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A STUDY ON HERBICIDES: RESIDUAL EFFECTS AND LEACHING

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ABSTRACT

A large part of modern agriculture is played by pesticides, and new formulations of these chemicals are introduced on a very regular basis. Both 2,4-D and MCPA, which are both chlorinated acid-phenoxy herbicides, are frequently utilized for the purpose of weed control in pasture, wheat, rice, corn, and sugar cane, among other crops. Over the past several years, environmental protection groups have been significantly more worried about the presence of these molecules in soils, water, and the air, particularly with regard to the protection of the quality of drinking water. Because of the worldwide pesticide industry and the economic significance of agriculture, it is quite likely that these materials will continue to be utilized globally for an extremely extended period of time. Therefore, the most practical application of these products would be their rational application under stringent control of their handling and use. This would primarily be done to prevent overdosing, application in inappropriate places, and improper washing of packaging and application equipment, all of which are frequently held on riverbanks. Accordingly, research is required in order to discover a solution to the problem of soil and water contamination that has been brought about by the extensive use of pesticides in modern agriculture across large regions.

KEYWORDS:

Herbicides, Residual, Leaching

INTRODUCTION

In view of the environmental transport processes that herbicides go through after being applied to agricultural regions, it is important to bring up the concepts of leaching and runoff. As a result of the molecule being transported and adsorbed to eroded soil particles or in solution, surface runoff contributes to the pollution of surface water. On the other hand, leaching is a process that results in groundwater contamination. In this situation, chemicals are carried in solution with the water that feeds the groundwater. Only a tiny fraction of the soil is comprised of herbicides that are used in a bioactive manner; the remaining component is discharged into the wider environment. Because of the large quantity of product that is required for this loss, there is a greater amount of damage done to the environment, which in turn causes harm to human health.

To regulate other processes that may have an effect on the dynamics of these molecules in the soil, it is necessary to have a solid understanding of sorption-desorption processes. This is because, once the amount of product present in the soil is understood, it is possible to exert control over other processes. As the sorption degree of a pesticide increases, the concentration of the pesticide in the air and water will decrease. As a consequence of this, there is a reduced likelihood that surface water and groundwater will get polluted as a consequence of concentration-dependent processes such as volatilization, bioavailability, and vertical pesticide transfer over the soil profile.

At this point in time, the aquatic ecology is far more vulnerable to contamination. Because they are more likely to be loaded by subsurface water flow and deposit, herbicides with high leaching potential—that is, those with a limited ability to be retained in the soil—may be more hazardous in this environment and have long-term consequences on aquatic populations. This is because they are more likely to be loaded by subterranean water stream and deposit. There is still a problem with water pollution due to the fact that agricultural areas are typically situated in close proximity to bodies of water such as lakes, streams, and rivers, which means that this environment is more likely to be exposed to soluble herbicides.

It is possible for the residue in water to attach to the material that is suspended in the water, accumulate in the sediment, or be absorbed by aquatic creatures, depending on the physical and chemical features of the reservoir. In order to carry organisms through the aquatic system, water can diffuse through sediments or even within the bodies of the organisms themselves. Moreover, there is the possibility that certain products will volatilize and then return to the environment. As a result, it is evident that pesticides, sediment, and water are continually interacting with one another and are impacted by temperature, turbulence, and the flow of water. It is possible that aquatic organisms may be subjected to potentially harmful substances for extended periods of time after this interaction has taken place.

Both the mobility and destiny of organic molecules in aquatic systems, including herbicides, are assumed to be influenced by this physical property, which is also a factor that impacts the soil sorption coefficient. It is believed to be the most significant physical characteristic connected with these processes. It is vital to take into consideration a number of elements, including sorption to soil and water solubility, in order to make an accurate prediction about the direction of migration of herbicide in the ground, whether it be horizontal or vertical.

According to the United States Environmental Protection Agency, the degree of non-polarity of a molecule rises with its K_{ow} value. This parameter is also connected with sediments and bioconcentration in aquatic organisms, as well as water solubility and soil sorption coefficient, according to research conducted in the field of environmental science.

Research has shown that these associations exist. Herbicides that have high $\log K_{ow}$ values (> 4.0) or are lipophilic have a tendency to accumulate in lipid material, such as soil organic matter, and as a result, they have restricted mobility. On the other hand, herbicides that are hydrophilic ($\log K_{ow}$ that is less than 1.0) and so more soluble in water would have a lower sorption and a greater potential to cause harm to aquatic life.

REVIEW OF RELATED LITERATURE

In academic publications, several examinations of pesticide-induced environmental pollution have been recorded. These investigations have been reported numerous times. There are several herbicides that belong to the triazine group, including prometryne, atrazine, simazine, and others. These herbicides are utilized extensively all over the world and are regularly discovered in soil and water samples. It is registered for use on a variety of crops, including sorghum, corn, sugarcane, and several others. As a result of its extensive application, substantial persistence, and moderate mobility in soil, this herbicide has been discovered in a number of environmental compartments, most notably surface waterways. [1]

Leaching is a method of transporting herbicides, and the amount of time that passes between the application of herbicides and the occurrence of irrigation or rainfall. The issue of atrazine's pollution of surface and underground rivers has been brought to the attention of a number of writers. Other authors have also brought attention to this problem. [2]

The results of the experiment revealed that the concentrations in the soil were, on average, four times higher below the surface than they were above it. This was discovered after the trial continued. The conclusion that may be drawn from this finding is that there is a considerable risk of groundwater contamination even after the research has been completed. Atrazine was found to be present in the United States in significant quantities in both surface water and groundwater. [3]

After being applied to the surface of the soil, the material has the potential to seep into the deeper layers of the earth, which poses a risk of polluting groundwater and, as a result, watercourses. The edaphic half-life can range anywhere from five to one hundred and seventeen days, depending on the kind of soil and the environmental conditions that are present in the surrounding area. [4]

Researchers have also expressed worry with ametryne, a herbicide that has a half-life of fifty to one hundred and twenty days in soil and two hundred days in water that occurs naturally at temperatures ranging from five to twenty-nine degrees Celsius and a pH of seven. It has been reported that this material has the capability of contaminating soils, surface water, and groundwater, which would make it hazardous to the environment. [5]

There is a possibility that ametryne might cause damage to aquatic ecosystems since it has the capacity to leach and is also capable of being transported by runoff. Amethyene residues have also been found in Brazil's surface waters. This is despite the fact that Brazilian legislation does not define a legal limit for the amount of amethyene that may be found in surface waters. [6]

Factors affecting persistence of herbicides applied to crops:

1. Microbial decomposition

2. Chemical decomposition

3. Soil adsorption

4. Volatilization

5. Photo decomposition

6. Plant uptake and metabolism

7. Leaching

8. Surface runoff

HERBICIDES: RESIDUAL EFFECTS AND LEACHING

Sediments have the potential to absorb glyphosate in the case that water is contaminated by the sediments that they transport. This often takes place in a short amount of time—within fourteen days—and as a consequence, the natural deterioration process is substantially slower. According to the United States Environmental Protection Agency (USEPA), a "health advisory limit" of 700 µg/L has been established for the presence of glyphosate in drinking water resources. In spite of this, the "maximum allowable concentration" for these compounds is set at 0.1 mg/L for the entirety of Europe. This is due to the fact that the overall concentration of pesticides in drinking water does not exceed 0.5 mg/L. Because of its broad-spectrum herbicide properties, which include its non-selective, systemic, and low toxicity to animals, it gained to popularity on a worldwide scale, which, in turn, demanded the construction of monitoring systems. A number of different water treatment techniques have been investigated to see how efficient they are in removing specific herbicides that have been discovered in freshwater samples. Among these are the adsorption of anionic molecules in lamellar double hydroxides (HDLs) through the processes of anion exchange or merge, the lectrochemical destruction of anionic molecules through photo-Fenton reactions, the adsorption on activated carbon, the adsorption on clays saturated with inorganic or organic cations, and the anaerobic degradation of anionic molecules.

However, despite the fact that determining the dosage of a pesticide that is harmful to an organism is the primary purpose, the subject of pesticide toxicity is a very problematic situation. By way of illustration, contaminants may travel long distances in suspension by droplets or particles when they enter a water environment. This means that the hazardous impact of a chemical substance could manifest itself in a location that is a significant distance from the point at which the substance was introduced into the medium.

The amount of a chemical that has an impact on fifty percent of a cohort of organisms is referred to as the effective dose or effective concentration (EC50 or ED50), and it is a metric that may be utilized to determine the level of toxicity that pollutants possess. The exposure affects on organisms are influenced by the physicochemical properties of the product, which include its solubility, chemical reactivity, stability, particle size, and other features along these lines.

The research took into consideration a number of different aspects, including the route of exposure (oral, inhalation, or cutaneous), the length and frequency of exposure, the species that were examined, and the variations in susceptibility and effect types that were seen among the different species. The findings of the study also revealed that the effects of the substance differed considerably amongst persons of different ages and genders, with younger and older people being more sensitive than adults. As a result of the potential for contamination and the requirement to use herbicides in order to increase agricultural production, scientists from all over the world are working hard to obtain a better understanding of these chemicals, to warn about them, and to lessen the impact that they have on the organisms that live in aquatic ecosystems. In response to this issue, ecotoxicology was founded as a field of study. The French toxicologist René Truhaut defines ecotoxicology as the study of how populations and communities of living things, such as plants, animals, aquatic and terrestrial species, are affected by toxins that are either naturally occurring or artificially produced.

In order to ascertain the manner in which chemicals influence live organisms, toxicity tests are carried out. In the field of ecotoxicology, these are tools that are extremely important since they allow for the determination of whether or not a certain substance has a toxic influence.

The Organization for Economic Cooperation and Development (OECD) concurrently adopted a number of test procedures across Europe for aquatic creature toxicity. These test methods included fish, algae, and microcrustaceans, among other aquatic organisms. In 1975, Brazil was the location where the first attempt was made to take a focused approach to the subject matter. After this year, further methods that make use of groups of organisms have come into existence, with a particular emphasis on fish.

The purpose of these studies is to get an understanding of the ways in which human actions have an effect on living organisms that are being used as models for other living things. Toxicity tests may be utilized to assess the level of environmental contamination that is brought about by a wide range of pollution sources. These pollution sources include garbage from households, factories, and farms, as well as chemical goods and medications in general. They may also be used to evaluate if a hazardous chemical or combination of agents has the potential to create adverse consequences, as well as the method in which those effects manifest and the place in which they occur. In addition, they offer data on the probable harm that a hazardous element can bring to aquatic life, including behavioral disorders, cancer, mutagenesis, teratogenesis, cumulative physiological effects, antagonistic effects, and synergistic effects.

The toxicity of a certain chemical substance is determined by the susceptibility of the organisms to that compound. This is due to the fact that their physiology, behaviour, food habits, development, and other factors all play a role. It is common for children to be more susceptible to the effects of toxins than adults are. This may be due to the fact that children are in various phases of development or have different detoxification systems. It is a regular occurrence in the environment for overly stressed organisms that have been exposed to a variety of toxicants in the past to become more vulnerable to the effects of the toxicants.

Acute and chronic toxicity testing are the two types of tests that are available. The objective of the acute test, which examines the effects of a brief exposure on organisms, is to ascertain the concentration of a test substance that is capable of causing detrimental effects in controlled environments. The impact that is observed in fish is known as lethality, and it is this specific impact that serves as an indicator of the dangerous agent concentration that results in fifty percent mortality (LC50). The average estimate concentration (EC50) that results in fifty percent immobility is obtained from the fact that microcrustaceans do not exhibit any mobility.

There are other research that investigate chronic toxicity. In these studies, organisms are subjected to dangerous substances on a continuous basis for a significant percentage of their life cycle, which can range anywhere from fifty percent to two thirds of their lifespan. These exams analyze non-lethal effects such as changed development and reproduction, altered behavior (difficulty in mobility, increased operculum opening frequency), altered physiology, altered biochemistry, and altered tissue. These investigations are intended to determine whether or not the consequences are fatal.

Due to the fact that sublethal dosages are calculated by utilizing the LC50 and EC50, the results of acute toxicity studies have a direct impact on the findings of chronic toxicity tests. The following selection criteria are frequently used to choose test organisms: availability and abundance; significant ecological representation within biocenoses; cosmopolitanism of the species; knowledge of its biology, physiology, and eating habits; genetic stability and uniformity of its populations; low seasonality index; constant and accurate sensitivity;

commercial importance; ease of laboratory cultivation; and, if possible, native species for better ecosystem representation.

Since the field of ecotoxicology was invented, a great number of studies have been carried out, all of which have been carried out with the intention of assessing the toxicity of a material for a particular test organism. These herbicides included paraquat, atrazine, and different combinations such as 2,4D + picloram, diuron + MSMA, and alaclhor + atrazine. 5.02 mg was the LC50 value after 96 hours had passed. This is a reference to atrazine. In addition, these researchers observed that organisms that were exposed to 2.5 and 5.0 mg.L-1 experienced a loss in weight. In comparison to the other products, the combination of alachlor and atrazine was the only one that was able to eradicate all of the organisms after being exposed to it for a period of forty-eight hours. After 96 hours, the fish Cyprinus carpio, Rhamdia quelen and Channa punctatus exhibited LC50 values of 18.8 mg.L-1, 10.2 mgL-1, and 42.38 mgL-1, respectively, according to data from prior studies that were conducted in relation to atrazine. In toxicity trials, the sensitivity of organisms might vary, even when the same drug is used. This is illustrated by the research on atrazine that was mentioned before in this paragraph.

At low quantities, this molecule is capable of interfering with the activity of hormones in both people and animals. As a result, the presence of this chemical in the environment constitutes a threat to both the species that live there and the ecosystem as a whole. Studies have shown that atrazine can also have an effect on the human reproductive system, which can lead to a reduction in the number of sperm and an increase in the number of people who are unable to conceive.

The growth of forty African frog males from their tadpole stage to their adult phase was investigated in a research that was carried out by the University of California. The water that contained atrazine was at levels that were lower than the permitted threshold set by the Environmental Protection Agency (EPA). This particular set of frogs was compared to another group of frogs that had not been exposed to water that had been contaminated. In the water that had been treated with herbicide, ten percent of the frogs that matured were able to develop into fertile females. In spite of the fact that their testosterone levels and fertility were low, ninety percent of the other people displayed characteristics that are often associated with men.

CONCLUSION

When it comes to the entire category of herbicides, glyphosate is without a doubt the product that is sold the most by consumers all over the world. There is a possibility that glyphosate is present in surface water as a result of its direct application as a pesticide with the intention of removing aquatic plants. As a result of its rapid adsorption, glyphosate is not easily leached from soil, which makes the possibility of groundwater contamination extremely low. Because it is difficult to separate the chemicals and is not considered to be a substantial water pollutant, this herbicide has been identified in water samples on occasion. However, this is mostly due to the fact that it is present in water samples.

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