IJCST International Journal of Crop Science and Technology
Volume 3, Issue 1, 2017 ISSN: 2458-7540

Pesticide Exposure: Minimization through User & Environment Friendly New Generation Pesticide Formulations

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ABSTRACT

The greatest risk to our environment and our health comes from the chemical pesticides. With the publication of Rachel Carson's book *Silent Spring* in 1962, public confidence in pesticide use was shaken. There has been growing awareness to the possible hazards to human health and the environment due to excessive and indiscriminate use of conventional pesticides. To minimize the pesticide exposure either directly or indirectly to human as well as environment phased out of conventional formulations must be done in regular basis by replacement of safe and environment friendly new generations' formulations.

Keywords: Pesticides, Hazards, Conventional, New generation

INTRODUCTION

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. Billion pounds of pesticides are deliberately released into the environment each year. Among these are some of the most dangerous synthetic chemicals manufactured today. With the publication of Rachel Carson's book *Silent Spring* in 1962, public confidence in pesticide use was shaken. Carson painted a grim picture of exposure consequences of careless pesticide use. After the publication of Rachel Carson, there has been growing awareness to the possible hazards to human health and the environment due to excessive and indiscriminate use of conventional pesticides (Carrie et. al., 1997). The benefits of agrochemicals seem to suddenly go unrecognized in recent times mainly because of the fact that risk exaggeration is more newsworthy than the risk reduction (Mandal, & Singh, 2010). To minimize the pesticide exposure either directly or indirectly to human as well as environment, phased out of conventional formulations like Dustable Powder (DP), Wettable Powder (WP), Granules (GR), Emulsifiable Concentrates (EC) etc must be done in regular basis by replacement of safe and environment friendly new generations' formulations like Suspension Concentrates (SC), Water Dispersible Granules (WG), Concentrated Emulsions (EW), Microemulsion (ME), Controlled Release Formulation (CRF) etc.

PESTICIDE EXPOSURE AND HUMAN HEALTH

The World Health Organization estimates that there are 3 million cases of pesticide poisoning each year and up to 2,20000 deaths, primarily in developing countries. The application of pesticides is often not very precise, and unintended exposures occur to other organisms in the general area where pesticides are applied. Children, and indeed any young and developing organisms, are particularly vulnerable to the harmful effects of pesticides

(Tariq et. al., 2007). Even very low levels of exposure during development may have adverse health effects. Further, persons who handle pesticides during application, transportation and storage are susceptible to health hazards (Bhat et. al., 2010).

At present, India is the 2nd largest producer of pesticides in Asia and ranks twelfth in the world for the use of pesticides with an annual production of 90,000 tons. Vast majorities of the population in India (56.7 percent) are engaged in agriculture and are therefore exposed to the pesticides used in agriculture. Pesticides being used in agricultural tracts are released into the environment and come into human contact directly or indirectly posing threat to safety of human kind (Srivastava et. al., 2011).

Exposure Pathways: How Does Exposure Occur To Human?

The greatest risk to our environment and our health comes from the chemical pesticides. Farmers and their families and other persons who use chemical pesticides regularly are at greatest risk for achieving toxic levels in their bodies (Chensheng et. al., 2006). The danger is spread out to larger areas, as the pesticides: carried on the wind, leave residues on produce and run off into open water, contaminating public water supply as well as fish and other seafood. Pesticides can enter your body during mixing, applying, or clean-up operations. There are generally three ways a chemical or material can enter the body: through the skin (dermal), through the lungs (respiratory/inhalation), or by mouth (oral/ingestion).

Dermal Exposure

In typical work situations, skin absorption is the most common route of poisoning from pesticide exposure. Absorption will continue as long as the pesticide remains in contact with the skin. The head (especially the scalp and ear canal) and the genital areas are particularly vulnerable. This absorption may occur as a result of a splash, spill or drift when mixing, loading or applying a pesticide. The dermal toxicity of a pesticide depends on the pesticide formulation, the site of contamination and the duration of the exposure.

Oral Exposure

Most severe poisoning usually result when pesticides are taken in through the mouth. Pesticides can be ingested by accident, through carelessness, or intentionally. The most frequent cases of accidental oral exposure are those in which pesticides have been taken from their original labeled container and put into an unlabelled bottle or food container. There are many cases where people, especially children, have been poisoned by drinking pesticides from a soft drink bottle. Workers handling pesticides or application equipment can also consume excessive levels of pesticides if they do not wash their hands before eating or smoking. Applicators must never try to clear a spray line or nozzle by blowing on it while holding it to their mouth.

Respiratory Exposure

Certain pesticides may be inhaled in sufficient amounts to cause serious damage to nose, throat and lung tissues, or to be absorbed through the lungs into the bloodstream. Vapors and very small particles pose the most serious risks. The hazard of poisoning from respiratory exposure is great because of the rapid and

complete absorption of pesticides through lung tissues.

Lungs may be exposed to pesticides by inhalation of powders, airborne droplets or vapours. Working with wettable powders can be hazardous because the powder which may be inhaled during mixing operations, packing and other manufacturing operations. High pressures are used or ultra low volume (ULV) or fogging equipment is used, the potential for respiratory exposure is increased. The droplets produced during these operations are in the mist or fog size-range and can be carried by air currents for a considerable distance.

Many pesticides give off a vapour when exposed to air. Fumigants are used because their toxic vapours are desirable for pest control. They also have the highest hazard with respect to worker exposure to vapours. Some non-fumigant pesticides are toxic to pests as liquid or solid formulations, but also give off vapours which could be toxic to applicators or bystanders. As temperatures increase, vapour levels of many pesticides increase. This is why it is recommended that pesticides should not be applied when air temperatures are above 30°C.

Symptoms of Pesticide Exposure

Nausea, vomiting, diarrhea, chest pain, coughing, difficulty breathing, excessive sweating, headache, eye, skin, throat irritation, itching, skin rash, blurred vision, small pupils, stomach/muscle cramps, drooling (mouth or nose), weakness, dizziness, jumpiness may be some of the symptoms which indicate that the person is experiencing pesticide poisoning.

Toxicity of Pesticide Exposure

There are two other ways that exposure is described: short-term (acute) or long-term (chronic) exposure.

Acute Exposure

Acute exposure refers to intake of a single dose or to a series of exposures within a short time period (e.g. one day). Acute exposures may be referred to as acute dermal, acute oral or acute inhalation poisoning. Acute exposure in humans, usually resulting from skin exposure due to poor handling procedures, usually resolves within 24 hours. Acute organophosphate and carbamate exposure causes signs and symptoms of excess acetylcholine, such as increased salivation and perspiration, narrowing of the pupils, nausea, diarrhoea, decrease in blood pressure, muscle weakness, and fatigue. These symptoms usually decline within days after exposure ends as acetylcholine levels return to normal.

Chronic Exposure

Chronic exposure to pesticides and other hazardous chemicals can result in delayed or long-term health effects (Terry et. al., 2006). Chronic effects may include deterioration of organs (especially the liver) and the nervous system, cancer, and changes or alterations in the reproductive system. Pesticides that are found to pose unacceptable risks from chronic exposure are removed from use (Chakraborty et. al., 2009). As in acute toxicity, chronic toxicity is dose-related. Health effects may appear first in those populations with the continuous pesticide exposure (e.g., production workers and pesticide applicators). Pesticide applicators should take appropriate protective

measures to reduce their long-term exposure to pesticides.

Preventing Pesticide Exposures

Here are some suggestions for reducing levels of pesticide exposure and minimizing potential hazards (Horrigan et. al., 2002):

- Select the safest user & environment friendly new generation formulations.
- Use a pesticide with a reduced concentration of active ingredient.
- Reduce the rate of application to the lowest effective level.
- Select a method of application that minimizes personal contact.
- Wear all protective clothing stipulated on the label.
- Avoid direct contact with the pesticide when mixing and filling equipment.
- Be cognizant of others around you during application.
- Dispose of pesticide containers properly.
- Always keep pesticides in their original, labelled pesticide containers.

ROLE OF NEW GENERATION FORMULATIONS

When a pesticide active ingredient is manufactured, it is not in a usable form. They may not mix will with water or may be unstable. Therefore they are mixed with other compounds to improve its effectiveness, safety, handling and storage. The other compounds can include solvents, mineral clays, stickers, wetting agents, or other adjuvants. This mixture and inert (inactive) ingredients is called a pesticide formulation.

Water Dispersible Granules [WG] (Dry Flowables)

Dry flowables—or water dispersible granules, as they are sometimes called—are manufactured in the same way as wettable powders except that the powder is aggregated into granular particles. They are diluted with water and applied as a spray exactly as if they were a wettable powder. Compared to dustable powder, wettable powder and soluble powder formulations, WG is better because of it is dust free, ease of handling, less chance of spillage etc.

Examples: Sulphur 80 WG, Sulfosulfuron 75 WG, Thiamethoxam 25 WG

Suspension Concentrates [SC] (Liquid Flowables)

The manufacture of liquid flowables (or flowables) mirrors that of wettable powders—with the additional step of mixing the powder, dispersing agents, wetting agents, etc., with water and stabilizing the suspension before packaging. The resultant suspension is further diluted with water before use. If we judge between wettable powder/soluble powder/water dispersible granule and suspension concentrate formulations, we can find SC is dust free, no inhalation hazard to the applicator during mixing and loading since the powder already is suspended in water, permitting it to be poured, handling ease and no problem of inhalation or flammability due to presence of no solvents etc.

Examples: Carbendazim 50 SC, Deltamethrin 2.5 SC, Isoproturon 50 SC

Concentrated Emulsions (EW)

Concentrated emulsions are emulsions of a liquid or low melting point active ingredient in water in presence of emulsifiers. Compared to emulsifiable concentrates and solution liquid formulations, EW is superior due to reduced dermal toxicity, less irritant to skin & eyes, non inflammable, environmentally safer and no problem of inhalation or flammability due to presence of no/less amount of solvents etc.

Example: Butachlor 50 EW

Microemulsions (ME)

Thermodynamically stable transparent emulsions of pesticide, water and surfactant/co surfactant having droplet size of < 0.05 microns (50 nm). ME is advantageous to emulsifiable concentrates and solution formulations as because it is water based, ease of application and has nolLow flammability.

Controlled Release Formulations

Microencapsulates consist of a solid or liquid inert (containing an active ingredient) surrounded by a plastic or starch coating. The resulting capsules can be aggregated to form dispersible granule or they can be suspended in water and the product sold as a liquid formulation. Encapsulation enhances applicator safety while providing timed release of the active ingredient. Liquid forms of microencapsulates are further diluted with water and applied as sprays. They form suspensions in the spray tank and have many of the same properties as liquid flowables. It is better formulation due to it has reduced mammalian toxicity; encapsulation enhances applicator safety while providing timed release of the active ingredient, reduced evaporative losses, educed leaching, lower doses etc.

Example: Diazinon 25 Microencapsulation

CONCLUSION

The applicator performs the duties of mixing, loading as well as application. Applicators come into close contact with both the concentrated and diluted product. A simple, personal interest in one's continued good health dictates the need to know the safety properties of the formulation being used. Furthermore, a concern for environmental quality which is reflected by a responsible application may require a familiarity with the attributes of a given formulation and its potential impact on the surroundings. Several themes developed in this publication can be used to construct a planning or decision making model to minimize pesticide exposure using new generation formulations.

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