Pesticide Characteristics and Use

Raymond A. Cloyd
University of Illinois

Pesticides that are used in landscapes are placed into categories based on their toxicity. Toxicity is the inherent poisonous nature or how dangerous a pesticide is under experimental conditions. Toxicity is commonly expressed as $LD_{50,}$ the dose required to kill 50% of a pest population, such as insects, mice, rats, and birds. Units used are mg/kg, milligrams of toxicant (active ingredient) per kilogram of body weight. This can be measured as either acute or chronic toxicity. Acute toxicity refers to immediate effects of a single, short-term exposure to a pesticide whereas chronic toxicity is repeated exposure to a pesticide. In addition, LD_{50} may be determined based on how a pesticide enters the body, such as orally (ingestion), dermally (skin), or by inhalation (breathing). This information is then extrapolated to humans. The lower the LD_{50} value, the more toxic the pesticide is to humans.

Based on this information, pesticides can be placed into four categories—I, II, III or IV—each with an appropriate signal word or words to indicate the level of toxicity.

- **Category I.** Contain signal words—Danger/Poison. In addition, a skull and cross-bones symbol is required on labels for all category I pesticides, which are described as highly toxic. These pesticides have an acute oral LD_{50} range of 0 to 50 mg/kg.
- **Category II.** Contain the signal word—Warning. Pesticides in this category are described as moderately toxic and have an acute oral LD_{50} range of 50 to 500 mg/kg.
- **Category III.** Contain the signal word—Caution. These are slightly toxic pesticides with an acute oral LD_{50} range of 500 to 5000 mg/kg.
- **Category IV.** Contain the signal word—Caution. These are very low toxicity pesticides that have an acute oral LD_{50} greater than 5000 mg/kg.

Insecticides and miticides are categorized by their chemical composition. Classes of pesticides include: chlorinated hydrocarbons (organochlorines), organophosphates, carbamates, pyrethroids, macrocyclic lactone, chloronicotinyls, insect growth regulators, and soaps and oils. Another class of pesticides, often referred to as microbials, is derived from bacteria and fungi. Examples include *Bacillus thuringiensis* var. *kurstaki* (Dipel) and spinosad (Conserve). The major chemical classes and their modes of activity are shown in Table 1. Some chemical classes have very similar modes of activity. For example, the organophosphates and carbamates, despite being different chemical classes, are both acetylcholinesterase inhibitors. Chlorinated hydrocarbons and pyrethroids have similar modes of activity, as they both affect nerve cell transmission. In order to avoid resistance, pesticide classes are rotated based on mode of activity.

When using insecticides or miticides to manage pests in landscapes, it is equally important to minimize impact on bees and other beneficial organisms. Honeybees and wild bees are important pollinators, and they are susceptible to pesticides, especially carbamates, such as carbaryl (Sevin). Honeybees are most severely harmed by pesticides that are applied when bees are foraging for nectar and pollen. In addition, beneficial insects and mites are highly susceptible to broad spectrum pesticides. The following recommendations will minimize any toxic effects to bees and other beneficial insects and mites.

- Do not apply pesticides directly to flowers.
- Avoid spraying pesticides when bees are foraging. Bees generally don't fly before dawn, after dark, or when temperatures are less than 55°F.
- Use so-called biorational or reduced risk pesticides that have minimal impact on bees and beneficial insects and mites. Avoid the use of broad-spectrum pesticides.
- Select pesticide formulations that are less toxic to bees and other beneficial insects and mites. For example, granules or soil-applied formulations are less toxic than sprays. Wettable powders and microencapsulated formulations are the most toxic. Microencapsulated pesticides are most harmful to bees because the capsules adhere to foraging bees and are packed along with pollen into pollen baskets where they are carried back to the hive and may be consumed. Systemic pesticides injected or applied to soil pose minimal hazard to bees and beneficial insects and mites, because they are not sprayed on the foliage. However, if the insect feeds on plant parts containing the pesticide, there is the possibility that it may have an affect.

When using pesticides in landscapes it is equally important to avoid plant injury (phytotoxicity). Excessive application rates are common causes of plant injury. Another cause of phytotoxicity is tank-mixing two pesticides that are incompatible, which is a physical condition that prevents pest control materials from mixing properly in a spray solution. Phytotoxicity may not always be caused by the pesticide active ingredient, but may be due to solvents in the formulation (for example, xylene) or impurities in the water mixed with the pesticide. In addition, environmental conditions, including temperature and sunlight at the time of application, may influence phytotoxicity. For example, pesticides should not be applied when the ambient air temperature is greater than 85°F and humidity is high. Phytotoxicity symptoms may vary depending on the plant type. Common symptoms include slight burning or browning of leaves (necrosis), bleaching of foliage, or death of the plant. The following guidelines will help to avoid problems of phytotoxicity.

- Calibrate application equipment before use.
- Follow recommended label rates. In addition, check label for certain plant species or cultivars that are susceptible to possible injury. For example, horticultural oils should not be applied to Colorado blue spruce (*Picea pungens* 'Glauca') because the oil changes the foliage color from blue to green.
- Select pesticide formulations that have low potential for phytotoxicity.
- Make pesticide applications in the early morning or late in the afternoon.
- Maintain plant health. Never spray plants under stress from drought or nutritional deficiencies, as these conditions increase susceptibility to spray injury.
- Properly store pesticides. Avoid exposing pesticides to extremes of hot or cold temperatures. In addition, in order to avoid contamination, never store insecticides and miticides with herbicides. Never use a spray tank that has contained herbicide to apply insecticides.
- When combining pesticides, be sure to perform a "jar test" to determine their compatibility. This involves mixing a sample of the spray solution (e.g., one pint) in an empty glass jar or other container, and letting the solution sit for approximately 15 minutes. If the pesticides are not compatible there will be noticeable separation or layering, or precipitates such as flakes or crystals may form. If they are compatible the solution will appear homogeneous or look like milk. Applications of pesticides that are not compatble with each other may result in plant injury.

Table 1. The major chemical classes and their mode of activity.

Chemical class	Mode of Activity
1. Organophosphates and Carbamates	Inhibit the enzyme cholinesterase. This prevents the termination of nerve impulse transmissions.
2. Pyrethroids and Chlorinated Hydrocarbons	Destabilize nerve cell membranes.
3. Macrocyclic Lactone	Affect gamma-amino butyric acid (GABA) dependent chloride ion channels which inhibits nerve transmission.
4. Insect Growth Regulators	Chitin synthesis inhibitors or juvenile hormone mimics. Chitin synthesis inhibitors prevent the formation of chitin, which is an essential component of an insect's exoskeleton. Juvenile hormone mimics cause insects to remain in a young stage.
5. Soaps and Oils	Damage the waxy layer of the exoskeleton of soft-bodied insects, which results in desiccation or the smothering of insects by covering the breathing pores (spiracles).
6. Chloronicotinyls	Inhibit reception of nerve impluse which results in loss of normal behavior.