

PESTICIDE TOXICITY

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Agricultural chemicals help farmers produce an abundance of high-quality, low-cost food products. Pesticides are intentionally designed to be toxic to plant, animal, or microbial pests including weeds, rodents, bacteria, insects, and fungi. Consequently, they must be applied with informed care and concern for the safety of users and consumers, and to protect the environment. Over the years, significant efforts have been made to ensure the safety of the general public, wildlife, environment, and workers exposed to pesticides. All new pesticides are thoroughly tested to determine their degree of toxicity, subsequent effects of exposure, and label requirements.

Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the U.S. Environmental Protection Agency (EPA) is responsible for approving new pesticides, ensuring that the pesticides meet a standard for safety to humans and the environment. They also assign each pesticide a degree of toxicity to determine what precautions must appear on the pesticide label. Precautions include:

- Use of protective clothing
- “Signal word” (caution, warning, danger)
- First aid statements
- Whether the pesticide may be used only by specially trained and certified applicators (restricted use pesticides)

The Occupational Safety and Health Administration (OSHA) regulates and enforces worker protection standards to ensure that employers provide a safe working environment for employees and ensure that workers receive personal protection equipment when handling pesticides. Employers who fail to follow EPA and OSHA standards are subject to substantial fines and penalties.

WHAT IS TOXICITY?

In general terms, toxicity is the measure of the ability of a pesticide to cause injury. There are two types of toxicity: acute and chronic. Acute toxicity of a pesticide is determined by subjecting laboratory animals to different dosages or concentrations of the active ingredient. Tests are also conducted to assess the impact through the skin, through inhalation, and orally. Test results are then used to classify pesticides into one of four toxicity categories (see Table 1.)

ACUTE TOXICITY

Acute toxicity usually results from a single exposure to a high dose or concentration of a toxicant, which can be either oral, dermal, or through inhalation. The acute toxicity is the basis for pesticide classifications on product labels. It is defined as the amount of a pesticide's active ingredient that kills 50 percent of the test population in a short period of time, referred to as LD50 (lethal dose 50) or LC50 (lethal concentration 50). Toxicity increases as the LD50 or LC50 decreases; thus, Category I pesticides are more toxic than Category IV pesticides.



Table 1. Pesticide Toxicity Categories

	Category I	Category II	Category III	Category IV
Oral LD50	Up to and including 50 mg/kg	From 50 through 500 mg/kg	From 500 through 5000 mg/kg	Greater than 5000 mg/kg
Inhalation LC50	Up to and including 0.2 mg/liter	From 0.2 through 2 mg/liter	From 2.0 through 20 mg/liter	Greater than 20 mg/liter
Dermal LD50	Up to and including 200 mg/kg	From 200 through 2000 mg/kg	From 2,000 through 20,000 mg/kg	Greater than 20,000 mg/kg
Eye effects	Corrosive; corneal opacity not reversible within 7 days	Corneal opacity reversible within 7 days; irritation persisting for 7 days	No corneal opacity; irritation reversible within 7 days	No irritation
Skin effects	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation at 72 hours

NOTE: The Hazardous Substances Labeling Act of 2003 legally defines a poison as any substance that causes death in 50 percent of laboratory animals exposed to doses of less than 50 milligrams per kilogram (mg/kg) of body weight.

Toxicity categories inform users of the potential hazards associated with the use of a particular pesticide. Specific signal word(s) must appear on product labels depending on pesticide toxicity category. For example, pesticides in Toxicity Category I must carry on their label the word “Danger.” Some Category I pesticides must also display the word “Poison,” and the skull and crossbones symbol. Child warning hazard statements must appear on practically all pesticide labels.

- **Toxicity Category I** – All pesticide products shall bear on the front panel the signal word “Danger.” In addition, if the product is assigned a Toxicity Category I on the basis of its oral, inhalation, or dermal toxicity, the word “Poison” shall appear in red on a contrasting background color, and the skull and crossbones shall appear in immediate proximity to the word “Poison.”
- **Toxicity Category II** – All pesticide products shall bear on the front panel the signal word “Warning.”
- **Toxicity Category III** – All pesticide products shall bear on the front panel the signal word “Caution.”
- **Toxicity Category IV** – All pesticide products shall bear on the front panel the signal word “Caution.”
- **Child Warning Hazard** – Every pesticide product label shall bear on the front panel the statement “Keep out of Reach of Children.” Limited exemptions exist only in cases where the likelihood of contact with children during distribution, marketing, storage, or use is demonstrated by the applicant to be extremely remote, or if the nature of the pesticide is such that it is approved for use on infants or small children.

The EPA also provides guidance on how much of a pesticide constitutes a lethal dose depending on the degree of toxicity. For example, Table 2 shows that the oral lethal dose for a 150-pound person of a highly toxic pesticide (labeled “Danger”) is only a few drops to a teaspoon. A person’s size will help determine the amount that is poisonous. The smaller the individual, the smaller the amount of a substance required to be lethal; the larger the individual, the larger the amount required. It takes much less of a toxicant to poison a small child than it does to poison an adult.

Table 2. Pesticide Label Words and Relative Toxicities

Signal Word	Toxicity	Oral Lethal Dose (for 150-lb person)
Danger	Highly toxic	Few drops to 1 teaspoon*
Warning	Moderately toxic	1 teaspoon to 1 tablespoon
Caution	Low toxicity	1 ounce to more than a pint
* Less for a child or person weighing under 150 pounds.		

CHRONIC TOXICITY

Chronic toxicity results from long-term, low-level exposure to a toxicant. This type of toxicity does not result in poisoning in the traditional sense. Chronic toxicity is evident in the long-term effects on the body. The three major causes of chronic toxicity are mutagenic toxicants, oncogenic toxicants, and teratogenic toxicants. Mutagens cause changes in the genetic material DNA. Oncogens cause the formation of tumors; a carcinogen causes the formation of malignant tumors (cancer). Teratogens cause birth defects. Chronic toxicity can also affect the reproductive system, nervous system, liver, and kidneys.

Cholinesterase Inhibition

One of the most widely occurring types of chronic toxicity is cholinesterase inhibition. Cholinesterase is an enzyme produced by the body that controls nerve impulse transmission. If cholinesterase were not present, impulses from one nerve to the next would flow continuously. Many pesticides function to work against, or inhibit, cholinesterase in insect pests. However, these chemicals can also be poisonous, or toxic, to humans in some situations. Prolonged exposure to cholinesterase-inhibiting chemicals, such as organophosphates and carbamates, can result from inhalation, ingestion, or eye or skin contact during the manufacturing, mixing, or applications of these pesticides. Unchecked nervous (or electrical) impulses can fire away continuously, causing uncontrolled, rapid twitching of some muscles, paralyzed breathing, convulsions, and, in extreme cases, death.

Organophosphate products can affect cholinesterase activity in both red blood cells and in blood plasma, and can act directly, or in combination with other enzymes, on cholinesterase in the body. Some of the most commonly used organophosphate products include acephate (Orthene™), diazinon (Spectracide™), and carbophenothion (Trithion™).

Carbamates vary widely in toxicity and work by inhibiting plasma cholinesterase. Some examples of carbamates are aldicarb (Temik™), carbaryl (Sevin™), and carbofuran (Furadan™).

FOR MORE INFORMATION

The National Pesticide Information Center (NPIC), operated by Oregon State University under a cooperative agreement with the EPA, provides objective, science-based information about a variety of pesticide-related subjects, including pesticide products, recognition and management of pesticide poisonings, toxicology, and environmental chemistry. NPIC also lists state pesticide regulatory agencies and provides links to their Web site: <http://npic.orst.edu>.

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