PESTICIDES IN THE MODERN WORLD - RISKS AND BENEFITS

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Preface

Volume 3 of the book series "Pesticides in the Modern World" is a compilation of 29 chapters focused on: pesticides and food production, environmental effects of pesticides, and pesticides mobility, transport and fate.

The first book section (Chapters 1-6) addresses the benefits of the pest control for crop protection and food supply increasing, but also the associated risks of food contamination. The advantages and the disadvantages of pesticides using in modern agriculture, and the effectiveness of their alternatives are comprehensively reviewed in Chapter 1. The objective of Chapter 2 is to assess the impacts of agrochemicals application on plants' pests and of some essential production factors on the quality of the vegetables produced in African urban settings. Chapter 3 reports research results on the efficacy of the insecticides imidacloprid, thiamethoxam, clothianidin, methidathion and fenobucarb and of their mixtures against the citrus psyllid on citrus plants in Vietnam. Chapter 4 examines the use of pesticides in cocoa production in Ghana, demonstrates that the current unsustainable agricultural practices create environmental and economic risks, and identifies improvement options. Chapter 5 provides data on industrial chemicals and organochlorine pesticides contamination of food. Chapter 6 documents the contamination of bee products with pesticides and presents information on the sources of contamination.

The second book section (Chapters 7-20) is dedicated to the environmental pesticides impacts. Chapter 7 comments on a number of pesticides ecological effects such as: effects involving pollinators, effects on nutrient cycling in ecosystems, effects on soil erosion, structure and fertility, and effects on water quality. The impacts of the pesticides in agricultural ecosystems, in terms of pesticides resistance development are discussed in Chapter 8. The occurrence of the inorganic pesticide lead arsenate in the environment, the pathways of its uptake, the methods for lead and arsenic toxicity assessment, and the contaminated soil remediation constitute the subject of Chapter 9. The effects of arsenic exposure are commented in details in Chapter 10.

Chapters 11-13 covers the genotoxic and immunotoxic effects of pesticides on the aquatic fauna: decapods, bivalves, and teleost fish. Using zooplancton to evaluate the ecotoxicity of the main pesticide applied in paddy field is discussed in Chapter 14. Investigations on the capacity of some herbal extracts and calcium to counteract the

pesticidal effects on Indian Major Carp are reported in Chapter 15. Comments concerning the assessment of the pesticides residues in otters and ospreys, considered as good sentinels and indicator species of contamination, bioaccumulation and biomagnification of toxic contaminants in rivers, estuaries, reservoirs and lakes are provided in Chapter 16.

Chapter 17 presents cases of insecticides miss-use in rice production in West Africa and the related effects on the non-target organisms and the environment. The possible impacts of Bt maize on the development and behaviour of stem borers and their natural enemies are analysed in Chapter 18. Experimental data on the termiticidal activity of bistrifluron are reported in Chapter 19. Camouflaging of seeds treated with pesticides to mitigate the mortality of birds in grain crops is discussed in Chapter 20.

The third book section (Chapters 21-29) furnishes numerous data contributing to the better understanding of the pesticides mobility, transport and fate. In Chapter 21 are presented investigations on the mode of deposition and transformation of the organochlorine pesticides into the sediment of Lake Liangzi in Central China. Chapters 22-24 address the complex phenomenon of environmental *pollutants transport* in surface and ground waters. Studies on the presence of pesticides in treated urban wastewaters are reported in Chapter 25. The fate of the pesticides in soils, namely the interaction of ionic pesticides with model systems of soil fractions, the imidacloprid sorption and degradation processes, and the release kinetics of organochlorine pesticides in the rhizosphere are discussed in Chapters 26-28. The factors involved in the retention and degradation of pesticides in soils are analysed in Chapter 29, applying an integrated approach.

The addressed in this book issues associated with the benefits and risks of pesticides should attract the public concern to support rational decisions to pesticides use. The efforts of all the contributing authors to provide recent information are greatly appreciated.

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Part 1

Pesticides and Food

1

Role of Pesticides in Human Life in the Modern Age: A Review

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1. Introduction

Food production capacity is faced with an ever-growing number of challenges, including a world population expected to grow to nearly 10 billion by 2050 and a falling ratio of arable land to population. Based on evidences, in 1900 there were 1.6 billion people on the planet; in 1992 this had risen to 5.25 billion and by the year 2050 it will reach 10 billion. World population is increasing by 97 million per year. This explosive increase in world population is mostly in developing countries and this is where the need for food is greatest and starvation threatens human life; as, FAO[1] estimates that 500 million are already undernourished (Anon, 1990a).

Civilization has been combating weeds, insects, diseases and other pests throughout history and there are many examples of how these pests have had a major impact on humans. One of the worst examples is the Black Plaque of Europe in the fourteenth century when millions died from a bacterial disease spread by fleas from rats (Hock et al., 1991). Another example is the infamous Irish potato famine of the nineteenth century in which millions died and many more were forced to emigrate. A fungus also destroyed the entire German potato crop in the early twentieth century resulting in 700,000 deaths from starvation (Anon, 1992b).

Thus, food plays a vital and strategic role in growing global population. But, food production is encounter to different limits. For example, there is a limit to new areas to cultivate; therefore we must increase agricultural production from the areas available. However, the specialization of production units has led to the image that agriculture is a modern miracle of food production (Stoytcheva, 2011).

In our global society there is a place for people to grow and consume organic food, but if all our farmers decided against using farm chemicals, we would soon find ourselves in a grave situation. Without the use of farm chemicals, the production and quality of food would be severely jeopardized with estimates that food supplies would immediately fall to 30 to 40% due to the ravages of pests (Anon, 1990b; Anon, 1992a). While there are mountains of food in Europe and the US, this represents only 45 days food supply for the world. Only part of the problem is distribution and the ability to pay for purchases.

[1] FAO

While the first recorded use of chemicals to control pests back to 2500 BC, it is really only in the last 50 years that chemical control has been widely used (Hock et al., 1991). Many of the earliest pesticides were either inorganic products or derived from plants (i.e. burning sulphur to control insects and mites). Other early insecticides included hellebore to control body lice, nicotine to control aphids, and pyrethrin to control a wide variety of insects. Some heavy metals like lead arsenate was first used in 1892 as an orchard spray while about the same time it was accidentally discovered that a mixture of lime and copper sulphate (Bordeaux mixture) controlled downy mildew, a serious fungal disease of grapes. It is still one of the most widely used fungicides (Hock et al., 1991).

Pesticides are an undeniable part of modern life, used to protect everything from flower gardens to agricultural crops from specific pests. Pesticides have contributed significantly to improving quality of life and safeguarding the environment. Although often taken for granted, without these important products, food production would decline, many fruits and vegetables would be in short supply and prices would rise. Some 20 to 40 percent of the world's potential crop production is already lost annually because of the effects of weeds, pests and diseases (according to the FAO reports) (WWW.CropLife America.mht). These crop losses would be doubled if existing pesticide uses were abandoned, significantly raising food prices. Even after harvest, crops are subject to attack by pests or diseases. Bugs, rodents or moulds can harm grains. In addition to increasing crop yields, crop protection products used in stored products can also prolong the viable life of products, prevent huge post-harvest losses from pests and diseases, and protect food safety for eating.

On the other hand, although pesticides are now commonplace, concerns still exist about their safety and proper use. Pesticides can be used safely and effectively. But if proper care is not taken, pesticides can harm the environment by contaminating soil, surface and ground water, and ultimately kill wildlife. Also, the modern human is constantly exposed to a variety of toxic chemicals primarily due to changes in life style. The food we eat, the water we drink, the air we breathe, and the environment we live in are contaminated with toxic xenobiotics. Humans are exposed to such chemicals while still in the womb of the mother (Lederman, 1996; Rathinam et al., 2004). Therefore, human life would be threatened not only directly by pesticides in environment, but indirectly by contaminated food chain.

However, the chapter tries to discuss about necessity of pesticides use in modern agriculture for supplying human food. Actually, traditional chemical pesticides have environmental inconvenience and disadvantages for human health; thus, the problems along with the benefits of pesticides in improvement of quality of agricultural products and food production and storage are mentioned. According to world's food demands and health hazards caused by traditional pesticides, modern and new generation of pesticides and/or alternative methods to chemicals are modified to one of the most essential needs for modern agriculture in the present age. Some of the methods are titled in this chapter.

2. Traditional pesticides

2.1 What is a pesticide?

As FAO defined, pesticide is any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest, including vectors of human or animal disease, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage, transport or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or substances

which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies. The term includes substances intended for use as a plant growth regulator, defoliant, desiccant or agent for thinning fruit or preventing the premature fall of fruit, and substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport. A pesticide may be a chemical substance, biological agent (such as a virus or bacterium), antimicrobial, disinfectant or device used against any pest. We use pesticides to cover a wide range of chemicals used to control insect pests, plant diseases, weeds, rats or other unwanted organisms. Currently, more than 800 pesticide active ingredients in a wide range of commercial products are registered for use in agriculture to meet food supply demands (Stoytcheva, 2011; Food and Agriculture Organization of the United Nations, 2002).

Pesticides can be classified by target organism, chemical structure, and physical state (Council on Scientific Affairs, American Medical Association, 1997). Pesticides can also be classed as inorganic, synthetic, or biologicals (biopesticides) which include microbial pesticides and biochemical pesticides. Plant-derived pesticides (botanicals), which have been developing quickly, include pyrethroids, rotenoids, nicotinoids, and a fourth group that includes strychnine and scilliroside (Kamrin, 1997). In addition, Pesticides can be classified based upon their biological mechanism function or application method. Basically, agricultural pesticides are divided into five categories, depending on the target pest (WWW. Humpath.com):

i. insecticides,
ii. herbicides,
iii. fungicides,
iv. rodenticides,
v. and fumigants.

All pesticides are toxic to some plant or rodent species; at higher doses, they can also be toxic to farm animals, pets, and humans. In general, prominent insecticide families include organochlorines, organophosphates, and carbamates. Acute toxicity of insecticides for mammals ranges from low to high. Herbicides used to control weeds have low acute toxicity for mammals; and fungicides are characterized as moderately toxic (Shokrzadeh & Saeedi Saravi, 2009).

2.2 Advantages of using pesticides

A plentiful supply of fresh products is vital for a healthy population. Numerous scientific studies demonstrate the health benefits of regularly eating a variety of fresh fruit and vegetables; and consumers are increasingly aware of these benefits. Agricultural productivity is a key to ensuring that this demand can be met at an affordable price; and crop protection products help increase productivity and usable crop yields.

The crop protection industry's primary aim is to enable farmers to grow an abundant supply of food in a safe manner and prevent costs from increasing. Food production processes benefit from continual advancements in agricultural technologies and practices; in fact, a population now nearly twice as large has more food available per capita than 40 years ago. Tools such as herbicides, insecticides, and fungicides reduce crop losses both before and after harvest, and increase crop yields.

The major benefits of pesticides and their role in food production are listed below (WWW.CropLife America.mht):