

An Imperative Need for Green Pesticides: A Review

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ABSTRACT

Pesticides are basically those chemicals or microbial agents which protect crops. Although pesticides help in combating pests, they also have many harmful effects on the Environment. The objective of this article is to bring forth the harmful effects of chemical pesticides and the possible solutions regarding the same. To this end, many relevant citations were studied and summarized. Pesticides affect the quality of soil, water and other vegetation. In some cases, heavy treatment of these pesticides can also spoil beneficial micro-organisms of soil. On entering aquatic systems, pesticides kill thousands of fishes, turtles, mussels and water birds. When it comes to humans, from acute health problems like abdominal pain, dizziness, headaches, vomiting, eye problems to chronic impacts like cancer, reproductive harm, endocrine disruption, neurological problems, reduced fertility in males, damage to germinal epithelium, Asthma, memory disorders- are some of the many disastrous effects. The rampant use of pesticides under the adage "if a little is good, a lot more will be better" has played a havoc with the environment. Green pesticides can prove to be very helpful in this situation. They are pest control solutions that are less harmful than chemical pesticides and just as effective. Plants like *Neem*, *Nettle*, *Tansy*, *Horsetail*, *Rhubarb* may be extremely useful in this regard.

Keywords: Pesticides, Harmful, Environment, Green pesticides

INTRODUCTION

A pesticide is a toxic chemical substance or a biological agent that is intentionally released into the environment in order to avert, control, kill or destroy populations of pests that include insects, weeds, fungi, rodents, etc. Pesticides attract, seduce and then destroy or mitigate pests. Different kinds of pesticides have been used for crop protection for centuries. In recent decades, there has been a steady increase in the amount of pesticides marketed for agricultural use. Between 2005 and 2010, the total volume of global sales of pesticides rose from US\$ 31 to US\$ 38 Billion. The amount of pesticides used internationally has risen fifty fold since 1950. More than 1,055 ingredients were registered as pesticides in the year 2007 [1]. It has been forecasted that the revenue from pesticide market will rise over 52 billion US\$ in 2019 [2]. It has been found that out of the twelve most dangerous and persistent chemicals, nine are pesticides [3]. Pesticides are a concern for sustainability of environment and global stability.

Materials and Methods

Harmful Effects of Pesticides

Pesticides benefit the crops; however, they also impose a serious negative impact on the environment. Excessive use of pesticides may lead to the destruction of biodiversity. Many birds, aquatic organisms and animals are under the threat of harmful pesticides for their survival. The Pesticide cycle is shown in figure 1.

Harmful Effects of Pesticides on Human Health

One of the most important aspects of pesticides is how they affect human health. There is an increasing

anxiety about the importance of small residues of pesticides often suspected of being carcinogens or disrupting endocrine activities in drinking water and food. Many human illness and deaths have occurred as a result of exposure to pesticides over the last fifty years. In Bhopal, India around 4000 deaths resulted from exposure to accidental emissions of Methyl Isocyanate from a pesticide factory [4]. Pesticides have been linked to a wide range of human health hazards, ranging from short-term impacts such as headaches and nausea to chronic impacts like cancer, reproductive harm and endocrine disruption. Acute health problems may occur in workers that handle pesticides such as abdominal pain, dizziness, headaches, vomiting as well as skin and eye problems. Figure 2 shows an example of skin problem due to pesticides. In China, an estimated half million people are poisoned by pesticides each year, 500 of who die. Pyrethrins, insecticides commonly used in Bug killers, can cause a potentially deadly condition if breathed in. Many studies have examined the effects of pesticides exposure on the risk of cancer. Association have been found with leukemic, lymphoma, brain, kidney, breast, prostate, pancreas, liver, lungs and skin cancers. Evidences links pesticide exposure to worsened neurological outcomes. The risk of developing Parkinson's disease is 70% greater in those exposed to even low levels of pesticides. Pesticides can cause birth defects, fetal death and altered fetal growth [5]. Agent Orange, a 50:50 mixture of 2, 4, 5-T and 2, 4-D, has been associated with bad health and genetic effects in

Malaya and Vietnam. One study found that premenopausal women who use pesticides generally have longer menstrual cycles and are more likely to miss a cycle than their non-pesticide using counterparts. Pesticides exposure resulted in reduced fertility in males, genetic alternation in sperm, a reduced number of sperm, damage to germinal epithelium and altered hormone function. Pesticides can affect the fetus in early stages and are a cause of reproductive disruption [6]. Problems like Asthma, memory disorders and depression are also caused by pesticides. According to researchers from National Institute of health, licensed pesticide applicators who used chlorinated pesticides on more than 100 days in their lifetime were at greater risk of diabetes. It has been estimated that global stockpiles

of obsolete pesticides in developing countries and economies in transition amount to something in the order of 400,000-50,000 tonnes. As a result of frequently problematic handling of pesticides in developing countries, 70% of all pesticide poisoning and 99% of resulting deaths occur in these countries. On a global scale, pesticide poisoning plays an important role as a method for committing suicide; at 31%, it is the most frequently used method. It is estimated that nearly 3 million farmworkers experience severe pesticides poisoning, resulting to about 18,000 deaths; while about 25 million workers suffer from mild pesticide poisoning each year. The proportion of pesticide related suicides varies regionally from 4% in Europe to as much as 50% in the Western Pacific region.

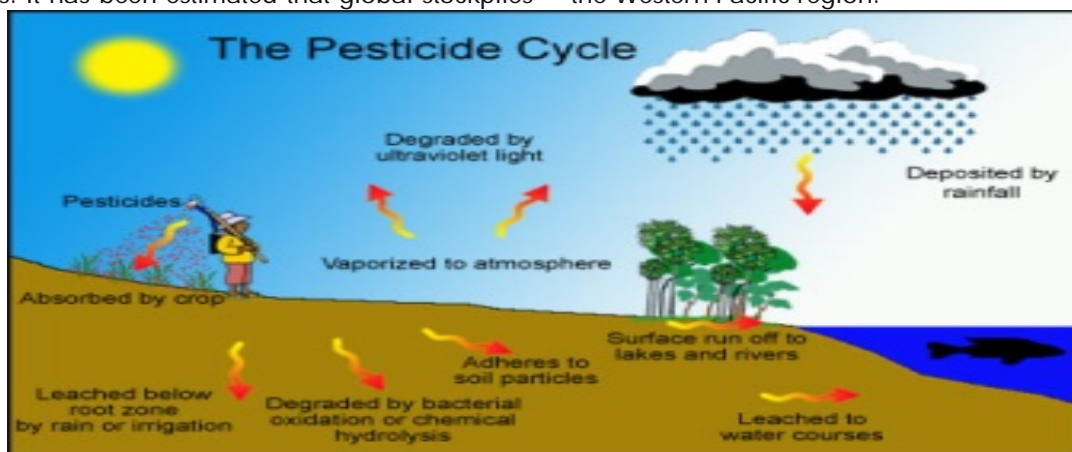


Figure 1. The Pesticide Cycle



Figure 2. Skin Problems due to pesticides

Harmful Effects of Pesticides on Animals

Pesticides have a major effect on the terrestrial animal populations. Pesticides can eliminate some animal's essential food sources, causing the animals to relocate, change their diet or starve. Residues can travel up the food chain; Some pesticides can bio-accumulate, or build up to toxic levels in the bodies of organisms that consume over time, a phenomenon that impacts species high on food chain especially hard. Insecticides such as carbamates, organophosphates and pyrethroids are responsible for the decrease in populations of bees (Figure 3) and beetles. Imidacloprid affects bee

foraging behaviour [7] and reduces their learning capacity [8]. Honey bee populations have dropped by 29–36 % since 2006. Since pre-agricultural times, 20–25 % of the bird populations have declined. Bald eagle populations in the USA declined primarily because of exposure to DDT and its metabolites.

Harmful Effects of Pesticides on Aquatic Life

Pesticides have played havoc with the aquatic life as well. Pesticides enter the water by runoff, through the soil or via drift. Pesticides can affect aquatic populations adversely. They decrease dissolved oxygen in the water and can cause physiological and behavioural changes in fish populations. Herbicides

kill aquatic plants which results in drastically low oxygen levels and ultimately leads to the suffocation of fishes (Figure 4) and reduced productivity [9]. Atrazine affects the immune system of some amphibians and is highly toxic to fishes [10]. Carbaryl has been found toxic for several amphibian species, whereas, herbicide glyphosate is known to cause high mortality of tadpoles and juvenile frogs [11]. Small concentrations of malathion have been

shown to change the abundance and composition of plankton and periphyton population that consequently affected the growth of frog tadpoles. It was discovered that 10 % of male frogs raised in atrazine-contaminated water developed into females. Male frogs that were genetically males phenotypically developed ovaries within their testes. They also developed the tendency lay eggs by mating with other males.



Figure 3. Honey Bee population has declined due to neonicotinoids

Harmful Effects of Pesticides on Soil

Another aspect of pesticide overuse is their leaching into the soil, which affects the microbes residing in it. Bacteria dependent processes like nitrification and de-nitrification are disrupted by Chlorothalonil and dinitrophenyl fungicides [12]. Insecticides and fungicides produce neurotoxic effects in earthworms and after a long term exposure they are physiologically damaged [13]. Herbicides also cause considerable damage to fungal species in soil. Growth of symbiotic mycorrhizal fungi is inhibited by trifluarlin and oryzalin [14].

Harmful Effects of Pesticides on Air

Pesticides are also a contributor to air pollution. Pesticides are suspended in the air as particles and

are carried by wind to other areas where they can contaminate the environment. Pesticides that are applied to crops can volatilize and may be blown by winds into nearby areas, potentially posing a threat to wildlife. Figure 5 shows an example of how pesticides can accumulate into the air. Many ester-formulation herbicides have been shown to volatilise off treated plants with vapours sufficient to cause severe damage to other plants [15]. Weather conditions at the time of application as well as temperature and relative humidity change the spread of the pesticide in the air. Pesticides that are sprayed on to fields and used to fumigate soil can give off chemicals called volatile organic compounds, which can react with other chemicals and form a pollutant called tropospheric ozone.



Figure 4. Pesticides are toxic to fishes

Green Pesticides- A Solution

It has been estimated that about 2.5 million tons of pesticides are used on crops each year and the worldwide damage caused by pesticides reaches

\$100 billion annually [16]. Looking for alternative plant-based pesticides could be a possible and viable solution to address this catastrophe which could serve as potent "Eco-friendly-agrochemicals".

Green pesticides, also called ecological pesticides, are pesticides derived from organic sources which are considered environmentally friendly and causing less harm to human and animal health, and to habitats and the ecosystem [17]. The green pesticides can contribute to reduce the pest population and increase food production. They are more compatible with the environment components than synthetic pesticides. The interest in green pesticides is based on the advantages associated with such products which are: inherently less harmful and less environmental load, designed to affect only one specific pest or, in some cases, a few target organisms, often effective in very small quantities and often decompose quickly, thereby resulting in lower exposures and largely avoiding the pollution problems and when used as a component of Integrated Pest Management (IPM) programs, green pesticides can contribute greatly. Plants contain a large number of secondary metabolites and those categorized under terpenoids, alkaloids, glycosides, phenols, tannins etc. play a major role in plant defence and cause behavioural and physiological effects on insects [18]. Many plant essential oils show a broad spectrum of activity against pest insects and plant pathogenic fungi ranging from insecticidal, anti-feedant, repellent, oviposition deterrent, growth regulatory and antivector activities. Further, while resistance development continues to be an issue for many synthetic pesticides, it is likely that resistance will develop more slowly to essential-oil based

pesticides owing to the complex mixtures of constituents that characterize many of these oils. Neem-based products have been demonstrated as a natural insect repellent and insecticide over hundred insect pests. Globally, *Cymbopogon citratus* or lemongrass is well-known due to its invincible nature and an infinite number of phytotherapeutic applications and potentialities [19]. Other plants like Nettle, Tansy, Horsetail, Rhubarb may be useful in this regard. Figure 6 shows Tansy plant. Apart from plant based pesticides, Microbial pesticides (which include bacterium, fungus, virus, protozoan or alga as active ingredients) can also control many different kinds of pests [20]. The most widely known microbial pesticides are varieties of the bacterium *Bacillus thuringiensis*, which can control certain insects in cabbage, potatoes, and other crops. It produces a protein that is harmful to specific insect pests. A yet another aspect of eco-friendly pesticides is a Biochemical pesticide which is a naturally occurring substance that control pests by non-toxic mechanisms [21]. Biochemical pesticides include substances that interfere with growth or mating, such as plant growth regulators, or substances that repel or attract pests, such as pheromones. Because it is sometimes difficult to determine whether a natural pesticide controls the pest by a non-toxic mode of action, Environmental Protection Agency (EPA) has established a committee to determine whether a pesticide meets the criteria for a biochemical pesticide.



Figure 5. Pesticides blown with the wind

Green pesticide is a promising alternative to chemical pesticide. Pest management in an eco-friendly manner is no longer a dream now. The tools and techniques of molecular biology and biotechnology facilitate producing bio-pesticides in crop plants itself in a safe and sustainable manner. In addition to the continuous search for new biomolecules and improving efficiency of the known

green pesticides, recombinant DNA technology is also being used for enhancing their efficacy. Fusion proteins are also being designed to develop next-generation bio-pesticides. The fusion protein may be produced as a recombinant protein in microbial system, which can be scaled up for industrial production and commercial formulations. Several other innovative approaches are being applied to

develop green pesticides as an effective, efficient and acceptable pest control measure.

Conclusion

As environmental safety is a global issue, we need to create awareness among the common men to switch-over to green-pesticides for their pest

management requirements. The need for green pesticides is imperative now. Discouraging chemical pesticides and taking a step towards eco-friendly pesticides will ensure sustainability of the environment. Prevention is better than cure they say.

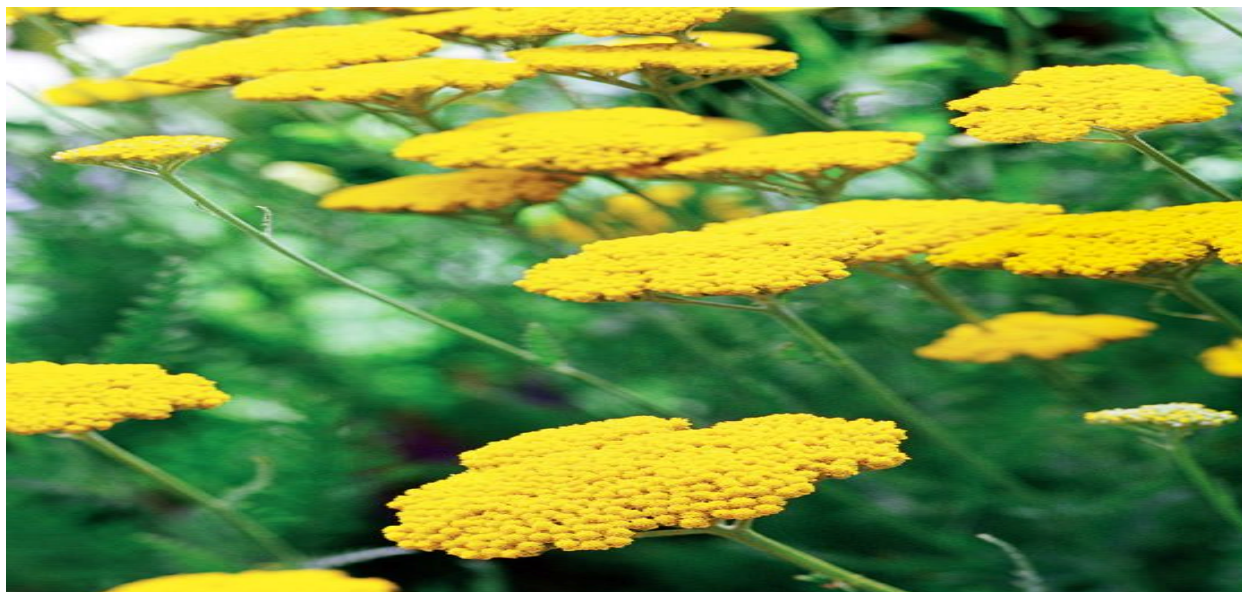


Figure 6. Tansy plant is used to make Green Pesticides

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