



Pesticide Toxicity and Hazard

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Introduction

Pesticide applicators should understand the hazards and risks associated with the pesticides they use. Pesticides vary greatly in **toxicity**. Toxicity depends on the chemical and physical properties of a substance and may be defined as the quality of being poisonous or harmful to animals or plants. Pesticides have many different modes of action, but in general cause biochemical changes which interfere with normal cell functions.

The toxicity of any compound is related to the dose. A highly toxic substance causes severe symptoms of poisoning with small doses. A substance with a low toxicity generally requires large doses to produce mild symptoms. Even common substances like coffee or salt become poisons if large amounts are consumed.

Toxicity can be either acute or chronic.

- **Acute toxicity** is the ability of a substance to cause harmful effects which develop rapidly following exposure, i.e. a few hours or a day.
- **Chronic toxicity** is the ability of a substance to cause adverse health effects resulting from long-term exposure to a substance.

There is a great range in the toxicity of pesticides to humans. The relative **hazard** of a pesticide is dependent upon the toxicity of the pesticide, the dose and the length of time exposed. The hazard in using a pesticide is related to the likelihood of exposure to harmful amounts of the pesticide. The toxicity of a pesticide can't be changed but the risk of exposure can be reduced with the use of proper personal protective equipment (PPE), proper handling and application procedures.

Pesticide Toxicity

Some pesticides are dangerous after one large dose (acute toxicity). Others can be dangerous after small, repeated doses (chronic toxicity).

Measuring Acute Toxicity (LD₅₀ And LC₅₀ Values)

Acute toxicity of a pesticide refers to the effects from a single dose or repeated exposure over a short time (e.g. one day), such as an accident during mixing or applying pesticides. Acute toxicity is measured by LD₅₀ and LC₅₀ values.

The LD₅₀ value is the amount of pesticide (lethal dose) which kills 50% of the test animals. These treatments are through the skin (dermal) or through the mouth (oral). These

The smaller the LD₅₀,
the more toxic
the pesticide.

Example: a pesticide with
an LD₅₀ of 5 mg/kg is 100
times more toxic than a
pesticide with an LD₅₀ of
500 mg/kg

values are given in milligrams per kilogram of body weight of the animal (mg/kg body wt.). A pesticide with a lower LD₅₀ is more toxic than a pesticide with a higher number because it takes less of the pesticide to kill half of the test animals.

The LC₅₀ value is a measure of the toxicity of a pesticide when test animals breathe air mixed with pesticide dust, vapours or spray mist. The LC₅₀ is the concentration of pesticide which is lethal to 50% of a population of test animals and is usually determined for a specific exposure period (e.g. inhalation for 4 hours). The length of exposure is important because shorter exposure periods generally require higher pesticide concentrations to produce toxic effects. LC₅₀ values for pesticides in air are expressed as the ratio of pesticide to air, in parts per million (ppm) or parts per billion (ppb). LC₅₀ values are also determined for fish and aquatic organisms based on the concentration of pesticide in water.

Important characteristics to note about LD₅₀ and LC₅₀ values:

- they are based on a single dose (LD₅₀) or short exposure (LC₅₀);
- they do not indicate cumulative effects of small doses;
- they are an indicator of the amount of chemical required to kill or severely injure animals, and do not indicate the amount of chemical causing less severe toxic effects.

Relation of oral LD₅₀ to approximate lethal dose in adult humans.

Oral LD₅₀	Approximate lethal dose to average size adult* (70 kg or 155 lb.)
less than 50 mg/kg	0.3 to 3 mL (a few drops to half a teaspoon)
50 to 500 mg/kg	3 mL to 30 mL (half a teaspoon to two tablespoons)
500 to 5,000 mg/kg	30 mL to 300 mL (1 to 10 fluid ounces)
5,000 to 15,000 mg/kg	300 mL to 900 mL (10 to 30 fluid ounces)

* Note that a child who is one-fifth the weight of an adult would require only one-fifth the amount of pesticide to suffer the same toxic effects as the adult.

Pesticides are grouped according to their LD₅₀ values. The groups are Very Toxic, Moderately Toxic and Slightly Toxic.

WorkSafeBC defines these groups as shown in the following table. These definitions are now the same as the criteria used by the Pest Management Regulatory Agency for use of warning symbols on product labels.

Relative toxicity of pesticides to humans based on acute oral and dermal LD₅₀'s.		
Acute Toxicity	Oral LD₅₀	Dermal LD₅₀
Very	less than 500 mg/kg	less than 500 mg/kg
Moderately	500 to 1,000 mg/kg	500 to 1,000 mg/kg
Slightly	1,000 to 2,000 mg/kg	1,000 to 2,000 mg/kg

Here are examples of LD₅₀ values for four pesticides.

Pesticide Active Ingredient (a.i.)	LD ₅₀ (mg/kg)	
	Oral	Dermal
aldicarb	0.8	3
diazinon	300	2,150
malathion	1,000	4,100
atrazine	1,780	7,500

Here are examples of LD₅₀ values for three common household compounds. They have a low acute toxicity but could cause toxic reactions if consumed in sufficient quantities.

Compound	Oral LD ₅₀ (mg/kg)
acetylsalicylic acid (Aspirin)	1,000
sodium chloride (table salt)	3,320
ethylene glycol (antifreeze)	460

The Pest Management Regulatory Agency requires a symbol on the label that represents the relative toxicity of the product.

Labels and Toxicity Symbols				
Poison Hazard Symbol				[No symbol]
	Danger Poison	Warning Poison	Caution Poison	Very low toxicity
Acute oral LD ₅₀	less than 500 mg/kg	500 - 1000 mg/kg	1000 - 2000 mg/kg	greater than 2000 mg/kg
Acute dermal LD ₅₀	less than 500 mg/kg	500 - 1000 mg/kg	1000 - 2000 mg/kg	greater than 2000 mg/kg

Adapted from: Canadian Centre for Occupational Health and Safety

Chronic Toxicity

Chronic toxicity refers to the effects of long-term or repeated lower level exposures to a toxic substance, such as when a pesticide applicator is frequently wetted with spray during unsafe spray practices. The effects of chronic exposure do not appear immediately after first exposure and may take years to produce symptoms. Pesticides which have a tendency to accumulate, or which break down slowly in body tissues, usually represent the greatest chronic exposure hazard. Someone who is frequently exposed to low doses of such pesticides may develop symptoms of poisoning long after the first exposure. Chronic exposure may include chronic oral, chronic dermal or chronic inhalation poisoning.

Very few pesticides now in use are known to cause chronic effects, if used according to label directions. However, a few pesticides are suspected or known to cause chronic illness in test animals or humans when exposure levels are high. The registration of some pesticides has been cancelled because the suspected or identified chronic effects represented a significant health hazard.

Exposure

Human Pesticide Exposure

There are three ways in which pesticides can enter the human body:

1. through the skin or eyes (dermal),
2. through the mouth (oral) and
3. through the lungs (respiratory or inhalation).

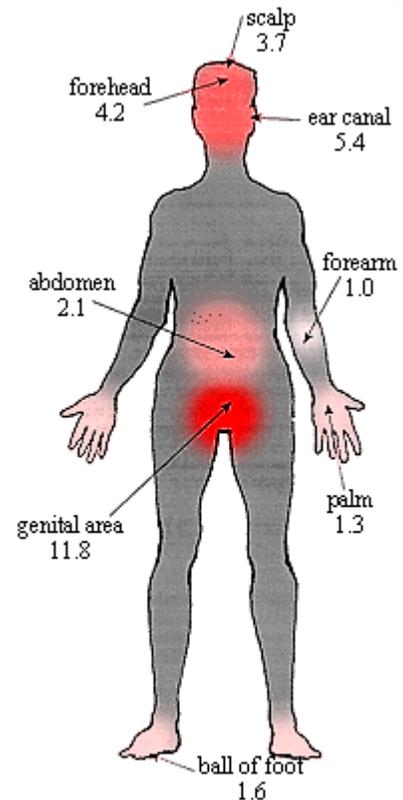
Dermal Exposure

In typical work situations, skin absorption is the most common route of pesticide poisoning. Absorption will continue as long as the pesticide remains in contact with the skin. The rate of absorption is different for each part of the body (see diagram). The head (especially the scalp and ear canal) and the genital areas are particularly vulnerable. Absorption may occur as a result of a splash, spill or drift when mixing, loading or applying a pesticide. Applicators may also be exposed to residues on application equipment, protective clothing or treated surfaces after pesticide application. Following exposure, residues can also be transferred from one part of the body to another. A cut or skin abrasion can greatly increase pesticide absorption.

The dermal toxicity of a pesticide depends on the pesticide formulation, the area of the body contaminated and the duration of the exposure. In general, liquids are more easily absorbed through the skin than wettable powders or granules. The hazard from skin absorption increases when workers are mixing pesticides because they are handling concentrated pesticides that contain a high percentage of active ingredient.

Protect yourself from dermal exposure. Follow these guidelines:

1. Wear protective clothing and equipment when using pesticides or repairing contaminated equipment.
2. Spray during periods when there is little or no wind.
3. Do not re-enter a sprayed field without protective clothing until the re-entry time has elapsed.
4. If your clothes become contaminated, change immediately. Wash affected areas of the skin.
5. Change clothes as part of the clean-up after pesticide use at the end of the day.
6. Wash and shower after using pesticides.
7. Wear clean clothes at the start of each day during pesticide application.



Relative absorption rates, as compared to the forearm (1.0)

Eye Exposure

The tissues of the eyes are particularly absorbent. Enough pesticide can be absorbed through the eyes to result in serious or fatal poisoning. In addition, some pesticides may cause chemical injury to the eye itself. Eye protection is needed when measuring or mixing concentrated or highly toxic pesticides. Protective face shields or goggles should be worn whenever there is a chance that pesticide sprays or dusts may come in contact with the eyes.

Protect yourself from eye exposure. Follow these guidelines:

1. Always wear eye protection when you measure or mix pesticides.
2. Always wear eye protection when pesticide sprays or dusts may contact your eyes.
3. Do Not wipe your eyes with contaminated gloves or hands.
4. Be prepared to respond to accidental eye exposure quickly (see [Pesticide Poisoning](#)).

Oral Exposure

Pesticides taken through the mouth result in the most severe poisoning, compared to other types of exposure. 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 stored in 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. People have also been poisoned by drinking water stored in contaminated containers. Workers handling pesticides or application equipment can also consume excessive levels of pesticides if they do not wash their hands before eating or smoking.



Protect yourself from oral exposure. Follow these guidelines:

1. Always store pesticides in their original labeled containers.
2. Never put pesticides in an unlabelled bottle or food container.
3. Never use your mouth to clear a spray hose or nozzle, or to begin siphoning a pesticide.
4. Always wash after handling pesticides and before eating, drinking, smoking, or using the toilet.
5. Never leave pesticides unattended.
6. Avoid splashes or dusts when mixing pesticides.
7. Label your pesticide measuring containers.



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. Vapours 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 may be inhaled during mixing operations and usually contains concentrated pesticide active ingredient. The hazard from inhalation of pesticide spray droplets is fairly low when dilute sprays are being applied with conventional low pressure application equipment. This is because most droplets are too large to remain airborne and be inhaled. However, when high pressures are used or ultra-low volume (ULV) or fogging equipment are 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 on air currents for a considerable distance.

Many pesticides give off a vapour when exposed to air. As temperatures increase, vapour levels of many pesticides increase. 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. The hazard is greatest in enclosed spaces where there is little air movement. For example, high vapour levels could result from a spill in an unventilated storage area or application in a confined space such as a greenhouse. Air currents due to wind or ventilation can substantially reduce vapour levels.

Many pesticides that produce vapours provide a warning of their presence by their smell or by causing irritation of the eyes, nose and throat. However, some pesticide vapours have little smell and provide little warning of their presence.

Pesticides with high vapour hazards will have label directions to use respiratory protection equipment. Protect yourself from respiratory exposure. Follow these guidelines:

1. Wear an appropriate and properly fitting respirator:
 1. If it is required on the label;
 2. If pesticides are used or mixed in poorly ventilated areas;
 3. If there is a possibility of inhaling spray droplets, vapour, or powder.
2. Do not re-enter a treated area too soon. Follow the re-entry guidelines on the label.
3. Ventilate greenhouses or enclosed structures after pesticide application, before re-entry.
4. Do not apply pesticides when air temperatures are above 30°C.

Toxicity of pesticides can vary depending on the type of exposure; dermal, oral or respiratory (inhalation), but it is important to remember that, in each case, the danger usually increases as concentration and duration of exposure increases. The longer a pesticide remains on the skin or in eyes, or the longer it is inhaled, the greater the damage that is likely to result.

Additional Resources

Canadian Centre for Occupational Health and Safety

http://www.ccohs.ca/oshanswers/chemicals/pesticides/health_effects.html

Hazard Shapes & Symbols

Warning symbols

Visual warning symbols on pesticide labels indicate the kind of harm that can result from a pesticide. They alert the user to the degree of the hazard (by the shape of the border) and to the type of hazard (by the centre "picture").



Poisonous

The "skull and cross bones" symbol warns that the chemical is poisonous if taken into the body. Keep the product out of reach of children. Use the appropriate safety measures when dealing with poisonous products.



Flammable

The "fire" symbol is a warning that the pesticide is flammable or easily ignited. Keep the pesticide away from heat, sparks, or open flames. Do not smoke while mixing or applying the product.



Explosive

The "exploding grenade" symbol indicates that the pesticide can explode, e.g., pesticide in pressurized cans. Explosive conditions may also be created by using glyphosate herbicide in a galvanized steel spray tank.



Corrosive

The "corroded hand" symbol indicates that the pesticide is corrosive to the skin and eyes. The chemical is either acid or alkali (caustic) and can burn the skin. Protect the skin and eyes when using these products.

Toxicity symbols

These symbols relate the oral LD₅₀ value (mg/kg) of a pesticide to its toxicity symbol.



Danger Poison

LD₅₀ less than 500 mg/kg indicates high toxicity.



Warning Poison

LD₅₀ 500 to 1,000 mg/kg indicates moderate toxicity.



Caution Poison

LD₅₀ 1,000 to 2,000 mg/kg indicates low toxicity.

(No Symbol
Required)

LD₅₀ greater than 2,000 mg/kg indicates very low toxicity.

Interpretation of Symbol Combinations

Poisonous Hazard:	 DANGER POISON	 WARNING POISON	 CAUTION POISON
Acute oral LD50	< 500 mg/kg	500 - 1,000 mg/kg	1,000 - 2,000 mg/kg
Acute dermal LD50	< 500 mg/kg	500 - 1,000 mg/kg	1,000 - 2,000 mg/kg
Respirator	yes	advisable in confined spaces	advisable in confined spaces
Eye Protection	yes	yes	advisable
Eye Effects	corrosive or irreversible	severe but reversible	irritation
Petroleum Distillates	10% or more	1% to 10%	-

Flammability Hazard:	 DANGER FLAMMABLE	 WARNING FLAMMABLE	 CAUTION FLAMMABLE
Liquid Products - Flash Point	< -6°C (20°F)	-6° to 10°C (20° to 50°F)	10° to 27°C (50° to 80°F)
Pressurized Products - Flame Projection	45 cm (18")	15-45 cm (6 to 18")	< 15 cm (6")

Explosive Hazard:	 CAUTION EXPLOSIVE
All Domestic Aerosols, Pressurized	

Corrosive Hazard:	 DANGER CORROSIVE	 WARNING CORROSIVE	 CAUTION CORROSIVE
acid or alkali materials	10% or more	5 to 10%	1 to 5%
organic acids	20% or more	5 to 20%	1 to 5%
available chlorine	-	10% or more as liquid	over 1% as solids
pH	-	0.5 or 13.5	0.5 to 2.5 or 11.5 to 13.5
Available chlorine > 4% and < 10% as liquid			 CAUTION IRRITANT
Available chlorine > 1% and < 4% as liquid			 CAUTION