

AGRICULTURAL CHEMICALS

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Summary

Large amounts of chemicals, particularly pesticides, are used in agriculture, helping to provide for the most basic of human needs through the production of food by growing crops and livestock. Clearly, the use of agriculture chemicals has increased production of crops, but pollution caused by pesticides has enormous potential for environmental damage.

Some pesticides possess toxic characteristics likely to cause adverse human health or environmental effects, and many diseases occurring in organisms are related to these chemicals in the environment. Many kinds of pesticides are included in the US-EPA priority pollutants list. These chemicals have been widely used in the last few decades. The adverse effect on environment caused by pesticides is and will continue to be a major issue in environmental protection for at least the next few decades. In view of the adverse effect of these chemicals on the environment and humans, it is important that information on them should be freely available.

1. Introduction

For agricultural chemicals, the source is the deliberate application to crops and soils. Over the last few decades, large amounts of chemicals have been used in agriculture to increase production of crops in both developed and developing countries. From the point of view of environmental concern, pesticides are probably the most important of these chemicals.

Pesticides are natural or synthetic substances that kill or otherwise control (for instance, by interfering with the reproductive process) an unwanted organism. All chemical pesticides share the common property of blocking a vital metabolic process of their target organisms. Almost half of the usage of pesticides in the USA involves agriculture.

They are used mainly in agriculture to control pest animals (insects, rodents), fungi and weeds. In health protection, pesticides as veterinary, household and hygiene products, are used mainly to control mosquitoes which carry diseases, particularly malaria. For other applications, pesticides are used to control pests in forestry, for wood and textile preservation, and also to control excessive growth of undesirable plants in water bodies.

The first mention of pesticides was made in 1763, when an infusion of tobacco was used to control louse. Later, some other uses of pesticides were reported; for example, in 1865, in controlling the Colorado beetle by the use of Paris Green (copper aceto-arsenite). The introduction of DDT during World War II marked the beginning of a period of very rapid growth in pesticide use.

As of the mid 1990s, U.S. agriculture used about 365 million kg of pesticides per year, whereas about 900 million kg of insecticides were used in non-agricultural applications including forestry, landscaping, gardening, food distribution, and home pest control. Among various kinds of pesticides, insecticides, fungicides and herbicides collectively represent the great bulk of the one billion kilograms of pesticides that are used annually in North America.

Insecticides and fungicides are the most important pesticides with respect to human exposure in food because they are applied shortly before or even after harvesting. Herbicide production has increased as chemicals have increasingly replaced cultivation techniques in the control of weeds and now account for the majority of agricultural pesticides. In the meantime, the widespread application of these chemicals has deleterious effects on ecosystems and on human health.

2. Insecticides

Insecticides of one type or another have been used by society for thousands of years. Insecticide production has remained about level during the last three or four decades. The use of this material has contributed to increased agricultural yield, protection of livestock, and the reduction of threat of vector-transmitted disease to humans. Currently, the greatest use of insecticides occurs in the growing of cotton. However, the global contamination caused by indiscriminate usage of pesticides has been found to be ubiquitous and persistent in various environmental media and biota.

2.1. Inorganic Insecticides

The earliest recorded usage of pesticides was the burning of sulfur to fumigate Greek homes around 1000 B.C.; fumigants are pesticides that enter the insect as an inhaled gas. The use of SO₂ from the burning of solid sulfur, sometimes by incorporating the element in candles, continued at least into the nineteenth century. Sulfur itself, in the form of dusts and sprays, was also used as an insecticide and as a fungicide; it is still employed in the latter capacity against powdery mildew on plants. Hydrogen cyanide gas has also been used as a fumigant. Its use to prevent damage to specimens in museum cases was recorded in 1877, and a few years later it was used to control insects in fruit trees. It is, of course, very lethal to humans.

Inorganic fluorides, such as sodium fluoride, NaF, were used domestically to control ant populations; both sodium fluoride and boric acid were used to kill cockroaches in infested buildings. Various oils, whether from petroleum or living sources such as fish and whales, have found use for hundreds of years as insecticides and as “dormant sprays” to kill insect eggs. Fluoride insecticides also include cryolite (Na₂AlF₆) and sodium fluorosilicate (Na₂SiF₆).

Arsenic compounds also found widespread use as pesticides before the modern era of organic chemicals. The use of arsenic and its compounds to control insects dates back to at least 900 A.D., and became quite widespread from the late nineteenth century until World War II. Paris Green, which is a copper salt containing the arsenite ion, AsO₃³⁻, was a popular insecticide introduced in 1867. Other salts containing this ion, or the arsenate ion, AsO₄³⁻, have also been employed; all operate as stomach poisons, and kill insects that ingest them. The common arsenic-based insecticides are lead arsenate, Pb₃(AsO₄)₂. Arsenic compounds continued to be heavily used as insecticides in the 1930s, 1940s, and early 1950s. Although its use in these applications has decreased, arsenic contamination from previous pesticide use, remains an environmental problem in some areas of the world.

2.2. Organic Insecticides

Unfortunately, inorganic and organometallic pesticides are usually quite toxic to humans and other mammals, especially at the dosage levels that are required to make them effective pesticides. Inorganic compounds, such as the arsenic commonly used in pesticides, are not biodegradable; once released into the environment, they will remain indefinitely in the water, wildlife, soil, or sediments and may enter the food supply if liberated from these sites.

During and after World War II, many organic insecticides were developed that have largely displaced these inorganic and organometallic substances. Usually only small amounts of the organic compounds are required to be effective against the target pests and thus smaller amounts of chemicals enter the environment. Given a dose of each large enough to act as a pesticide, the organic substances are generally much less toxic to humans than are the inorganic pesticides. Finally, organic pesticides were initially thought to be biodegradable, although, as we shall see, this has certainly not been found to be universally true.

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Biographical Sketches

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