

The Impact of Pesticides on Soil Properties and their Characterization

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ABSTRACT: The term pesticide covers a wide range of compounds including insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth regulators and others. Among these, organochlorine (OC) insecticides, used successfully in controlling a number of diseases, such as malaria and typhus, were banned or restricted after the 1960s in most of the technologically advanced countries. The introduction of other synthetic insecticides – organophosphate (OP) insecticides in the 1960s, carbamates in 1970s and pyrethroids in 1980s and the introduction of herbicides and fungicides in the 1970s–1980s contributed greatly to pest control and agricultural output. Ideally a pesticide must be lethal to the targeted pests, but not to non-target species, including man. Unfortunately, this is not the case, so the controversy of use and abuse of pesticides has surfaced. The rampant use of these chemicals, under the adage, “if little is good, a lot more will be better” has played havoc with human and other life forms. The primary benefits are the consequences of the pesticides' effects – the direct gains expected from their use. For example the effect of killing caterpillars feeding on the crop brings the primary benefit of higher yields and better quality of cabbage. The three main effects result in 26 primary benefits ranging from protection of recreational turf to saved human lives. The secondary benefits are the less immediate or less obvious benefits that result from the primary benefits. They may be subtle, less intuitively obvious, or of longer term. It follows that for secondary benefits it is therefore more difficult to establish cause and effect, but nevertheless they can be powerful justifications for pesticide use. For example the higher cabbage yield might bring additional revenue that could be put towards children's education or medical care, leading to a healthier, better educated population. There are various secondary benefits identified, ranging from fitter people to conserved biodiversity.

KEYWORDS: pesticides, soil, properties, plants, lethal, benefits, controlling diseases, conserved

I. INTRODUCTION

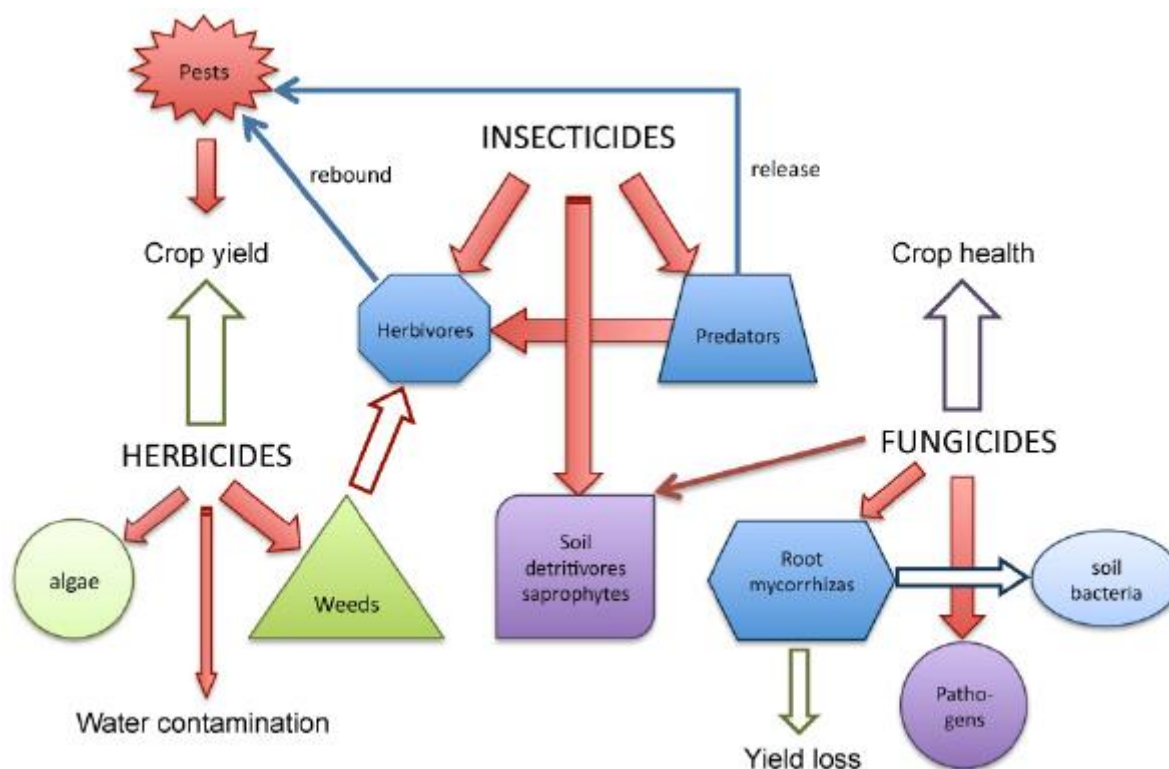
Uncontrolled application of pesticides can contaminate soil and may kill other nontarget organisms. Pesticides can damage soil biomass and microorganism such as bacteria, fungi, and earthworms. Microbial biomass is a labile component of soil organic matter and has an important role in soil nutrient element cycle [1]. S. A. Reinecke and A. J. Reinecke (2007) had studied earthworm biomass and cholinesterase activity affected by pesticides [2]. The authors concluded that earthworms were affected detrimentally by the pesticides due to chronic (chlorpyrifos) and intermittent exposure (azinphos methyl). Other research also showed that malathion exposure gave the significant reduction in body weight and decreased sperm viability of *Eisenia fetida* adults species. The organism also had an adverse impact on growth and reproduction by the chlorpyrifos exposure, and the cypermethrin exposure also gave the significant reduction in cocoon production [3–6]. Pesticides which are applied to the soil could have an impact on nontarget organisms and damage the local metabolism that is required by soil fertility and pesticide degradation itself [7–11]. The large pesticides application and its impact can be identified in Indonesian shallot farming. Pesticides can cause significant changes in the composition, diversity and basic functioning of important soil microflora.2,3,4

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This soil life is critical both to carbon sequestration and to a thriving, sustainable agriculture system. Some studies have found that pesticides decrease soil microbial biomass;⁵ others indicate that while total microbial biomass may not change, pesticides can reduce the abundance and diversity of soil organisms, damaging and altering important dynamics in the soil community.^{6,7,8} Some organisms can be suppressed while others may proliferate in the resulting vacant ecological niches, so organisms that were rare become abundant and vice versa.⁹ Research also shows that pesticides can impact larger fauna that help maintain the structure and fertility of the soil. For example, by impairing the reproductive capacity and survival of earthworms and springtails. Intensive use of agrochemicals mainly pesticides in natural environments have become a major concern and have stimulated scientists to develop reliable methods to assess the potential for the transformations of these anthropogenic chemicals. These informations are very much essential for modeling the fate and effects of these chemicals in the environment. This article is a review of the information available in the literature highlighting the various soil properties, which will influence the degradation of pesticides. The extent of biodegradability depends upon the chemical structure of the pesticides. [12-20] Soil physico-chemical properties influence the transformation of pesticides to a great extent. Soil microbial components largely govern pesticide degradation in soil. Maintenance of soil quality constitutes considerable intervention in the research agenda. Soil microbial biomass and its activities are important attributes of soil quality. The impact of pesticides on the soil microbial biomass, ergosterol content, respiration and fluorescein diacetate hydrolyzing activity as available in the literatures is reviewed here with especial emphasis. Most of the pesticides at field application rate did not impair the soil biological parameters. At higher rates of application the suppressive effects were transitory. Studies revealed positive correlation between pesticide transformation rate, soil physico-chemical and biological properties. Ecophysiological parameters, like the ratio of basal soil respiration to microbial biomass (qCO_2), are helpful to detect the stress on microorganisms due to pesticides. Most of the studies were conducted under laboratory conditions. Field studies are conspicuously lacking in the world literature. Future research need is projected.

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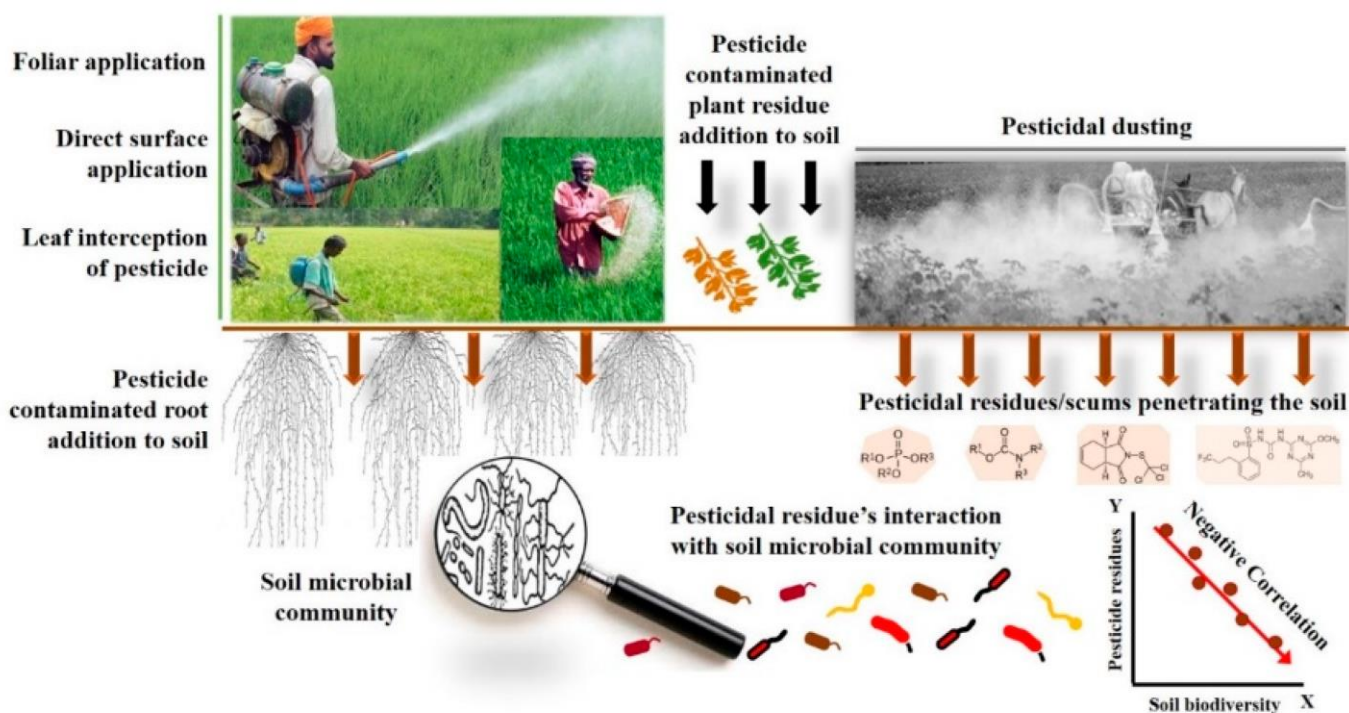
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II. DISCUSSION

Majority of pesticides applied to the soils are not specifically targeting the pest only but also taking another dimension of environmental concern.



Typically, when pesticides are sprayed to the plants, they dissolve speedily and enter various components of soil medium. This situation brings into existence a relationship between soil and chemicals contained in the pesticides. This relationship creates abnormal condition in soil and makes it to behave contrary to its natural stage of formation. This paper has taken into account an illustrated concept of pesticides behaviour under this condition as a challenge to four major soil components namely: soil quality, water quality, air quality and human quality. However, complex activities of soil challenges by pesticides as affecting these soil components include the agricultural activities, waste disposal, industrial environmental issues such as mining, chemical disposals, and accidental oil spills and occurrence of acid rain. Soil contamination and pollution by pesticides can be related to the concentration of chemicals pesticides and chemical elements in the soil in such a situation whereby they become more than normal. This implies that the concentration of a substance (e.g. pesticide chemicals, organic chemicals acidic or saline compound) in soil might be higher than would naturally occur [5]. However, the continuity of this contamination in soil could result to what is called 'soil pollution'- the situation that can be related to an accumulation and build-up of toxic chemical compounds resulted from the activities of man and caused adverse effect on soil properties, human, animal health, plants and soil biota [10]. The term has been also regarded as a situation whereby harmful objects and chemicals are applied to soils directly or indirectly in a way that cause harm to other living things or even destroys soil mineral particles or water ecosystem [21-40].

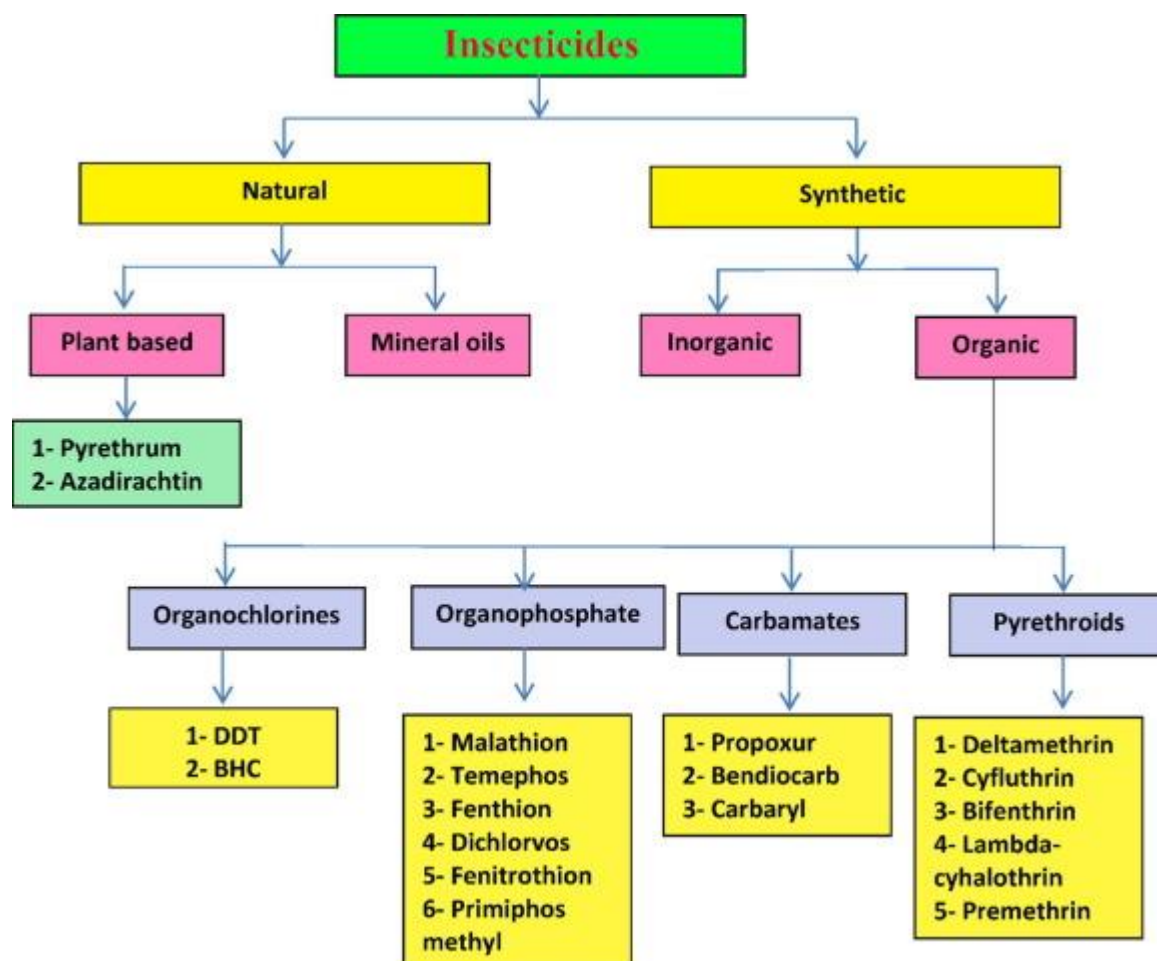
The extensive use of pesticides in agricultural production can degrade and damage the community of microorganisms living in the soil, particularly when these chemicals are overused or misused as chemical compounds build up in the soil.[59]

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The full impact of pesticides on soil microorganisms is still not entirely understood; many studies have found deleterious effects of pesticides on soil microorganisms and biochemical processes, while others have found that the residue of some pesticides can be degraded and assimilated by microorganisms.[60] The effect of pesticides on soil microorganisms is impacted by the persistence, concentration, and toxicity of the applied pesticide, in addition to various environmental factors.[61] This complex interaction of factors makes it difficult to draw definitive conclusions about the interaction of pesticides with the soil ecosystem. In general, long-term pesticide application can disturb the biochemical processes of nutrient cycling.[40-60]

Many of the chemicals used in pesticides are persistent soil contaminants, whose impact may endure for decades and adversely affect soil conservation.[62]

The use of pesticides decreases the general biodiversity in the soil. Not using the chemicals results in higher soil quality,[63] with the additional effect that more organic matter in the soil allows for higher water retention.[49] This helps increase yields for farms in drought years, when organic farms have had yields 20-40% higher than their conventional counterparts.[64] A smaller content of organic matter in the soil increases the amount of pesticide that will leave the area of application, because organic matter binds to and helps break down pesticides.[49]

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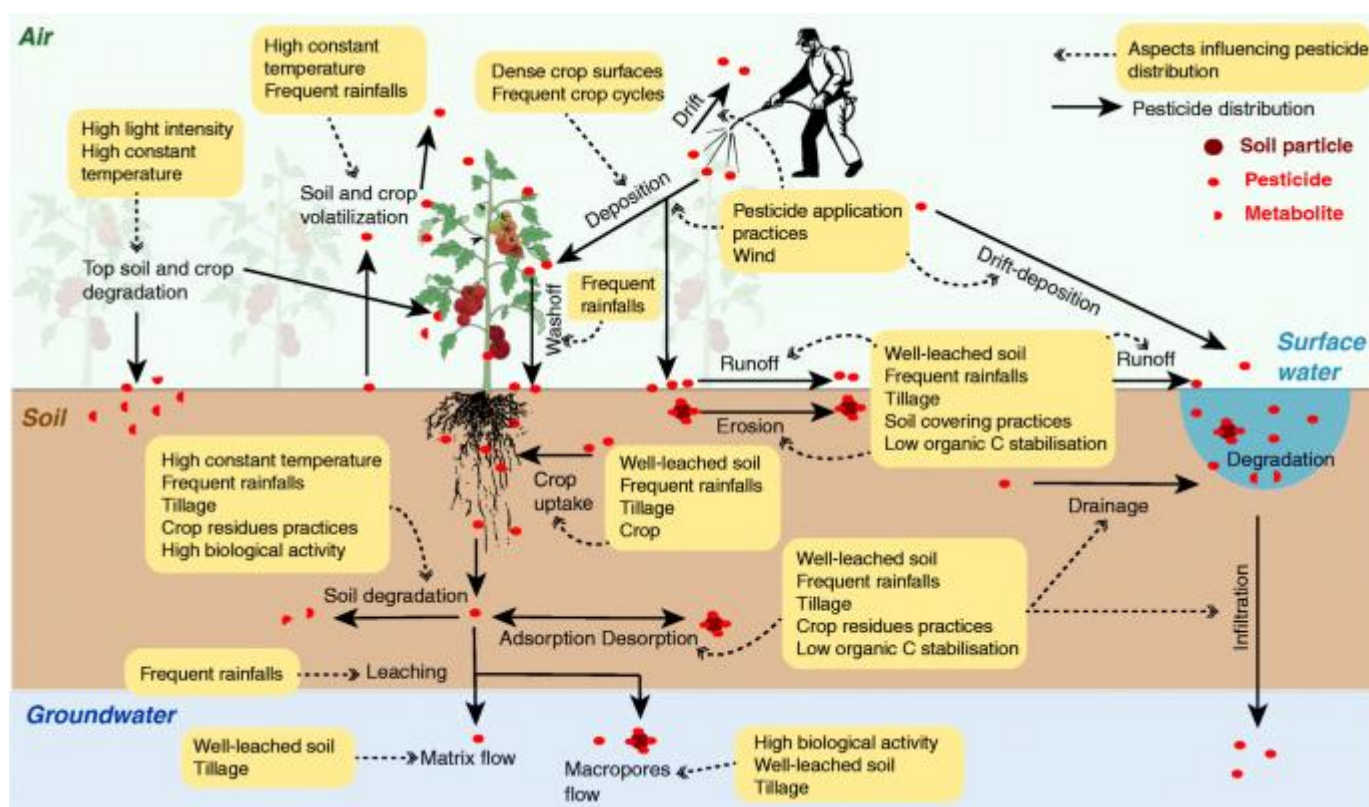
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Degradation and sorption are both factors which influence the persistence of pesticides in soil. Depending on the chemical nature of the pesticide, such processes control directly the transportation from soil to water, and in turn to air and our food. Breaking down organic substances, degradation, involves interactions among microorganisms in the soil. Sorption affects bioaccumulation of pesticides which are dependent on organic matter in the soil. Weak organic acids have been shown to be weakly sorbed by soil, because of pH and mostly acidic structure. Sorbed chemicals have been shown to be less accessible to microorganisms. Aging mechanisms are poorly understood but as residence times in soil increase, pesticide residues become more resistant to degradation and extraction as they lose biological activity.[65]

RESULTS

Soil can be degraded and the community of organisms living in the soil can be damaged by the misuse or overuse of pesticides. Some pesticides are more toxic to soil organisms than others. Some pesticides may break down quickly when applied to soils, while others may persist for longer periods. The type of soil and the type of pesticide can also affect pesticide persistence



- Review the "Environmental Hazards" section of the product label, and always follow the **label directions**.
- Adopting **IPM methods** of controlling pests can reduce the need for pesticides application to soils.
- Pesticides in soil may be taken up by plant roots and moved to other plant tissues, including the fruit.
- Pesticides applied to sandy or coarse-grained soils are more likely to leach through the soil and **contaminate groundwater**.

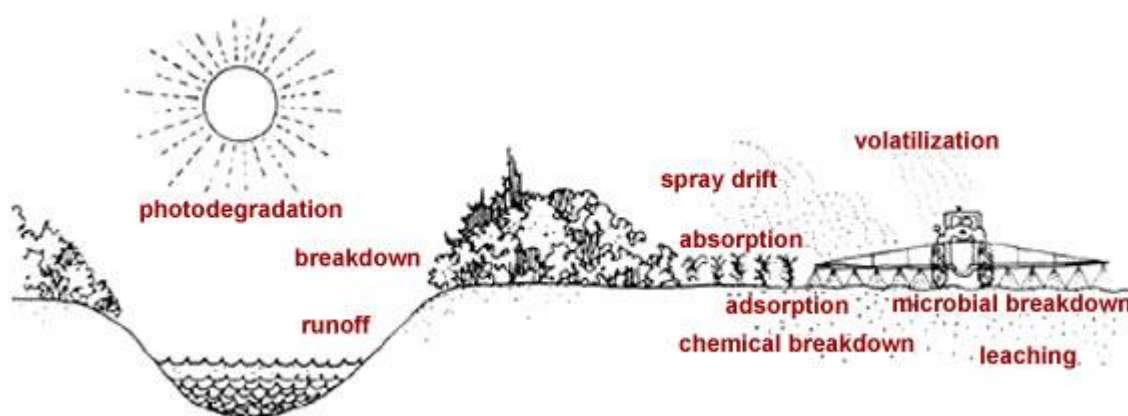
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Once the influence of organic amendments on an individual pesticide has been studied and documented by laboratory assays, the next step should be to extend these studies to field scale under real conditions.



This will allow considering additional factors such as the undisturbed soil structure, precipitation, temperature, irrigation, or the presence of crops affecting the dynamics of pesticides through the uptake process or simply controlling for water dynamics. A holistic view jointly evaluating the different pesticide processes and their interactions affected by the application of the organic amendments will contribute to a more complete and more effective interpretation of the environmental fate of pesticides in amended soils. Despite the potential relevance of the results obtained in this kind of study, only a few assays combine pesticides-organic amendments at field scale. The optimization of the use of pesticides together with organic amendments in soil therefore calls for field studies to assess pesticide behavior under different amended soil scenarios, together with models for simulating and predicting pesticides' environmental fate as future perspectives.[64,65]

IV. CONCLUSIONS

Synthetic pesticides are used to control the weeds and insect pests, affecting the agricultural systems. Water, soil and air serve as an important medium for transportation of pesticides from one site to another. Among different classes of pesticides, organochlorine pesticides are the most harmful one due to their slow rate of decomposition, greater stability and long half-life. These pesticides can migrate and get accumulated in the upper trophic levels of food chain. Pesticide contamination is a serious problem for each ecosystem and is harmful for all associated organisms. So, in order to control pesticide usage, new methodologies and techniques are needed in assessing the effect of widespread use of pesticides on ecosystem and efforts should be made to provide awareness among public to minimize the application of harmful pesticides. Use of biopesticides should be encouraged over chemical pesticides.[65]

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