Chapter 3

Contemporary Research on Agricultural Pesticides: Future Challenges

Ceiro WG[1]*, Chasi WP[2], Corbacho O[3] and Tamayo LA[4]

[1]Department of Crop Production, Agricultural Science Faculty, Granma University, Cuba
[2]Academic Unit of Agricultural Sciences and Natural Resources, Technical University of Cotopaxi, Ecuador
[3]Plant Health Laboratory, Cuba
[4]Department of Biological Science, Agricultural Science Faculty, Granma University, Cuba

***Corresponding Author:** Ceiro WG, Department of Crop Production, Agricultural Science Faculty, Granma University, Bayamo Municipality, Granma Province, Cuba, Email: wcieroc@udg.co.cu; wcieroc@gmail.com

First Published **November 26, 2016**

Abstract

Since the man began to agriculture develop for the food production he had to control pest in the crops, because they cause affectations about the yields and harvest quality. The work´s objective is showing the results of research that approach the pesticide´s effect has more than enough organism's target, non-target, the environment, the man and the future challenges in the product´s use. It was carried out a revision art´s state of this thematic in the world and as a result of the analyzed research it was verified that the pesticides arose like a necessity human´s species to control in a quick way the pests and to avoid the crop´s losses. The pesticides cause in their target inhibition enzymatic process, proteins and chlorophyll denaturalization and producing physiologic disorders, nervous dysfunctions and paralysis. Also, the pesticides can cause affectations to the component biotic and abiotic of the agroecosystem, as well as to the public health. The consulted works argue the necessity to carry out thoroughly more research than they allow evaluating the pesticide´s risks in the human foods and their impact on the environment and the non-target organisms. The network's establishment of pesticides quick alert to reduce the product impacts in agricultural sector and with the use sure choice for the pest management as the integrated pest management, the agroecology pest management, the biopesticides and the botanical pesticides would be achieved a rational use of the pesticides in the agriculture.

Background

Restrepo [1] report that the foods world production in the 20th century was enough to satisfy the population´s nutritional requirements. However, the problems of bad distribution, storage, transport and commercial speculation was wasted 40% of the food products. At the present time it is considered that 90% of the world feeding depends on 15 plant´s species and seven animal's species [2]. This contemporary scenario points out a complex challenge to continue feeding to the present and future generations in the planet.

In the developed countries the intensive crops systems and the new technologies contributed to increase the crop yields, while; in the poor and developing countries potential are needed the more yields crops. This choice propitiated that the denominated "Green Revolution" was developed, time that was characterized by the technology intensive use: agricultural machinery, irrigation, fertilizers and pesticides application. These last ones caused affectations to the agriculture, registering damages on the biodiversity, the pest's resistance appeared, it was affected the environment and the human health [3].

At the moment, the pests affect annually near 35% of the crops and in the period postharvest the insects, the microorganisms and the rodents cause losses among 10-20%. Usually the main method used for the pest´s control is through the pesticide application [2].

In the course of that, many countries adopt measures to reduce pesticide uses and in other prohibit the use of the most polluting substances. Nevertheless, generally different products and the transnational companies are still applied that produce them to obtain new formulations of these substances, which are marketed and they are applied under the field conditions; although the effects are unknown that it will have to medium and long term about the environment and the public health [4-6].

In accordance with that exposed, it intends as objective in this book chapter, to show the research results that approach the pesticide effect has more than enough target, non-target organisms, the environment, the man and the challenges future in the use of these products.

The Pesticide´s Effects on Target Organisms

In the first place, it is important to highlight that the pesticide use in the alone agriculture is justified when the presence of a pest surpasses the crops economic threshold and when other management alternatives don't achieve control effectiveness.

Pesticide is all substance natural or synthetic that is used to pest control. As major advantages of these products it stands out the quick effect on the target, the high effectiveness, the easy application, the wide availability and

economic productivity. Even so; these products can have effects in the appearance of new pests, it causes biological disruption, resistance develop, environment pollution and affect the public health [7].

The pesticides are classified by their origin in: natural and synthetic and these it can have its action for contact or systemic, the systemic ones are absorbed by the plant and they protect them of certain pathogens organisms [8].

There are several types of pesticides according to its target, among themselves; insecticides, acaricides, fungicides, nematicides, herbicides, molluscicides and rodenticides (Table 1).

Table 1: Pesticide types according to target.

Number	Pesticide type	Target
1	Insecticides	Incept
2	Acaracides	Mite
3	Fungicides	Fungi
4	Nematicides	Nematode
5	Herbicides	Weeds
6	Molluscicides	Mollusk
7	Rodenticides	Rat

The most common effects that cause the pesticides to their target are: inhibition of the enzymatic processes, the proteins and chlorophyll denatured, cause physiologic disorders, nervous disruptions and paralysis; all these effects can to involve the organism´s death [7].

Agriculture Target-Pesticide Cases Study

To the long and wide of the world are published papers daily therefore on the thematic one that intends to analyze in this chapter, the authors carried out a selection of some exceptional considered works in this field of the scientific research to show them next.

In cereal crops like the rice that it has a great importance for the human´s world feeding, under the tropical conditions is affected by different pest, among these it stands out the Tagosodes orizicolus insect. This insect´s damages cause to the plants from development early stages and it is vector of the white leaf virus. Therefore, when the presence of the insect overcomes the economic threshold the use of insecticides it is recommended, being demonstrated that it lower the field conditions in Cuba the insecticide thiametoxan is the best to control the males of T. orizicolus with 100% of control, while; it had a smaller effect the insecticide monocrotofox; etofenprox; cipermetrin and imidacloprid [9]. That exposed demonstrates that the rational use of an insecticide can to control efficiently to its target and it contributes with the rice production.

It is known that in countries producing of wheat, corn and rice they are used the insecticides systematically for the pest control, specifically the Spodoptera spp., (Lepi-

doptera: Noctuidae) as key pest for the damages that it causes on the host plants foliage and for the economic losses that it causes; commonly are used for an efficient pest control the products cihalotrin, cipermetrin and clorpirifos [10-11].

Although it is known that it is necessary the pests control, they should also be known which the main disadvantages insecticide use under the field conditions, these products can produce the following affectations: 1) target resistance development, 2) elimination of non-target organisms, 3) insecticides residuals accumulation in the crop and 4) environment pollutions [12]. For this reason, is suggested to carry out an insecticides rational use in the field and as alternative to these it is recommended to apply the integrated pest management (IPM) [13].

With relationship mite´s control, it was demonstrated recently in Brazil that the acaracide dimetoate and espirodiclofene were highly efficient to control Schizotetranychus hindustanicus (Hirst) in citric´s plantations. Nevertheless, it was also report that these acaracides affects non-target mite's species, which point out risk on beneficent mite fauna of the agroecosystem [14].

On the other hand, the mite denominated spider of two stains Tetranychus urticae Koch (Mite: Tetranychidae) it is pointed out as one of the pest species that more problems cause in the world agriculture. Their high reproductive potential allows it to increase its population

quickly, in such a way that can surpass the crop economic threshold in a short time [15].

Recently Landeros-Flores et al. [16] in an assay under conditions controlled in the bean´s crops, demonstrated that the acaricide flufenoxuron to a concentration of 17.7, 59.9 and 106.7 ppm achieve a bigger mortality to 98% in T. urticae on a period of 72h. These authors recommend that the treatment with flufenoxuron can be effective to control the T. urticae populations quickly in field conditions.

When being designed the mite´s control, it should be valued that the acaricide to use doesn't affect the non-target mite, because these mites can be biorregulators of mite´s pest, as well as; that the products to use don't cause resistance on their target [17]. In this case is recommended to select other mite control tactics based mainly on the biological control and the IPM.

On the other hand, the fungicides are some of the pesticides more used in the agriculture, due to the presence of a great quantity of pathogenic fungal species of plants. The plant pathogenic fungi can affect to the plants from the first development stages, and they can affect crops of grains, vegetables, roots, tubers, banana plant, fruit tree, ornamental, agribusiness among others. These organisms damage different plant´s parts: the leaves, the flowers, the stem, the fruits, the seeds and the roots, which influences negatively about the yields and its quality [18-19].

Many of the fungicides used in the agriculture have their effect on fungi β-tubulins, this proteins molecules

are very important to microtubules development in the filamentous fungi species [20-21]. The fungicides besides affecting the growth mycelial, inhibit the sporulation, which reduces the fungal populations [22].

The fungicides wide use in the agriculture, the fewer selectivity of some of these substances on non-target species and the resistance development in target species, it needs to be carried out a meticulous products selection to apply in the field, as well as; to value the use of other alternatives as the biological control through of the antagonistic fungi Trichoderma spp., and other tactics of IPM with view to an effective management of plants pathogenic fungal species [23-24].

Inside the agricultural pesticide, the nematicide are considered substances biocides and environment pollutants; their action way is based on the liberation of toxic gases that it kills quickly to the nematode ones and in turn they eliminate all type of alive organisms that it inhabits the soil, inside which are pest´s natural enemy [25].

Appropriate to the Montreal Protocol, in the signatory countries of the same one the agricultural use of the methyl bromide was prohibited due to the damage that causes to the ozone layer, nevertheless; nowadays they are frequently used other nematicides like dazomet (metilisotiocianate precursor) and agrocelhone (1,3 dicloropropene + cloropicrina + trifluralina) [26].

In the intensive systems of vegetables production to

open field and in the greenhouse it is frequently used the agrocelhone product, this soils fumigant, although it kills the nematodes it has not solved the pest control problem, where Meloidogyne spp., it can cause economic losses of 40% in vegetables crops [27-29].

Crow and Luc [30] evidenced the nematicide effect of a new furfural formulation in the grass Bermuda in United States of America (USA), the results indicated that the nematode´s populations decreased in the soil and it improved the grass health, these authors proposed the furfural like a tool for the integrated nematodes management in the grass.

In big extensions of the cotton´s crop in Texas state (USA), it is controlled Meloidogyne spp., with the soil´s fumigant 1,3-dichloropropene (Telone II, Dow Agro Sciences, LLC, Indianapolis, IN) (1,3-D), considered a relatively less expensive nematicide compared with other products that are used for the control of root-knot nematode [31].

Therefore, the use of the integrated nematode´s management, based on the innovation and in the search of local and viable economically alternatives to the farmers, it could be used for the effective management of this pest in the contemporary agriculture [32].

The herbicides have an important role on the weed´s control in the agriculture. The weeds can reduce the yields of the rice´s grain between 37-79% and the herbicides use

it controls this serious problem, which offers an effective technological solution for the farmers dedicated to the rice production [33].

The selective herbicides in widely cultivated areas of sugar cane, have an important role to the weed´s control of the these they contribute to maintain the clean fields during the growth cycle´s and during the crop harvest. Also, in other crops like the banana plant, the grains and the cereals it is importance vital the herbicides use like alternative to the weeds control [34]. Despite of these results, it is necessary to carry out an herbicides rational use in the agriculture, with a view to avoiding affectations on the non-target organisms, to minimize the environment pollution and to prevent the resistance development [35].

Nowadays, mollusks are not paid great attention as like agricultural pests, nevertheless; it is known that some species cause direct affectations in the agriculture, others are intermediate host of animal's parasites, of the man and viral diseases vectors that affect the public health [36]. The substances denominated molluscicides are used for the mollusks control that it affects to the plants in the field, in the gardens and to eliminate other diseases vectorial pest. It is considered that more than 7 000 chemical products they have been evaluated with this purpose and very few they are considered effective. With effectiveness on the mollusks it can consider itselves: copper sulfate, gramaxone, calcium hydroxide, N-tritilmorfoline (Frescon),

niclosamide (Bayluscid), carbamate, metaldeide, organofosfate [37-38].

In line with the United Nations (UN) the synthetic molluscicide Niclosamide (N-(2-chlorine-4 nitrofenil)-5-clorosalicilanilide) it is the only substance recommended to combat the diseases vectorial mollusks [39]. While, the use of this substance has generated concerns as: toxicity to non-target species, environment pollutions and it has caused resistance in certain target species [40]. It exposed demonstrates that it is necessary to carry out research works to search biological alternative, cultural and ecological that facilitate an effective and sure mollusk´s management.

The rodents cause direct damages in the livestock farming and in the agriculture and they are vectorial of mortal diseases for the animals and the man. These animals are characterized to be extremely intelligent, they have a great capacity of adaptation to the environment, a high reproduction power and survival capacity [41-42].

The control based on rodenticide should be characterized to use products of high quality and of great palatal, so that they are attractive for the rodents compared with other sources of foods. From the point of view of their action, the rodenticide can be classified in products of anticoagulant action and non-anticoagulant. The anticoagulants are derived substances of 4-hidroxicumarine (anticoagulants of first generation) and the indane-1, 3-dione (anticoagu-

lants of second generation or superwarfarinics) [43].

To guarantee the control of rodents in the fields sugar cane, banana plant and in intensive breeding it is a priority in the agricultural sector to achieve productions of good quality and to minimize damages about the public health and the economy [44].

To work in the discovery of new agents of rodent´s biological control to use traps for their capture and to maintain good hygiene and cleaning inside of the infrastructure, they are measured that will minimize the pest incidence [45-46].

In summary of this part, it is exhorted to carry out a more rational use of the pesticides in the agriculture, to apply the most effective substances and the less polluting ones, as well as; to evaluate the systematically pesticides effects on the non-target organisms and the public health. To achieve a true pesticides reduction, it is suggested to use the IPM more thoroughly, agroecology pest management (APM) and the biopesticide.

Pesticides Effect on Non-Target Organisms and the Environment

The pesticides according to their toxicity on non-target organisms they are classified as: class 1: inoffensive (<25% mortality), class 2: lightly harmful (25-50%), class 3: moderately harmful (51-75%) and class 4: harmful (>75%). To know the selectivity of the substances pesticides on the non-target organisms is a necessity to use these products appropriately in the agriculture [47].

Next, some scientific results will be shown on the impacts that have the pesticides it has more than enough species of microorganisms, insects, the man and the environment.

The Microorganisms

To understand the interactions that take place between the pesticides and the non-target microorganisms is complex and through of the current scientific knowledge it is not possible to explain totally.

However, it is known that in Europe scientific methodologies are used that point out the steps to evaluate the exposure from the pesticides to soil organisms. These approach models determine the concentration and distribution of the pesticides in the field, they are carried out statistical analysis to evaluate the risks and the maps are elaborated where the results are shown [48]. This tool type facilitates the taking of decisions with relationship to the agriculture pesticide use.

Today it worries to the international scientific community the effects that can cause the pesticide on the microorganisms that have as crop biofertilization function, the microbial pest control and those that degrade soil toxic substances [49-50].

Haney et al. [51] determined the effect of the herbicide glyphosate on the soil microbial biomass and they demonstrated that this product stimulated the activity of the microbial biomass, seemingly the herbicide was degraded quickly by the microorganisms and the degradation depended on the soil type and the organic matter contents.

When studying the ecological toxicity of the insecticides flubendiamide and spinosad it was demonstrated that in the Arachis hypogaea L. crop these products improve the activity enzymatic cellulolase, invertase and amilase of the soil, derived of an effective biological activity [52].

Fernandez et al. [53] informed that the combination fungicidal+insecticide (neonicotinoide + triazol + fenilpirrol) it propitiated the biggest value Glomus intraradices colonization in corn seeds in comparison with the treatment where the mycorrhiza it was alone applied.

However, in other works it has been demonstrated just the opposite, according to Fabra et al. [54] and Pell et al. [55] the herbicides can alter the soil´s bacteria that transform ammonium in nitrite, the herbicide glyphosate it affects to the nitrogen fixing bacteria and 2,4-D it reduces the fixation nitrogen symbiotic in the bean plants root.

It was demonstrated that the fungus Glomus mosseae reduces the bean roots colonization by effect dimetoate insecticide, which affects the activity biofertilizer of this mycorrhiza species [56].

The triclopyr product was evaluated as toxic for several micorrizas species and oxadiazon it reduces the spores number that it produces these fungi in the plants root [57-58].

With relationship to the effect of the pesticides has more than enough microbial control agents of pests it was demonstrated that the nematophagous fungus Pochonia chlamydosporia is compatible with fosthiazate nematicide in the potato crop under field conditions; the treatment combined fungi+fosthiazate had a control effect on Globodera spp., similar to the shown by alone fosthiazate [59].

In a study under in vitro conditions where the pesticides compatibility was evaluated with the P. chlamydosporia var. catenulata strain IMI SD 187, was verified that the clamidosporas germination went superior to 50% with the treatments control and the insecticide amidor. The clamidosporas production was stimulated with the insecticide cipermetrin, karate and amidor, the acaracide mitigan and the fungicide benomilo and zineb. The study concluded that the products cipermetrin, karate, amidor, benomilo, zineb and mitigan were compatible with the strain IMI SD 187 and was classified as incompatible the acaracide rogor and the fungicides cuproflow, mancozeb, domar and galben [22].

When evaluating the insecticides effect on the isolate DEBI008 of the Beauveria bassiana entomopathogenic

fungus, it was evidenced that flufenoxuron is not compatible with this species because it inhibits its development completely, while; imidacloprid was compatible, this last insecticide was selected to carry out combined applications with B. bassiana in IPM programs [60].

When determining the compatibility in vitro of four pesticides imidacloprid, metamidofos, dicofol and abamectin with the strain AND-57 of Lecanicillium lecanii (Zimm.) Zare & Gams it was demonstrated that dicofol is very toxic, lightly toxic metamidofos and abamectin and imidacloprid were compatible with this fungus. The pesticide dicofol inhibited the conidial germination totally to all evaluated concentrations, metamidofos inhibited to the field dose and abamectin and imidacloprid they didn't cause affectation [61]. The authors pointed out that it is safe to use the insecticide abamectin and imidacloprid in IPM jointly with the AND-57 strain.

Reyes et al. [62] reported that the antagonist fungus Trichoderma asperellum Samuels reduced the growth micelial for effect of the herbicides fenoxaprop-p-ethyl and 2,4D amine salt, however; these products didn't affect the conidial germination to the dose used in field and the product bispiribac-sodium didn't affect to T. asperellum.

The Insects

Many of the insecticides that are used to eliminate the crops pest contain substances that can be toxic for the non-target insect [63].

The melliferous bees are important natural pollination they carry out 85% of the pollination of the economic importance crops. The market of the bee honey constitutes an important economic line in the entire world. These insects can be affected by the pesticides starting from a direct interaction or through the polluted pollen, being able to take the pesticide until the colony, that which causes disorders in the bee's behavior and it can intoxication´s die. The bees are considered very sensitive to the insecticide malathion, carbaryl and methyl parathion [64-66]. That exposed is considered very harmful for the good development of the world´s beekeeping.

El-Heneidy et al. [67] they informed that the insecticides applications in the field can reduce among 70-80% the number of entomophagous species in the cotton crop and in the wheat crop it is registered parasitoids affectations and insectivorous among 68-72%.

It was demonstrated scientifically that the insecticide cryolite affects the duration of the biological cycle in the larvae stage, pupae and emergency Drosophila melanogaster fly in comparison with a control treatment [68]. Which evidences a potential risk of this insecticide for the biodiversity of D. melanogaster in the agroecosystems.

According to Moura et al. [69] when evaluating the effect of different insecticides on the Chrysoperla externa entomophagous it evidenced that carbaryl, fenitrothion and methidathion caused 100% of mortality in the first and second larval state of this insect. Moreover, the affectation

of abamectin, sulfur and trichlorfon were not observed in the oviposition and development of first and second larval stage. Carbaryl, fenitrothion and methidathion were harmful to C. externa, trichlorfon affected to the first and second larval state and abamectin and sulfur were highly harmful on all larval instars evaluated.

Mandour [70] studied the spinosad toxicity on the immature states of the C. carnea entomophagous species and their effect on the reproduction and the adult's survival, concluding that the spinosad insecticide was inoffensive.

While Nadeem et al. [71] observed that C. carnea in cotton crop under field conditions increased the number plant´s larvae, pupae and adults in control treatment compared with the other that was sprayed with an insecticide.

Cabral et al. [72] evaluated the effects of primicarb and pymetrozine on the voracity of the Coccinella undecimpunctata larval state, evidencing that the entomophagous voracity is bigger when interacted with the pesticides compared with the control treatment.

On the other hand, the collembolans are arthropods species very small that it lives in the soils and it have an important function in the organic matter decomposition, according to Endlweberet et al. [73] the insecticide chlorpyrifos and dimethoate affected the collembolans populations significantly, however; the evaluated products didn't show effect on the species number. These results point out the insecticides risk on the collembolans species that soil inhabit.

The Man

The pesticides are applied systematically in the crop, in the forest activities, in the roads or highways, in the public health, in gardens, among others. Their wide use can cause interaction with the human beings and other organism´s species. The poisoning for pesticides can take place for acute, chronic, secondary or indirect effects [74].

The acute poisoning consists on short expositions to the pesticides that can cause the death. The chronic one is considered a long exposition to the pesticide without it causes lethal quickly. The secondary one is when they waste away foods that contain pesticides residuals, resultant of an accumulation and movement of persistent chemical in the foot chains. The indirect one is when the habitat is affected, it modifies the nutritious supplement, for example, the herbicides can reduce the vegetable covering and with they are affected it the birds nesting places and insects [2]. At the present time, the study of the indirect effects requires of more research work to long-term and short-term.

With relationship to the previously exposed thing, the pesticides are considered responsible for causing significant affectations in the public health and based on their chemical grouping: organochlorine, organophosphate, carbamate and other types, will be shown their effects and risks next about the human health.

Organochlorine

These products have a wide use as insecticides, they are characterized to inhibit the cholinesterase enzyme, the poisoning form for contact can be oral, intravenous, dermal, conjuncial, intestinal and for the breathing. Their effect like potent inhibitors of the acetylcholinesterase and pseudocholinesterase activity, this cause secretion abundant [75].

The dichlorodiphenyl-trichloroethane (DDT) pesticide persists in the atmosphere and in the human body for several years, due to their high solubility in lipids and to their resistance to be denaturalized. The DDT and other organochlorine pesticides have been detected in the breast milk and in the baby's adipose tissue. Studies carried out in USA relate the presence of congenital defects of the heart in babies by the exposure from the mothers to this substance [76].

Mills and Yang [77] found that individual's farmer exposed to high relatively levels of organochloride (linden and heptachlor) they experienced high risk of prostate cancer, in comparison with farmer pesticides non-exposed.

Besides, the organochloride pesticide has been detected in the breast milk, which puts in risk to the suckling baby and their mothers [78].

These substances are considered of risk high by their effects to long-term, such as reproductive alterations, immunologic disruption, endocrine alterations and of the development, and they are considered as carcinogenic potential agents [2].

A recent study with a social focus and age in the population, evidenced that the pesticides organochlorides: DDT, p,p'-dichlorodipenyldichloroethylene, β-hexachlorocyclohexane, trans-nonachlor, oxychlordane and heptachlor epoxide influence in the capacities cognitive of the grown-ups that have ages among 60-85 years [79]. Which points out the risk of these pesticides about the people's quality of the third age life and does it demonstrate the necessity to carry out more research on this thematic one.

Lastly, it thinks about that the main road of the human population exposition to the organochlorides pesticides are the vegetable and animal foods [80].

Organophosphate and Carbamate

The organophosphate pesticide and the carbamate are used in the entire world to control a great number of insect's species, fungi and weeds. Dozens of products based on these compounds are applied in the agriculture, the livestock farming, and the forests and in the urban areas. These pesticides are accumulating inevitably in the soil and the waters, which affects to the biotic component that it inhabits these ecosystems [81].

These pesticides are constituted structurally for chemical diverse and their action depends on its chemical

structure. The main action mechanism is the inhibition of the acetylcholinesterase enzyme, this serine esterase enzyme that is present in the vertebrate's central nervous system, this has as function physiologic hydrolyser of the acetylcholine neurotransmission. The acetylcholine accumulation alters the function of the nervous system, the neuron and the brain, this affects directly the locomotion, the respiration and the body posture. The organophosphate pesticides are associates with memory deficit and this cause visual problems by retina and optic nerve degeneration [82].

A product organochlorine denominated dichlorvos is considers with high risk of causing prostate cancer, particularly in farmers that are exposed at high levels of this substance [77].

On the other hand, Bustos-Obregon et al. [83] informed that parathion and paraoxon affect the quality of the sperm in the mammal's species.

The organophosphate, unfortunately they have caused the people´s massive death from the foods contamination, registering in different world´s parts cases of poisoning and death for the parathion pesticide [84].

In USA, Thompson et al. [85] demonstrated that in 211 children's urine samples and 213 of adults registered five types of compound organophosphate, of these, the dimethylthiophosphate was found in 88% of the children´s samples and in 92% of the adult's samples. Likewise, this

study evidenced that in samples of the houses and the vehicles of the farmers were the pesticides remains azinphospmethyl, malathion and M-parathion. This shows the importance of the surer practices application for the pesticide management.

Other Pesticide

In a study carried out in France by Baldi et al. [86] demonstrated that the pesticides expositions are related with the diseases presence such neuron degenerative as Alzhaimer and Parkinson. Although it should not be related these diseases problems to a specific pesticide, they author highlight that people that live and work in agricultural areas where used pesticides they have more risk to fall ill.

The pesticides methylbromide and simazine are associate with risks to suffer prostate cancer, particularly in farmer that are exposed to these products [77].

In the 80th in last century it registered in California USA three events of vegetables contamination in watermelon and cucumber with pesticides, which caused people poisoning and they manifested diarrheas, vomits, salivation and convulsions symptoms [84].

In this thematic one, the greater part of the studies on pesticides toxicity have been focused on the enzymatic, hormonal, mutagenic and cancer-causing disruptions. Nevertheless, it is needed to deepen more in the pesticides effect on the answers of the immune system to short, me-

dium and long term [2]. This way, pesticides more risks would be known about the human health and they would take the corresponding management with a view to minimizing their effects.

The Environment

Unquestionably the environment pesticides impact, these they can contaminate the soil, the water, the grass and another vegetation type. Their toxicity on the birds, fish and beneficial insects can cause big ecological affectations [33].

The organochloride compound represents an important group of persistent organic pollutants, which have caused concern in the entire world to be very toxic products of the environment [87].

The organophosphate pesticides like the DDT; they have been broadly used in the last decades for the agriculture pests control and in the public health area, at the present time these products are still in use in some developing countries [88]. Those evidence potential risks of environment contamination due to their slow degradation and persistence.

It is known that the field pesticides application in powdered or liquid form, causes a distribution in the different phases environment: the soil, water, air, animals and plants (Fig 1). The environmental effects of these products will depend on their concentration in each one of these phases [89].

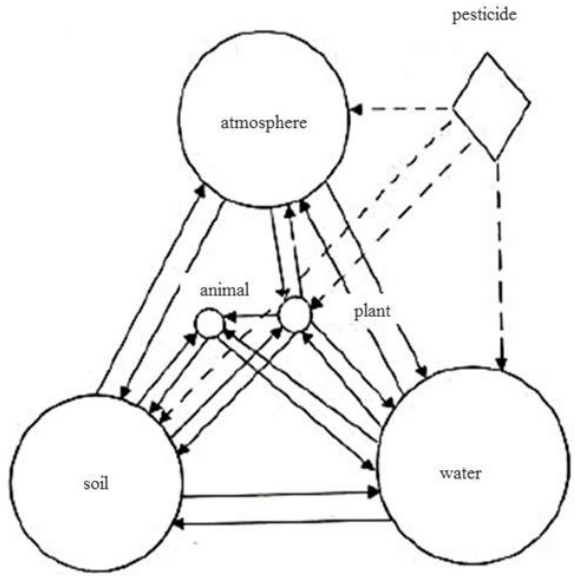

Figure 1: Pesticide distribution in the phases different from environment. Taken of Sanchez and Sanchez [89].

Soil

The soil is considered an important natural resource, its exploitation it facilitates to obtain foods vegetable and animal to satisfy the human´s nutritional necessities, as well as; to produce raw materials and services. Next, aspects concerning with the soil pesticides interaction will be analyzed.

The pesticides persistence and movement in the soil and their transformations are determined by several parameters: solubility in water, soil-sorption constant (Koc), the octanol/water partition coefficient (Kow), and half-life in soil (DT50). The pesticides retention in the soil so much of the soil properties depends like of those of the pesticide, nevertheless; it is considered very important the organic matter (OM) content, being demonstrated that in soil with high contents of OM happens bigger absorption and pesticides transformation. The pH is important also, because soil pH reductions values potential the absorption of the ionize pesticides (e.g. 2,4-D, 2, 4,5-T, picloram, atrazine) [90].

In a research developed in the Merida state, Venezuela, was demonstrated that the organochlorides pesticides total concentration, DDT and its metabolitos in the soil in potato and carrot crop decrease when increasing the pH values. Likewise, an increase of the pesticides concentration was observed when it registered bigger sand content in the soil. In this research all the analyzed soil was classified as potentially contaminated by pesticides, due to the DDT concentrations, dieldrin and endrin [91]. Besides, was sustained that the DDT several years ago is not applied and it still persists in the soil, which evidences its high residual in the environment.

Water

The water is an essential element for the life in the planet and its quality can affect for the pesticides contamination [92]. The Organization Guidelines for Drinking-Water Quality Standards (WHO) informed that the concentration of a single pesticide in the drinking water cannot exceed 0.1 g.L-1 and the pesticides total concentration it won't exceed 0.5 g.L-1. Otherwise the water doesn't have quality to be consumed [93].

Through the pesticides applications to the crop and the soil the superficial waters can be contaminated, being known that the contamination with organochlorides can persist for more than one decade [94]. In this respect Kole et al. [95] in USA evidenced that 90% of the water samples and analyzed fish they contained pesticides residuals.

In an investigation carried out in Hungary among the years 1990-2015 it was demonstrated that high levels of the acetochlor pesticide exist in the water dedicated for the human drinking, the residuals of this herbicide were originated mainly by the industry of agrichemical production [96]. Which points out that an industrial management more efficient of the residual ones should be carried out so that they don't affect the water quality.

According to EPA [97] the contamination of the water for pesticides is a serious problem for the public health, because the process for decontaminate is very complex, expensive, it requires of time and of specialized personnel, also with the existent technology cannot always achieve a total decontaminate. In Colombia the genotoxicity risk was analyzed of different chemical in sources of water and its pointed out to the pesticides like causing of altering

the human lymphocytes [98]. These authors suggested to take quick measures to improve the water quality for the human dinking and to avoid in this way that it originate public health problems.

Air

The air quality that we breathe today is influenced largely by the anthropogenic activity in the air they can register different polluting substances and the pesticides are inside them. These substances concentrate on the air for volatilization and through the hydrological cycle. Studies carried out in the arctic one show that the particles of insecticides and herbicides they arrive farther through the air in the cold climates than in the template ones from three to eight times [99].

Recently Vincenzo et al. [100] informed that in the region of Molise (Italy center) during different stations of the year it registered the presence in the air of parathion-ethyl, dimethoate, omethoate and malathion, being demonstrated that the concentration of these pesticides depended on the atmospheric conditions of every analyzed period.

Recently it was demonstrated in Brazil the pesticides presence in the air in mountainous areas that which was considered as a risk for the human health, for the ecology and for the processes of climatic change that are happening in the planet [101].

The exposed results point out that it should be continued fulfilling that agreed in the Montreal Protocol, with relationship to not using the pesticides that affect to the ozone layer, for example the soil fumigant methyl bromide [26].

Future Challenges in the Pesticides use in the Agriculture

We consider that the humanity should face big challenges with relationship to the pesticides use for the immediate-future. In the first place, it should exist a political will of the governments and the international organizations to continue perfecting the regulatory mechanisms for the registration, the production and the pesticides use in the agriculture [102].

As tendency for the production of new pesticides formulations to be kept in mind the reduction of the application doses, to use the most effective active ingredients for the pests control that it does not believe resistance that it are innocuous to the environment, the human health and that the products marketing costs allow their acquisition for the developing countries [13].

It should be deepened more in the effects that cause the pesticides to short, medium and long term on the component biotic and abiotic of the agroecosystem, as well as in the genotoxicity and the human beings' fecundity. To carry out more research than they allow evaluat-

ing them pesticide risks in the human foods and in the breast milk [76].

Finally, the farmers training on alternative sure for the pest management as the IPM, the APM, the biopesticidas and the botanical pesticides are options to rationalize the pesticides in the future agriculture.

Conclusions

The pesticides have a wide use in the agriculture for the pest control in different crop of economic importance. The indiscriminate use of those these products cause serious problems like the pest resistance, the new pest resurgence, the contamination of the foods, the soil, the water, the air, kill non-target organisms and it alter the agroecosystem functions. This element point out the necessity to carry out a more rational use of the pesticide like alternative to the same ones you can use the integrated pest management, the ecology pest management, the biopesticides and botanical pesticides. In these moments it urges the network creation that it guarantees the pesticides early alerts in the agricultural sector.

Acknowledgement

We thank kindly to the Ph. D. Jose Sariol Bonilla for the revision of this paper and for the carried out suggestions.

References

1. Restrepo I. Los plaguicidas en Mexico: Naturaleza muerta. Rev. Ciencias. 1988; 13: 40-50.
2. Badii MH, Landeros J. Plaguicidas que afectan a la salud humana y la sustentabilidad. CULCyT// Toxicol Plag. 2007; 4: 21-34.
3. Martínez-Valenzuela C, Gomez-Arroyo S. Riesgo genotoxico por exposicion a plaguicidas en trabajadores agri-colas. Rev. Int Contam Ambient. 2007; 23: 185-2007.
4. Velders GJ, Andersen SO, Daniel JS, Fahey DW, McFarland M. The importance of the Montreal Protocol in protecting climate. Proc Natl Acad Sci U S A. 2007; 104: 4814-4819.
5. Molina M, Zaelke D, Sarma KM, Andersen SO, Ramanathan V. Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO2 emissions. Proc Natl Acad Sci U S A. 2009; 106: 20616-20621.
6. Food and Agriculture Organization (FAO). Pesticide Disposal Series: Environmental Management Tool Kit for Obsolete Pesticides. Volume 3, Safeguarding strategy, Disposal strategy, Environmental assessment report and environmental management plans. Office of Knowledge Exchange,

Research and Extension, FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy. 2011; 103.

7. Agrios G. Control of plant diseases. Plant Pathology, Fifth Edition. San Diego: Elsevier Academic Press. 2005; 295-350.
8. Jaramillo BE, Martelo I, Duarte E. Toxicidad aguda de pesticidas organo fosforados y analisis de la relacion cuantitativa de estructura actividad. Biot Sec Agrop Agroind. 2013; 11: 76-84.
9. Meneses R, Calvert L, Gutierrez A, Gomez J, Hernandez J. Manejo Integrado de los principales insectos y acaros plagas del Arroz. Instituto de investigaciones del arroz. Registro de obra literaria protegida No. 716-2008 del Centro Nacional de Derecho de Autor, Republica de Cuba. 2008.
10. Storer NP, Kubiszak ME, Ed King J, Thompson GD, Santos AC. Status of resistance to Bt maize in Spodoptera frugiperda: lessons from Puerto Rico. J Invertebr Pathol. 2012; 110: 294-300.
11. Velez AM, Spencer TA, Alves AP, Moellenbeck D, Meagher RL, et al. Inheritance of Cry1F resistance, crossresistance and frequency of resistant alleles in Spodoptera frugiperda (Lepidoptera: Noctuidae). Bull Entom Res. 2013; 103: 700-713.
12. Lebeau T. Bioaugmentation for In Situ Soil Remediation: How to Ensure the Success of Such a Process. Chap 7. Singh A, Parmar N, Kuhad RC. Eds. Bioaugmentation, Biostimulation and Biocontrol. Springer-Verlag, Berlin, Heidelberg. 2011; 129-186.
13. E Birch AN, Begg GS, Squire GR. How agro-ecological research helps to address food security issues under new IPM and pesticide reduction policies for global crop production systems. J Exp Bot. 2011; 62: 3251-3261.
14. Marsaro AL, Sato ME, de Aguiar RM, Vieira GB, da Silva RJ, et al. Efeito de acaricidas sobre Schizotetranychus hindustanicus (Hirst) (Acari: Tetranychidae) e acaros predadores em citros no estado de Roraima, Brasil. Arq Inst Biol. 2012; 79: 75-83.
15. Gould HJ. Protected crops. In: AJ Burn, TH Croaker, PC Jeppson (editors). Integrated Pest Management. Academic. Press Co. 1987; 404-405.
16. Landeros-Flores J, Chacon-Hernandez J, Couoh-Cab JG, Cerna-Chavez E, Ochoa-Fuentes YM, et al. Efecto de concentraciones subletales de flufenoxuron sobre parametros poblacionales de Tetranychus urticae koch (Acari: Tetranychidae). Acta Zool Mex (n.s.). 2014; 30: 491-499.
17. Rodriguez H, Montoya A, Perez-Madruga Y, Ramos M. Reproduccion masiva de acaros depredadores Phytoseiidae: retos y perspectivas para Cuba. Rev. Proteccion Veg. 2013; 28: 12-22.

Pesticides

18. Perez N. Manejo Ecologico de Plagas. CEDAR. Centro de Estudios de Desarrollo Agrario y Rural. La Habana, Cuba. 2004; 70.

19. Martínez G, Morales A, Maestro A, Cermeño S, Oliva J. Determination of Nine Fungicides in Grape and Wine Using QuEChERS Extraction and LC/MS/MS Analysis. J AOAC Int. 2015; 98: 1745-1751.

20. Sahu S, Ghosh S, Fujita D, Bandyopadhyay A. Live visualizations of single isolated tubulin protein self-assembly via tunneling current: effect of electromagnetic pumping during spontaneous growth of microtubule. Sci Reports. 2014; 4: 1-9.

21. Janke C. The tubulin code: molecular components, readout mechanisms, and functions. J Cell Biol. 2014; 206: 461-472.

22. Ceiro WG, Arévalo Jersys e Hidalgo-Díaz L. Efectos de plaguicidas y bioestimulantes vegetales sobre la germinacion de clamidosporas y desarrollo in vitro del hongo nematofago Pochonia chlamydosporia. Rev. Iberoam Micol. 2015; 32: 277-280.

23. Martinez B, Infante D, Yusimy R. Trichoderma spp. y su funcion en el control de plagas en los cultivos. Rev Proteccion Veg. 2013; 28: 1-11.

24. Artz DR, Pitts-Singer TL. Effects of Fungicide and Adjuvant Sprays on Nesting Behavior in Two Managed Solitary Bees, Osmia lignaria and Megachile rotundata. PLoS One. 2015; 10: e0135688.

25. Wheeler TA, Lawrence KS, Porter DO, Keeling W, Mullinix BG Jr. The relationship between environmental variables and response of cotton to nematicides. J Nematol. 2013; 45: 8-16.

26. Perez E, Fernandez E, Cuadra R, Paredes E. Metodos de preparacion de suelo, rotaciones de cultivos, policultivos y cultivos trampas para el control de plagas de suelo, como alternativas al Bromuro de Metilo (Capi-tulo I). Perez E (ed). Tecnologi¬as en el proceso de eliminacion total del Bromuro de Metilo en tratamientos al suelo en Cuba. Ed. CIDISAV, La Habana, Cuba. 2012; 5-27.

27. Rodríguez Mayra G, Sánchez Lourdes, Gómez Lucila. Meloidogyne spp. plagas de las hortalizas: alternativas para su manejo en sistemas de cultivo protegido. Rev. Proteccion Veg. 2005; 20: 1-10.

28. Hidalgo-Diaz L, Kerry BR. Integration of biological control with other methods of nematode management. Ciancio A, Mukerji KG (eds). Integrated management and biocontrol of vegetable and grain crops nematode. 2008; 29-49.

29. Gómez Lucila, Rodríguez Mayra G, Enrique R, Miranda Ileana, González E. Factores limitantes de los rendimientos y calidad de las cosechas en la

produccion protegida de hortalizas en Cuba. Rev. Proteccion Veg. 2009; 24: 117-122.

30. Crow WT, Luc JE. Field efficacy of furfural as a nematicide on turf. J Nematol. 2014; 46: 8-11.
31. Wheeler TA, Siders KT, Anderson MG, Russell SA, Woodward JE. Management of Meloidogyne incognita with Chemicals and Cultivars in Cotton in a Semi-Arid Environment. J Nematol. 2014; 46: 101-107.
32. Collange B, Navarrete M, Peyre G, Mateille T, Tchamitchian M. Root-knot nematode (Meloidogyne) management in vegetable crop production: The challenge of an agronomic system analysis. Crop Prot. 2011; 30: 1251-1262.
33. Aktar MW, Sengupta D, Chowdhury A. Impact of pesticides use in agriculture: their benefits and hazards. Interdiscip Toxicol. 2009; 2: 1-12.
34. Green JM. Current state of herbicides in herbicide-resistant crops. Pest Manag Sci. 2014; 70: 1351-1357.
35. Shigueyoshi A, Ferreira M, Aparecida de Souza R, Pereira da Silva A, Bueno dos Reis-Juniord F, et al. Effects of the glyphosate-resistance gene and of herbicides applied to the soybean crop on soil microbial biomass and enzymes. Field Crops Res. 2014; 162: 20-29.

36. Costa AV, Almeida BR, Goncalves LV, Crico KB, Ignacchiti MDC, et al. Efeito moluscicida do oleo essencial de Cymbopogon winterianus Jowitt (Poaceae) sobre Lymnaea columella (Say, 1817) e Biomphalaria tenagophila (D'Orbigny, 1835). Rev. Bras. Pl. Med., Campinas. 2015; 17: 707-712.
37. Cantanhede SPD, Marques AM, Silva-Souza N, Valverde AL. Atividade moluscicida de plantas: uma alternativa profilatica. Rev Bras Far. 2010; 20: 282-288.
38. Singh SK, Yadav RP, Singh A. Molluscicides from some common medicinal plants of eastern Uttar Pradesh, India. J Appl Toxicol. 2010; 30: 1-7.
39. Pinheiro L, Garcia DA, Vidotti G, Young MC, Ferreira AG. Estudo fitoquimico e avaliacao da atividade moluscicida da Kielmeyera variabilis Mart (Clusiaceae). Qui¬m Nova. 2003; 26: 157-160.
40. Gasparotto A, Brenzan MA, Piloto IC, Garcia DA, Vataru Celso, et al. Estudo fitoquimico e avaliacao da atividade moluscicida do Calophyllum brasiliense camb (Clusiaceae). Qui¬m Nova. 2005; 28: 575-578.
41. Coeurdassier M, Riols R, Decors A, Mionnet A, David F. Unintentional wildlife poisoning and proposals for sustainable management of rodents. Conserv Biol. 2014; 28: 315-321.

42. Papini S, Nakagawa LE. Current Status of Rodenticide Intoxication in Brazil: A Preliminary Survey from 2009 to 2011. Braz Arch Biol Technol. 2014; 57: 685-688.

43. Quiles A. Control de roedores en las explotaciones porcinas. Ediporc. Edicion especial. Higiene y desinfeccion. 2015; 36-42.

44. de Masi E, Vilaça P, Razzolini MT. Environmental conditions and rodent infestation in Campo Limpo district, Sao Paulo municipality, Brazil. Int J Environ Health Res. 2009; 19: 1-16.

45. Papini S, Nakagawa LE, Narciso E, Andrade MIM. Paraffin blocks not-exposed and exposed to the environment. In: 7th International Conference on Urban Pests: Proceedings; 2011 Aug; Ouro Preto, Brazil. Sao Paulo: Instituto Biologico. 2011; 223-226.

46. Rodríguez TM, Castellanos L, Rodríguez Irán.. Manejo de plagas para la cana de azucar en la Empresa Azucarera "Melanio Hernandez" . Rev. Centro Agri. 2014; 41: 35-41.

47. El-Heneidy AH, Khidr AA, Taman AA. Side-effects of Insecticides on Non-target Organisms: 1- In Egyptian cotton Fields. Egy J. Biol Pest Cont. 2015; 25: 685-690.

48. Tiktak A, Boesten JJ, Egsmose M, Gardi C, Klein M. European scenarios for exposure of soil organisms to pesticides. J Environ Sci Health B. 2013; 48: 703-716.

49. Chowdhury A, Pradhan S, Saha M, Sanyal N. Impact of pesticides on soil microbiological parameters and possible bioremediation strategies. Indian J Microbiol. 2008; 48: 114-127.

50. Aktar MW, Sengupta D, Chowdhury A. Impact of pesticides use in agriculture: their benefits and hazards. Interdiscip Toxicol. 2009; 2: 1-12.

51. Haney RL, Senseman SA, Hons FM. Effect of roundup ultra on microbial activity and biomass from selected soils. J Environ Qual. 2002; 31: 730-735.

52. Jaffer G, Srinivasulu M Subramanyam K, Madakka M, Meghana D, Rangaswamy V. Influence of insecticides flubendiamide and spinosad on biological activities in tropical black and red clay soils. 3 Biotech. 2015; 5: 13-21.

53. Fernandez R, Veitia M, Rubio E, Rodriguez Y. Compatibilidad entre nuevos plaguicidas químicos sistemicos y el hongo micorrizogeno Glomus intraradices Schenk y Smith. Rev. Fitos. 2011; 15: 99-105.

54. Fabra A, Duffard R, Evangelista de Duffard A. Toxicity of 2,4-dichlorophenoxyacetic acid to Rhizobium sp in pure culture. Bull Environ Contam Toxicol. 1997; 59: 645-652.

Pesticides

55. Pell M, Stenberg B, Torstensson L. Potential denitrification and nitrification tests for evaluation of pesticide effects in soil. Ambio. 1998; 27: 24-28.

56. Menendez A, Martínez A, Chiocchio V, Venedikian N, Ocampo JA. Influence of the insecticide dimethoate on arbuscular mycorrhizal colonization and growth in soybean plants. Int Microbiol. 1999; 2: 43-45.

57. Chakravarty P and Sidhu SS. Effects of glyphosate, hexazinone and triclopyr on in vitro growth of five species of ectomycorrhizal fungi. Euro J. For Path. 1987; 17: 204-210.

58. Moorman TB. A review of pesticide effects on microorganisms and microbial processes related to soil fertility. J. Prod. Agric. 1989; 2: 14-23.

59. Tobin JD, Haydock PPJ, Hare MC, Woods SR, Crump DH. Effect of the fungus Pochonia chlamydosporia and fosthiazate on the multiplication rate of potato cyst nematodes (Globodera pallida and G. rostochiensis) in potato crops grown under UK field conditions. Biol Control. 2008; 46: 194-201.

60. Alizadeh A, Amin MS, Khezri M, Saberi RR. Compatibility of Beauveria bassiana (Bals.) Vuill., with Several Pesticides. Int J. Agri Biol. 2007; 9: 31-34.

61. Castellanos L, Lorenzo ME, Lina B. Compatibilidad de cuatro plaguicidas de diferentes grupos quimicos con Lecanicillium lecanii (Zimm.) Zare & Gams. Rev. Proteccion Veg. 2013; 28: 199-203.

62. Reyes Y, Infante D, Garcia-Borrego J, Del Pozo E, Cruz A, et al. Compatibilidad de Trichoderma asperellum Samuels con herbicidas de mayor uso en el cultivo del arroz. Rev. Proteccion Veg. 2012; 27: 45-53.

63. Hassan SA. Comparative of three different laboratory methods and one semi-field test method to assess the side effects of pesticides on Trichogramma cacoeciae. IOBC/WPRS Bull. 1994; 17: 133-141.

64. Coppa R, Huerta G. Pesticidas vs. abejas. Agricultura. 2011; 20: 81-84.

65. Sanford MT. Protecting Honey Bees from Pesticides. CIR534, one of a series of the Entomology and Nematology Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. 2011.

66. Tirado R, Simon G, Johnston P. El declive de las abejas: Peligros para los polinizadores y la agricultura de Europa. Unidad Cientifica de Greenpeace, Universidad de Exeter, Reino Unido Greenpeace. Nota tecnica de los laboratorios de Greenpeace. JN446, Greenpeace Internacional Ottho Heldringstraat 51066 AZ Amsterdam (Pai-

ses Bajos). 2013; 43.

67. El-Heneidy AH, Fayad YH, Shoeb AM. Influence of insecticidal application on aphid populations and their natural enemies in wheat fields. Egypt J. Biol Pest Cont. 1991; 1: 79-85.

68. Podder S, Roy S. Study of the changes in life cycle parameters of Drosophila melanogaster exposed to fluorinated insecticide, cryolite. Toxicol Ind Health. 2015; 31: 1341-1347.

69. Moura AP, Carvalho GA y Marcos Botton. Residual effect of pesticides used in integrated apple production on Chrysoperla externa (Hagen) (Neuroptera: Chrysopidae) larvae. Chil J. Agr Res. 2012; 72: 217-223.

70. Mandour NS. Influence of spinosad on immature and adult stages of Chrysoperla carnea (Stephens) (Neuroptera: Chrysopidae). Bio Control. 2009; 54: 93-102.

71. Nadeem MK, Nadeem S, Ahmed S, Ashfaq M, Ahmad SF. Comparative survival of Chrysoperla carnea (Stephens) (Neuroptera: Chrysopidae) in cotton with and without insecticides under field conditions. Pak. Entomol. 2011; 33: 93-95.

72. Cabral S, Soares AO, Garica P. Voracity of Coccinella undecimpunctata. Effects of insecticides when foraging in a prey/plant system. J. Pest Sci. 2011; 84: 373-379.

73. Endlweber K, Schadler M, Scheu S. Effects of foliar and soil insecticide applications on the collembolan community of an early set-aside arable field. App Soil Ecol. 2006; 31: 136-146.

74. Osman KA. Human Health Risk of Dietary Intake of Some Organochlorine Pesticide Residues in Camels Slaughtered in the Districts of Al-Qassim Region, Saudi Arabia. J AOAC Int. 2015; 98: 1199-1206.

75. Guven M, Ata A. Intravenous organophosphate intoxication. Am J Emerg Med. 2000; 18: 640-641.

76. Loffredo CA, Silbergeld EK, Ferencz C, Zhang J. Association of transposition of the great arteries in infants with maternal exposures to herbicides and rodenticides. Am J Epidemiol. 2001; 153: 529-536.

77. Mills PK, Yang R. Prostate cancer risk in California farm workers. J Occup Environ Med. 2003; 45: 249-258.

78. Albert L. Organochlorine pesticide residues in maternal milk and their risk to health. Bol Oficina Sanit Panam. 1981; 91: 15-29.

79. Kim SA, Lee YM, Lee HW, Jacobs DR Jr, Lee DH. Greater cognitive decline with aging among elders with high serum concentrations of organochlorine pesticides. PLoS One. 2015; 10: e0130623.

80. Fattore E, Fanelli R, La Vecchia C. Persistent or-

ganic pollutants in food: public health implications. J Epidemiol Community Health. 2002; 56: 831-832.

81. Hao XM, Wang CL, Dong DM, Hua XY, Ren JF, et al. Sorption and transportation of heavy metals and organochlorine pesticides in agricultural soils from a Shenyang suburb. Acta Sci. Circum. 2010; 30: 1880.

82. Mileson BE, Chambers JE, Chen WL, Dettbarn W, Ehrich M. Common mechanism of toxicity: a case study of organophosphorus pesticides. Toxicol Sci. 1998; 41: 8-20.

83. Bustos-Obregon E, Caballero J, Ortiz C. Morphofunctinal damage of mammalian sperm incubated in organophosphoric agropesticides. Andrology. 2003; 35: 4-5.

84. Langford NJ, Ferner RE. Episodes of environmental poisoning worldwide. Occup Environ Med. 2002; 59: 855-860.

85. Thompson B, Coronado GD, Grossman JE, Puschel K, Solomon CC. Pesticide take-home pathway among children of agricultural workers: study design, methods, and baseline findings. J Occup Environ Med. 2003; 45: 42-53.

86. Baldi I, Lebailly P, Mohammed-Brahim B, Letenneur L, Dartigues JF. Neurodegenerative diseases and exposure to pesticides in the elderly. Am J Epidemiol. 2003; 157: 409-414.

87. Wurl O, Obbard J. Organochlorine pesticides, polychlorinated biphenyls and polybrominated diphenyl ethers in SingaporeÂ´s coastal sediments. Chemosphere. 2005; 58: 925-933.

88. Rissato SR, Galhiane MS, Ximenes VF, de Andrade RM, Talamoni JL. Organochlorine pesticides and polychlorinated biphenyls in soil and water samples in the Northeastern part of São Paulo State, Brazil. Chemosphere. 2006; 65: 1949-1958.

89. Sanchez MJ, Sanchez M. Los plaguicidas. Adsorcion y evolucion en el suelo. Temas de divulgacion 1a edicion. Instituto de recursos naturales y agrobiología. Salamanca, Espana. 1984; 49.

90. Andreu V, Pico' Y. Determination of pesticides and their degradation products in soil: critical review and comparison of methods. Tren Anal Chem. 2004; 23: 72-789.

91. Uzcategui J, Araujo Y, Mendoza L. Residuos de plaguicidas organoclorados y su relacion con parametros fisico-qui¬micos en suelos del municipio Pueblo Llano, estado Merida. Bioagro. 2011; 23: 115-120.

92. Oladele G, Ayanwuyi S, Obayomi-Davies O. Organochlorine pesticide in water and bottom sedi-

ment from Aiba Reservoir (Southwestern Nigeria). Chem Ecol. 2014; 30: 513-531.

93. Singh J, Singh H, Singh S, Bajwa BS. Estimation of uranium and radon concentration in some drinking water samples of Upper Siwaliks, India. Environ Monit Assess. 2009; 154: 15-22.

94. Loganathan BG. Global contamination trends of persistent organic chemicals: An overview. In: Laganathan BG, Lam PKS (eds). Global contamination trends of persistent. Chemicals CRC Press. 2012; 593-628.

95. Kole RK, Banerjee H, Bhattacharyya A. Monitoring of market fish samples for endosulfan and hexachlorocyclohexane residues in and around Calcutta. Bull Environ Contam Toxicol. 2001; 67: 554-559.

96. Szekacs Andras, Mortl Maria, Darvas Bela. Monitoring Pesticide Residues in Surface and Ground Water in Hungary: Surveys in 1990-2015. J. Chem. 2015; 1-15.

97. EPA. Source water protection practices bulletin: Managing small scale application of pesticides to prevent contamination of drinking water. Washington, DC: Office of Water (July). EPA 816-F-01-031. 2001.

98. Tobon F, Lopez L. Genotoxicidad del agua contaminada por plaguicidas en un area de Antioquia. Rev. MVZ Cordoba. 2011; 16: 2605-2615.

99. Canada H. Health and the environment: handbook for health professionals. Ministry of Public Work and Government Services, Ottawa. 1998.

100. Vincenzo M, Avino P, Cinelli G, Notardonato I. Sampling of organophosphorus pesticides at trace levels in the atmosphere using XAD-2 adsorbent and analysis by gas chromatography coupled with nitrogen-phosphorus and ion-trap mass spectrometry detectors. Anal Bioanal Chem. 2012; 404: 1517-1527.

101. Meire R, Khairy M, Targino A, Galvao P, Torres J, et al. Use of passive samplers to detect organochlorine pesticides in air and water at wetland mountain region sites (S-SE Brazil). Chemosphere. 2016; 144: 2175-2182.

102. Lexley M, Pereira P, Boysielal K, Siung-Chang A. Pesticide regulation, utilization, and retailers' selling practices in Trinidad and Tobago, West Indies: current situation and needed changes. Rev. Panam Salud Publica. 2007; 22: 93-90.