Herbicides and Their Role in the Environment

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***Abstract*: Extensive use of herbicides may directly affect the population of soil microorganisms like bacteria, fungi, algae, protozoa, actinomycetes, and earthworms that have a vital role in maintaining the soil productivity. As soil microbial biomass is considered an active nutrient pool to plants, use of herbicides may negatively affect the health of the soil. In addition, algae represent the basal component of aquatic food webs, since they are consumed by a variety of invertebrates or directly by fish, both of which are consumed by other fish species.**

Microalgae are also quite sensitive to herbicides because they share many characteristics with higher plants. Many scientific reports clearly says that there is no universal pattern of herbicidal effect on biotic (Micro) components of terrestrial and aquatic ecosystem because of temperature, pH, rainfall and overall climatic conditions of the area. Persistence, mode of degradation and microbes involved in degradation is also governed by various factors.

***Keywords*: Herbicides, Biotic, Biomass, microbes**

Introduction

Pesticides are widely used to control the growth and proliferation of unwanted target organisms, such as weed, fungi or insects. Following application, particularly in agriculture, substantial amounts of these anthropogenic compounds are introduced into freshwater ecosystems which raise concerns about potentially detrimental effects on non-target organisms. Since herbicides constitute the largest proportion of pesticides used, freshwater algae, which are part of the basis of the ecologically highly relevant aquatic food web, might be particularly at risk. To assess this risk, eco-toxicological testing procedures are typically employed. This involves standardized toxicity testing based on growth inhibition of unicellular algae. Since this endpoint is highly integrative, no information regarding mechanisms of toxic action can be obtained. This understanding, however, is crucial for addressing current and future challenges in eco-toxicology. To obtain it, it is necessary to analyze physiological, biochemical and sub-cellular molecular effects caused by the investigated compounds which underlie the impacts on the whole-organism level. About 60 percent population in India is involved in agricultural sector which contributed to a very important part of Indian economy. Several pesticides including organochlorine, organophosphate, carbamate, fungicides, herbicides and synthetic pyrethroids are used in modern agricultural production to meet the need for abundant, safe and affordable food and fiber. Although the use of pesticides has led to increased agricultural production but, their use has also been associated with several concern, including risk to human health and environment (Ejaz et al. 2004).

Herbicides are chemicals commonly used to control weeds in agriculture and are often discharged into aquatic environments through surface runoffs and atmospheric deposition. They are also very harmful for various biotic components of agricultural ecosystem including bacteria, fungi, algae, earthworms and other beneficial insects. The discharge and leaching of herbicides in adjoining water bodies can also lead to contamination of aquatic environments which are hazardous to resident organisms (Fargasova, 1994). Herbicides act via a wide variety of toxic mechanisms affecting diverse cellular targets (Duke, 1990; Wakabayashi and Böger, 2004a; Wakabayashi and Böger, 2004b. Microalgae are also quite sensitive to herbicides because they share many characteristics with higher plants. Many scientific reports clearly says that there is no universal pattern of herbicidal effect on biotic (Micro) components of terrestrial and aquatic ecosystem because of temperature, pH, rainfall and overall climatic conditions of the area. Persistence, mode of degradation and microbes involved in degradation is also governed by various factors. In addition to that recently many multinational companies have released new herbicide molecules with addition of various new inerts, which have again opened a huge scope for studying the influence of these molecules on various ecosystems.

Profile of Herbicides in Environment

The use of herbicides in agriculture could influence the biological balance of soil microflora, which has an important role in soil fertility and microbial ecosystem. The herbicides have different effects on soil bacteria and actinomycetes (Zaid et al. 2014). In a study from Japan five herbicides (Pretilachlor, Butachlor, Simetryn, Mefenacet, and Esprocarb) were taken for environmental concentrations and IC_{50} analysis with simulations algal density dynamics study against environmental concentration of each herbicide in soil. The results suggested that the risk of Pretilachlor was highest out of the five herbicides, both in terms of the spatial distributions and the temporal durations (Hayashi TI et al., 2015). High concentration of some herbicide like Glyphosate was found in the ground water of Denmark (Hansen et al., 2015). Various biodegradation protocols have been studied using different species of *Pseudomonas* and *Bacillus* isolated from soil contaminated with high concentration of various herbicides (Bestway et al., 2014). Paddy herbicides have high-risk on aquatic plants, including algae, because they easily move from paddy fields to the nearby water bodies. A concentration - response relationships of four paddy herbicides for algal growth inhibition and mortality were carried out, and concluded that pretilachlor and quinoclamine had both algicidal and algistatic effects, whereas bensulfuron-methyl only had an algistatic effect, and pentoxazone only had an algicidal effect (Nagai T et al 2011). Four

herbicides (Atrazine, Norflurazon, Bromacil Metolachlor and Simazine) were found in the water samples of South Florida canal. Out of total 87%, 90-95%, 14-36%, 1.8-10% 10-35% samples were found contaminated with Atrazine, Norflurazon, Bromacil Metolachlor and Simazine respectively (Wilson et al., 2011). Risk analysis was conducted for nine herbicides (four triazines: ametryn, atrazine, simazine, and prometryn; two triazinones: hexazinone and metribuzin; two substituted ureas: diuron and linuron; and a uracil: bromacil) and a pyridazinone herbicide (norflurazon) for the aquatic ecosystem in South Florida. The herbicides were detected in the water bodies in a measurable quantity (Schuler et al., 2008).

During the last few decades, widespread contamination and toxic effects of organic chemicals have becomes a serious environmental problem. They enter the soil by direct treatment or being washed off from the plant surface during rainfall. Their physico-chemical characteristics, which include hydrophobicity and resistance to degradation, make these chemicals to accumulate in soils and sediments (Hong et al. 2008; Hu et al. 2010). Soil and sediments can act as a contributor of organic pollutants to the atmosphere, especially of semi volatile compound in warm climates. The fate of pesticides in soils with different cropping land use has been extensively studied worldwide including India (Pillai 1986; Viet et al. 2000; Om Prakash et al. 2004; Oldal et al. 2006; Shegunova et al. 2007; Senthil Kumar et al. 2009).

In India, there are 165 pesticides registered for use and there is a sequential rise in the production and consumption of pesticides during last three decades. India is the fourth largest pesticide producer in the world after the US, Japan and China. During 2003-2004, the domestic production of pesticides was approximately 85 TMT (thousand metric tons), and about 60 TMT used annually (Anonymous 2005), against 182.5 million hectare of land where 70% accounts for DDTs, HCHs and organophosphate pesticides (Bhattacharyya et al. 2009; Nirula and Upadhyay 2010). The domestic consumption of pesticides in agriculture is comparatively low (0.5 kg/ha), (only 3.75% of global consumption) against 12.0, 7.0, 6.6, and 3.0 kg.ha-1 in Japan, USA, Korea and Germany, respectively (Chauhan and Singhal 2006). The higher concentration of different Pesticides and Herbicides were reported in Soils from Agriculture Areas of Delhi Region in which Pendimethalin was detected dominant herbicides followed by butachlor and fluchloralin in soil (Kumar Bhupander in 2011). The ability of herbicides to be adsorbed by the soil and sediment and their tendency to be desorbed are some of the most important factors affecting soil and water contamination. The low value of the soil organic carbon partition coefficient (Koc) of cyhalofop-butyl in the sandy loam soil suggested its weaker adsorption in soil and thus increased its risk of mobility into water sources (Sondhia et al., 2014). Bioaccumulation of herbicides in plant produce may cause ailing effect on animals and human beings through food chain contamination. The accumulation of herbicide metamitron for its persistence and degradation in sugar beet crop and soil were studied. Metamitron persist in plant up to 15 days while up to 30 days in soil. It was detected on day 90 when higher quantity applied in field (Janaki et al., 2013). Chlorimuron is used to control of important broad leaved weeds in soybean and maize crop. Aspergillus niger was found effective to degrade the herbicide in soil (Sharma et al., 2012). The external application of organic materials like rice straw, manure, saw dust and charcoal were found to stimulate the degradation of atrazine in soil (Mukherjee et al., 2009).

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