Toxicology Basics

* Units used to measure chemicals in the environment:
  + PPM: Parts per million (10-6)
  + PPB: Parts per billion (10-9)
  + PPT: Parts per trillion (10-12)
* One part per million is
  + 1 inch in 16 miles
  + 1 minute in 2 years
  + 1 ounce of salt in 31 tons of potato chips
  + 1 bad apple in 2000 barrels of apples
* One part per billion is
  + 1 inch in 16000 miles
  + 1 second in 32 years
  + 1 cent in $10,000,000
  + 1 pinch of salt in 10 tons of potato chips
  + 1 lob in 1,200,000 tennis matches
  + 1 bad apple in 2,000,000 barrels of apples.
* One part per trillion is
  + 1 postage stamp in the area of the city of Dallas
  + 1 inch in 16 million miles (more than 600 times around the earth)
  + 1 second in 320 centuries
  + 1 flea on 360 million elephants
  + 1 grain of sugar in an Olympic sized pool
  + 1 bad apple in 2 billion barrels.
* On the left side of the decimal point (<- .)
  + 1 trillion is bigger than 1 billion
  + 1 billion is bigger than 1 million
  + 1 million is bigger than 1 thousand
* On the right side of the decimal point (. ->)
  + 1 part per trillion is smaller than 1 part per billion
  + 1 part per billion is smaller that 1 part per million
  + 1 part per million is smaller than 1 part per thousand
* For water at STP (standard temperature (23 C) and pressure (15 psi))
  + 1 cc = 1 ml = 1 g
  + (1000 ml or cc ) < 1 liter of water = 1 kg > (1000 g)
  + (1/1000 g) < 1 mg / kg > (1000 g) = 1 ppm
  + (1/1000 cm3) < 1 mm3 / liter > (1000 cm3 ) = 1 ppm
  + (1/1000 g) < 1 mg / liter > (1000 g) = 1 ppm
* Toxicity of chemicals is determined in the laboratory.
* The normal procedure is to expose test animals.
  + By ingestion, application to the skin, by inhalation, gavage (forced feeding) or some other method which introduces the material in to the body, or...
  + By placing the rest material in the water or air of the test animals’ environment.
* Toxicity is measured as clinical “endpoints” which include
  + Mortality (death)
  + Teratogenicity (ability to cause birth defects)
  + Carcinogenicity (ability to cause cancer), and
  + Mutagenicity (ability to cause heritable change in the DNA)
* When using mortality as a clinical “endpoint”, 2 measures of mortality – the LD50 and the LC50.
* LD50: The median “lethal dose”
* The amount (dose) of a chemical which produces death in 50% of a population of test animals to which it is administered by any of a variety of methods.
  + Substance (1/1000 g) < mg/kg > (1000 g) body weight
  + Normally expressed as milligrams of substance.
* LC50: The median “lethal concentration”
* The concentration of a chemical in an environment (generally air or water) which produces death in 50% of an exposed population of test animals in a specified time frames
  + Substance (1/1000 ml) < mg/L > (1000 ml) body weight
* Normally expressed as milligrams of substance per liter of air or water (or as ppm)
* There are three primary routes by which organisms are exposed to pesticides
  + Oral
  + Dermal
  + Inhalation
* Oral Exposure:
  + Any exposure to pesticide which occurs when a chemical is taken in through the mouth and passes through the gastrointestinal tract
  + During oral exposure, although carried within the body, the pesticide is still outside of the body proper until it passes through epithelial cellular membranes.
* Dermal Exposure:
  + Exposure of the skin to a pesticide
  + Most common route of human exposure
  + With proper hygiene this type of exposure is generally not serious unless there is a specific, rapid toxicology effect (often eye effects) which is of concern.
* Inhalation Exposure:
  + Occurs when a pesticide is breathed into the lungs through the nose or mouth
  + Significant route of exposure for aquatic organisms
  + Not of toxicological concern until it crosses from the lung into the body (unless the chemical is corrosive)
* Duration of Exposure
  + Acute ~ singe exposure of short duration
  + Chronic ~ repeated long-term contact
  + Sub chronic ~ repeated exposure over
* Acute Exposure
  + Application of a single or short-term (generally less than a day) dosing by a chemical
  + If toxic symptoms are expressed, they are referred to as symptoms of “acute toxicity”
* Chronic Exposure
  + Expression of toxic symptoms only after repeated exposure to a chemical in doses regularly applied to the organism for a time greater than half or its life expectancy.
  + If toxic symptoms are expressed, they are referred to as symptoms of “chronic toxicity”
* Sub chronic Exposure
  + Toxic symptoms are expressed after repeated application for a timeframe less than half the life expectancy of the organism – but more often than a singe dose or multiple dosed applied for only a short time.
  + If toxic symptoms are expressed, they are referred to as symptoms of ‘sub chronic toxicity”
* For pesticides – less is more when dealing with toxicity
  + The less you need to cause a toxic effect – the more toxic the substance is.
  + This an LD50 of 25 mg/kg is more toxic than is one of 7000 mg/kg
* Pesticides are chemicals introduced into the environment to perform a function
* The source of a chemical (synthetic vs. natural) is irrelevant when considering its toxicity
* Pesticides should be treated with care and proper respect – but so should household cleaners, gasoline and kerosene, bleaches, paints and all other chemicals