Chapter 1

GENERAL INFORMATION

Many pests affect our daily lives. Insect, weed, and disease pests attack crops, forests, and ornamental plants. Insect pests invade homes and buildings. When pests impact human health, property values, farming or forest operations, they may require control.

Pest managers can use chemical pest control or pesticides. Pesticides are hazardous. Some are very toxic to humans, while others threaten water, fish, wildlife, or livestock. Any pesticide must be handled and applied safely. Failure to use them in a proper manner may result in exposure to humans, or contamination of food crops or the environment.

This chapter looks at:

- The way in which pesticides work
- Types of pesticides
- Advantages and disadvantages of each

Learning Objectives

Completing this chapter will help you to:

- **Understand the need for safe and effective pesticide use.**
- **Understand words related to pesticides.**
- **Know how different types of pesticides work.**
- **Identify pesticide formulations by abbreviations and the benefits, and uses of each.**
- **Know the function of adjuvants.**
- **Identify different adjuvants.**

Learning Objectives, cont'd.

- **Know the meaning of pesticide compatibility and when it is proper to mix products in the same spray tank.**
- **Know how to tell if pesticides are compatible.**
- **Know the risks of mixing pesticides that are not compatible.**

Sources of Information

There are a number of ways to get information on the safe and effective use of pesticides. The label attached to each container is the best source of information. Pesticide handlers must be familiar with the label information. This information results from tests and studies carried out by the manufacturer. It is also reviewed and approved by Health Canada during registration. Failure to follow directions on the label is a violation of the federal *Pest Control Products Act* (PCP Act) and Regulations under Health Canada.

Information on proper handling and use of pesticides can be accessed at the following internet sites:

Pest Management Regulatory Agency (PMRA) e-mail questions to:
PMRA_INFOSERV@hc-sc.gc.ca

PMRA Website:
http://www.pmra-arla.gc.ca/english/index-e.html

Croplife Canada Website
www.croplife.ca

Provincial Websites:
www.gov.ns.ca/enla/envin/ipm/default.asp
www.gov.pe.ca
www.gov.nf.ca/env/Env/PollPrev/pesticides/pesticide_control2.asp
www.gnb.ca/0009/index-e.asp

Information can be obtained from:

- Material Safety Data Sheets (MSDSs) **(See Chapter 3: Labeling)**
- Manufacturers
- Researchers
- Federal and provincial publications
- Pest control experts

General Pesticide Terminology and Definitions

Pest

A pest is any harmful, noxious, or problem organism that causes an unwanted effect. Pests include:

- Fungi
- Bacteria
- Viruses
- Weeds
- Insects
- Mites
- Rodents
- Birds

Wildlife (e.g., raccoons, wolves, deer) can sometimes be named as pests. If left unmanaged, pests may impact human health or cost money.

Pesticide

A pesticide is designed to kill, control, repel, attract, or manage pests. Any product that claims to do any of these things is a pesticide under the *Pest Control Product Act* and Regulations. Pesticides include chemicals that regulate plant growth, defoliants, or plant desiccants.

Components of a Pesticide

Formulation

A formulation is one or more active ingredients combined with formulants to make an effective product. The pesticide manufacturer develops the formulation to make it safe, convenient, and effective. Active ingredients and formulants are reviewed and approved for registration and use by Health Canada.

A formulation is one or more active ingredients combined with one or more formulants (inerts or non-active materials).

Active Ingredient

The active ingredient is the part of the formulation that gives the desired or toxic effect. A pesticide can have more than one active ingredient.

Formulant

A formulant is an inert (non-active) substance added by the manufacturer to the active ingredient. This allows it to be stored, handled, or applied. A formulant can be liquid or solid.

Carrier

A carrier is mixed with an active ingredient to make the pesticide:

- Safer to handle
- Easier to apply
- Better suited for storage

Carriers include water, oil, solvents, or clay. Some pesticides do not need a carrier. These are called Ready-to-Use (RTU) formulations.

Adjuvant

The manufacturer can add an adjuvant to the formulation. An adjuvant can also be added to the spray tank by the applicator. Adjuvants change application traits to make products:

- Safer
- More effective
- Easier to handle
- Easier to apply

Adjuvants increase the effectiveness of a pesticide by changing a physical or chemical trait. These broaden the conditions under which a pesticide can be used **(See Table 1-1)**.

Table 1-1: Adjuvants.

Type	*Activity*
Penetrants	Allow the pesticides to get through the outer layer of a treated surface.
Spreaders	Allow the pesticides to form a uniform coating over the treated surface.
Stickers	Allow the pesticide to remain on the treated surface.
Surfactants	Improve the spreading, dispensing, or wetting properties of a pesticide.
Wetting Agents	Allow wettable powders, and dry flowables to mix with water and better stick to target surfaces.
Antifoaming Agents	Reduce foaming of spray mixtures that require vigorous agitation.
Buffering Agents	Increase the solubility of pesticides in water or slow the chemical breakdown of some pesticides by lowering the pH of alkaline water.
Drift Retardants or Thickeners	Increase the droplet size of the spray material, reducing particle drift.
Emulsifiers	Allow oil-based pesticides to mix with water.
Invert Emulsifiers	Allow water-based pesticides to mix with oil-based carriers.

Formulation Types

Pesticides can be liquids, solids, or gases. Liquid formulations include:

- Emulsifiable concentrates
- Flowables
- Microcapsulated suspensions
- Solutions

Solid formulations include:

- Dusts
- Granules
- Pellets
- Soluble granules
- Soluble powders
- Baits
- Tablets
- Dry flowable powders
- Wettable powders

Gas formulations are fumigants. These can be purchased as solids, liquids, or gases.

A list of solid, liquid and gas formulations and their positive and negative characteristics is given in **Table 1-2**.

Applicators must look at more than cost when choosing a pesticide. It must be:

- Designed to control the pest
- Registered for the intended use (e.g., crop, ornamentals, turf, etc.)
- Approved for use with available application equipment

Care should be taken to select a formulation with the lowest risk to:

- Applicators
- Bystanders
- Non-target organisms
- Crops or target areas
- The environment

Abbreviations of Some Common Formulations

The formulation types of many pesticides appear as Abb. on the pesticide label. A list of those used for common formulations and descriptions of each are given in **Table 1-2**.

Table 1-2: List of Formulation Types

Name	*Abb.*	*Description*	*Advantage(s)*	*Disadvantage(s)*	*Typical Use(s)*
Baits	B	Particulates that are active ingredients mixed with an attractant or edible base.	Easy to handle. Used for spot treatment.	Attractive to children and pets.	Insect and rodent control.
Dry Flowables	DF	A wettable powder (WP) formulated into small pellets or granules.	Easy to handle, with less dust than wettable powders (WP).	Agitation required.	General use.
Dusts or Powders	DU	Finely ground dry material with a low concentrate of active ingredient(s).	No dilution required. Ready to use.	Applicator exposure and drift.	Direct application as a spot treatment.
Emulsifiable Concentrates or Emulsions	EC	Liquids containing the active ingredient(s), solvents, and emulsifiers. Forms milky spray mixtures when mixed with water.	Little agitation required. Non-abrasive. Low visible residue.	Possibly flammable. May require respirator when handling.	General use.
Flowables or Suspensions	F	Liquids that consist of solid particles of active ingredient(s) suspended in a liquid. Usually need to be diluted.	Less bulk due to high concentration of active ingredient. Seldom clog nozzles.	Constant agitation required.	General use.

Table 1-2: List of Formulation Types, cont'd.

Name	*Abb.*	*Description*	*Advantage(s)*	*Disadvantage(s)*	*Typical Use(s)*
Granulars	GR	A mix of dry, large free-flowing particles usually in a low concentration of active ingredient.	No mixing required. Minimal potential for drift.	Special application equipment required.	Soil treatment, for insect and vegetation control.
Micro-encapsulated Suspensions	MS	Small capsules of active ingredient suspended in the liquid. Slow release of active ingredient.	Increase of residue of active ingredient. Reduced hazard to operator.	May be expensive.	Insecticides.
Pellets	PE	Preformed mixtures of active ingredients and inert materials to form small solid spheres or cylinders.	Easy to spot treat.	Attractive to children and pets.	Baits to control rodents, slugs, etc.
Pressurized Products	PP	Aerosols, sprays, foam, and dusts packaged in a pressurized container. May be liquids, solids, or gases.	No mixing required.	Hazard from pressurized container.	Flying insect control.
Soluble Granulars	SG	Solid materials like granular, but soluble in water.	Containers empty easily. No liquid spills.	Dusty.	General use.
Soluble Powders	SP	Dry material similar to dust or granulars, but soluble in water.	Containers empty easily. No liquid spills.	Dusty.	General use.

Table 1-2: List of Formulation Types, cont'd.

Name	*Abb.*	*Description*	*Advantage(s)*	*Disadvantage(s)*	*Typical Use(s)*
Solutions	S	Active ingredient is in solution and remains clear when mixed with water.	Requires little agitation.	Possible corrosive.	General use.
Tablets	T	Active ingredients alone or with formulants formed into small blocks or spheres.	Easy to measure and use.	Attractive to children and pets.	Fumigation.
Wettable Powders	WP	Active ingredient plus a powder. Contains a wetting agent and a dispersing agent. Mix with water to form a suspension.	Containers empty easily with no splashing, or liquid spills. No special heated storage required.	Dusty. Requires agitation to remain in suspension.	General use.

Special Formulations

Pesticide manufacturers produce special formulations to meet the needs of specific applicators. These include fumigants and soluble packages.

Fumigants

Fumigants are available as gases, liquids, and solids. Carbon dioxide and ethylene oxide are compressed gases used as fumigants. Liquid fumigants become gases when applied. Solid fumigants come as dust, pellets, or tablets that release gases when exposed to moist air.

Soluble Packages

Pre-weighed amounts of wettable or soluble powder can be packaged in water-soluble plastic bags. When bags are placed in spray tank water, they dissolve and release their contents. These formulations reduce hazards around mixing and loading; there is no need to measure and no leftover product.

Naming Pesticides

A pesticide can be identified by product name, common name, or chemical name. Understanding the use of these can reduce confusion when seeking information on a pesticide. **Table 1-3** gives a listing of some product and common names.

Product Name

The product name is the registered trade name or trademark chosen by the manufacturer. The product name is clearly displayed on the principal panel of the label (e.g., Roundup).

Common Name

The common name is the name(s) of the active ingredient(s) in the product. It appears in lower case letters, often next to the word "Guarantee" on the principal panel of the label. The same active ingredient may be present in a number of products. Active ingredients are not always limited to one manufacturer. For example, the active ingredient glyphosate is made by a number of companies.

Chemical Name

The chemical name refers to the complex chemical structure of the active ingredient(s). These are used mostly by chemists. The chemical name does not always appear in full on the label. It is found in the Material Safety Data Sheet for the product.

Table 1-3: Product and Common Names

Product Name	*Common Name*
2,4-D	2,4-D
Aatrex	atrazine
Ambush, Pounce	permethrin
Avadex BW	triallate
Basudin	diazinon
Cymbush, Ripcord	cypermethrin
Dithane M-22	maneb
Dual	metolachlor
Garlon 4	triclopyr
Gramoxone	paraquat
Lannate	methomyl
Monitor	methamidaphos
Princep Nine-T	simazine
Polyram	metiram
Ridomil, Subdue	metalazyl
Thimet	phorate
Thiodan	endosulfan

Grouping Pesticides

There are many pesticides available. They can be grouped in a number of ways. The most common groupings are based on:

- Target pests
- The way they work (mode of action)
- Chemical family

Grouping by Target Pest

The most common way to group pesticides is by the pest(s) they are registered to control. Common pesticide types and the groups of pests they are designed to control are given in **Table 1-4.**

Table 1-4: List of pesticide type with target pest.

Pesticide Type	*Target Pest*
Acaricide	spiders, mites & ticks
Algicide	algae
Avicide	birds
Bactericide	bacteria
Fungicide	fungi
Growth regulator	plants & insects
Herbicide	plants (mostly weeds)
Insecticide	insects
Miticide	mites
Molluscicide	snails and slugs
Nematicide	nematodes
Piscicide	fish
Rodenticide	rodents

Grouping by Mode of Action or Route of Entry

Pesticides can be grouped by the way in which they work to control target pests (mode of action). Two main modes of action are contact and systemic. A list of other modes of action is given in **Table 1-5**. Many pesticides fall into more than one mode of action group.

Contact Pesticides

Contact pesticides control pests when they come in direct contact with the pest. Weeds are killed when enough of their surface area is covered with a contact herbicide. Insects are controlled when sprayed directly, or when insects travel across treated surfaces.

Systemic Pesticides

Systemic pesticides control pests when applied to one area of a plant or animal. The pesticide eventually moves throughout the entire plant or animal. A systemic herbicide absorbed through a plant's roots moves throughout the whole plant and kills it.

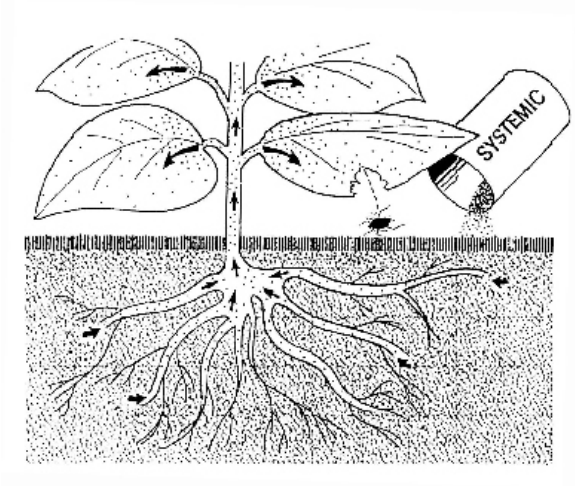

Figure 1-1: Systemic pesticide

Systemic insecticides enter plants through the roots or plant surfaces. These move throughout the plant and kill insects that feed on plant juices **(*see* Figure 1-1)**. A systemic insecticide applied to the skin of an animal (e.g., beef cow) will control internal parasites and pests when it moves throughout the animal's body.

Table 1-5: Some pesticide modes of action.

Group	*Mode of Action*
Attractants	Pesticides that have a particular odour or scent that attracts insects to a trap for identification or control.
Eradicants	Fungicides that can kill a pest once the pest has infected a plant, but before the pest becomes well established. Eradicants provide better pest control than protectants, because they have an element of post-infection control.
Fumigants	Pesticides that work in the gaseous form and control pests when the pests breathe in gases, or the gases are absorbed into their bodies through another manner.
Growth regulators	Pesticides that, once taken in by the pest, act like a pest's own hormones, disrupting normal development, causing it to die before it can become fully developed.
Protectants	Fungicides that prevent disease infection by creating a barrier between the pest and the plant preventing the disease from becoming established.
Repellents	Pesticides that produce an odour, repelling the pest from the treated area or plants.
Stomach ingestion	Pesticides that poison the pest once they are eaten.
Contact	Contact pesticides control pests when they come in direct contact with the pest.
Systemic	Systemic pesticides, when applied to one area of a plant or animal, are transported throughout the plant or animal. They kill all pests which feed on or in that plant or animal.

Grouping by Chemical Family

Pesticides can be grouped by chemical family. A chemical family is a group of chemicals that have similar chemical structures and properties such as:

- Poison symptoms
- Persistence (ability to stay in the environment without changing)
- Mode of action

Pesticides in the same chemical family tend to have similar guidelines for first aid, cleanup, and safe handling.

Applicators should be aware that repeated use of pesticides from the same chemical family might increase the chance of pest resistance. This is especially so with insecticides. Using insecticides from different chemical families reduces the chance of resistance. Alternating insecticides from different chemical families extends the life of each product. Pest resistance is covered in detail in **Chapter 7: Integrated Pest Management**.

Knowing the chemical family of a pesticide will help the applicator to better know how it works and how to use it safely.

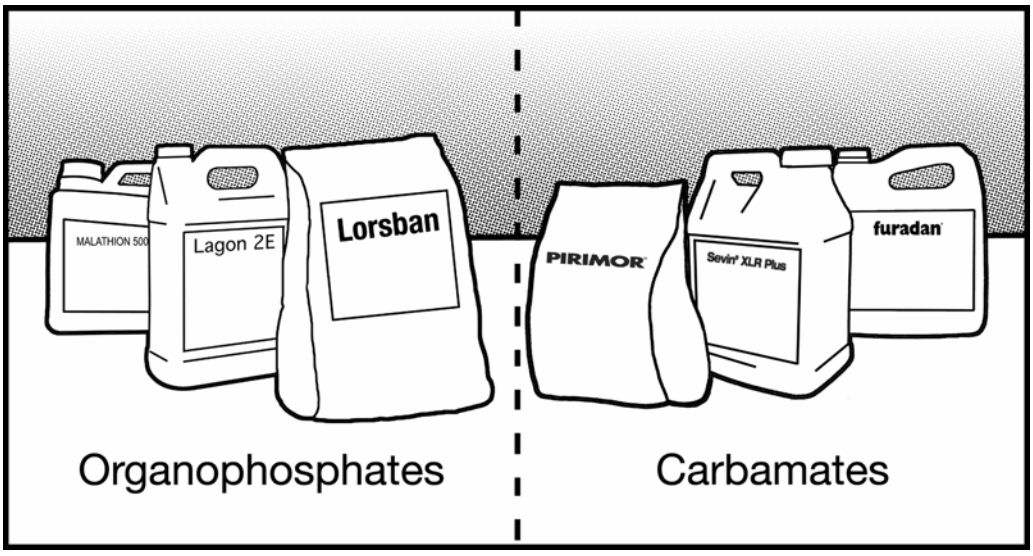

Figure 1-2: Examples of Two Chemical Families.

Pesticide active ingredients can be grouped as being inorganic or organic. Inorganic pesticides do not contain carbon. They are usually made from mineral ores such as copper, sulphur, or their salts (e.g., copper sulphate, sodium chlorate, ferrous sulphate).

Organic pesticides contain carbon in their chemical structure. Most organic pesticides are made from petroleum compounds. Organic pesticides taken from plants are called 'botanicals'.

Chemists have grouped organic pesticides into groups or families with similar molecular structures. Organic pesticides within a group often have similar properties. The most important organic groups are noted below.

ORGANOPHOSPHATE PESTICIDES (OP'S)

Most organophosphate pesticides are insecticides. This group contains some of the most toxic pesticides used in Canada. They often have a short persistence in soil, food, and animal feed. All OP's are cholinesterase inhibitors **(See Chapter 4: Human Health)**. Common organophosphate insecticides include phorate, malathion, diazinon, and dimethoate.

CARBAMATE PESTICIDES

The carbamates include insecticides, fungicides, and herbicides **(see Table 1-6).** Most have short persistence in the environment. Carbamate pesticides range in their level of toxicity from slightly to very toxic. Carbamate insecticides are cholinesterase inhibitors **(See Chapter 4: Human Health).**

Table 1-6: Pesticides in the Carbamate Family.

Classification	*Common Names*
Insecticides (carbamates)	aldicarb, carbaryl, carbofuran, methomyl, and pirimicarb
Herbicides (thiocarbamates)	triallate, EPTAC, and butylate
Fungicides (dithiocarbamates)	maneb, mancozeb, metiram, and thiram

ORGANOCHLORINE PESTICIDES (OC'S)

Organochlorine pesticides are rarely used today because they have a long persistence in the environment. They also tend to accumulate in human and animal fatty tissues. Some organochlorine insecticides with shorter persistence and lower toxicity to mammals are still available. Endosulfan and methoxychlor are examples of organochlorine pesticides.

TRIAZINE PESTICIDES

Compounds in this chemical group are all herbicides. All are mildly toxic to humans. These include amitrole, atrazine, hexazinone, metribuzin, and simazine. Most are systemic and enter the plant through its roots. A few are absorbed through leaves and then move through the plant. Triazines are persistent and residues may stay in the soil for a long time.

PHENOXY PESTICIDES

Grains and grasses are resistant to phenoxy herbicides. As a result, these are widely used for broadleaf weed control in grain crops and on turfgrass. The most common members of this group are 2,4-D, MCPA, and mecoprop. They have low to moderate human and animal toxicity.

Compatibility

Compatible pesticides can be mixed together to control a wider range of pests in a single application. Some product labels may state that the pesticide is "compatible" with another pesticide. This is not the same as stating that these products can be used in a "tank mix". These statements only indicate physical compatibility.

The mixture of two non-compatible pesticides can result in:

- Chemical reaction
- Reduced pest control
- Crop damage
- The forming of precipitate (e.g., gluey globs)

Pesticides should never be mixed unless they are listed as compatible on the label.

Mixing pesticides that are not compatible can cause plant or crop injury, reduced pest control, or damage to non-target organisms. A non-sprayable mixture may also form; and damage to spray equipment may occur.

Tank Mixing

A "tank mix" of more than one pesticide can be undertaken when it is clearly stated on the pesticide label. They are mixed together in the same spray tank. Label directions on the order to add the pesticides to the tank and the correct amount of each to add must be followed exactly. Pesticides whose labels indicate that they can be tank mixed have been tested to ensure their safety and effectiveness, that they are physically compatible and that no negative impacts on crop residue will result.

The applicator assumes the risk and responsibility with respect to safety, effectiveness, and damage, if he or she decides to tank mix pesticides whose labels do not clearly state that this can be done. The manufacturer or Canadian registrant is only responsible for the pesticide's performance when the pesticide is used according to label directions.

Figure 1-3: Pesticides should never be mixed in the same spray tank unless directions to do so are stated on the label of each product.

Summary

Pesticides are registered products designed to kill or control pests. Pests can impact humans, pets, livestock, crops, or valued parts of the environment. Formulated products consist of one or more active ingredients that control the pest. Adjuvants and additives can be added to make pesticides safer, more effective, or more convenient to use.

Pesticides are grouped by what they control, mode of action, and chemical family. Pesticides in the same chemical family have similar chemical structures, poisoning symptoms, level of persistence, and modes of action. Applicators should know pesticide-related terminology. They should also know the benefits and disadvantages of different formulations. This information allows applicators to make informed decisions on pesticide selection and proper use. Applicators need to know the importance of treating pesticides with care. The product label is the main source of information for safe and proper use of a pesticide.

Terms and meanings can be found in the Glossary of Terms in Appendix C.

Self-test Questions

Answers are located in Appendix A of this manual.

1. Explain the role of the active ingredient in a pesticide.

   _____

   _____

   _____

2. What is the name of a substance added by the manufacturer to a product formulation, or by the applicator to the spray tank, to improve the way in which a pesticide works?

   _____

3. What pests do each of the following pesticides control?

   a). Rodenticides _____

   b). Fungicides _____

   c). Herbicides _____

4. Name the type of formulation each abbreviation stands for. Give two advantages of each.

   a). GR _____

   _____

   b). F _____

   _____

   c). PE _____

5. When is it proper to "tank mix" two or more pesticides?

_____

_____

6. How does a contact herbicide act?

_____

_____

7. How does a systemic insecticide act?

_____

_____

8. Organophosphate pesticides are very toxic to humans. **True or False?**