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Pesticides Toxicities: A review

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Abstract:

For the sake of high crops yield with low labor, demand for more and potent pesticides increases year by year. These pesticides on one hand had helped farmers but on the other hand, it is a serious threat to humans, animals and non-targeted microbes. High concentration of these pesticides alters plant physiology and contaminates environment. This review article focuses on various aspects of pesticides induced toxicities.

Key words: Contamination, Microbes, Pesticides, Toxicity

Introduction

Pesticides are widely used in most sectors of the agricultural production to prevent or reduce losses by pests and thus can improve yield as well as quality of the produce (Oerke and

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Dehne, 2004). Pesticides are widely used throughout the world. There are several definitions of pesticide; the Food and Agriculture Organization of the United Nations (FAO) defines pesticide as, any substance or mixture of substances used for preventing, destroying or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage or marketing of food, agricultural commodities, wood and wood products or animal food stuffs or which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies (FAO, 1986). Extensive use of pesticides and other agrochemicals cause environmental pollution which not only limit plant growth but may also induce mutagenic and carcinogenic effects on non-target microorganisms (Pimental, 1971). Exposure to pesticides is one of the most important occupational risks among farmers in developing countries (Coronado et al., 2004). Occupational exposure to pesticides is of great interest in order to identify the hazards of pesticide use and the establishment of safe methods of pesticide handling. This is because pesticide misuse in various sectors of the agriculture often has been associated with health problems and environmental contamination worldwide (Remor et al., 2009). Low education levels of the rural population, lack of information and training on pesticide safety, poor spraying technology, and inadequate personal protection during pesticide use have been reported to play a major role in the intoxication scenario (Atreya, 2008). Despite their popularity and extensive use, pesticides serious concerns about health risks arising from the exposure of farmers when mixing and applying pesticides or working in treated fields and from residues on food and in drinking water for the general population have been raised (Maroni et al., 2006). Pesticides can also improve the nutritional value of food and sometimes its safety (Boxall, 2001). There are also many other kinds of benefits that may be

attributed to pesticides, but these benefits often go unnoticed by the general public (Damalas and Hashemi, 2010).

Pesticide and Environment

Pesticides have negative effects on human health as well as on environment (water, soil and air contamination, toxic effects on non-target organisms (Burger et al., 2008). In particular, inappropriate use of pesticides has been linked with: (1) adverse effects on non-target organisms (reduction of beneficial species populations), (2) water contamination from mobile pesticides or from pesticide drift, (3) air pollution from volatile pesticides, (4) injury on non-target plants from herbicide drift, (5) injury to rotational crops from herbicide residues remained in the field, (6) crop injury due to high application rates, wrong application timing or unfavorable environmental conditions at and after pesticide application (Eleftherohorinos, 2008). Many of the adverse effects of pesticides on the environment depend on the interactions between the physicochemical properties (vapor pressure, stability, solubility, pKa) of the pesticide, soil adsorption and soil persistence, soil factors (pH, organic components, inorganic surfaces, soil moisture, soil micro flora, soil fauna), plant species, and climatic variation (Eleftherohorinos, 2008).

Pesticide and Vegetables

Vegetables are important ingredient of our food and having good nutritional value. Vegetables like, okra, eggplant, spinach, cauliflower, tomato, pumpkin, carrots, turnips etc. are produced in the country for local consumption as well as for export purposes (FAO, 1986). For better production farmers are used a large amount of insecticides during the entire period of growth and the fruiting stage. This insecticide absorbed and become

the inner part of vegetables and causes toxic effect on the health of consumer (FAO, 1986).

Pesticide and Human Health

Human exposure to pesticides may occur through occupational exposure in the case of agricultural workers in open fields, greenhouses, workers in the pesticide industry, and exterminators of house pests (Van, 1996). Pesticide residues found on food and drinking water consists of a potential threat to human health is still the subject of great scientific controversy (Maroni et al., 2006). Regardless of the difficulties in assessing risks of pesticide use on human health, the authorization for pesticide commercialization in Europe currently requires data of potential negative effects of the active substances on human health. These data are usually obtained from several tests focused on metabolism patterns, acute toxicity, sub-chronic or sub-acute toxicity, chronic toxicity, carcinogenicity, genotoxicity, teratogenicity, generation study, and also irritancy trials using rat as a model mammal or in some cases dogs and rabbits (Matthews, 2006). In human it can cause a variety of disorders such as, asthma, rheumatoid arthritis, Parkinson, diabetes mellitus, and hypertension. Chronic pesticides exposure, also negatively affects reproductive system by causing infertility, ejaculatory problems, erectile problems, reduced libido and low serum testosterone level (Nabi et al., 2014).

Pesticide Classification

Pesticides are classified as follow:

Insecticides

Insecticides are pesticide used to control or kill insects. They are used in agriculture, home, office buildings, schools, lawns,

gardens, and in veterinary practice. Some major groups of insecticides are organophosphates, carbamates, pyrethrins, pyrethroids, biologicals and organochlorines (Schwartz et al., 2004).

Herbicides

Herbicides are used to kill weeds in farm land, parks, golf clubs, gardens, and lawns. There are several types of herbicides, designed to work in different ways.

Herbicides control actively growing weeds. Herbicides may be selective or non-selective. A non-selective herbicide kills most plants while a selective herbicide kill specific plants. (Schwartz et al., 2004)

Fungicides

Fungicides are used to control molds and fungi. They are used in agriculture and in the home and garden to protect seed grains, berries, flowers and grasses. Common health effect is irritation to the skin, mouth, and nose. Toxic fungicide can cause headaches, nausea, vomiting and dizziness (Schwartz et al., 2004).

Rodenticides

Rodenticides are used to kill rats, mice, and other rodents. Some rodenticides contain an anticoagulant (blood thinner). When rodents eat these, they begin to bleed internally until they die. If a human accidentally swallows an anticoagulant rodenticide it can cause internal bleeding in the person. Other rodenticides can cause breathing difficulties, nausea, vomiting, and unconsciousness (Schwartz et al., 2004).

Insecticides

It includes:

Cypermethrin

Cypermethrin is a pyrethroid insecticide. It was first synthesized in 1974 (WHO, 1989). It is the most widely used Type II pyrethroid pesticide. The insecticide cypermethrin belongs to the group of pyrethroids classified by the World Health Organization as moderately harmful (WHO, 1989). The typical half-life of cypermethrin in the soil is 30days, although it can range from two to eight weeks. Cypermethrin has an extremely low potential to move in the soil. It is unlikely to contaminate ground water because it binds tightly to soil particles. Cypermethrin is stable in sunlight. The average half-life of cypermethrin on foliage is 5 days (USEPA, 1989).

Exposure to Humans

Excessive cypermethrin can cause nausea, headache, muscle weakness, salivation, shortness of breath and seizures. In humans, cypermethrin is deactivated by enzymatic hydrolysis to several carboxylic acid metabolites, which are eliminated in the urine. Worker exposure to the chemical can be monitored by measurement of the urinary metabolites, while severe over dosage may be confirmed by quantitation of cypermethrin in blood or plasma (Baselt, 2008).

Exposure to Animals

Cypermethrin kills insects that eat or come into contact with it. It works by quickly affecting the insect central nervous system (Tomlin, 1994). It is highly toxic to fish, bees and low in toxicity to birds (USEPA, 1989). Recent study at Xuzhou Medical College in China showed that, in male rats cypermethrin can exhibit a toxic effect on the reproductive system. After 15 days of continual dosing, both androgen receptor levels and serum testosterone levels were significantly reduced. These data suggested that cypermethrin can induce impairments of the structure of seminiferous tubules and spermatogenesis in male rats (Hu et al., 2013).

Mode of action

Cypermethrin like all synthetic pyrethroid kill insects by affecting the normal function of the nervous system. In insects as well as in humans, nerve impulses travel along the nerves when the nerve became permeable to sodium atoms, allowing sodium to flow into the nerves. Pyrethroid delay the closing of the gate that allow the sodium flow (Vijverberg and Bercken, 1990), this result in multiple nerve impulses instead of single impulse causes the nerve to release the neurotransmitter acetylcholin and stimulate other nerves (Eells, et al., 1992). Other effects include the inhibition of ϒ-aminobutyric acid receptor cause excitability and convulsion (Ramadan et al., 1988). It also inhibit calcium uptake by nerve and inhibit monoamine oxidase enzyme that break down neurotransmitter (Rao and Rao, 1993). Cypermethrin also affects an enzyme not directly involved with the nervous system, adenosine triphosphatase. It is involved in cellular energy production, transport of metal atoms, and muscle contractions (El-Toukhy and Girgis, 1993).

Chlorpyrifos

Chlorpyrifos is a white crystalline organophosphate insecticide that inhibits acetylcholinesterase and is used to control insect pests. First registered for use in the United States in 1965.Chlorpyrifos is used on agricultural food and feed crops, cattle ear tags, golf course turf, industrial plants and vehicles, non-structural wood treatments including processed wood products, fence posts and utility poles, and to control public health pests such as mosquitoes and fire ants (Roy et al., 1998).

Action of Chlorpyrifos on Target and Non Target Organism

Chlorpyrifos is a broad-spectrum insecticide which kills insects upon contact by affecting the normal function of the nervous system (EPA, 1999). It affects the nervous system by inhibiting

the breakdown of acetylcholine (ACh), a neurotransmitter (Smegal, 2000). When insects are exposed, chlorpyrifos binds to the active site of the cholinesterase (ChE) enzyme, which prevents breakdown of ACh in the synaptic cleft (Karanth, 2009). The resulting accumulation of ACh in the synaptic cleft causes overstimulation of the neuronal cells, which leads to neurotoxicity and eventually death.

The mode of action of chlorpyrifos is similar for target and non-target organisms (ATSDR, 1997). Acetylcholine is found throughout the mammalian nervous system, including at cholinergic synapses in the central nervous system, the junction of post-ganglionic parasympathetic neurons in exocrine glands and smooth and cardiac muscles, at pre and post-ganglionic neurons in the autonomic nervous system. It is also found at neuromuscular junctions of the somatic nervous system and on the surface of red blood cells (Blodgett, 2006). Chlorpyrifos also interacts with other enzymes, such as carboxylesterases and A-esterases. The functional role of these enzymes is not well understood, although they occur in many mammalian systems (Karanth, 2009).

Effect of Chlorpyrifos on plants

Parween et al., 2011 studied the effect of chlorpyrifos on the growth and nitrogen metabolism of green gram plant (*Vigna radiata*). They subjected 20 days old plants to chlorpyrifos through foliar spray in the field condition at concentrations ranging from 0 to 1.5 mM. They detected variation in root and shoot length, activities of nitrate reductase (NR) and content of nitrate, sugar, soluble amino acid and soluble protein were studied at pre flowering (5 day after treatment, DAT), flowering (10 DAT) and post flowering (20 DAT) stages of plant development. Different concentrations of chlorpyrifos had different effect such as 0.6 and 1.5 mM showed comparatively more severe toxicity to green gram plants by decreasing root and shoot length, nitrate, NR, soluble sugar and protein

content. Whereas at low concentration (0.3 mM) of chlorpyrifos increased the same parameter.

Conclusion

Pesticides increases soil fertility and thus crop yield. Pesticides toxicities can be minimized through awareness in farmers as most of the farmers are illiterate. They should be aware that, use of protective clothing such as mask, gloves, dress, glasses etc. is necessary during fumigation. Similarly, fumigation when crop is ready for harvesting should not be performed as they accumulate in crops. Pesticides bags and bottles should be properly disposed. WHO banned pesticides should be avoided. Further, for sustaining echo friendly environment this is the responsibility of government to formulate biological control methods instead of chemical methods.

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