Chapter 20
Prospects of Pesticide Contamination and Control Measures in Aquatic Systems: A Green Approach

Roopa Rani
Manav Rachna University, India

Prem Kishore Patnala
Manav Rachna University, India

Vinayak V. Pathak
Manav Rachna University, India

ABSTRACT

In this chapter, up-to-date knowledge on extenuation strategies to diminish pesticide accumulation in aquatic systems, which has remained a major concern for ground water as well as surface water, adversely affecting aquatic ecosystems and humans through bio-magnification, are included. Several factors affect the toxicity of pesticides like dosage of concentration, relative toxicity, and chemical interactions. The best approach to decrease pesticide pollution in environment is to use safer, non-chemical control methods, and industrial or sewage superfluous should not be dumped into water reservoirs without proper pretreatment. Biological and chemical methods used for the control measures of pesticides pollution in aquatic systems. Thus, a greener approach for remedy of pesticide-contaminated aquatic system could be more cost-effective and sustainable.

INTRODUCTION

Application of chemical pesticide has become a valuable practice to enhance the agricultural productivity and yield. Despite of its beneficial use to control pests in crop fields, they are associated with severe environmental impacts affecting all the dimension of environment i.e. soil, air, water, sediment,

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sludge, etc (Ali *et al.,* 2014). Resistant nature of these is found to cause environmental degradation of some pesticides. The residues derived from degradation of pesticides have been found to possess significant toxicological effects. Different types of pesticides are used to control pests, insects, weeds, etc. depending upon the type of crop being produced. Among different pesticides organochlorine pesticides such as DDT, hexachlorocyclohexane (HCH), aldrin and dieldrin are widely used in Asian countries to control the undesired agricultural pests or insects and contaminated disease (Abhilash & Singh, 2009). However, most of the developed countries have banned the use of organochlorine pesticides due to their bioaccumulation potential and other biological effects. Recent estimation of pesticide consumption revealed that the consumption of pesticide in India has increased from 55,540 tonnes in 2010-11 to 57,353 tonne in 2014-15 (FICCI, 2015). Pesticides are becoming the largest sub-segment of agrochemicals with 60% market share. Economic survey 2015-16 reported an increase in pesticide residue due to lack of implementation of pesticide use guidelines. Initially synthetic use of DDT was started in 1948-49 for the cure of malaria and locust. Today, Indian pesticide market is dominated by the significant share of insecticide with a projected growth of 2, 29, 884.8 Million INR in financial year 2018 (Ratings, 2017).

In aquatic ecosystem organochlorine pesticide can enter through different ways such as sewerage discharge from industrial sector, runoff from non point sources, wet and dry deposition, etc. A study reports that about 9000 tonnes of pesticides are applied annually in Ganga river basin (Santanu, Chattopadhyay & Vass, 2000). Substantial amount of pesticides are dissipated at the site of application through chemical and biological degradation process, though reasonable fraction of these pesticide residues reaches to the ocean through agricultural runoff, atmospheric transport and sewerage discharge (WHO, 1999). Earlier studies revealed that Ganges water is highly contaminated with hexachlorocyclohexane (HCH), dichlorodiphenyl- trichloroethane (DDT), endosulfan (Samanta, 2013; Kaushik *et al.,* 2010). Simultaneous presence of several pesticides is found to trigger the toxicity of aquatic ecosystem that causes the damage to non target species. Contamination of pesticide is often found as mixture of several pesticides in aquatic ecosystems, the synergistic effect of these became much toxic rather than individual pesticide. Wang *et al.,* found that mixture of 11 pesticides exhibited synergistic effects on zebrafish (*Danio rerio*) (Wang *et al.,* 2018).

The pesticides have different toxicity among different species and thus numerous methods are approached and developed to eradicate these from the aquatic ecosystem. Some of the conventional methods are chemical treatment, thermal degradation, etc but it consumes much energy and thus depletes the resources. In this era, there is a need for rapid, simple, green approaches like microwave radiations (Onuska & Terry, 1993), ultra-sonication (Benitez, Acero & Real, 2002), ozonation (Matouq *et al.,* 2008), adsorption using clay (Manisankar, Selvanathan & Vedhi, 2006), bio-beds (Spliid, Helweg & Heinrichson, 2006) and immobilized on surface of titanium dioxide (Echavia, Matzusawa & Negishi, 2009), carbon slurry (Gupta, Ali & Saini, 2006), biodegradation methods like white rot fungi (Bending, Friloux & Walker, 2002), bacterial (Ogram *et al.,* 1985) and solar-photocatalytic (Konstantinou & Albanis, 2003), etc. This chapter contains a brief discussion of some of the green methods used to eliminate pesticides in aquatic system.

PESTICIDE CLASSIFICATION

The organic compounds which are classified among pesticides (like dichloro diphenyl trichloro ethane, lindane) emerged in the beginning of 19 century, as a result to develop chemical weapons tested against