Trakia Journal of Sciences, Vol. 11, Suppl. 1, pp 539-549, 2013

Available online at:
http://www.uni-sz.bg

ISSN 1313-7069 (print)
ISSN 1313-3551 (online)

PESTICIDES

M. Sidorenko*

Department of Anatomy and Histology, Pathologic Anatomy and Forensic Medicine, Medical Faculty, Sofia University, Sofia

Pesticides are substances or mixture of substances intended for preventing, destroying, repelling or mitigating any pest. [1] Pesticides are a special kind of products for crop protection. [2] Crop protection products in general protect plants from damaging influences such as weeds, diseases or insects. [2] A pesticide is generally a chemical or biological agent (such as a virus, bacterium, antimicrobial or disinfectant) that through its effect deters, incapacitates, kills or otherwise discourages pests. [2] Target pests can include insects, plant pathogens, weeds, molluscs, birds, mammals, fish, nematodes (roundworms), and microbes that destroy property, cause nuisance, spread disease or are vectors for disease. [2] Pesticide formulations contain both "active" and "inert" ingredients. [3] Active ingredients are what kill the pest, and inert ingredients help the active ingredients to work more effectively. [3] Although there are human benefits to the use of pesticides, some also have drawbacks, such as potential toxicity to humans and other animals. [2] According to the Stockholm Convention on Persistent Organic Pollutants, 9 of the 12 most dangerous and persistent organic chemicals are pesticides. [2]

Pesticides are categorized into four main substituent chemicals: herbicides; fungicides; insecticides and bactericides.[4, 5] Pesticides can be classified by target organism, chemical structure, and physical state. [6] Pesticides can also be classed as inorganic, synthetic, or biologicals (biopesticides). [6] Biopesticides include microbial pesticides and biochemical pesticides. [7] Plant-derived pesticides, or "botanicals" include the pyrethroids, rotenoids, nicotinoids, and a fourth group that includes strychnine and scilliroside.[8] Many pesticides can be grouped into chemical families. [2] Prominent **insecticide** families include organochlorines, organophosphates, and carbamates. [2] Organochlorine hydrocarbons (DDT, lindane, aldrin, dieldrin, heptachlor etc.) operate by disrupting the sodium/potassium balance of the nerve fiber, forcing the nerve to transmit continuously. [2] Their toxicities vary greatly, but they have been phased out because of their persistence and potential to bioaccumulate. [8]:239-240 Organophosphate and carbamates largely replaced organochlorines. [2] Both operate through inhibiting the enzyme acetylcholinesterase, allowing acetylcholine to transfer nerve impulses indefinitely and causing a variety of symptoms such as weakness or paralysis.They are the most common pesticides (organophosphate pesticides – fozalon, dimethoate, fenitrothion etc.; carbamates – carbaryl, oxamyl, methomyl etc.) [2] Organophosphates are quite toxic to vertebrates, and have in some cases been replaced by less toxic carbamates. [8]:136-137 Prominent families of **herbicides** include pheoxy and benzoic acid herbicides (e.g. 2,4-D), triazines (e.g. atrazine), ureas (e.g. diuron), and Chloroacetanilides(e.g. alachlor). [2] Many commonly used pesticides are not included in these families, including glyphosate. [2]

***Correspondence to**: *Malina Mitkova Sidorenko, assistant professor, Department of anatomy and histology, pathologic anatomy and forensic medicine, Medical Faculty, Sofia University, Sofia, Mailing address: 1 „Koziak" Str., Lozenetz, Sofia 1407, Telephone number: +359877/ 235-200, E-mail: raspberry.b@abv.bg*

Table 11.1 Pesticide Class and Function

Pesticide	Function
Insecticide	Controls or kills insects.
Herbicide	Controls or kills weeds.
Fungicide	Kills fungi.
Bactericide	Kills bacteria.
Disinfectant	Destroys or inactivates harmful microorganisms.
Defoliant	Removes leaves.
Desiccant	Speeds drying of plants.
Repellant	Repels insects, mites, ticks, dogs, cats.

Table is a partial list of different types of pesticides and their functions. [9]

Pesticides can be classified based upon their biological mechanism function or application method. [2] A systemic pesticide moves inside a plant following absorption by the plant. [2] Systemic insecticides, which poison pollen and nectar in the flowers, may kill bees and other needed pollinators. [2] In 2009, the development of a new class of fungicides called paldoxins was announced. [2] These work by taking advantage of natural defense chemicals released by plants called phytoalexins, which fungi then detoxify using enzymes. [2] The paldoxins inhibit the fungi's detoxification enzymes. [2] They are believed to be safer and greener. [10]

Pesticides work by interfering with an essential biological mechanism in the *pests*, but because all living organisms share many biological mechanisms, pesticides are never specific to just one species.[3] While pesticides may kill pests, they may also kill or harm other organisms that are beneficial or at least not undesirable. [3] They may also harm people who are exposed to pesticides through occupational or home use, through eating foods or liquids containing pesticide residue, or through inhaling or contacting pesticide-contaminated air. [3] The ideal pesticide would be highly specific to only the target organism, be quick acting, and would degrade rapidly to harmless, inert materials in the environment. [3]

HISTORY

Pesticides have been in use for centuries. In 470 B.C., the Greek philosopher Democrates used olive extracts on plants to prevent blight. [9] Biological control was found effective by the ancient Chinese who used ants to protect their trees from insect pests. [9] One of the first pesticides was sulfur, used by the Chinese in around 1000 BC to control bacteria and mold (fungus) .[11] Sulfur is still widely used today. [11] For example, it is used in the wine industry to control unwanted bacterial growth in empty wine barrels and is commonly added to wine to kill unwanted yeast. [11] The Chinese also pioneered the use of arsenic-containing compounds to control insects. [11] *Arsenic* has a long history of use both as an insecticide and herbicide, and also as a medicine. [11] Arsenic trioxide was used as a weed killer (herbicide) in the late 1800s, and lead arsenate, containing both lead and arsenic, was used as an insecticide, particularly in orchards, prior to the development of synthetic pesticides following WWII. [11] Some of the first concerns about pesticide safety were raised over lead arsenate residue on fruit and in orchards, and to this day, some orchard soils remain contaminated with lead and arsenic. [11] Arsenic (in the form of chromated copper arsenate (CCA)) is used today as a wood preservative. [11]

Plants have provided several other important nonsynthetic pesticides. [11] In the late 1600s *nicotine*, an extract from tobacco leaves, was recognized as a potent insecticide and is now in limited use as a pesticide. [11] Another group of nonsynthetic insecticides is pyrethrums, which are harvested and refined from chrysanthemums. [11] The Strychnine tree, Nux vomica, contains strychnine used to kill rodents. [11] Finally, *rotenone*, an insecticide and fish poison, is extracted from the root of Derris elliptica, a climbing plant from Southeast Asia.[11] Plant extracts are useful for controlling pests, but they are often difficult to purify and produce in large quantities. [11]

Synthetic chemistry advanced rapidly in the 1930s and by the early 40s, a range of new pesticides had been developed, including organochlorine insecticides like DDT. [11] In 1937 the first organophosphate compounds were synthesized by a group of German chemists. [11] These very potent compounds were kept secret during World War II and were originally developed as potential chemical warfare agents. [11] After the war, these organophosphate compounds were re-purposed as insecticides, and many organophosphate insecticides continue to be used today. [11] Herbicides were developed after WWII in order to increase food production and create possible warfare agents. [11] In 1946, the first commercially available chlorine-based herbicides were marketed to kill broadleaf plants. [11] This class of compounds includes 2,4-D (2,4-Dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-Trichlorophenoxyacetic acid), synthetic auxins (plant hormones) that disrupt plant growth. [11] These herbicides have been extensively utilized in agriculture and to clear roadsides and rights of way. 2,4,5-T was used extensively during the Vietnam War to defoliate jungle plants. [11] Dioxins, like other chlorinated compounds including DDT, bioaccumulate in body fat and persist in the environment for many years (the soil half-life is 10 to 12 years). [11] Dioxins are classified as carcinogens and are also known to affect the reproductive and immune systems. [11] The U.S. EPA cancelled the use of 2,4,5-T because of the dioxin contamination, but 2,4-D is still one of the most widely used herbicides. [11]

USAGE

Pesticides are used to control organisms that are considered to be harmful. [12] For example, they are used to kill mosquitoes that can transmit potentially deadly diseases like West Nile virus, yellow fever, and malaria. [2] They can also kill bees, wasps or ants that can cause allergic reactions. [2] Insecticides can protect animals from illnesses that can be caused by parasites such as fleas. [12] Herbicides can be used to clear roadside weeds, trees and brush. [2] Toilet bowl cleaners and disinfectants often contain pesticides. [12] The pesticides in wool and our wood makes our clothes and furniture last longer. [13] Raw commodities and packaged grocery products—the foods we eat—are protected from insect contamination by the controlled use of insecticides in processing, manufacturing, and packaging facilities. [12] Pesticides are used in grocery stores to manage insects and rodents attracted to food and food waste. [12] The pesticides in insect sprays and baits help reduce the cockroaches in our homes. [12] Herbicides are commonly applied in ponds and lakes to control algae and plants such as water grasses that can interfere with activities like swimming and fishing and cause the water to look or smell unpleasant. [14] Uncontrolled pests such as termites and mould can damage structures such as houses. [12] Pesticides are used in grocery stores and food storage facilities to manage rodents and insects that infest food such as grain. [2] Pesticides are commonly used to slow the spread of exotic pest populations. [12] The role of pesticides in protecting public health is broad and varied. Water utility companies apply the pesticide chlorine to public drinking water to kill harmful bacteria. [12] Pesticides known as disinfectants eliminate dangerous organisms that cause Legionnaire's disease, and hospitals rely on disinfectants to prevent the spread of bacteria such as Staphylococcus. [12] Rodenticides are used in public housing units to control rodents that carry diseases such as the deadly hantavirus. [12] Avicides are used to control birds near silos and grain storage buildings, reducing the likelihood of grain contamination and exposure of workers to the lung disease histoplasmosis. [12] Insecticides control insects that vector disease, inflict painful bites, and cause stress on livestock. [12] They are applied to the animals and/or their stalls, pens, corrals, barns, and etc. [12] Insecticides can be used to control termites, carpenter ants, and other structural insects. [12] Museum directors use them to protect irreplaceable and extremely valuable collections from insect feeding; exhibits that contain plant, cloth, leather, and animal specimens are particularly vulnerable. [12] Herbicides are also used on athletic fields, parks and playgrounds. [12] Pesticides are routinely combined with nonchemical pest management strategies. Nonchemical pest solutions are effective in certain situations: planting resistant varieties for apple scab control, mowing or tilling for weed control in problem areas, using pheromones (sex attractants) to lure and capture insects, etc. [12]

Presently, we are using more pesticides than ever. In the US are used almost 1.8 kg (4 pounds*)* of it annually per person [13]! The EPA (Environmental Protection Agency) reported that 4.9 billion pounds of pesticide products were used in the United States in 2001, which is equivalent to 4.5 pounds per person.[15] Although most modern pesticides are much safer than their predecessors, a few of our commonly used pesticides are considered toxic. [13] Environmental Protection Agency (EPA) has made a report, Pesticides Industry Sales and Usage: 2006 and 2007 Market Estimates. This report contains the latest estimates of agricultural and nonagricultural pesticide use in the United States.[16] It illustrates graphically historical trends and levels of use over the last 20 years. [16] Also included are data on imports, exports, and pesticide producers and users. [16] Highlights include:

- In the United States, pesticide sales were approximately $12.5 billion at the user level, which accounted for 32% of the nearly $40 billion world market in 2007.Pesticide use in the United States was 1.1 billion pounds in 2007, or 22% of the world estimate of 5.2 billion pounds of pesticide use.
- Total pounds of U.S. pesticide use decreased by approximately 8% from 1.2 to 1.1 billion pounds from 2000 to 2007.
- Use of conventional pesticides decreased about 3% from 2002 to 2007 and 11% from 1997 to 2007.
- Approximately 857 million pounds of conventional pesticide active ingredient were applied in 2007.
- Organophosphate insecticide use decreased about 44% from 2002 to 2007, 63% from 2000 to 2007, and 55% from 1997 to 2007.
- About 33 million pounds of organophosphate insecticides were applied in 2007.
- Eighty percent of all U.S. pesticide use was in agriculture.
- Herbicides remained the most widely used type of pesticide in the agricultural market sector.
- Among the top 10 pesticides used in terms of pounds applied in the agricultural market were the herbicides glyphosate, atrazine, metolachlor-s, acetochlor, 2,4-D, and pendimethalin, and the fumigants metam sodium, dichloropropene, methyl bromide, and chloropicrin.
- Herbicides were also the most widely used type of pesticide in the home and garden and industrial, commercial, and governmental market sectors, and the herbicides 2,4-D and glyphosate were the most widely used active ingredients. [16]

PESTICIDES AND ENVIRONMENT

Once a pesticide has been released into the environment it may become airborne, get into soil, enter bodies of water, or be taken up by plants and animals. The environmental fate of pesticides depends on the physical and chemical properties of the pesticide as well as the environmental conditions. [17] The physical and chemical properties of the pesticide determine how likely it is to travel through soil (soil mobility), how well it dissolves in water (water solubility), and how likely it is to become airborne (volatility). [17]

In the environment, pesticides can be broken down by:

- exposure to sunlight (photolysis)
- exposure to water (hydrolysis)
- exposure to other chemicals (oxidation and reduction)
- microbial activity (bacteria, fungi, and other microorganisms)
- plants or animals (metabolism)

Scientists do experiments to determine how long pesticides last in various environments. [17] They apply pesticides to soils, leaves or other surfaces and measure the time it takes for half of the pesticide to break down, a measure called the half-life. [17] After one half-life, half of the chemical may be broken down. Following another half-life, half of the 50% remaining may be broken down, leaving 25% of the original amount and so on. [17] The half-life can be a useful measure of how long a pesticide may last, but studies have found a wide range of half-lives for the same pesticide under different environmental conditions. [17] Some pesticide chemicals break down into other chemicals that can also be toxic. [17]

The table below lists some of the more commonly used pesticides with an estimate of their persistence in soil.

Grouping of pesticides based on persistence in soils

Non persistent (half-life less than 30 days)	Moderately persistent (half-life greater than 30 days, less than 100)	Persistent (half-life greater than 100 days)	
Aldicarb	Aldrin	Heptachlor	Bromacil
Captan	Atrazin	Linuron	Chlordane
Dalapon	Carbaryl	Parathion	Lindane
Dicamba	Carbofuran	Phorate	Paraquat
Malathion	Diazinon	Simazin	Picloram
Methyl parathion	Endrin	Terbacil	Trifluralin
2, 4-D	Fonofos	TCA	
2, 4, 5-T	Glyphosate		

http://psep.cce.cornell.edu/facts-slides-self/facts/gen-pubre-soil-water.aspx

Following release into the environment, pesticides may have many different fates. [18] Pesticides which are sprayed can move through the air and may eventually end up in other parts of the environment, such as in soil or water. [18] Pesticides which are applied directly to the soil may be washed off the soil into nearby bodies of surface water or may percolate through the soil to lower soil layers and groundwater. [18] Pesticides which are injected into the soil may also be subject to the latter two fates. [18] The application of pesticides directly to bodies of water for weed control, or indirectly as a result of leaching from boat paint, runoff from soil or other routes, may lead not only to build up of pesticides in water, but also may contribute to air levels through evaporation. [18] The movement of pesticides in the environment is very complex with transfers occurring continually among different environmental compartments. [18] Initial distribution is determined by the method of application, the amount, timing, frequency and placement. [19] Weather conditions during application can also affect initial distribution. Land form (topography), vegetation type and density, soil conditions, and the proximity of water bodies also are important. [19] Together, these factors help determine how much pesticide is distributed to the air, soil, water, plants, and animals. [19] In some cases, exchanges occur not only between areas that are close together (such as a local pond receiving some of the herbicide application on adjacent land) but also may involve transportation of pesticides over long distances. [18] The worldwide distribution of DDT and the presence of pesticides in bodies of water such as the Great Lakes far from their primary use areas are good examples of the vast potential of such movement. [18] While all of the above possibilities exist, this does not mean that all pesticides travel long distances or that all compounds are threats to groundwater. [18] In order to understand which ones are of most concern, it is necessary to understand how pesticides move in the environment and what characteristics must be considered in evaluating contamination potential. [18] Two things may happen to pesticides once they are released into the environment. [18] They may be broken down, or degraded, by the action of sunlight, water or other chemicals, or microorganisms, such as bacteria. [18] This degradation process usually leads to the formation of less harmful breakdown products but in some instances can produce more toxic products. [18] The second possibility is that the pesticide will be very resistant to degradation by any means and thus remain unchanged in the environment for long periods of time. [18] The ones that are most rapidly broken down have the shortest time to move or to have adverse effects on people or other organisms. [18] The ones which last the longest, the so-called persistent pesticides, can move over long distances and can build up in the environment leading to greater potential for adverse effects to occur. [18]

In addition to resistance to degradation, there are a number of other properties of pesticides which determine their behavior and fate. [18] One is how volatile they are; that is, how easily they evaporate. [18] The ones that are most volatile have the greatest potential to go into the atmosphere and, if persistent, to move long distances. [18]Another important property is solubility in water; or how easily they dissolve in water. [18] If a pesticide is very soluble in water, it is more easily carried off with rainwater, as runoff or through the soil as a potential groundwater contaminant (leaching). [18] In addition, the water-soluble pesticide is more likely to stay mixed in the surface water where it can have adverse effects on fish and other organisms. [18] If the pesticide is very insoluble in water, it usually tends to stick to soil and also settle to the bottoms of bodies of surface water, making it less available to organisms. [18]

It might seem that a short half-life would mean a pesticide would not have a chance to move far in the environment. [18] This is generally true; however, if it is also very soluble in water and the conditions are right, it can move rapidly through certain soils. [18]As it moves away from the surface, it moves away from the agents which are degrading it such as sunlight and bacteria. [18] As it gets deeper into the soil, it degrades more slowly and thus has a chance to get into groundwater. For example, several pesticides with short half-lives, such as aldicarb, have been widely found in groundwater. [18] In contrast, very persistent pesticides may have other properties which limit their potential for movement throughout the environment. [18] Many of the chlorinated hydrocarbon pesticides are very persistent and slow to breakdown but also very water insoluble and tend not to move down through the soil into groundwater. [18] They can, however, become problems in other ways since they remain on the surface for a long time where they may be subject to runoff and possible evaporation. [18] Even if they are not very volatile, the tremendously long time that they persist can lead, over time, to measurable concentrations moving through the atmosphere and accumulating in remote areas. [18]

Living organisms may also play a significant role in pesticide distribution. [18] This is particularly important for pesticides which can accumulate in living creatures. [18] Since this pesticide is stored in the organism, the pesticide accumulates and levels increase over time. If this organism is eaten by a higher organism which also can store this pesticide, levels can reach higher values in the higher organism than is present in the water in which it lives.[18] Levels in fish, for example, can be tens to hundreds of thousands of times greater than ambient water levels of the same pesticide. This type of accumulation is called bioaccumulation. [18] In this regard, it should be remembered that humans are at the top of the food chain and so may be exposed to these high levels when they eat food animals which have bioaccumulated pesticides and other organic chemicals. It is not only fish but also domestic farm animals which can be accumulators of pesticides and so care must be used in the use of pesticides in agricultural situations. [18]

PESTICIDES BREAK DOWN

How long a pesticide lasts or persists in the environment is determined by its resistance to break down. [19] All pesticides react in the environment to form new chemicals, it is the rate at which they react and products formed that are important. [19] There are many ways that pesticides can react, but most often they react with oxygen (oxidation) or water (hydrolysis). In addition, all pesticides are subject to breakdown in the presence of sunlight. [19] In soil and sediments, microorganisms (bacteria, fungi, etc.) are primarily responsible for pesticide breakdown. [19] Some pesticides may enter plant roots or foliage and break down through plant metabolism.[19] Pesticides applied directly to animals are also subject to uptake and metabolism. [19] The rate at which pesticides breakdown depends on their reactivity in each media (air, soil, water, plants, animals). [19] Each pesticide has unique properties that determine reactivity. [19] Some pesticides are sensitive to acidic and/or basic conditions (pH), others are sensitive to sunlight, microbial attack, or plant and animal metabolism. [19] In the atmosphere, most pesticides breakdown rapidly by reaction with oxygen or free radicals, catalyzed by sunlight (indirect photolysis). [19] Some pesticides break down by directly absorbing sunlight (photolysis). In water, breakdown is usually by hydrolysis, often mediated by pH. [19] In aquatic systems, pesticide break down by microorganisms in sediments may also be important. [19] The predominant pathway in soil is microbial degradation. [19] Pesticides break down in plants or animals (including microorganisms) by metabolism.[19] Metabolic reactions are catalyzed by enzymes. [19] Environmental conditions can influence reaction rate and therefore how fast pesticides break down. [19] For air, these conditions include temperature, moisture, sunlight intensity, and free radicals. [19] For water, conditions include temperature, pH, sunlight intensity, and sediment microbial activity. [19] For soil, conditions include temperature, soil type, organic matter, moisture, pH, aeration, and microbial activity. [19] For plants and animals conditions include rates of uptake, metabolism and elimination. Metabolism may be temperature dependent. [19]

The complete breakdown of pesticides and other organic substances is called mineralization. [19] The products of mineralization are carbon dioxide, water, and minerals containing elements which commonly include sulfur, phosphorus, nitrogen, and the halogens: chlorine, fluorine, and bromine. [19] Pesticides usually form many break down products. [19] These products break down to other products. [19] There can be many steps before mineralization. [19] Rarely is it known if and when a pesticide has mineralized. [19] Some pesticide break down products are incorporated into soil organic matter. [19] Those taken up by plants or animals may be used by the organism or the metabolites excreted. [19] At some point in a pesticide's break down the products are no longer of concern, as they are not biologically active (toxic). [19] Usually the initial break down products are much less toxic than the pesticide, but sometimes they are of similar or greater toxicity. [19]

Pesticides applied to soil, water, vegetation, or other surfaces indoors usually breakdown at a slower rate than pesticides applied outdoors. [19] This is due primarily to the lack of sunlight indoors. [19] This includes glass greenhouses, as the UV light necessary for pesticide breakdown is filtered out by glass. [19] Pesticides applied indoors are not affected by wind or rain, and are less likely to move by mass transfer from the point of application. [19] Vapor loss may also be less, as surfaces are not exposed to the heat of the sun. [19]

PESTICIDE EFFECTS

In lab tests where high doses of pesticides were given, researchers have observed some significant health effects. [13] Genetic damage, reproductive problems, and possible links to cancer are just some of the risks associated with pesticides. [13] Each use of a pesticide carries some associated risk.

DDT, sprayed on the walls of houses, is an organochloride that has been used to fight malaria since the 1950s. Recent policy statements by the World Health Organization have given stronger support to this approach. [20] DDT, sprayed on the walls of houses, is an organochloride that has been used to fight malaria since the 1950s. Recent policy statements by the World Health Organization have given stronger support to this approach. [20] Poisoning may also occur due to use of DDT and other chlorinated hydrocarbons by entering the human food chain when animal tissues are affected. [2] Symptoms include nervous excitement, tremors, convulsions or death. [2] Scientists estimate that DDT and other chemicals in the organophosphate class of pesticides have saved 7 million human lives since 1945 by preventing the transmission of diseases such as malaria, bubonic plague, sleeping sickness, and typhus. [21] However, DDT use is not always effective, as resistance to DDT was identified in Africa as early as 1955, and by 1972 nineteen species of mosquito worldwide were resistant to DDT**.** [22] A study for the World Health Organization in 2000 from Vietnam established that non-DDT malaria controls were significantly more effective than DDT use. [23] The ecological effect of DDT on organisms is an example of bioaccumulation. [2]

Children are vulnerable to repeated, very small, unintended exposure to pesticides. They are much more sensitive to pesticides and chemical exposures than adults. [24] Per pound of body weight, pesticides have a greater effect on children's growing bodies and developing nervous and hormonal systems and organs. [24] According to PCP's annual report 2008/2009 (President's Cancer Panel) "Approximately 40 chemicals are classified by the International Agency for Research on Cancer (IARC) as *known, probable, or possible human carcinogens*, and are used in EPA-registered pesticides now on the market." [25] It also says that "…Occupational exposure to these chemicals (pesticides) has been linked to brain/central nervous system (CNS), breast, colon, lung, ovarian (female spouses), pancreatic, kidney, testicular, and stomach cancers, as well as Hodgkin and non-Hodgkin lymphoma, multiple myeloma, and soft tissue sarcoma."[25]. PCP's report also alarm that "…there are many studies showing positive associations between solid tumors and pesticide exposure."[25],p.16. Solid tumors refer to cancers of the lung, breast, pancreas, brain, prostate, stomach, ovaries, and kidneys. [24]

Many pesticide products are toxic to dogs, cats and other pets. [24] Pets with access to treated landscapes may pick up pesticide residues on their paws and fur, licking it or tracking it into the house. [24] Slug bait containing metaldehyde poses a special risk because dogs are attracted to it and may eat enough to be seriously injured or even die. [24] Many beneficial insects help control insect pests. [24] Since pesticides can kill beneficial insects and pollinators with the pests, pest populations can increase after spraying. [24] Beneficial insects often take longer to rebuild their populations than pest insects, so spraying can create a pest population explosion. [24] Many synthetic, and some naturally-occurring, chemicals can interfere with animal and human hormone systems, potentially affecting reproduction and development. [24] These chemicals include a number of pesticides. [24] The extent to which human and wildlife health problems are caused by hormone-disrupting chemicals is not yet known. [24] Most insecticides are toxic to beneficial insects, bees and other pollinators, and some insecticides are toxic to birds. [24] Insecticides can kill bees directly or when they land on treated plants. [24] Foraging bees can carry pesticides back to their hives, threatening the entire colony. [24] Some researchers believe that pesticide use may be implicated in honey *bee colony* collapse disorder. [24] A study showed that 64% of deaths are related to pesticide poisoning in 2011 [26] In the other cases, it comes to diseases (29%), starvation (5%) and errors of beekeepers (2%). [26] Another two studies have been published in march issue of Science in 2012. One experiment, *conducted by French researchers*, indicates that the chemicals fog *honeybee* brains, making it harder for them to find their way home. [27] The other study, *by scientists in Britain*, suggests that they keep bumblebees from supplying their hives with enough food to produce new queens. [27] According to the U.N. Food and Agriculture Organization 71 of the 100 crops that provide 90 percent of human food are pollinated by bees. Nevertheless, there reached a majority of the total ban of pesticides, but it is enough to impose a two-year ban on the use of hazardous substances. This ban include three neonicotinoid insecticides — clothianidin, imidacloprid and thiametoxam — for treating seeds, soil and leaves on flowering crops attractive to bees, like corn, sunflowers and rapeseed, the source of canola oil. The products may still be used on crops like winter wheat for which the danger to bees is deemed to be small. Use by home gardeners will be prohibited. (Two companies make neonicotinoids in Europe, the German giant Bayer CropScience and Syngenta, a Swiss biochemical company) According to the European Commission's proposals ban should come into force on 1 December 2013. [26] However, expectations are that this can be done from July 1. [26]

EU AND BULGARIAN LEGISLATION

EU legislation on undesirable substances in feed begins in 1974 - Directive 1999/29/EC of undesirable substances and products in animal nutrition. There is set limits for many substances as arsenic, mycotoxins, pesticides, botanical purity. [28]

EU rules on plant protection products establish a "dual" system:

The Commission approves the active substances contained in the products;

EU countries authorise the products on their territory and ensure compliance with EU rules.[29]

As laid down in Directive 91/414/EEC, in 1993 the European Commission launched the work programme on the Communitywide review for all active substances used in plant protection products within the European Union. [28] In this review process, each substance had to be evaluated as to whether it could be used safely with respect to human health (consumers, farmers, local residents and passers-by) and the environment, in particular groundwater and non-target organisms, such as birds, mammals, earthworms, bees. [30]

There were about 1 000 active substances (and tens of thousands of products containing them) on the market at the time the Directive was adopted. [30] Decisions only really started to be taken in 2001 as harmonized technical requirements had to be set first. [29] This enabled the review program to be finalised in March 2009 when the last decisions were taken. [30] This achievement has been possible due to the efforts of the Commission and the European Food Safety Authority, as well as the strong commitment of Member State experts. [30]

There are some Regulations and Directives concerning pesticides:

- *Commission Directive 2001/35/EC of 11 May 2001 amending the Annexes to Council Directive 90/642/EEC on the fixing of maximum levels for pesticide residues in and on certain products of plant origin, including fruit and vegetables*
- *DIRECTIVE 2002/32/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 7 May 2002 on undesirable substances in animal feed*
- *Directive* 2009/128/EC *of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides*
- *REGULATION (EC) NO 396/2005 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC*
- *REGULATION (EC) No 1107/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC*
- *COMMISSION REGULATION (EU) No 277/2012 of 28 March 2012 amending Annexes I and II to Directive 2002/32/EC of the European Parliament and of the Council as regards maximum levels and action thresholds for dioxins and polychlorinated biphenyls*
- *COMMISSION REGULATION (EU) No 744/2012 of 16 August 2012 amending Annexes I and II to Directive 2002/32/EC of the European Parliament and of the Council as regards maximum levels for arsenic, fluorine, lead, mercury, endosulfan, dioxins, Ambrosia spp., diclazuril and lasalocid A sodium and action thresholds for dioxins*

There are also some other Regulations concerning common requirements of control, hygiene and traceability:

- *REGULATION (EC) No 178/2002 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 28 January2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety*
- *REGULATION (EC) No 882/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 29 April 2004 on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules*
- REGULATION (EC) No 183/2005 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 January 2005 laying down requirements for feed hygiene

According to *REGULATION (EC) No 882/2004* member states have a duty to control:

- Eliminate or reduce the risks to acceptable levels.
- Ensuring fair trade practices and protect interests of the consumers

- Monitoring should be carried out regularly and based on the assessment of risk and frequently
- Controls to identify risks, past records line, the reliability of self-control, information discrepancies.
- At all stages of production, processing, distribution and use.

According to Directive *2009/128/EC*, Article 4, 1. “Member States shall adopt National Action Plans to set up their quantitative objectives, targets, measures and timetables to reduce risks and impacts of pesticide use on human health and the environment and to encourage the development and introduction of integrated pest management and of alternative approaches or techniques in order to reduce dependency on the use of pesticides. These targets may cover different areas of concern, for example worker protection, protection of the environment, residues, use of specific techniques or use in specific crops.”… Article 4, 2.
…and some uncommon regulations:

REGULATION (EC) No 767/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 July 2009 on the placing on the market and use of feed, amending European Parliament and Council Regulation (EC) No 1831/2003 and repealing Council Directive 79/373/EEC, Commission Directive 80/511/EEC, Council Directives 82/471/EEC, 83/228/EEC, 93/74/EEC, 93/113/EC and 96/25/EC and Commission Decision 2004/217/EC

COUNCIL DIRECTIVE 1999/29/EC of 22 April 1999 on the undesirable substances and products in animal nutrition (Amended with aforementioned DIRECTIVE 2002/32/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 7 May 2002 on undesirable substances in animal feed)

Bulgarian legislation:
LAW ON PLANT PROTECTION of 10 October 1997
REGLAMENT 31 of 2004 regarding maximum residue levels of pesticides in or on food
REGLAMENT FOR THE AUTHORIZATION OF PLANT PROTECTION PRODUCTS of 6 October 2006

Bulgarian Agency for Food Safety is the competent state authority to carry out official controls in Bulgaria under EU legislation regulating the activities (required to art. 3, para. 1.) [31] Bulgarian Agency for Food Safety (BFSA) was established to Minister of Agriculture and Food with a Law for Bulgarian Agency for Food Safety from 25.01.2011.

WHAT WE CAN DO NOW

- ✓ Cut out the fat from meat and poultry, as many of the pesticides accumulate right there
- ✓ Remove fish skin
- ✓ Remove the fat from the broth and soups, throw fat after frying
- ✓ Wash thoroughly fruits and vegetables with running water, preferably with a brush.
- ✓ Peel fruits and vegetables before use if it’s possible
- ✓ Do not use bark, especially oranges and other imported fruits
- ✓ Avoid consumption of the most contaminated foods
- ✓ Consume fruits and vegetables mainly in their season
- ✓ Avoid greenhouse products especially for children and pregnant
- ✓ Grow your own fruits and vegetables if it’s possible
- ✓ If you do not have a garden, growing herbs at least

The release of pesticides into the environment may be followed by a very complex series of events which can transport the pesticide through the air or water, into the ground or even into living organisms. [32] The most important route of distribution and the extent of distribution will be different for each pesticide. [32] It will depend on the formulation of the pesticide (what it is combined with) and how and when it is released. [32] Despite this complexity, it is possible to identify situations that can pose concern and to try to minimize them. [32] However, there are significant gaps in the knowledge of pesticide movement and fate in the environment and so it is best to minimize unnecessary release of pesticides into the environment. [32] The fewer pesticides that are unnecessarily released, the safer our environment will be.

CONCLUSION

Despite the fact that pesticides have aided in the control of malaria, schistosomiasis, and filariasis in tropical countries, there are still 150 million cases of malaria and about 250 million cases of schistosomiasis and filariasis each year in the world. [9] There is no way of knowing and no way to calculate how many lives will be saved or improved by the use of pesticides to control diseases and increase our food production. Likewise there is no way to calculate how many lives will be lost from pesticide use either. Some dangerous pesticides that are banned or restricted in North America and Europe have been unloaded on Third World countries. [9]

May be it's time to think about natural defense as the ancient Chinese did using ants against insect pests. The first step is done if we read carefully some of the Regulations and Directives of the EU legislation. Directive 2009/128/EC shows us some ancient and simple way to do that - crop rotation, use of adequate cultivation techniques (e.g. stale seedbed technique, sowing dates and densities, under-sowing, conservation tillage, pruning and direct sowing), use of balanced fertilization, liming and irrigation/drainage practices, preventing the spreading of harmful organisms by hygiene measures (e.g. by regular cleansing of machinery and equipment) (Annex III). As characters in a cartoon says "Power is in your hands"

REFERENCES

1. US Environmental (July 24, 2007), What is a pesticide? epa.gov. Retrieved on September 15, 2007. http://en.wikipedia.org/wiki/Pesticide#cite_ref-