parasites, insect population changes (Out-break of secondary pests) genetic disorders
Man	Biochemical changes, residues in tissues and organs effect of occupation exposure, mortality and deformations
Food	Presence of the residue

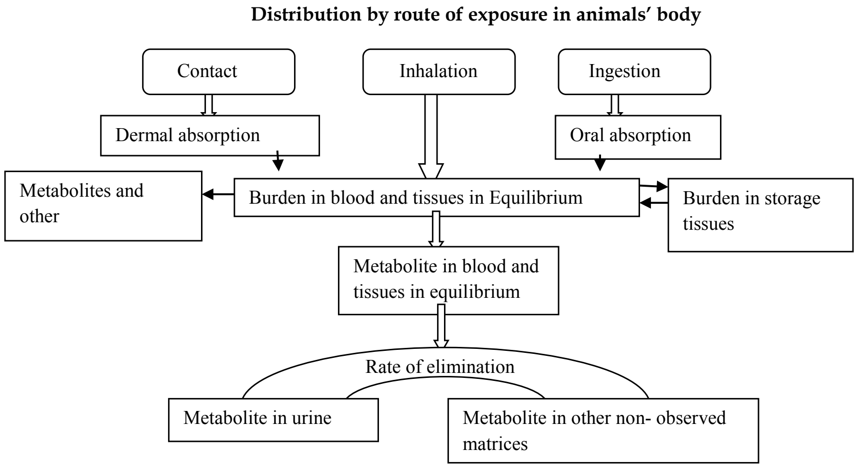

Fig. 2 The representation of toxicokinetic model.

development of pesticide resistance (Georghiou and Taylor, 1977). Insecticide bioassays using whole insects continue to be one of the most widely used approaches for detecting resistance (Brown and Brogdon, 1987; Gondhalekar, *et al.,* 2013). In the past two decades, however, several new methods employing advanced biochemical and molecular techniques, and combination of insecticide bioassays have been developed for detecting insecticide resistance (Symondson and Hemingway, 1997; Scharf, *et al.,* 1999; Zhou, *et al.,* 2002).

Effects of pesticides on non-target organisms

The effect of pesticides on non-target organisms has been a source of worldwide attention and concern for decades. Adverse effects of applied pesticides on non-target arthropods have been widely reported (Ware, 1980). Unfortunately, natural insect enemies e.g., parasites and predators are most susceptible to insecticides and are severely affected (Aveling, 1977; Vickerman, 1988). The destruction of natural enemies can exacerbate pest problems as they play an important role in regulating pest population levels. Usually, if natural enemies are absent, additional insecticide sprays are required to control the target pest. In some cases, natural enemies that normally keep minor pests under check are also affected and this can result in secondary pest outbreaks. Along with natural enemies, population of soil arthropods is also drastically disturbed because of indiscriminate pesticide application in agricultural systems. Soil invertebrates including nematodes, springtails, mites, micro-arthropods, earthworms, spiders, insects and other small organisms make up the soil food web and enable decomposition of organic compounds such as leaves, manure, plant residues etc. They are essential for the maintenance of soil structure, transformation and mineralization of organic matter. Pesticide effects on above mentioned soil arthropods therefore negatively impact several links in the food web. The following are the examples of non-target organisms that are adversely impacted by pesticides.

Effects on humans

The deleterious effects of pesticides on human health have started to grow due to their toxicity and persistence in environment and ability to enter into the food chain. Pesticides can enter the human body by direct contact with chemicals, through food especially fruits and vegetables, contaminated water or polluted air. Both acute and chronic diseases can result from pesticide exposure and these are summarized in Fig. 2. Organochlorines pesticides are described different types of the basic component of toxic of many acute and chronic illnesses.

Table 3. The list of chronic diseases that are linked to the exposure to pesticides

Disease	References
Cancer (Childhood and adult brain cancer; Renal cell cancer; lymphocytic leukaemia (CLL); Prostate Cancer)	Lee, *et al*., 2005; Shim, *et al*., 2009; Heck, *et al*., 2010; Xu, *et al*., 2010; Band, *et al*., 2011; Cocco, *et al*., 2013
Neuro degenerative diseases including Parkinson disease, Alzheimer disease	Elbaz, *et al*., 2009; Hayden, *et al*., 2010; Tanner, *et al*., 2011
Cardio-vascular disease including artery disease	Abdullah, *et al*., 2011; Andersen, *et al*., 2012
Diabetes (Type 2 Diabetes)	Son, *et al*., 2010; Lee, *et al*., 2011a
Reproductive disorders	Petrelli and Mantovani, 2002; Greenlee, *et al*., 2003
Birth defects	Winchester, *et al*., 2009; Mesnage, *et al*., 2010
Hormonal imbalances including infertility and breast pain	Xavier, *et al*., 2004
Respiratory diseases (Asthma, Chronic obstructive pulmonary disease (COPD)	Chakraborty, *et al*., 2009; Hoppin, *et al*., 2009

Symptoms of acute poisoning can include tremors, headache, dermal irritation, respiratory problems, dizziness, nausea, and seizures. Organochlorines are also associated with many chronic diseases, which include various types of cancer, neurological damage, Parkinson's disease, birth defects, respiratory illness, and abnormal immune system function. Many organochlorine are found to be hormone disruptors and its extremely low levels of exposure in the womb can cause irreversible damage to the reproductive and immune systems of the developing fetus. This group also includes POPs, which are currently or were in the past used as pesticides. These are organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic processes, and therefore, these are persistent in the environment. In this review included different types of pest for the different uses shown in Table 1.

Acute illness

Acute illness mostly appears a short time after contact or exposure to the pesticide. Pesticide drift from agricultural fields, exposure to pesticides during application and intentional or unintentional poisoning generally leads to the acute illness in humans (Dawson, *et al.,* 2010; Lee, *et al.,* 2011). Several symptoms such as headaches, body aches, skin rashes, poor concentration, nausea, dizziness, impaired vision, cramps, panic attacks and in severe cases coma and death could occur due to pesticide poisoning (Pan-Germany, 2012). The severity of these risks is normally associated with toxicity and quantity of the agents used, mode of action, mode of application, length and frequency of contact with pesticides and person that is exposed during application (Richter, 2002).

Chronic illness

Continued exposure to sub-lethal quantities of pesticides for a prolonged period of time (years to decades), results in chronic illness in humans (Pan-Germany, 2012). Symptoms are not immediately apparent and manifest at a later stage. Agricultural workers are at a higher risk to get affected, however general population is also affected especially due to contaminated food and water or pesticides drift from the fields (Pan-Germany, 2012). Incidences of chronic diseases have started to grow as pesticides have become an increasing part of our ecosystem. There is mounting evidence that establish a link between pesticides exposure and the incidences of human chronic diseases affecting nervous, reproductive, renal, cardiovascular, and respiratory systems (Mostafalou and Abdollahi, 2012). The list of chronic diseases that are linked to prolonged pesticide exposure by various studies summarized in Table 3.

Toxicity of pesticides

Organochlorines have been adverse effects on the reproductive and immunological immunities observed in birds, marine mammals and fishes (Livingston, 1976). Man-made organochlorines have been considered a serious threat to the long-term health of the aquatic environment for many years. The main reasons are their strong accumulation in tissues of fresh and marine biota as well as the high toxicity to aquatic organisms and the slow degradation of several members of pesticides groups.

Organochlorine pesticides contamination scenario in river system

Pesticides in river water

Pesticides enter in to the aquatic ecosystem from various sources such as agricultural runoff, industrial effluents and direct deposition from spray operation, spraying of cattle, dust and rainfall. In water, the residues and their degradation products are distributed between the truly dissolved form and those incorporated into sediments, benthic invertebrates, aquatic plants, plankton, aquatic invertebrates, suspended detritus, and fish. Pesticides can leave aquatic systems by volatilization or co-distillation, as residues in fish, which are eaten by humans, birds and animals or by degradation, burial in sediments or overflow. Some of the pesticides also end up in ground water systems by leaching down through the soil. They easily find their way from the soil surface to the atmosphere, due to their high vapour pressures and migrate with the air currents to distant areas and then later fall back to land as precipitation, into streams, lakes, and even drinking water. That is why pollution by pesticides occurs even in remote area where they have not been used for decades (Wania and Mackay, 1996).

Pesticides in river sediment

Pesticides residues reach the aquatic environment through direct runoff, leaching and careless disposal of empty container, equipment washing etc. (Milindis, 1994). Surface water contamination may have ecotoxicological affect for aquatic flora and fauna as well as for human health if use for public consumption (Forney and Davis, 1981; Mulla and Main, 1981; Leonard, 1988; Miyamoto, *et al.,* 1990). Sediments are ecologically important component of aquatic habitats, which play a significant role in maintaining the tropic status of any water body (Singh, *et al.,* 1997). Highly polluted sediments are adversely affecting the ecological functioning of rivers due to persistence in the environment and long range (Singh, *et al.,* 2002). In India, the concentration of these pesticides has been detected in almost all sediments of environment due to their extensive use in past, which have shown potential to biomagnifications/ accumulate in animals tissue, human blood adipose tissue and breast milk (Beg, *et al.*, 1989). Since the pesticides are lipid soluble in nature, cumulative accumulation of low concentration of these in the body fat of mammals might pose potential hazards in long run (Metcaf, 1997).

Sarkar, *et al.,* 1997) studied the contamination of organochlorine pesticides in marine and estuarine sediments along the west coast of India and reported the concentration of various pesticides like t-HCH, aldrin, dieldrin, endrin, and t-DDT among which the most predominant metabolites were found to be p,p-DDE and α-HCH in sediments from the mouth of different estuaries along the coast. Zhou, *et al.,* studied the deabsorption of the tefluthrin insecticide from soil in simulated rainfall runoff systems kinetic studies and modelling and reported that about 95% of tefluthrin was sorbet onto soil particles, and a very small amount, about 3%, was left in the water. The partition coefficients (kp, koc) are lower than those previously determined for tefluthrin and λ-cyhalothrin due to the relatively high concentration of soil used in slurries.

Hans, *et al.,* studied the agricultural produce in the dry bed of the river Ganga in Kanpur, India, a new source of pesticide contamination in human diets and reported that vegetables grown in the dry bed field of this area consists of mean levels of HCH and DDT in upstream and downstream industrial areas, which were under safe limits as per Indian standards, but some samples have HCH levels above WHO/FAO limits. (Schulz, 2001) studied the rainfall induced sediment and pesticide input from orchards into the Lourens River, Western Cape, South Africa and reported that average peak levels of current use insecticides applied to adjacent orchard plots were 1.5 μg/l azinphos methyl, 0.2 μg/l chloropyriphos, and 2.9 μg/l endosulfan in the river itself, which were extremely high levels and exceed national water quality standards established by the USA environmental protection agency. This results in acute toxic effects on aquatic invertebrates and fishes.

Pesticides in river fish

Pesticide toxicity to fish has been investigated in several studies (Hamelink and Spacie, 1977; Kumaraguru and Beamish, 1981; Mulla and Mian, 1981; Barry, *et al.,* 1995; Steinberg, *et al.,* 1995; Moore and Waring, 1996; Moore, *et al.*, 1998; Csillik, *et al.*, 2000). However, fish are not usually target organisms for pesticides, and knowledge about effects of pesticides in the field is still sparse. Surprisingly, only a few studies have shown that fish, inhabiting natural freshwater ecosystems, may be affected by unintentional spreading of pesticides (Bálint, *et al.,* 1997; Csillik *et al.,* 2000). Herbicides are often regarded as relatively harmless to fish. Direct effects caused by, for example, the herbicide atrazine are scarce. However, studies have demonstrated that atrazine concentrations as low as 5 μg/L affect the swimming behaviour of zebrafish (Brachydanio rerio; Steinberg, *et al.,* 1995). The fish was exposed for atrazine in low concentrations for four weeks, during which its preference of light or dark habitats was investigated. Already in the lowest concentration tested (5 μg/L) more than three orders of magnitude below acute toxicity.

Fish species are sensitive to enzymic and hormonal disruption. Chronic to low level of pesticides may have a more significant effect on fish population than acute poisoning. The pesticides dose that are not have a more significant effect on fish population than acute poisoning to kill fish are associated with subtle changes in behaviours and physiology that impair both survival and reproduction (Kegley, *et al.,* 1997). Biochemical changes induced by pesticidel stress lead to metabolic distributions, inhibition of important enzymes, retardation of growth and reduction in the fecundity and longevity of the organism. Liver, kidney, brain, and gills are the most vulnerable organs of a fish exposed to the medium containing any type of toxicant (Malik and Maurya, 2015). The fish show restlessness, rapid body movement, convulsions, difficulty in respiration, excess mucus secretion, change in colour and less of balance when exposed to pesticides. Similar changes in behaviour are also observed in several fish exposed to different pesticides (Haider and Inbaraj, 1986).

Singh and Singh, reported that the ovary is an important organ for the bioaccumulation of OCPs. Their study indicated that during the reproductive phase, OCPs are transferred to the ovary from the liver, which may cause reproductive disorders. They observed a decrease in gonadosomatic index (GSI) and plasma levels of testosterone and 17B-estradiol in female fish captured from polluted river (Ganga and Gomti River) compared to the same species from unpolluted ponds.

Mechanisms of pesticide action

Pesticides can be classified according to their mechanisms of action in living bodies. For example, insecticides like organochlorines, organophosphates, and carbamates act primarily by disrupting nervous system function, while herbicides often target photosynthesis pathways (Ecobichon, 1991; DeLorenzo, *et al.,* 2001). The breakdown of organic molecules provides energy for the survival of living systems. In fungi, as well as in other eukaryotes, a part of this catabolic process take place in the mitochondria and lead to the synthesis of the high energy intermediate ATP. Several groups of fungicides disturb the energy supply in fungi and all such compounds are powerful inhibitors of spore germination (Leroux, 1996).

Pesticides enter into the body through the following route: dermal exposure, inhalation exposure and oral exposure. Dermal exposure can occur at any time when a pesticide is mixed, applied, or handled, and sometimes it often goes undetected. Dry materials, dusts, wet table powders, and granules, as well as liquid pesticides can be absorbed through the skin. Inhalation exposure results from breathing pesticide vapours, dust, or spray particles. Like oral and dermal exposure, inhalation exposure is more serious with some pesticides than with others, particularly fumigant pesticides, which form gases. Inhalation exposure can occur by breathing smoke from burning containers, breathing fumes from pesticides while applying them without protective equipment, and inhaling fumes while mixing and pouring pesticides shown in Fig. 2.

The intrinsically reactive chemical nature of organophosphorus pesticides means that enter the body are immediately liable to a number of bio-transformations and reactions with tissue constituents, so that the tracing of radiolabelled material alone does not give any clue to the unchanged parent compound. In view of the inherent instability of the organophosphorus pesticides, storage in human tissue is not expected to be prolonged. Experimental animal studies indicate rapid excretion of these compounds. However, some organophosphorus pesticides are very lipophilic and may be taken into, and then released from, fat depots over a period of many days. For example, a case of fenitrothion poisoning promptly treated by conventional therapy caused a recurrence of symptoms attributed to mobilization of the organophosphate stored in adipose tissue. In contrast, dichlorvos (a dimethyl phosphate) and omethoate (a dimethyl phosphorothioate) are rapidly hydrolyzed by plasma and tissue esterases to inactive products and are unlikely to cause late clinical effects (Ecobichon, *et al.,* 1977; Minton and Murray, 1988).

Effects of pesticides on target organisms

Some pesticides are high ability to persistent in the environment and affected one trophic level to another trophic level. They may represent long-term dangers as they biomagnified up the food-chain and effected on target organs like brain, kidney, cardiovascular, fetous and other organs. The pesticides continuous increase in the target a broad spectrum of pests. The increased quantity and frequency of pesticide applications have posed a major challenge to the targeted pests causing them to either disperse to new environment and adapt to the novel conditions (Meyers and Bull, 2002; Cothran, *et al.,* 2013). The adaptation of the pest to the new environment could be attributed to the several mechanisms such as gene mutation, change in population growth rates, and increase in number of generations etc. This has ultimately resulted in increased incidence of pest resurgence and appearance of pest species that are resistant to pesticides.

Pesticides and biomagnifications

The increase in concentration of pesticides due to its persistent and non-biodegradable nature in the tissues of organisms at each successive level of food chain is known as biomagnification. Due to this phenomenon, organisms at the higher levels of food chain experience greater harm as compared to those at lower levels. Several studies have been undertaken that demonstrate enhanced amount of toxic compounds with increase in trophic levels. About

36 species collected from three lakes of northeastern Louisiana (USA) that were found to contain residues of 13 organochlorines, tertiary consumers such as green-backed heron (*Butorides striatus*), and snakes etc., contained the highest residues as compared to secondary consumers (bluegill (*Lepomis macrochirus*), Blacktail shiner [*Notopis venustus*]) (Niethammer, *et al.,* 1984). Similarly, significantly higher concentrations of dichlorodiphenyltrichloroethane (4,4′-DDE) were found in the top consumer fish in Lake Ziway, catfish (*Clarias gariepinus*) than in lower consumers, Nile tilapia (*Oreochromis niloticus*), tilapia (*Tilapia zillii*) and goldfish (*Carassius auratus*) (Deribe, *et al.,* 2013). Some of the adverse effects of pesticides on non-target organisms such as fish, amphibians and humans discussed in the above section have also occurred as a result of biomagnifications of the toxic compounds. For example, reproductive failure and population decline in the fish-eating birds (e.g., gulls, terns, herons etc.) was observed as a result of DDE induced eggshell thinning (Grasman, *et al.,* 1998). The extent of biomagnifications increases with increase in persistence and lipophilic (fat-loving) characteristics of the particular pesticide. As a result of this, organochlorines are known to have higher biomaginification rate and are more persistent in a wider range of organisms as compared to organophsphates (Favari, *et al.,* 2002). It is important to do the risk assessments associated with the pesticides on the basis of their bioaccumulation and biomagnifications before considering them for agricultural purposes. Prevention suppression and eradication are three approaches to maintain pest damage below economic levels. Prevention includes such things as panting weeds and disease free seed and growing varieties of plant resistant to diseases or insect, sanitation, using cultural control to prevent weeds plants from seeding and choosing planting or harvesting times that minimize pest problems. Pesticides are sometime use for pest prevention as well.

Integrated pest management (IPM)

IPM is a science-based, decision-making process that identifies and reduces risks from pests and pest management related strategies. IPM coordinates the pest biology of the environmental information and available different technology to prevent unacceptable levels of pest damage by the most economical means, while minimizing risk to people, property, resources, and the environment. IPM provides an effective strategy for managing pests in all developed agricultural, residential, and public lands to natural and wilderness areas. IPM provides an effective improvement, all encompassing, low-risk approach to protect resources and people from pests” (USDA NIFA 2013).

IPM integrates multiple management tactics in ways that usually allow production systems to move away from traditional, chemically based management to ecologically sound strategies (Mac Hardy, 2000; Prokopy, 2003). When chemicals are applied, the applications are guided using economic and treatment thresholds based on monitoring pest and beneficial organisms, and environmental conditions. (Cooley and Coli, 2009). IPM practices are typically crop and region-specific, and are intended to result in effective, timely and affordable pest control while also reducing use of pesticides to health and the environment. IPM can address any pest complex including insects, diseases, weeds, vertebrates and others, and can be adapted to any production goals including conventional, sustainable and organic (Biddinger and Rajotte, 2015). IPM can readily evolve to meet new challenges such as food safety (Rajotte, 1993). IPM protocols, or collections of practices for specific crops and regions, often include related practices such as irrigation and nutrient management, at least to the extent that they influence pest management. The carefully timing management for irrigation cycles so plant foliage will dry quickly limits potential for plant disease growth and spread.

Prevention and control goals of pesticides

The prevention of pesticide resistance management tactics that have been proposed risk-free and have a reasonable chance of success under a variety of different circumstances. Headmost among these are monitoring of pest population in field before any pesticide application, alteration of pesticides with different modes of action, restricting number of applications over time and space, creating or exploiting refugia, avoiding unnecessary persistence, targeting pesticide applications against the most vulnerable stages of pest life cycle, using synergists which can enhance the toxicity of given pesticides by inhibiting the detoxification mechanisms. The most difficult challenge in managing resistance is not the unavailability of appropriate methods but ensuring their adoption by growers and pest control operators (Denholm, *et al.,* 1998; Dhaliwal, *et al.,* 2006). Pest resurgence is a dose-dependent process and there are ways to tackle this problem using correct dosage of effective and recommended pesticides. Resurgence problem occurs due to a number of reasons. One of them is due to farmers’ tendency to apply low-dose insecticides

(A) Suppression

Suppression pest control methods are used to reduce pest pollution levels. The methods chosen usually do not eliminate all pests, but reduce their population to a tolerable level or to a point below an economic injury level. Additional suppression measure may be required if the first attempt dose not achieve the management goal.

(B) Eradication

Eradication is the total elimination of a pest from a designation area. Over larger area eradication may be very expensive and often has limited success. Large eradication programmes are usually directed at exotic or introduced pests posing an immediate are wide public health or economic threat.

PEST MANAGEMENT METHODS

The most important aspect of prevention and control of organochlorine pesticide are to update and create awareness among population on pesticide action on body tissues and also on the disease itself. Specific house pests such as ants, sprinkle powdered red pepper, paprika, dried peppermint, or borax where the ants enter; for beetles, kill them manually when you see them; for slugs and snails, pour half a cup of black caffeinated coffee on the pests, and for weeds, spray vinegar onto the leaves of larger weeds. Make sure to coat the leaves evenly. This works best on hot, sunny days. An easy all purpose garlic spray for repelling insects from plants in your garden can be made by mixing one half cup of finely chopped garlic with 500 ml water. Let this mixture sit for an hour. Strain out the garlic, pour into a spray bottle, and spray your plants. These alternative methods will contribute a lot in controlling pesticide pollution to a great extent.

The seriousness of the exposure depends on the oral toxicity of the material and the amount swallowed. Toxicity of pesticides is categorized into two types: acute toxicity and chronic toxicity. Acute toxicity refers to the ability of the pesticide to produce harmful effects as a result of one exposure. A pesticide with a high acute toxicity may be deadly even if a very small amount is absorbed. Acute toxicity may be measured as acute oral, acute dermal and acute inhalation. Chronic toxicity refers to the ability of the pesticide to produce harmful effects as a result of long-term exposure and can cause various adverse effects, which may include carcinogenesis (production of malignant tumours), teratogenesis (production of birth defects that includes changes in the structure or function of the offspring), mutagenesis (production of changes in genetic structure), blood disorders, endocrine disruption, and reproductive toxicity.

(A) Natural controls

Natural controls include climatic factor such as wind temperature sunshine and rain. Topographic feature such as river, lakes and mountain can influence pest movement naturally occurring predators, parasites, and pathogens can regulate pest population. Human must intervene and apply the pest management controls. Maintaining populations of natural enemies by avoiding damaging cultural practices or the indiscriminate use of pesticides can be one of the most economical means of control. If pesticides are part of your control program, apply pesticides at lower that label rates to avoid harming natural enemies. Sometimes it is possible to modify certain part of the environment, such as by planting crops or group cover, to maintain or enhance natural enemies. Sometimes it is possible to modify certain part of the environment, such as planting of crops or ground covers to maintain or enhance natural enemies.

(B) Biological control

The process of using natural enemies of particular pests to reduce their populations to such a level where economic losses are either eliminated or suppressed is called biological control. Traditionally the most important biocontrol agents are parasitoids, predators and pathogens. Biological control involves three major techniques, viz., introduction, conservation, and augmentation of natural enemies. Biocontrol agents include vertebrates, nemathelminthes (flatworms, and roundworms), arthropods (spiders, mites, and insects), pathogens like viruses, bacteria, protozoa, fungi and rickettsiae all of which play a dynamic role in natural regulation of insect and mite populations (Dhaliwal, *et al.,* 2006). In 1762, the Indian Mynah, *Acridotheres tristis* (Linnaeus), was introduced to control red locust in Mauritius. First significant success in controlling a pest was achieved on the suggestion of C. V. Riley of California (USA) in 1888. The Vedalia beetle (*Rodolia cardinalis* Mulsant), was introduced from Australia into California (USA) for the control of cottony-cushion scale (*Icerya purchasi* Maskell) on citrus plants. This scale insect had been accidentally introduced earlier from Australia (Dhaliwal, *et al.,* 2006).

Biological control of weeds has been very successful worldwide. There are about 41 species of weeds which have been successfully controlled using insects and pathogens as biocontrol agents. Also, 3 weed species have been controlled using native fungi as mycoherbicides (Mcfadyen, 2000). A total of 12 insects were released in Australia against prickly pear (*Opuntia stricta*), out of these, *Dactylopius opuntiae* and *Cactoblastis cactorum* were responsible for the successful control of prickly pear weed (Julien and Griffiths, 1998). In the past decade, Australia has released 43 species of arthropods and pathogens in 19 different projects for successful biological control of many exotic weeds. Effective biological control was achieved in several projects and outstanding success was achieved in the control of rubber vine (*Cryptostegia grandiflora*), and bridal creeper (*Asparagus asparagoides*) (Palmer, *et al.,* 2010). Most pests have natural enemies that control suppress then effectively in some situation. Natural enemies including pathogens and insects are being used successfully as biological control agents to manage certain insect, mite, fungus, animal, and weed pests. Biological control is often directed against pests that are not native to a geographical area. Pest introduced after cause problems in their new locations because they lack natural enemies to help control them. Laws have been enacted that strictly control the important of all organisms, including biological control agents, into the USA, to prevent these organisms from also becoming pests. Biological control also involves that means release of large numbers of natural enemies into fields, orchards, greenhouse or other location control specific pests for specific animals shown in Table 1. Several natural enemies are reared or cultured commercially predatory mites. Nematodes and fungi are being studies as biological control agents for certain weeds and some insects general predators, such as praying mantis and lady beetles are sold with claims made for biological control. In many cases, however, their effectiveness has not been established.

(C) Mechanical control

Mechanical control involves the use of devices, machines, and other physical methods to control pests or alter their environment. Traps, screens, barriers, fences, and net or examples of devices used to prevent pest activity or remove pests from an area and different uses.

(I) Cultivation

Cultivation is the most important methods of controlling weeds, it is also used for some insects and other soil inhabiting pests. Devices such as plods, disks, mowers, cultivators, and bed conditioners physically destroy weeds or control their growth and disrupt soil conditions suitable for the survival of some microorganisms and insects.

(II) Exclusion

Exclusion is a mechanical control technique that consists of using barriers to prevent pests from getting into an area. Window screens, for example exclude flies, mosquitoes and other fling insects. The patching or sealing cracks, crevices, and other small opining in building can exclude insects, rodents, bats, birds or other pests wire or cloth mesh excludes birds from fruit trees. Sticky materials painted onto tree trunks. Posts, wires and other objects prevents crawling insects from crossing.

(III) Trapping

Traps physically catch pests within an area or building. Several types of traps are commonly used. Some kill animals that come in contact with the trap other snore animals so they can then be relocated or destroyed. Traps are either mechanical devices or sticky surfaces.

(VI) Cultural control

The goals of cultural control are to alter the environment, the condition of the host, or the behaviour of the pest to prevent or suppress an infestation. It disrupts the normal relationship between the pest and the host and makes the pest less likely to survive, grow or reproduce cultural practice and sanitation are two examples of cultural control.

(V) Cultural practices

Many cultural practices influence the survival of pests. In agriculture crops, selectin of crop plant varieties, timing of planting and harvesting, irrigation management, crop rotation and use of trap crop help reduce population of weeds, microorganisms, insects mites and other pests, weeds also can be managed by mulching (with plastic, straw shredded, bark, or wood chips) and by using cover crops.

(IV) Sanitation

Sanitation or sources radiation involves elimination food, water shelter or other necessities important to the pests' survival. In crop production, sanitation is including such pesticides as removing weeds that harbor pest insects or rodents, eliminating weed plant before they produce seed, destroying and keeping field borders or surrounding areas free of pests and pest breeding sites. Animals manure management is an effective sanitation practice used for preventing or reducing fly problems in poultry and livestock operations.

Host resistance or genetic control

Sometime plants and animals can be bred or selected to resist specific pest problems. For examples, particular livestock breeds are selected for physical characteristics that prevent attack by some pest by some pests or provide physiological resistance to disease or parasites organisms. Resistance also in enhanced by maintaining the hosts health and providing for its neutriseanal needs, certain plants varieties are naturally resistant to insects, varieties are naturally resistant to insects pathogens or nematodes, many plants actually repel various types of pests, and some contain toxic substances.

Chemical controls

Sometimes cultural and other agro-technical practices are not sufficient to keep pest population below economic injury level (lowest pest population density that will cause economic crop damage). Therefore, the chemical control agents are resorted to both as preventive and curative measures to minimize the insect pest damage. A good pesticide should be potent against pests, should not endanger the health of humans and non-target organisms, and should ultimately break down into harmless compounds so that it does not persist in environment. Both relative and specific toxicities of the pesticide need to be estimated in order to determine its potency. It is very important to know spray droplet size and density chemical dosage, application timing, which can provide adequate pest control.

Chemical controls of pesticides that is either naturally derived or synthesized. Pesticides often play a key role in pest management programme and frequently control methods available major benefits associated with the use of the pesticides are their effectiveness, the speed and ease of controlling pests, and in many instances their reasonable cost compared with other control options usually pest damage stops or pests or destroyed within a few hours (for insects) to a few days (for weed) after application of a pesticides using a fungicides may provides immediate, short term protection against microorganisms. A pesticide defined as any material that is applied to plants and soil water harvested crops, structure clothing and furnishings, or animals to kill, attract, repel, regulate or interrupt plant growth, pesticide include a wide assortment of chemicals with specialized names and function they are commonly grouped according to the type of pest they control.

CONCLUSION

The above review research mentioned studies revealed that all the different types of organochlorine pesticides are most commonly found as they break down slowly and remain in the environment, which is the most notorious organochlorine pesticide, was banned in the 1970s but still is present in traces as its half-life is 75 years. These pesticides were found in almost all the inter compartments of water, sediments, atmospheric air, biotic environment, etc. Unused pesticides and their degradation products and metabolites in various compartments (air, water, soil, and aquatic biota, etc.) can affect human as well as aquatic biota and other domestic life directly or indirectly. Pollution by these organochlorine pesticides leading to food chain accumulation cannot be ignored and there need to monitor the concentration of pesticides in every inter compartment from time to time and also to generate awareness among people so as to fight this serious problem.

Pesticides control is necessary for protect our environment and eventually health hazards associated with it. Alternative pest control strategies such as IPM that deploys a combination of different control measures such as cultural control, use of resistant genotype, physical and mechanical control, and rational use of pesticide could reduce the number and amount of pesticide applications. Further, advanced approaches such as biotechnology and nanotechnology could facilitate in developing resistant genotype or pesticides with fewer adverse effects. Community development and various extension programs that could educate and encourage farmers to adopt the innovative IPM strategies hold the key to reduce the deleterious impact of pesticides on our environment and I suggest that the all formers use the biopesticides or alternatives of pest control for the crop protection.

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