Volume

3

ATLANTIC CANADA PESTICIDE APPLICATOR TRAINING MANUAL SERIES

# Agriculture

# Training Manual

New Brunswick Environment and Local Government
Newfoundland & Labrador
Nova Scotia Environment and Labour
Prince Edward Island Canada

Cooperatively developed by the Atlantic Working Group for Pest Management Education and Training Standards

# Agriculture



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The Atlantic Working Group is composed of representatives from the regulatory department that maintains responsibility for pesticide licensing/certification programs within each Atlantic Canada province. The mission of the AWG is to develop and maintain high quality pesticide education and training materials that meet or exceed the national *Standard for Pesticide Education, Training and Certification in Canada*. The development of this manual will promote consistency and harmonization of pesticide education, training, and licensing/certification programs, thereby allowing for greater reciprocity within Atlantic Canada.

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# PREFACE

The basic knowledge requirements for pesticide application education in Canada consist of information covering the following topics:

| | |
|---|---|
| General | Environment |
| Labelling | Emergency Response |
| Regulations | Pest Management |
| Human Health | Application |
| Safety | Public Relations |

The *Applicator Core Training Manual* provides the basic information all applicators need to know about applying pesticides safely and effectively. There are 10 category specific modules that provide further information for applying pesticides in specific areas. **NOTE: For ease of use, information from the *Applicator Core Training Manual* and the agriculture module have been combined in one *Agriculture Training Manual*.** The applicator core plus a specific module will provide full information for applying pesticides within a given area. The 10 specific areas are:

| | |
|---|---|
| Aerial | Greenhouse |
| Agriculture | Industrial Vegetation |
| Aquatic | Landscape |
| Forestry | Mosquito and Biting |
| Fumigation | Structural |

To obtain a licence or certificate in pesticide application you must write a pesticide applicator exam. This exam consists of information found in the *Applicator Core Training Manual* as well as a specific category manual. **NOTE: For agricultural applicators, the applicator core and agriculture category exams have been combined.**

The Applicator Core Training Manual and all category specific manuals are currently available in Nova Scotia from the Nova Scotia Department of Environment and Labour website at www.gov.ns.ca/enla/pests/applicatortraining.asp

To purchase hard copies of the Agriculture Training Manual please contact the Nova Scotia Agriculture College Bookstore at (902) 893-6728.

# DISCLAIMER

The information in this manual is supplied with the understanding that no discrimination is intended, and that listing of commercial products implies no endorsement by the authors or the Nova Scotia Department of Environment and Labour.

Due to changes to laws and regulations that occur over time, the Nova Scotia Department of Environment and Labour assumes no liability for the suggested use of pesticides contained herein.

**No pesticide can be used unless it is registered in Canada for the intended use and has a *Pest Control Products Act* registration number. At all times, pesticides must be applied according to the label directions on the pesticide container.**

# TABLE OF CONTENTS

# Chapter 1

## GENERAL INFORMATION

The success of farming depends in part on the proper management of crop pests. The most responsible approach to pest control is to use an integrated pest management (IPM) program.

IPM uses a number of pest control measures. These will depend on the type of pest you need to control. Pests can often be controlled through good crop management practises, such as:

- Planting pest resistant or tolerant crops
- Using mechanical control measures, like trapping for insects and mowing for weed control
- Practising crop rotation

For additional information on IPM see **Chapter 7**: **Integrated Pest Management**.

A responsible IPM program will sometimes require the use of pesticides. Training in the safe use of pesticides will help you to protect people, animals, and the environment from harm. It will also help you protect crops from costly damage. This chapter covers general information about pesticides. Basic terms and concepts that will be used in the manual are also discussed.

### Learning Objectives

**Completing this chapter will help you to:**

- **Identify safety guidelines for selecting and handling pesticides.**
- **Identify the importance of safe pesticide use.**

### Learning Objectives, cont'd.

- **Identify pesticides and their uses.**
- **Recognize pesticide groupings.**
- **Use proper pesticide terms.**
- **Explain the concept of pesticide resistance.**
- **Find good sources of information on pesticides.**

## Pesticides and their Uses

Pests are organisms in places where they are harmful or not wanted. For the purpose of this manual, weeds, insects, rodents (and sometimes birds), and diseases are all considered to be pests.

Pesticides are products designed to control or manage pests. Many pesticides kill their target pests. However, controlling pests does not always mean that they have to be killed. Some pesticides simply repel pests from a site where they are causing a problem.

**Pest**

**Any harmful, noxious, or troublesome organism. Pests include weeds, insects, fungi, bacteria, viruses, rodents, or other plants or animals.**

**Pesticide**
**Any device, organism, or mixture intended for preventing, destroying, repelling, killing, or mitigating problems caused by any insects, rodents, weeds, nematodes, fungi, or other pests; and any other substance or mixture intended for use as a plant growth regulator, defoliant, or desiccant.**

Pesticides play key roles in food production by preventing the spread of disease, and protecting crops and livestock.

Modern pesticides help Canadian farmers to compete with farmers in other countries. This is important for the survival of one of our country's most important industries. Pesticides also promote lower food costs in North America. Without pesticides, it is estimated that food production in Canada could drop by 40%. Production costs could increase by over 30%.

Pesticide use in Canada is lower than in many other parts of the world. Our climate, the crops we produce, and our low pest levels help to keep down the need for chemical controls.

# Pesticide Groupings

There are many types of pest control products. Pesticides have been developed for use in a wide range of situations. Pesticides are grouped in three ways:

- By the types of pests they control
- By the way they work (their mode of action)
- By their chemical family

## Target Pests

Pesticides are most commonly grouped by the types of pests they control. Common types of pesticides and their targets include:

| *Type of Pesticide* | *Target Pest* |
|---|---|
| Fungicides | fungi |
| Herbicides | plants (weeds) |
| Insecticides | insects |
| Nematicides | nematodes (microscopic worms) |
| Avicides | birds |
| Rodenticides | rodents |
| Acaricides | spiders, mites |
| Algicides | algae |
| Bactericides | bacteria |
| Miticides | mites |
| Molluscicides | snails, slugs |
| Piscicides | fish |

**Table 1-1: Type of pesticide and target pest.**

## Mode of Action

The mode of action identifies the way a pesticide works. Each pesticide works in some way to stop the normal function of the pest. Doing this will suppress or kill the pest.

**Mode of Action**

**Indicates the way that the pesticide works to stop the normal function of the pest, and eventually suppress or even kill the pest.**

Many pesticides fall into more than one mode of action group. For more information on the function of pesticides see **Chapter 7: Integrated Pest Management.**

Pesticides grouped by their mode of action include:

| *Type of Pesticide* | *Mode of Action* |
|---|---|
| Contact pesticides | Contact pesticides are pesticides that control pests by direct contact. |
| Systemic pesticides | Systemic pesticides are pesticides applied to the leaves or roots of plants. These are absorbed and move (are translocated) throughout the plant to the place where they interrupt plant function. |
| Stomach ingestion | Pesticides can control insect pests after an insect eats the pesticide-treated crop. |
| Fumigants | Fumigants work as a gas. They control pests that breathe in the gas. |
| Attractants | Attractants have a smell or scent that attracts insects to a trap. |
| Protectant pesticides | Protectant pesticides are often fungicides. They prevent disease by providing a protective covering for the plant. Protectant pesticides form a barrier between the pest and the plant before the disease arrives. |
| Eradicant pesticides | Eradicant pesticides kill a pest once the pest has infected a plant, but before the pest is well established. |
| Growth regulators | The pest ingests growth regulators. These act like a pest's own hormones and disrupt normal pest development. This causes the pest to die before it grows and reproduces. |
| Repellents | Repellents produce an odour to repel insects from treated plants. |

**Table 1-2: Type of pesticide and mode of action.**

## Chemical Family

A chemical family is a group of pesticides with a similar chemical makeup. Pesticides in the same chemical family often have similar modes of action, poisoning symptoms, and persistence in the environment. Knowing chemical families will help you:

- Select the proper pesticide
- Decide on the personal protective equipment needed
- Understand the handling precautions for each product

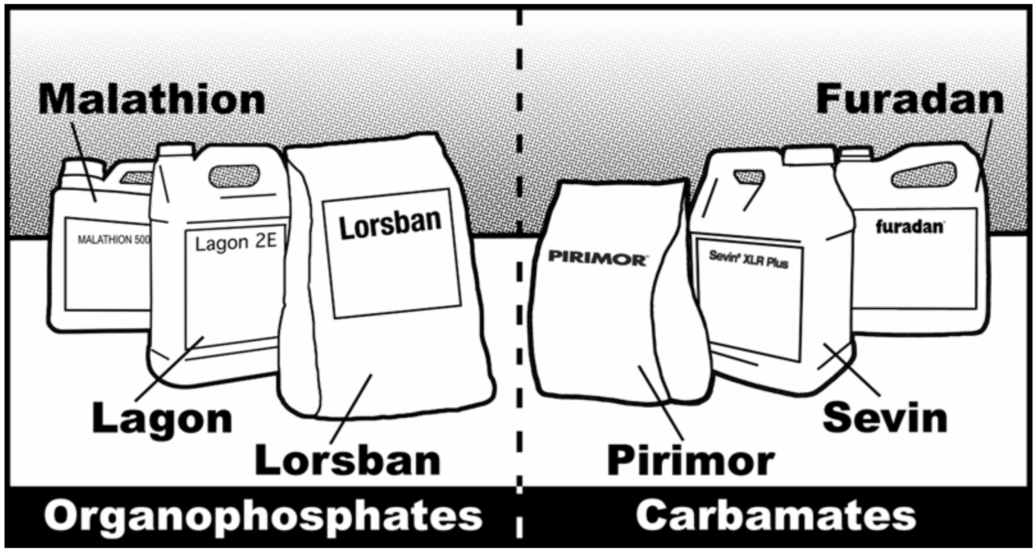



**Figure 1-1: Chemical families.**

Common pesticide chemical families include:

- Chlorinated hydrocarbons
- Organophosphates
- Carbamates

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

**Table 1-3: Pesticides in the carbamate family.**

## In Review

**Understanding how pesticides work, the pests they control, and their chemical family can help you choose the best product for an application. It can also help you better protect human health and the environment when using pesticides.**

# Pesticide Terminology

Knowing basic pesticide terms, and the types and names of pesticides, can help you make informed purchases. You should know the following key terms before using pesticides:

**Active ingredient** (a.i.) is the part of a pesticide mixture that gives the desired or toxic effect. A pesticide can contain more than one active ingredient.

**Active Ingredient**

**The part of a pesticide formulation that controls the pest.**

**Inert (or inactive) ingredients** are liquids or solids added to the active ingredient. These make it better suited for storage, handling, or application.

**Formulations** are mixtures of one or more active and inert ingredients. Together they create a saleable product. Formulations are discussed in **Chapter 3: Labelling**.

**Trade or product name** is the name the manufacturer uses to identify the pesticide. A pesticide can be sold under a number of trade names. Names can differ by the manufacturer or by the formulation of active ingredient**.**

Pesticides produced by different companies can contain the same active ingredients. The active ingredients will sometimes differ in concentration or there can be different additives. The trade or product name is clearly marked on the label. It is also used in written references and advertising for that product.

**Common name** refers to the name of the pesticide's active ingredient. This name is unique to each product and often appears on a label next to the word "Guarantee". In pesticide formulations with more than one active ingredient, each ingredient has its own common name.

For example, *glyphosate* is the common name of a herbicide. *Roundup* and *Touchdown* are two trade names for *glyphosate*. *Carbaryl* is the common name for a well-known insecticide. The trade name of this insecticide is *Sevin*.

The table below provides a sample of other pesticide common and trade names.

| Pesticide Type | Common Name | Trade Name |
|---|---|---|
| Herbicides | Dicamba | Banvel |
| | Metribuzin | Sencor |
| | Trifluralin | Treflan, Bonanza |
| | 2,4-D + Dicamba + Mecoprop | Killex, Kil-mor |
| Fungicides | Chlorothalonil | Bravo 500 |
| | Mancozeb | Dithane, Manzate |
| Insecticides | Metalaxyl | Ridomil Gold |
| | Endosulfan | Thiodan, Endosulfan |
| | Azinphos-methyl | Sniper, Guthion |
| | Cypermethrin | Ripcord, Cymbush |

**Table 1-4: Pesticide common and trade names.**

### In Review

**To correctly select, purchase, and apply pesticides, you need to understand pesticide-related terms. You should be familiar with the active ingredient, formulation, common name, and trade name of those chemicals and chemical families that you use.**

# Pesticide Safety

Safety is critical in any work involving pesticides. Any time you handle a pesticide —choosing, buying, storing, moving, mixing, loading, applying, cleaning up, or disposing of pesticides—always be safety conscious.

Pesticides can poison people, pets, and livestock. They can also harm the environment. Safe pesticide use will minimize risk to the applicator, other people, animals, and the environment.

As a pesticide applicator, you are at the greatest risk of exposure. Always work safely. Other people who may come in contact with pesticides should also follow good safety practises. Keep bystanders away from pesticide storage and mixing areas. Ensure that the person responsible for washing contaminated clothing follows the proper laundry procedures.

**The safe use and handling of a pesticide is the applicator's responsibility.**

Problems that can result from pesticide use include:

- Contamination of water, soil, or food
- Harm to non target plants
- Poisoning of people or animals
- Harm to fish, birds, bees, or other animals
- Failure to control the target pest
- Damage to the crop

No matter what you are doing with a pesticide (e.g., transporting, mixing/loading, applying), **always put safety first**.

## General Safety Guidelines

Following safety guidelines can help to protect people and the environment from pesticide exposure. Pesticide applicators should:

- Know common safety practises
- Handle and select pesticides safely
- Keep detailed application and storage records

These common safety practises should be followed each and every time a pesticide is used or handled.

### Regular Review

Product information and safety practises change over time. Review and keep your understanding of these products and their use up-to-date. This will encourage ‘best practises’, and discourage carelessness.

### Safe Handling

Common safety practises when handling any pesticide include the following:

- Always read and follow label information and directions.

**Figure 1-2: Improper pesticide use can pose a risk to the health and well being of adults, children, pets, and wildlife.**

- Wear clean protective clothing. If a spill or splash occurs, attempt to clean the affected person at once. Remove heavily contaminated clothing.

- Take first-aid and safety training courses. Maintain proper emergency-response and first-aid equipment near the work site.

- Keep work areas clean. Clean all dirty safety equipment and return it to its proper place. Keep empty pesticide containers in storage areas until you can properly dispose of them.

- Do not wear contact lenses when handling or applying pesticides.

- Never eat, drink, smoke, or chew tobacco when working with pesticides. Do not carry food, cigarettes, or cigars when handling pesticides. Avoid touching your face or head. This could cause contamination from dirty hands or clothing.

- Wash your hands often with strong soap and warm water. Always wash your hands before eating, drinking, or using the washroom. Clean up before going into the office, work areas, or lunchroom. Wipe pesticide contaminants from sinks and washroom fixtures before you exit.

- Avoid using a vehicle if you have pesticide on your hands, clothes, or footwear.

- Avoid physical contact with others after handling pesticide containers. For example, do not shake hands or pick up a child until you have washed your hands and removed affected clothing.

- Shower using strong soap and plenty of water after applying a pesticide. Wash your body, hair, and fingernails well. The longer a pesticide remains on the skin, the greater the risk of absorption into the body.

- Keep detailed pesticide application records. Good records can help you plan future applications, re-entry times, harvest dates, and grazing times. Records will also provide information on past applications and equipment settings. Good records can help you answer questions and solve problems that come up after an application. See **Chapter 11**: **Traceability** for more information on record keeping.

## In Review

**As an applicator, you are responsible for using pesticides safely. Everyone who works with pesticides should be aware of the risks involved. There are many types of pesticides, and each has its own level of risk.**

**Following proper safety guidelines will help you to safely handle a pesticide with little risk. These guidelines limit or prevent exposure to harmful products.**

# Pesticide Selection

There are a host of pesticides registered for farm pest control. You should try to choose the right pesticide to fit an IPM program <u>and</u> control a given pest.

When choosing the best pesticide for a given situation, you will need to consider a number of factors. These include:

- Pest(s) to be controlled (target pest)
- Product registration
- Beneficial organisms
- Applicator safety or risk of exposure
- Application equipment needed
- Personal protective equipment needed
- Crop health and growth stage
- Product compatibility with other pesticides
- Your work schedule
- Pest resistance
- Environmental factors

## Target Pest

It is important to identify target pests and the economic risk they pose when choosing a pesticide. Pest identification and control are discussed in **Chapter 7: Pest Management**.

## Product Registration

The pesticide must be registered by Health Canada for use on both the crop and the pest to be controlled. Pesticide registration is discussed in **Chapter 2: Regulations**.

## Beneficial Organisms

It is important to choose the pesticide that poses the least hazard to beneficial organisms (e.g., bees and birds).

## Safety, Risk of Exposure

The pesticide should present the least risk to the applicator, other people, and animals. Any of these can be exposed during an application. The pesticide should also pose a low level of risk to the environment. This includes risk to beneficial and non-target species. (See **Chapter 4**: **Human Health**, **Chapter 5**: **Pesticide Safety**, and **Chapter 6**: **Environmental Safety**. These chapters explain the human health and environmental risks of pesticide use.)

## Required Application Equipment

The pesticide will also have to suit the application equipment available. **Chapter 8: Application Technology** outlines common types of application equipment.

## Required Personal Protective Equipment

You would not choose a pesticide based simply on the protective gear available. However, you should check that you have the personal protective equipment (PPE) required to apply a chosen product. The pesticide label will sometimes call for certain PPE.

## Crop Health

Some pesticides work better when they are applied to strong, healthy plants. These pesticides often need to be absorbed and moved throughout the plant to work. If a plant is under stress or not actively growing, it may not absorb and move the pesticide. This can result in poor pest control.

## Compatibility with Other Pesticides

The applicator will have to check for compatibility of the product with other pesticides if they are to be applied to the same crop at the same time. Pesticide compatibility and tank mixes are discussed in **Chapter 3**: **Labelling**.

## Work Schedule

The pesticide applicator will have to plan around the minimum time that must pass before someone can safely re-enter a field after a product application. This is the re-entry period. Other work to be done in the same field should be planned around re-entry times.

Some pesticides require a minimum number of days between application and harvest. This is the pre-harvest interval. Careful attention to the pre-harvest interval will help to minimize the risk of pesticide residues on the crop. Re-entry periods and pre-harvest intervals are discussed in **Chapter 3: Labelling**.

## Pesticide Resistance

Pesticide application may not fully control a pest. Some pest individuals can develop resistance (or tolerance) to a given pesticide. Resistant individuals then produce offspring that also resist the pesticide. If resistance to one pesticide develops, the pest will often show resistance to other pesticides in the same chemical family.

You should plan to minimize the buildup of resistance. If the pest to be controlled is resistant to a given pesticide or group of pesticides, a product from another chemical family should be chosen.

As resistance develops, it can become harder to control the pest. **Chapter 7: Integrated Pest Management** discusses ways to identify, avoid, and reduce pesticide resistance.

## Environmental Factors

Environmental factors include soil, water, and air. Environmental conditions at the treatment site should be taken into account when choosing a pesticide. This will help to ensure pesticide effectiveness and safety.

The effectiveness of a pesticide application will depend on the following weather factors:

### Temperature

Some pesticides require a certain temperature to work. Certain temperatures may also be required for the pest to be active enough to take up the pesticide.

### Rainfall

Both foliar-applied and soil-applied pesticides can be affected by rain before or after their application.

For foliar-applied pesticides, rain that occurs before application will wet plant leaves. Wet leaves can limit the amount of pesticide that sticks to the plant. This can reduce the pesticide’s effectiveness. Rain too soon after a pesticide application can wash the product off leaves. This also reduces pesticide effectiveness.

Soil-applied pesticides require rain to wash them into the soil. They must reach the root zone of the crop or weed to work. In this case, rainfall after an application will increase pesticide effectiveness.

## Wind

The risk of pesticide drift increases with wind speed. Pesticides that are prone to drift should be applied when wind speeds are light to moderate. (See **Chapter 8: Application Technology**.) The product label will sometimes state wind restrictions.

**Always check the product label for details about the effects of weather on the safety and effectiveness of a pesticide.**

## Topography

The topography of a field includes the slope of the land and any nearby sensitive areas. Steep slopes can limit or restrict the use of certain pesticides that could wash into watercourses.

Sensitive areas, such as wetlands and watercourses, have to be protected from pesticide contamination. Extra care must be taken when choosing and applying pesticides near these areas. Buffer zones may need to be created. Pesticide labels or provincial law may require leaving buffer zones around waterways and sensitive land areas.

## Soil Type

The soil type in a field where a soil-applied pesticide is used can affect its performance. For example, in highly porous sandy soils, pesticides that dissolve in water can quickly move down through the soil. This process is known as leaching. (See **Chapter 6**: **Environmental Safety** for information on leaching.) Leaching will increase the risk of groundwater contamination.

Pesticides that bind tightly to soil particles are less likely to leach. Heavy soils, such as clays, or soils with high levels of organic matter, bind more pesticide. This reduces leaching.

In some cases, soils with high clay or organic matter may bind too much pesticide. This can reduce the availability and effectiveness of the pesticide.

**Consult the pesticide label for warnings and instructions to deal with environmental concerns.**

## In Review

**Care is needed to choose the pesticide that best controls a pest and minimizes risk. Product cost will be an important factor when choosing a pesticide. However, you will also need to consider:**

- **Pest resistance**
- **Re-entry periods and pre-harvest intervals**
- **Compatibility with other pesticides**
- **Exposure risks**
- **Equipment needed to apply the pesticide**

**Factors like topography, buffer zones, plant health, and soil type will change the effectiveness of a pesticide. When choosing the best product for a situation, protection of the applicator, other people, non-target organisms, and the environment should always take priority**.

# Sources of Information

Before buying or using a pesticide, applicators should have a good understanding of the product. This includes knowing:

- The hazards of handling and mixing the pesticide
- How it must be applied
- How it can be safely stored

This information will help you select the pesticide that provides the best pest control while minimizing risk. The best sources of information on pesticide use include:

- Pesticide labels (legal documents, and the most important source of information)
- Source - Manufacturer
- Material safety data sheet (MSDS)
- Provincial or regional specialists and publications
- Industry experts and consultants

## Pesticide Labels

Pesticide labels provide detailed information on the use of the product. The label is a legal document. It is the most important information source on the safe and effective use of a pesticide. Label information is the result of extensive laboratory and field testing. It is the most complete information source about a product. (See **Chapter 3**: **Labelling** for more detail on pesticide labels. )

The label includes information on:

- The product's active ingredient(s)
- Crops and pests for which the product is registered
- Application rates
- How to use the product safely and effectively
- The risks of using the product

**Always follow the label instructions when using a pesticide. It is against the law to use a pesticide in any way other than that given on the label.**

## Material Safety Data Sheet (MSDS)

The Material Safety Data Sheet is written by the manufacturer. It contains detailed information on the chemical aspects of the pesticide. It also provides details on health hazards, personal safety, and environmental protection. (See **Chapter 3**: **Labelling** for more information on MSDS.)

## Provincial or Regional Government Specialists and Publications

Provincial or regional (Atlantic) specialists and publications can serve as a local resource for pesticide selection and use. However, these are not meant to replace the label. Checking with a specialist or reviewing available publications can be a good first step in choosing a product.

## Industry Representatives and Consultants

Crop specialists, pesticide manufacturers, certified pesticide vendor staff, private consultants, and crop scouts can also provide information on the selection and use of pesticides

## In Review

**The first step in a responsible, long-term pest control plan is having the right information. This, together with sound practise, will help you to safely choose and apply pesticides. The label is the main source of product information. It describes the pesticide, the crops and pests it can be used on, and conditions for its use.**

**The MSDS will provide more details on the chemical makeup and handling procedures for the pesticide**.

# Case Study: Identifying and Delaying Pest Resistance

Wally has been growing potatoes for many years. He is proud of his management and success on the farm. Wally runs an efficient operation. He works hard to make sure that his farming does little harm to the environment.

Wally's neighbours have been having trouble with Colorado Potato Beetles over the past year or two. They are having trouble controlling the beetles in fields where they had no pest control problems before.

The neighbours were talking about their problem with Wally. He found out that the neighbors were using the same insecticide they had used for years. They were applying the recommended label rate, and using proper application procedures. However, the insecticide was no longer controlling the beetles.

Wally's neighbours were relying on one or two pesticides more than they should have. Two products had worked very well in the past. These were also cheap when compared with other pesticides. Wally's neighbours have used these cheaper products a lot to reduce costs. It appears to Wally that resistance is building up in the beetles. This is happening because the same products are being used over and over by a group of farmers who farm close to one another.

The problem has Wally concerned. He knows that if this problem is not addressed, resistant insects from his neighbours' fields are likely to move into his fields. This will result in pest control problems for his crop too.

Wally decides to meet with his neighbours to discuss the problem. He is hoping they can find solutions. He knows that his neighbours are trained and certified to apply pesticides. They are also sure that they have been using the insecticides properly. So what is the problem?

At their first meeting, an invited speaker reminds Wally and his neighbours of the basic principle of resistance. Resistance builds when a pest is able to survive rates of pesticide application that worked in the past. Resistance can occur if pesticides are used poorly or too often. The speaker goes on to explain that in many areas of the province, a number of pests have become resistant to certain herbicides, insecticides, or fungicides.

So, what is the solution? The speaker explains that research has shown that the repeated use of the same pesticide, or pesticides from the same chemical family, can cause pest resistance.

Wally and his neighbours should use pesticides from many chemical families to slow pest resistance. They should use a product from a given chemical family in one application and a product from another family in the next application.

The next step in their plan to deal with pest resistance will be to develop an integrated pest management (IPM) plan. IPM will include the use of chemical and non-chemical pest control methods. The specialist suggested that pesticides should only be used when the pest(s) exceeds economic thresholds.

A pest management specialist and a crop consultant work with Wally and his neighbours. They work on a plan to slow pest resistance. They want to prevent resistance from becoming a greater problem in the coming growing season.

Their plan involves a number of steps. It begins with the regular scouting of fields to identify pests and their levels. The growers plan to reduce their use of chemical pesticides when possible. They plan to use other methods of pest control (e.g., physical or mechanical, cultural, biological, or genetic).

When chemical control is needed, the growers plan to coordinate pesticide use in fields that are near each other. This will allow them to rotate chemical products from a number of chemical families.

To evaluate progress, the group keeps records of pesticides used on each crop and field. They also agree to get together on a yearly basis to look back on the season and come up with a pest control plan for the next year.

Wally and his neighbours know that IPM does not guarantee that pest resistance will not occur. However, they better understand that the use of many control methods in a well-planned program will help to delay such resistance in a crop.

# Self-study Questions

*Answers are located in Appendix A of this manual.*

1. Which of the following statements about pesticide information sources is correct?

   a) the MSDS is the most important source of information regarding a pesticide.
   b) the label is a legal document and the most important source of information on a pesticide's safe use.
   c) the MSDS provides additional supporting information that may not be included on the product label.
   d) b and c only

2. A chemical family is a group of pesticides

   a) with similarities in chemical makeup
   b) with the same active ingredient
   c) that are active against the same pest
   d) that are made by the same manufacturer

3. An applicator wants to control a population of insects in his potato crop, and must choose the best pesticide for the job. Which of the following factors will best determine the appropriate product for control?

   a) mode of action of the pesticide
   b) chemical family of the pesticide
   c) types of pest to be controlled
   d) all are of equal importance

4. A pesticide applicator is trying to decide which of two products can give him the best level of pest control in his crop. If the pest is an insect that can produce a very high number of offspring during it's development, what pesticide mode of action will be best suited to control this pest?

   a) protectant pesticide
   b) systemic pesticide
   c) eradicant pesticide
   d) growth regulator

Chapter 2

# PESTICIDE REGULATIONS

Federal, provincial, and municipal governments regulate pesticide use. Pesticide laws protect the vendor, buyer, applicator, consumer, and environment.

Federal laws deal mainly with the manufacture and registration of pesticides for use in Canada. They address the labeling, import, and export of pesticides.

Provincial laws work with federal laws. The provincial laws control the sale, purchase, transport, storage, handling, application, and disposal of pesticides within a province.

Some towns and cities address public health concerns by further regulating the use of pesticides.

## Learning Objectives

**Completing this chapter will help you to:**

- **Interpret and apply federal pesticide laws.**
- **Interpret and apply provincial pesticide laws.**
- **Interpret and apply municipal pesticide laws.**
- **Access current laws.**

# Federal Pesticide Legislation

To ensure the safe handling and use of pesticides, the federal government controls these products through federal acts and codes. These include:

- *Pest Control Products Act (PCP Act*). This legislation establishes regulations that address:
    - Pesticide registration
    - Pesticide labeling
    - Pesticide classification
    - Pesticide re-evaluation

Other federal legislation, including:

- *Food and Drugs Act*
- *Pesticide Residues Compensation Act*
- *Migratory Birds Convention Act*
- *Fertilizers Act*
- *Feeds Act*
- *Fisheries Act*
- *Transportation of Dangerous Goods Act*
- *Canadian Environmental Protection Act (CEPA)*
- National Building Code of Canada *(NBC*)

## *Pest Control Products Act (PCP Act)*

The *Pest Control Products Act* is the primary law that controls pesticides in Canada. Its focus is on human health, environmental protection, and pesticide effectiveness.

The Pest Management Regulatory Agency (PMRA), a division of Health Canada, administers the act. **All pesticides sold or used in Canada must be registered by Health Canada under the *PCP Act*.**

*The PCP Act* makes sure that:

- Pesticides are manufactured, stored, displayed, distributed, and used safely.
- Pesticides are not packaged, labeled, or advertised in a way that is misleading or likely to create a false impression of the product.
- Only pesticides that are registered and have a Pest Control Product (PCP) number are sold in, or brought into, Canada.

## Pesticide Registration

Before a pesticide is registered, the manufacturer must supply supporting data to the PMRA. This helps to ensure that a product is safe and effective when used as stated on the label. The manufacturer must submit scientific data on the following:

- Chemistry (how the pesticide behaves)
- Toxicology (effects of the pesticide on a number of pest and non-pest species)
- Metabolism (breakdown of the pesticide in plants and animals)
- Residues (pesticide that remains in the soil or in crop plants after application)
- Environmental impact (effect of the pesticide on the environment)
- Effectiveness of the pesticide (how well the pesticide works to control target pests)

The PMRA reviews all information to make sure that the product does not create an undue risk to human health, plants, animals, or the environment.

Reviewing the toxicity of a pesticide allows the PMRA to decide which precautionary statements and hazard symbols must appear on the label. (See **Chapter 3: Pesticide Labels** and **Chapter 4: Human Health.)** People who could be exposed to a pesticide need this information to assess the hazards of using the product.

Once a pesticide passes evaluation, the product is registered. This gives the manufacturer the right to make or sell the product in Canada. After registration, the product is given a Pest Control Product (PCP) number. This identifies the pesticide and <u>must</u> appear on all product labels.

## Pesticide Classification

Pesticides are registered and regulated in Canada by the federal *PCP Act.* Pesticides are grouped or classified by their use. The product class appears on the label.

Registered pesticides are grouped in one of four classes under the federal *PCP Act*:

- Domestic class
- Commercial class (agricultural class or industrial class)
- Restricted class
- Manufacturing class

### DOMESTIC CLASS

Domestic class pesticides are used in or around the home. People often use these to control flies, wasps, mice, and garden bugs.

These pesticides can be safely handled with little personal protective equipment, if you follow label directions. The law does not require special training regarding the use of domestic pesticides.

Domestic pesticides come in small packages. They have a lower toxicity, and pose a low risk to users and the environment. (See **Chapter 4: Human Health** for details on toxicity, exposure, and risk.)

### COMMERCIAL CLASS

Commercial class pesticides are used in agriculture, forestry, industry, and other commercial operations. Active ingredients in commercial pesticides can be the same as those in domestic products.

Commercial pesticides are often packaged in large containers or prepared with higher concentrations of active ingredient. This creates a greater risk to human health and the natural environment. Some commercial products are too toxic, persistent, or hazardous to be used by the general public. Only those people trained in safe pesticide handling and application procedures can use these. Personal protective equipment must also be used.

**If the words "agricultural" or "industrial" appear on the label, the pesticide is a commercial class product.**

### RESTRICTED CLASS

Restricted class pesticides are used mainly as commercial pesticides. They have added restrictions on the label. These restrictions may be due to high toxicity, required application method, or the level of risk to the environment. Restrictions can also apply to the following:

- Product display
- Product storage
- Product distribution
- Product application
- Applicator qualifications

### MANUFACTURING CLASS

Manufacturing class pesticides are used in manufacturing, formulating, or repackaging. General pesticide applicators do not have access to these.

## Pesticide Re-evaluation

Under the *PCP Act*, the PMRA may re-evaluate a registered product at any time. This can happen if new information becomes available, or the manufacturer wants to add a new use to the label. Registered products are reviewed using current information. For example, a PMRA regulator might chose to add precautions, or change the way a product may be used. The PMRA also has the right to suspend or cancel a pesticide registration. When a pesticide is suspended, dealers may sell any product already in the store. The manufacturer may not distribute any more of the product.

When a pesticide is cancelled, dealers must stop selling the product immediately. The product may be recalled. The manufacturer can appeal any change to the registration of a pesticide. When effect or safety is a concern, the manufacturer can choose to voluntarily remove the product.

The PMRA regularly re-evaluates pesticides that have been registered for many years. The re-evaluation of organophosphate and carbamate insecticides is the highest priority. Both of these pose a high risk to human health and the environment. (See **Chapter 4: Human Health**.)

## Other Federal Legislation

Other federal laws impact the use, sale, and manufacture of pesticides in Canada. These laws deal with:

- Pesticide residue levels in foods
- Damage to fish or fish habitat
- Damage to migratory birds
- Transport of pesticides that are classed as dangerous goods

Other federal acts and laws that cover these subjects include:

The ***Food and Drugs Act*** protects the health of consumers. It does not allow the sale of food that contains harmful or poisonous substances (including pesticides). Some pesticides can leave residues in food. The safety of the product must be proven to Health Canada before it can be registered under the *PCP Act*. The **maximum residue level (MRL)** places a limit on the amount of pesticide residue, at harvest, that may be contained in food. Health Canada tests to ensure that pesticide residues do not exceed the MRL in domestic and imported crops. Crops that exceed the MRL may be seized and destroyed under the *Food and Drugs Act*. The pesticide applicator may face legal action.

The ***Pesticide Residues Compensation Act*** allows crop producers to be compensated for damage or loss if the sale of their produce is prevented because it exceeds the MRL of the *Food and Drugs Act*. To receive compensation, the producer must prove that the pesticide was applied in keeping with label directions.

The ***Migratory Birds Convention Act*** is administered by Environment Canada to protect waterfowl and other migratory birds. This law makes it an offence to release a substance harmful to migratory birds into a waterway or area used by these birds. Violation can lead to charges. If other animals are harmed, the pesticide applicator can face charges under provincial law.

The ***Fertilizers Act*** is administered by Agriculture and Agri-Food Canada. This act requires that all fertilizers and fertilizer–pesticide mixtures sold or used in Canada be registered. The import and sale of fertilizer and supplement products are controlled. Standards are set for packaging and labeling. Regulators have the power to inspect and sample products for legal compliance.

The ***Feeds Act*** is administered by Agriculture and Agri-Food Canada. This act is designed to prevent feed contamination. Laws on the import, manufacture, and sale of feed set standards for packing and labeling. This act also gives regulators the authority to inspect and sample products for compliance.

The ***Fisheries Act*** protects fish and fish habitat, such as spawning grounds, nurseries, rearing areas, food supply, and migration routes. Consult this act when using pesticides where there are nearby streams, ponds, lakes, or other water bodies.

The ***Transportation of Dangerous Goods Act*** limits the transport of dangerous goods to properly trained handlers. This law requires:

- Shipping documents
- Special labels and markings
- Proper vehicle placards
- Safety measures on the movement of dangerous goods

The shipper, transporter, and receiver of dangerous goods share responsibility under this law. The supplier, manufacturer, or distributor may set transportation requirements.

The ***Canadian Environmental Protection Act (CEPA)*** protects both human health and the environment. This act is administered by Environment Canada, and covers:

- Procedures to review and approve chemicals
- Reporting of adverse effects from chemicals
- Import and export controls
- Recalls and clean ups

The **National Building Code of Canada (NBC)** provides requirements for health, safety, and structure in new buildings. Requirements exist for facilities that store hazardous materials. The NBC offers excellent guidelines and should be checked before building or renovating a pesticide storage facility.

## In Review

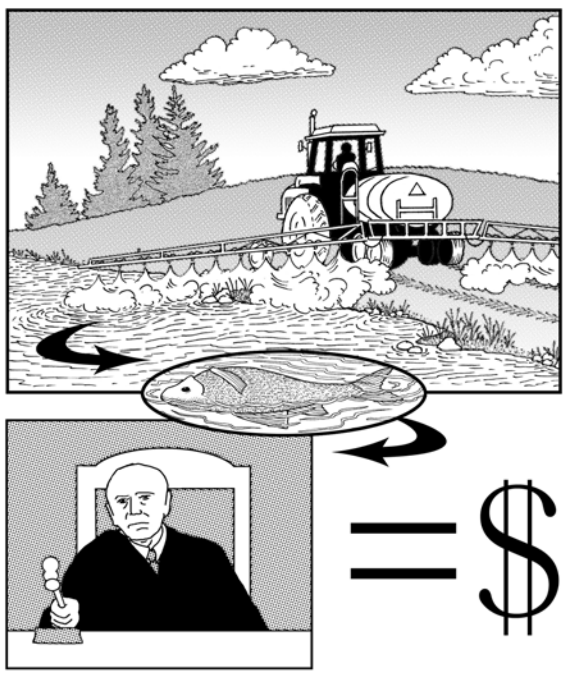
**The federal government has laws that control many aspects of pesticide use in Canada. The *Pest Control Products Act* controls the manufacture, registration, classification, and use of all pesticides. This is the principal federal law that deals with pesticides. Other federal laws regulate pesticide use by:**

- **Ensuring the safety of food**
- **Protecting the habitat of fish and migratory birds**
- **Governing the transport of dangerous goods**
- **Keeping livestock feeds safe**

**These laws are based on scientific research. They are designed to protect pesticide users, the public, livestock, wildlife, and the environment. Applicators must know and follow federal laws to ensure safe and effective pesticide use.**

# Provincial and Municipal Pesticide Legislation

Each province in Canada has its own provincial pesticide law. These support federal laws. Provincial laws control the transport, storage, sale, handling, mixing, application, and disposal of pesticides. Provincial laws may also govern control of a given pest.



The ***Nova Scotia Pesticide Regulation*** identifies the licence requirements for commercial pesticide applicators and vendors. It also covers the certification requirements for private applicators. A number of pesticide applicator categories are established (agricultural, forestry, aerial, landscape, structural, and biting fly control). The *Pesticides Regulation* covers pesticide transport, display, storage, application, special-use permits, and record keeping.

**Figure 2-1: The illegal application of a pesticide can cause severe environmental damage and result in a significant penalty for the applicator.**

**Municipal legislation** may set additional restrictions on the sale or use of pesticides. Keep in touch with municipal authorities concerning pesticide-use bylaws. Check for building codes that restrict the location, construction, or operation of pesticide storage facilities.

## In Review

**It is important to know federal, provincial, and municipal laws that affect the sale, purchase, transport, storage, handling, application, and disposal of pesticides**.

# Current Regulatory Information

Pesticide applicators should be aware of changing regulatory requirements. Up-to-date information can come from pesticide salespeople, distributors, provincial legislators, and local PMRA agents. NS-specific sources include:

**Nova Scotia Pesticide Regulatory Program**

http://www.gov.ns.ca/enla/pests/

**Canadian Food Inspection Agency (CFIA**)

(902) 426-2110 (NS office)
www.inspection.gc.ca

**Pest Management Regulatory Agency (PMRA**)

(Pest Management Information Service)
1-800-267-6315
www.pmra-arla.gc.ca
pmra_infoservice@hc-sc.gc.ca

# Case Study: Pesticide Legislation

Darren is a graduate of the Nova Scotia Agricultural College. He works as a pest management specialist on a modern blueberry farm. Darren enjoys his work, but knows he still has a lot to learn. He is not familiar with the laws that control pesticide use in Nova Scotia. Darren has not yet handled pesticide products that are often used on this farm.

Darren's boss, Mr. Johnson, has decided to train him on the job. This will allow him to point out the legal requirements of the work that Darren will be involved in when using pesticides. Darren will then move on to earn his pesticide use certificate or licence. Mr. Johnson tells Darren that he will have to take a training course and write an exam to obtain a licence. He cautions Darren that even after he has a licence, he will have to keep learning about new products and equipment to stay up to date.

As on-the-job training begins, the first activity involves the purchase of pesticides. Darren and his boss purchase a number of bags of herbicide to control weeds in the blueberry fields.

The vendor checks to make sure that there is a legible label on each bag of product. The product label will provide much of the information the applicators will need to safely and properly use the pesticide.

They now need to move the bags of herbicide back to the farm. Darren carries the first bag out to the truck. He places it on the floor in the front seat. Mr. Johnson explains that pesticides should never be carried in the passenger compartment of any vehicle. He gets Darren to move the pesticide to the cargo box of the truck. Mr. Johnson checks that it is safely placed. He secures all of the bags with a tie-down.

Mr. Johnson runs through a list of items that Darren will need to remember before he moves pesticides:

- Confirm that each package is the product that you think it is.
- Make sure that a label is attached to each package.
- Check that each product package is not broken, cracked, torn, or leaking.

Darren needs to understand that he must plan ahead to make sure the product will not come into contact with human food or animal feed during transport. Mr. Johnson points out that moving pesticide in the cab of the truck is not safe. It might expose Darren, or others who might later use the vehicle, to the pesticide.

When they get back to the farm, Darren removes the herbicide from the truck. He plans to store it in a nearby machine shop. Mr. Johnson tells Darren that pesticides need to be stored in a proper storage area.

The machine shop is not secure. A person could easily enter the shop and be exposed to the pesticide. If product spills, it will contaminate the work area and put people at risk.

Darren and his employer move the bags of herbicide to the farm's pesticide storage building. This building is designed for safe pesticide storage. Mr. Johnson outlines the key features of the facility.

**A few days later…**
Weather conditions are suitable. The weeds are at the right stage to apply herbicide to the blueberry fields. Darren will now see how to handle and load pesticides. Mr. Johnson asks Darren to watch him fill the sprayer with water and mix the herbicide.

Darren asks if there is anything he should know about the product before they begin. Mr. Johnson is impressed that Darren is thinking ahead. He explains that anyone who handles a pesticide should always read the label before using it.

Darren reads the label and finds a great deal of useful information on handling the product. He learns that personal protective equipment (PPE) should be worn when handling and mixing the pesticide. For this product, PPE includes chemical-resistant gloves, rain gear or an apron, and chemical-resistant boots. Other statements on the label include limits on wind speed, precautions when applying near water, and application rates.

Mr. Johnson explains that sprayers must not be filled, washed, or flushed near an open water body. To prevent the backflow of sprayer contents from the tank to the water, it is illegal to fill the tank directly from a stream, river, or other water body.

The next step is to apply herbicide to the blueberry field. Mr. Johnson tells Darren that it would not be legal for him to apply the pesticide, since he does not have a valid pesticide applicators certificate.

Mr. Johnson explains that there may be a number of other legal requirements when applying pesticides. These can include wind speed limits, and buffer zones around watercourses, organic farms, institutions, or private homes.

The wind is blowing at about 12 km/h on this day. The label requires a wind speed under 10 km/h for this product. Mr. Johnson measures wind speed, and decides to delay the application until later that evening when the wind lowers. At that time, Darren suits up in rain gear, rubber boots, and rubber gloves. He watches his boss add the proper amount of water (from a nurse tank) and herbicide to the spray tank. Amounts are calculated from the given label rate.

Once the application is complete, Mr. Johnson has to clean the sprayer and dispose of a small amount of mixture left over in the spray tank. Darren wonders what should be done with the excess product. His boss tells him that it should be applied, as needed, to another field. Re-applying to the same blueberry field can damage the crop or the environment.

Mr. Johnson sees that an empty herbicide bag has blown into the fence line. He asks Darren to dispose of it. Darren picks up the bag and tosses it into a nearby garbage barrel. He plans to burn it later with other waste. His boss stops him, and tells him that pesticide containers must not be burned or buried. This can release harmful vapours or concentrated product. Mr. Johnson removes the bag from the garbage barrel and places it in the pesticide storage facility to await proper disposal.

Now there is only one important task left to do. They must record information about the application. Mr. Johnson explains the importance of noting weather conditions, application rate, and crop stage at the time of the application. This will help to assess the effectiveness of the application later. This will also be a good way to track pesticide use on the farm.

At the end of the day, Darren knows that using pesticides is complex. To teach him more, his boss has signed him up for a pesticide applicator training course.

## Self-study Questions

*Answers are located in Appendix A of this manual.*

1. All pesticides sold and used in Nova Scotia must have a registration number that is assigned under which one of the following:

   a) federal *Food and Drugs Act*
   b) provincial *Pesticides Control Act*
   c) federal *Pest Control Products Act*
   d) manufacturer's quality control guarantee

2. Registered pesticides are classified according to their intended use. Match each pesticide class with its registered use (note that all definitions will not be used).

   a) domestic class
   b) commercial class
   c) restricted class
   d) manufacturing class

   _____pesticides intended for use in the agriculture and forestry industry
   _____ pesticides that are used when manufacturing other products
   _____ pesticides that are intended for use in or around the home
   _____ pesticides that carry additional use limitations on the label
   _____ pesticides that are designed for specific targeted pests

3. Match the terms with the appropriate descriptions (not all terms will be used and some terms may be used more than once)

   a) *Migratory Bird Act*
   b) *Canadian Environmental Protection Act*
   c) *Pesticides Control Act* and Regulations
   d) *Fertilizers Act*
   e) *Migratory Bird Act*
   f) *Pest Control Products Act*

_____ the primary legislation regulating pesticides in Canada
_____ designed to protects the environment and human health
_____allows government the right to suspend a pesticide registration
_____ prohibits the release of a pesticide into any waterway frequented by birds
_____ requires all fertilizer/pesticide mixtures sold in Canada to be registered

4. Select the true statements about pesticide regulations

   a) Federal laws deal mainly with the manufacture, registration, and classification of pesticides.
   b) Provincial laws deal with the sale, purchase, application, and storage of pesticides.
   c) Municipal bylaws deal with the transportation and storage of pesticides.
   d) all of the above
   e) a and b only

5. A farmer plans to spray a pesticide near a small field in which silage (feed) for cattle is being grown. Which act(s) regulate pesticide application in this situation?

   a) *Pesticide Residues Compensation Act*
   b) *Fisheries Act*
   c) *Pesticides Control Act* and Regulations
   d) *Feeds Act*
   e) c and d only

Chapter

3

# LABELLING

## SECTION A: PRODUCT LABELS

Every pesticide sold in Canada has a label that provides detailed information about the product and its use. This label is a legal document. Label information includes:

- The name of the product
- The active ingredient
- The Pest Control Product (PCP) number
- Safety precautions
- Directions for product use

Pesticide applicators should have a product label and Material Safety Data Sheet (MSDS) on file for each pesticide they handle.

### Learning Objectives

**Completing this section will help you to:**

- **Recognize the legal status of pesticide labels.**
- **Interpret and apply label information.**

# Pesticide Labels

The label is the best information source on a pesticide product. The label is also a legal document. It is not legal to use a pesticide in any way other than that stated on the label.

The label is often fastened to the pesticide container. It can also take the form of a small booklet or pamphlet packaged with or on the container. If a label cannot be read, in part or in whole, contact the vendor at once to get a replacement label for that product.

Manufacturers may provide other product information in the form of pamphlets, brochures, and advertisements. Manufacturers may print extra information on the product wrapper. Stickers or tags may be affixed to the container. These support, but do not substitute for, the label. Government publications and trade magazines can also provide information. These must never be used in place of the label.

## Parts of the Label

A pesticide label has two parts:

- The **primary display panel** must be fixed to the container.
- The **secondary display panel** is often a booklet attached to the container.

### Primary Display Panel

The following is a sample of a primary display panel. (Numbers indicate label parts, as discussed below.)


**Figure 3-1: Primary display panel.**

## PARTS OF THE PRIMARY DISPLAY PANEL

The primary display label has eight parts. Each part is identified and described below:

1. **Product name**
2. **Class designation**
3. **Net contents**
4. **Precautionary symbols and wording**
5. **"Read the label before using." Statement**
6. **"Guarantee" statement**
7. ***Pest Control Products Act* registration number**
8. **Name and address of the pesticide registrant (manufacturer)**

1. **Product name** includes the following:

   - **Trade Name** - The **trade name** is registered with the PMRA. In this example the trade name is CONTROL-ALL 500 EC.

   - **Formulation** - The **formulation** may be printed in full, stated as an abbreviation, or both. In this example we know the product's formulation is a liquid because it is an emulsifiable concentrate (EC). Detailed information on formulations will be covered later in this topic.

   - **Description of use** - In this example, the **description of use** describes the pesticide as a herbicide. It is identified as being registered to control crop weeds.

2. **Class designation** identifies the product classification. It indicates who may use the product. As described in **Chapter 2: Pesticide Regulations**, there are four classes of applicators:

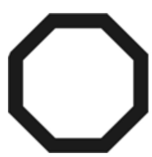
    - Domestic
    - Commercial (also known as Agricultural or Industrial)
    - Restricted
    - Manufacturing

    In this example, the pesticide is classed as Agricultural.

3. **Net contents** tells how much of the product is in the container. In this example, the container holds 10 litres (10L) of product.

4. **Precautionary symbols and words** state the hazards of using a pesticide. The *PCP Act* requires these.

## Precautionary Shapes



An octagon on the label indicates an extreme hazard. The signal word “danger” is associated with it.

A diamond indicates a moderate hazard. This has the signal word “warning” associated with it.

An upside-down triangle indicates a slight hazard. This has the signal word “caution” associated with it.

**Figure 3-2: Precautionary shapes.**

## Precautionary Pictograms

A skull and crossbones on a label indicates that a product is a poison.

A flame indicates that a product is flammable.

A bony hand indicates that a product is corrosive.

An exploding grenade indicates that a product is explosive.

**Figure 3-3: Precautionary pictograms.**

The graphic found in the precautionary symbol combines the shape and word. Together they identify the type and degree of hazard from a pesticide.

In the example label, the diamond-shaped warning symbol refers to a moderate hazard. The skull and crossbones, and "POISON" signal word, states that the product is a poison.

Some pesticides pose a number of hazards. All hazards must be stated on the label through symbols and hazard identifying words. Only one signal word must be provided. The signal word that describes the greatest hazard must be displayed.

5. A **"Read the label before using" statement** must appear on the primary display panel of all pesticides sold in Canada.

6. A **"Guarantee" statement** provides the common name of the product's active ingredient (a.i.). When there is more than one active ingredient in a product, more than one common name will appear on the label. If the

product does not have a common name, the chemical name will be used on the label.

**The active ingredient is the part of the pesticide product that controls the pest.**

**The chemical name is the name for the chemical structure of the active ingredient**.

The guarantee also shows how much chemical is in the product (the concentration). The concentration may be given in two ways:

- **Weight per unit volume –** In this example, 500 grams of the active ingredient (*monolochlor*) is present per litre of product (500 g/L).
- **Percentage by weight –** For example, the guarantee of a wettable powder (WP) formulation could be stated as “40% by weight”. This means that for each 100 parts of pesticide, 40 parts are active ingredient.

**7**. The ***Pest Control Products Act*** **registration number** shows that the product is registered with Health Canada. All pesticides sold or used in Canada must have a *PCP Act* registration number. The higher the number, the more recent its registration. The registration number is unique to the pesticide. It should be given to any doctor or poison control official if someone is exposed to the product. In this example, the *PCP Act* registration number is XXXXX.

**8**. The **name and address of pesticide registrant (manufacturer)** provides information on the company that registered the product in Canada. This label information will allow you to contact the company in case of an emergency. It will also allow the applicator to contact the company with questions on the product.

## Secondary Display Panel

The following is a sample of a secondary display panel: (Numbers indicate label parts, as defined below.)

### PARTS OF THE SECONDARY DISPLAY PANEL

The secondary display panel contains seven parts. These include:

**9. Directions for use**

**10. Precautions**

**11. Disposal instructions**

**12. First aid instructions**

**13. Toxicological information**

**14. Notice to use**

**15. Notice to buyer (limitation of warranty statement)**

**9. Directions for use** provides information on proper product use:

- Pests that can be controlled (e.g., weeds, insects, or diseases)
- Crops on which the product can be used
- Amount of product needed and how it should be mixed
- Application procedure and rate(s)
- Application equipment needed
- How to ensure crop safety, and when the product should not be used
- When to harvest (pre-harvest interval, days to harvest)

10. **Precautions** state hazards that can result from product use. This section explains how to use the pesticide safely. It also states how to protect the user and others when mixing, applying, storing, and disposing of product. Precautionary statements may relate to human health or environmental concerns. They may also relate to application methods, handling, and buffer zones. You will find the child hazard warning "KEEP OUT OF REACH OF CHIDLREN" here for Restricted and Commercial class products. This warning must be on the principle display panel of Domestic class products.

11. **Disposal** gives directions to safely dispose of the product and product containers.

12. **First aid instructions** tell what to do if someone is poisoned or injured by the pesticide. Instructions may, for example, describe what to do if the pesticide is spilled on skin, splashed in the eyes, or swallowed. Read this section of the label carefully before handling a pesticide.

13. **Toxicological information** provides information that may be needed by medical personnel in case of pesticide poisonings or injuries. It may list common signs and symptoms of poisoning. Information may be given on the antidote. Other substances that affect treatment will also be discussed. Provide this information to medical authorities in the event of an accident.

14. **Notice to user** directs the applicator to follow label directions. It is against the law to use a pesticide in an unsafe way.

15. **Notice to buyer (limitation of warranty statement)** states that the buyer accepts all risks of product use. It can also appear as a Seller's Guarantee that states the seller's liability as limited to label instructions.

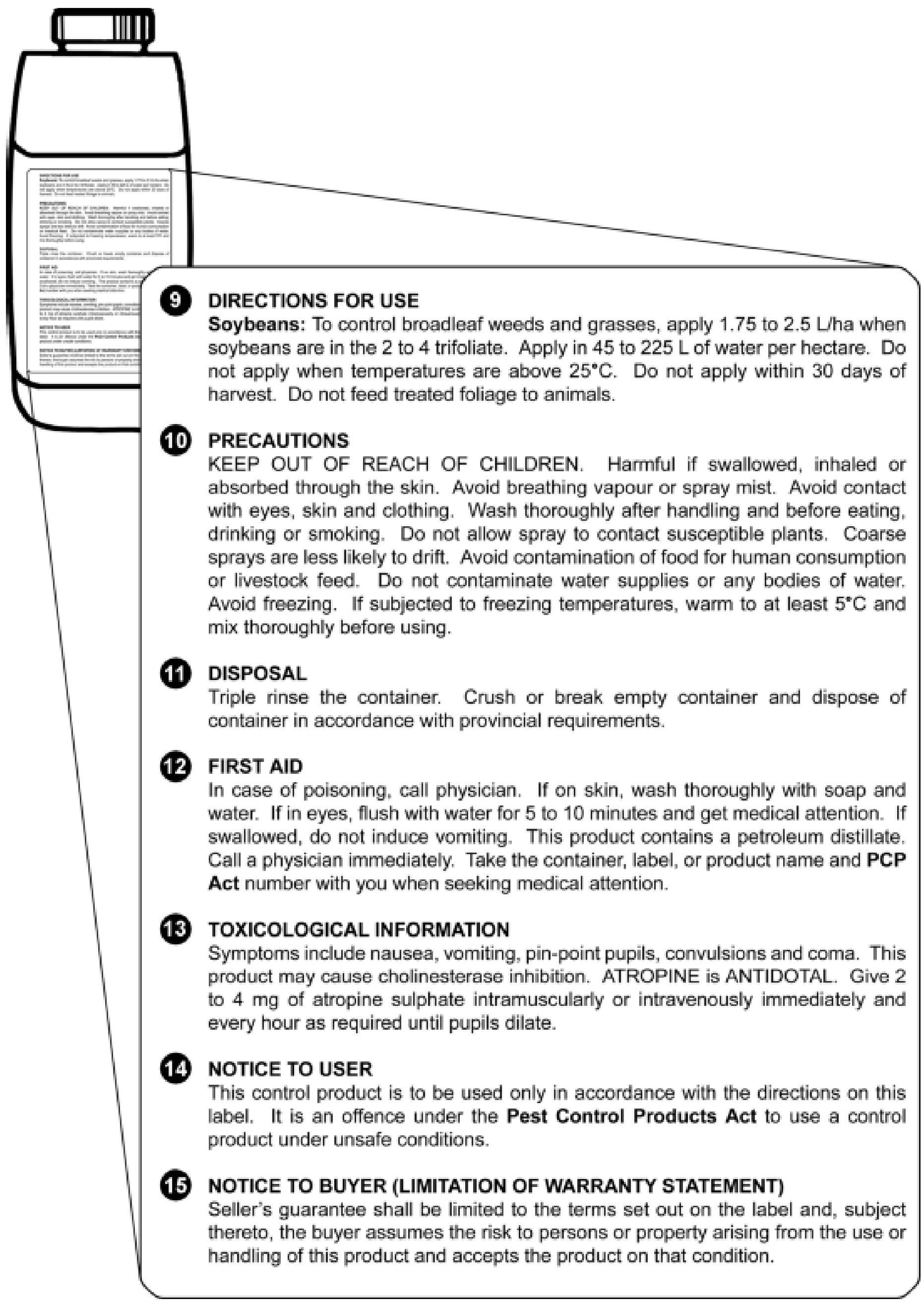
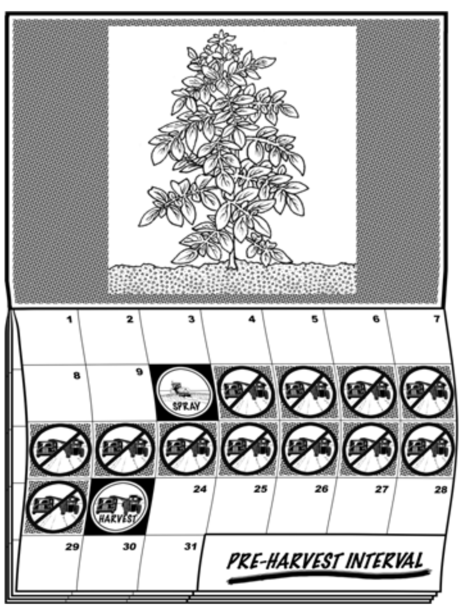



**Figure 3-4: Secondary display panel.**

## Other Label Information

The primary and secondary display panels must at least contain the 15 parts described above. Pesticide display panels can also give more information. This additional information should also be read and understood before using the product. Product labels may provide information on:

- Pre-harvest interval
- Pre-grazing interval
- Pre-slaughter interval
- Re-entry period
- Spill cleanup instructions
- Emergency contact statements
- Environmental hazards
- Buffer zone statements
- Total number of applications per season
- Crop rotation statements
- Storage information
- Steps to reduce drift
- Resistance management statements
- Compatibility
- Soil type precautions




**Pre-harvest interval** is the time that must pass between the last pesticide application and any use of the crop. This might also involve harvesting or cutting for livestock food. Failure to wait this period of time can result in pesticide residue levels above the maximum residue limit (MRL) for that crop. Examples of pre-harvest interval statements include:

- "Do not harvest forage or cut hay within 30 days after application."
- "After application, wait at least 24 hours before harvest."

**Figure 3-5: Some pesticide labels identify a pre-harvest interval to avoid excessive residue levels on the harvested crops.**

**Pre-grazing interval** is the time that must pass between the last pesticide application and using the crop to feed grazing animals. Failure to wait can poison animals, or contaminate their meat or milk. The label statement will vary with the product. Examples of pre-grazing interval statements include:

- "Do not graze or harvest for livestock feed within 7 days of application."
- "Do not permit lactating dairy animals to graze fields within 7 days of application."

**Pre-slaughter interval** is the time that must pass between treatment of an animal with a pesticide, and the slaughter of the animal for food. Failure to wait can contaminate meat and make it illegal to sell as human food. The label statement will vary with the product. Examples of pre-slaughter interval statements include:

- "Withdraw meat animals from treated fields at least 3 days before slaughter."
- "Feed animal untreated diet for 30 days before slaughter."

**Re-entry period** is the minimum time between a pesticide application and the return of workers to a crop area. Label statements can also identify personal protective equipment (PPE) needed for field re-entry. Handling treated plants or going back into the application area too soon can result in poisoning. Examples of re-entry period statements include:

- "Do not re-enter treated areas within 48 hours. If required, individuals may re-enter treated areas within 48 hours for short term tasks not involving hand labour only if at least 4 hours has passed since application; and long pants, long-sleeved shirt, hat, and chemical resistant gloves are worn."
- "Do not enter or allow worker entry into treated areas during the restricted entry interval of four (4) hours."

**Figure 3-6: To guard against pesticide poisoning incidents, do not enter a treated area until the re-entry period has passed.**

**Regional fact sheets and crop production guides can provide more information on re-entry periods for common pesticides.**

**Spill cleanup instructions** are often given on the pesticide label. These vary with the product. Examples of spill cleanup statements include:

- "Wear appropriate protective equipment (gloves, glasses, apron) when attempting to clean up the spill. If the container is leaking, secure leak and place the container into a drum or heavy gauge plastic bag. Contact company (see emergency telephone number) for further information."
- "For spills and leaks; contain the liquid with dykes of inert material (soil, clay, kitty litter, etc.). Absorb the spill onto inert material and shovel into a sealable waste container."

**Emergency contact statements** are printed on the product label. Examples of emergency contact statements include:

- "In case of a major spill or fire, call 1-800-XXX-XXXX."
- "In case of pesticide poisoning, call the Poison Control Centre at 1-800-XXX-XXXX."

**Environmental hazards** are often listed on a pesticide label. If so, they can appear under the "Precautions" section of the secondary panel. However, there is often an added section that lists these risks. The statements will be specific to each product. Examples of environmental hazard statements include:

- "This product is extremely toxic to fish and aquatic vertebrates."
- "This product is very toxic to bees; avoid spraying when bees are foraging. Spray deposit should be dry before bees commence foraging in treated crop."

**Buffer zone statements** appear on a label to tell how to protect areas next to a pesticide application. Only some products have a buffer zone statement on the label. This is determined by the PMRA during product registration. The decision is based on the:

- Organism to be protected
- Amount of pesticide that will affect the organism
- Application methods

The label statement will vary with the product. A buffer zone statement on a label might appear like this:

- "A buffer zone of 100 metres for aerial applications and 15 metres for ground applications to protect surface water bodies including lakes, streams, ponds, or sloughs from drift must be observed."

**Figure 3-7: Many pesticide labels indicate the need to establish buffer zones. Even if a buffer zone statement does not appear on a product label, maintaining a buffer zone may be a regulatory requirement in your province.**

**Total number of applications per season** can be limited for some products due to risk of:

- Food, feed, or soil residues
- Crop damage
- Development of pest resistance

The label will sometimes state a maximum number of applications for one field season. The label statement will vary with the product. Examples of application per season statements include:

- "Do not make more than two (2) applications at 0.75 L or one application at 1.5 L per growing season."
- "Do not make more than four (4) applications, for a total of 2.0 kg applied, per season."

**Crop rotation statements** are sometimes listed on a pesticide label. Pesticides (in particular herbicides) break down slowly in the soil. This can damage crops planted in the field the next year. The label statements will vary with the product. They will often provide information on sensitive crops. Examples of crop rotation statements include:

- "Winter cereals may be planted 4½ months following application."
- "Do not apply this product to any field more often than every second year. This practice must be respected in order to avoid potential injury to future rotational crops, and to minimize the potential for carryover and accumulation of soil residues."

**Storage information** for a product is given on some labels. Pesticides can release toxic vapours, be highly flammable, or react with other chemicals. For example, stored herbicides can emit vapours that contaminate other pesticides. To protect your investment, check pesticide labels for special handling or storing instructions. (See **Chapter 5: Pesticide Safety** for information on the safe storage of pesticides.) An example of a storage information statement is:

"Store this product at least 10 metres (10 m) from other pesticide products".

**Instructions to minimize drift** will explain the steps needed to protect nearby areas. Provincial laws can prohibit pesticide application above or below certain wind speeds. Some pesticide labels set legal wind speeds. The label may also provide direction to reduce drift. Examples of minimizing drift statements include:

- "Do not spray in winds exceeding 10 km/hour."
- "If susceptible plants are growing within a distance of 400 m from the area being treated, spray only when there is a light breeze away from the susceptible plants."
- "Do not apply this product in the vicinity of sensitive crops when the temperature on the day of application is expected to exceed $30^{o}$ C as drift is more likely to occur."

**It is illegal to apply a pesticide if the wind speed is greater than the maximum allowable wind speed printed on the product label.**

**Resistance management statements** are listed on the labels of some pesticides. These statements explain how to avoid pest resistance to a given pesticide. Examples of resistance management statements include:

- “Some naturally occurring populations of weeds have been identified as resistant to this herbicide. Rotate the use of this herbicide with others that have a different mode of action, or use cultural control practices, in order to delay selection for resistant populations of weeds.”
- “Because of the risks of resistance development, it is strongly advised that this product be used in a sound resistance management program that includes the use of other products with different modes of action.”
- “For resistance management purposes, it is recommended that this product is not applied more than twice in sequence or more than six times per crop (annually) or per year for perennials.”

**Compatibility information** advises whether a product is registered and safe for tank mixing with other pesticides. Tank mixes are combinations of different pesticides in the same spray tank. All registered tank mixes will be listed on the label of one, or both, products. Do not tank mix pesticides that are not approved for mixing. Compatibility statements will vary by product. Examples include:

- “This product is compatible with most pesticides; do not mix with lime or other alkaline materials.”
- “Do not use tank mixes containing this product on sweet corn.”
- “Allow 4 days between application of this product and any other product not recommended as a tank mix combination on this label.”

**Soil type precautions** address pesticide residual activity, or the risk of product leaching. The label will sometimes contain statements that limit the soil types on which a product may be used. Examples of soil type precautionary statements include:

- “Do not apply to soils that contain less than 1% organic matter or more than 10% organic matter.”
- “Do not apply the high rate to sandy soils, since leaching could occur.”

## In Review

**The pesticide label is the best source of product information. Before buying a pesticide, always read the label to confirm that the product will fit your pest control needs. Information found on a pesticide label provides detailed product application instructions and personal safety guidelines. It will often provide advice on how to prevent contamination of non-target plants or animals, or the environment. Always read and follow label directions. Remember, the label is a legal document.**

# Pesticide Formulations, Adjuvants, and Tank Mixes

The pesticide label also contains important information about formulations, adjuvants, and tank mix compatibility.

## Formulations

The active ingredients in pesticides are not often used or sold in their chemically pure form. They tend to be mixed with other materials and sold as a pesticide formulation. These occur as solids, liquids, or gases. The same active ingredient can be present in more than one formulation.

Understanding formulations helps in choosing application equipment and selecting the best pesticide for the job. Each formulation has a unique name and abbreviation.

| *Name* | *Description* | *Advantage* | *Disadvantage* |
|---|---|---|---|
| **Liquids** | | | |
| Emulsifiable Concentrate (EC) | Contains the active ingredient, solvent, and emulsifiers. They form milky spray mixtures when mixed with water. | A high concentration of active ingredient in each container. Buy less bulk. | Possibly flammable. |
| Flowable (F) | Consists of solid particles of the active ingredient suspended in a liquid. They must be diluted and constantly agitated to ensure they remain mixed. | A high concentration of active ingredient in each container. Buy less bulk. | Active ingredient may settle out of formulation. |
| Solution (S or SN) | Composed of the active ingredient dissolved in solvents. They are clear in appearance. | A high concentration of active ingredient in each container. Buy less bulk. Requires little agitation when added to water in spray tank. | Possibly corrosive. |

**Table 3-3: Comparing formulations.**

| *Name* | *Description* | *Advantage* | *Disadvantage* |
|---|---|---|---|
| **Solids** | | | |
| Dust (DU) | Dry material made of the active ingredient and inert materials. They are ready to use. | Ready to use. | Dusty. Drifts. Can easily be seen on surfaces treated. |
| Granular (GR or G) | Dry mixture of large, free-flowing particles with a low concentration of the active ingredient. | No mixing required. Ready to use. Drift minimal. | Some dust. Requires special application equipment. |
| Pellet | A mixture of active ingredient and inert ingredients formed into small pieces. | Easy to spot treat for pests. | Children, pets, or wildlife may eat visible pellets. |
| Seed Treatment | A finely ground dry material, which sometimes contains a coloured dye. | May colour seeds. Treated seed is easier to tell from untreated seed. | Care must be taken when handling and planting treated seed. |
| Soluble Powder or Granule (SP/SG) | Dry dust-like material that must be dissolved in a liquid before application. | Containers empty easily. No liquid spills. | Dusty. Requires good agitation. |
| Wettable Powder (WP) | Contains inert dust, and a wetting agent. To use, they are mixed with water to form a suspension. | Containers empty easily. No liquid spills. | Dusty. Requires constant agitation to remain in suspension |

**Table 3-3: Comparing formulations, cont'd.**

| ***Name*** | ***Description*** | ***Advantage*** | ***Disadvantage*** |
|---|---|---|---|
| **Gases** | | | |
| Fumigants | Unstable liquids or solids packaged for release as a gas. | Toxic to many life stages of the pest at one time. Can penetrate cracks and crevices. | Area to be fumigated must be well sealed. Highly toxic. |

**Table 3-3: Comparing formulations, cont'd.**

## Adjuvants

A formulation can also contain one or more adjuvants. An adjuvant is a substance that improves one or more of the pesticide's qualities or promotes better application of the active ingredient. Adjuvants can:

- Improve pesticide effectiveness by helping the active ingredient to stick to the target surface.
- Improve the uniformity of spray droplets to give better coverage.
- Change the pH of tank water to prevent rapid product breakdown.
- Increase or decrease evaporation to improve the drying of spray mixture.

| *Type of Adjuvant* | *Function* |
|---|---|
| 1. Surfactants | Improve the spreading, dispersing, and/or wetting properties of a pesticide mixture. |
| ▪ Wetting agents (type of surfactant) | Allow wettable powders and dry flowables to mix with water and stick on surfaces. |
| ▪ Spreaders (type of surfactant) | Allow pesticides to form an even coating layer over the treated surface. |
| 2. Stickers | Allow pesticides to stay on the treated surface. |
| 3. Drift retardants | Reduce drift. |
| 4. Thickeners | Reduce drift by increasing droplet size. |
| 5. Anti-foaming agents | Reduce foaming of spray mixtures. |
| 6. Buffers | Slow chemical breakdown of some pesticides by lowering the pH of alkaline tank water. |

**Table 3-4: Common adjuvants and their function.**

Adjuvants can be added by the manufacturer or by the applicator when the product is being used. Applicators wishing to add adjuvants must follow label directions. The adjuvant label will list the pesticides and formulations with which it can be safely combined. Pesticide labels also state whether or not adjuvants should be used with a given product.

Using an adjuvant not listed on a pesticide label should be avoided since this can change the product’s effectiveness. This could:

- Lead to unpredictable results
- Result in a need to reapply the pesticide
- Injure the crop or non-target life
- Create extra work or expense

**The use of unregistered adjuvants is illegal under the *Pest Control Products (PCP) Act.***

## Tank Mixes and Pesticide Compatibility

Tank mixes are combinations of different pesticides in the same spray tank. Mixes can increase the effectiveness of each pesticide. Tank mixing can also save time and costs by allowing a number of products to be applied to the same area at the same time. Use only tank mixes that are registered on the pesticide label. The label will provide guidelines for their proper use. It will also provide data on physical compatibility, effectiveness, safety, and residues.

**Physical compatibility information on the label should not be taken as a recommendation for tank mixing.**

Improper tank mixing is unwise and illegal. Mixing pesticides that are not compatible can reduce their effectiveness, injure the treated crop, or cause solids to settle out. If solids settle out, they can create a sludge that cannot be sprayed. These solids will often plug sprayer nozzles, or damage equipment and leave it hard to clean.

### In Review

**Pesticide label information is developed through laboratory and field testing. Be familiar with label instructions before buying, mixing, applying, or storing a pesticide.**

**Information on pesticide formulations also appears on the label of each product. There are many pesticide formulations. You should know the pros and cons of each. Assessing these will help you to select the best formulation to control pests.**

**Adjuvants improve pesticide effectiveness. Check both the pesticide and adjuvant labels. This will confirm their compatibility for mixing, and avoid the hazards and costs of misuse. It is illegal and unsafe to mix pesticides that are not compatible. This can also damage application equipment.**

# SECTION B: MATERIAL SAFETY DATA SHEETS

The Material Safety Data Sheet (MSDS) provides additional information that is not included on the product label. This information can include health hazards, safety precautions, and guidelines to protect the environment.

Pesticide applicators should have a product label and MSDS on file for each pesticide product that they use.

### Learning Objective

**Completing this section will help you to:**

- **Source, interpret, and apply Material Safety Data Sheet (MSDS) information.**

# Material Safety Data Sheets (MSDS)

Commercial (Agricultural or Industrial) or Restricted class pesticide labels will sometimes refer you to their MSDS. The MSDS will provide information that is often not on the label. This can include:

- Health hazards
- Personal safety precautions
- Safeguards for environmental protection

The MSDS usually contains nine sections:

1. **Product identification –** This provides the trade name, chemical name, and primary use of the product. It also lists the name, address, and emergency telephone numbers of the manufacturer and supplier.
2. **Hazardous ingredients –** This explains what active ingredient(s) the product contains. It can also list other ingredients. It includes the chemical registration numbers and transportation class for the product.
3. **Physical data –** This includes details on appearance, odour, specific gravity, pH, and boiling point.
4. **Occupational procedures and preventive measures –** This explains what personal protective equipment should be used (e.g., for eye, skin, or respiratory protection). It outlines steps for safe product handling and storage.
5. **First aid and emergency procedures –** This explains what to do if someone is exposed to the product. Always call for medical help in an emergency.
6. **Fire and explosion hazard –** This states the temperature of the flash and ignition points for the product. Steps are provided for fighting a fire that involves the product.
7. **Toxicity and health effects –** This explains the risk to human health from exposure to the pesticide. Results of the manufacturer’s research on the product are outlined. This toxicological data can help medical personnel deal with a pesticide emergency.

| MATERIAL SAFETY DATA SHEET | Company XYZ Emergency number - 24 hours: 519-674-SSSS |
|---|---|

**Chemical Product and Company Identification**

| | |
|---|---|
| **Product Identifier:** | CONTROL-ALL 500 EC |
| **Registration Number:** | 54321 |
| **Chemical Class:** | aromatic hydrocarbon solvent 40% |
| **Product Use:** | herbicide to control broadleaf weeds and grasses |
| **Preparation Date:** | 2004/05/21 |
| **Supercedes:** | 2002/08/11 |
| **Manufacturer/Distributor:** | see above |

**Composition/Information on Ingredients**

| | |
|---|---|
| **Active Ingredient:** | monolochlor, 500 g/L emulsifiable concentrate |
| **CAS No:** | 10101-22-3 |
| **Chemical Identity:** | 3-(1-methylethyl)-2H-2,1-monolochlor |

**Hazards Identification**

**Warning Statements:**
PRECAUTION! Keep out of reach of children. MAY CAUSE EYE AND SKIN IRRITATION. HARMFUL IF SWALLOWED. This product is slightly toxic to fish and aquatic invertebrates.

**Potential Health Effects:**
Likely routes of exposure: eyes, skin, lungs, mouth
Eye contact: may cause eye irritation
Skin contact: may cause skin irritation. Prolonged contact may cause increased skin irritation.
Inhalation: may cause irritation to the nose, throat and lungs.
Ingestion: ingestion may produce irritation of the mouth, nausea, vomiting and diarrhea.
Refer to section 11 for toxicological information.

**First Aid Measures**

| | |
|---|---|
| **Skin Contact:** | Immediately remove contaminated clothing and wash affected skin with soap and water. |
| **Eye Contact:** | Flush eyes with plenty of water for 15 minutes and seek medical advice immediately. |
| **Inhalation:** | Remove victim to fresh air and if breathing has stopped, give artificial respiration. Seek medical attention. If swallowed, do not induce vomiting but rush victim to nearest hospital taking the container or this sheet with you. |
| **Ingestion:** | Use gastric lavages and saline cathartics. |
| **Storage Precautions:** | Do not handle or store near flame, heat or strong oxidants. Do not store near food or animal feed. Avoid freezing temperatures. |

**Figure 3-8: MSDS.**

| MATERIAL SAFETY DATA SHEET | Company XYZ<br>Emergency number - 24 hours: 519-674-SSSS |
|---|---|
| **Fire Fighting Measures** | |
| **Flash Point and method:** | 70°C Setaflash closed cup |
| **Ignition Point:** | N/D |
| **Extinguishing Media:** | Dry chemical, foam or carbon dioxide. Water or foam may cause frothing when applied to flammable liquids with flash points above 100°C. Fire-fighters should wear full protective clothing and self-contained breathing apparatus. |
| **Accidental Release Measures** | |
| **Procedures for dealing with release or spills:**<br>Before handling any spills, wear protective equipment - see section 8. For small spills, absorb with sand or other non-combustible material like clay or kitty litter. For large spills, dike up and contain the spill. Collect into a suitable container. Absorb the rest with sand, earth or clay. Decontaminate the area and equipment with laundry bleach or hydrated lime. | |
| **Handling and Storage** | |
| **Handling Practices:**<br>Keep Out of Reach of Children. Avoid contact with eyes, skin or clothing, and wash immediately after exposure. Avoid contact with eyes, skin or clothing, and wash immediately after exposure. Avoid inhalation of spray. Always wash thoroughly after handling. Remove contaminated clothing promptly, and wash it before wearing again.<br>**Appropriate storage practices:**<br>Store in a well-ventilated, secure area set aside for pesticides. Do not store food, beverages, or tobacco in the same area. Protect from heat. | |
| **Exposure Control/Personal Protection** | |
| **Personal Protective Measures:** | Wear respirator; neoprene gloves; goggles or face shield |
| **Preventative Measures:** | Do not smoke, eat or drink while working with this product and wash thoroughly before doing so. |
| **Technical Protective Measures:** | Avoid breathing vapours, ventilate enclosed spaces and wear cartridge type respirator. |
| **Special Precautions for Transport:** | Keep containers tightly closed when not in use. |
| **Physical and Chemical Properties** | |
| **Appearance:** | clear, viscous, yellow |
| **pH:** | 8 - 8.5 |
| **Odour:** | aromatic odour |
| **Form:** | liquid |
| **Water Solubility:** | miscible EC formulation |
| **Boiling Point:** | 86°C |
| **Specific Gravity:** | 1.002 |

**Figure 3-8: MSDS, cont'd.**

| MATERIAL SAFETY DATA SHEET | Company XYZ<br>Emergency number - 24 hours: 519-674-SSSS |
|---|---|
| **Stability and Reactivity** | |
| Chemical Stability: | stable |
| Hazardous Polymerization: | will not occur |
| Incompatibility: | Avoid contact with strong acids, alkalis, and strong oxidants; nitric acid, acetaldehyde, hydrogen peroxide, chlorinated compounds. |
| Hazardous Decomposition Products: | Thermal decomposition may produce toxic smoke, CO and $CO_2$. |
| **Toxicological Information** | |
| Acute Oral $LD_{50}$: | 756 mg formulated product/kg body weight (rats) |
| Acute Dermal LD50: | 1480 mg formulated product/kg body weight (rats) |
| Inhalation LC50: | >3.63 mg/L air (4 hour) (rats) |
| Dermal Irritation: | mild irritant (rabbits) |
| Dermal Sensitization: | Dermal sensitization, Guinea pig - not a sensitizer |
| Carcinogenicity: | Monolochlor was found not to be carcinogenic in studies with rats and mice. |
| Reproductive toxicity: | Monolochlor is not developmentally toxic, and does not affect reproductive performance. |
| Teratogenicity: | Monolochlor was not teratogenic in a study with rats. |
| **Ecological Information** | |
| **Aquatic Invertebrates:** | 48-hr EC50 Daphnia magma: 24-37 mg/L; slightly toxic |
| **Warmwater Fish:** | 96-hr LC50 Bluegill sunfish: 5.8-14 mg/L; slightly to moderately toxic |
| **Terrestrial Invertebrates:** | 48-hr LD50 Honeybee: >0.1 mg/bee; Practically Nontoxic |
| The results of degradation and bioconcentration studies with this material indicate that the active ingredient is rapidly adsorbed to soil, readily biodegrades in soil and water, and does not bioaccumulate. | |
| **Disposal Considerations** | |
| **Waste Disposal:**<br>Treatment, storage, transportation, and disposal must be in accordance with applicable Federal, Provincial, and local regulations. Do not flush to surface water or sanitary sewer system. Triple rinse the container. Offer for recycling or reconditioning or puncture and dispose of in a sanitary landfill in accordance with the provincial and local regulations. Do not re-use empty containers. | |
| **Transport Information** | |
| **TDG Classification – Road/Rail:** not regulated | |

**Figure 3-8: MSDS, cont'd.**

| MATERIAL SAFETY DATA SHEET | Company XYZ<br>Emergency number - 24 hours: 519-674-SSSS |
|---|---|
| **Regulatory Information** | |
| Regulated under the **Pest Control Products Act**. WHMIS classification: Exempt<br>This MSDS has been prepared in accordance with WHMIS requirements and the data are presented under 16 headings. | |
| **Other Information** | |
| The above information is intended to describe our product in respect to safety and handling requirements only. We have attempted to be complete and correct however liability for any damage or injury is hereby declined since conditions of use and utilization of the product are beyond our control. Observance of all legal requirements is the responsibility of the user. | |

**Figure 3-8: MSDS, cont'd.**

8. **Reactivity data –** This identifies any special chemical properties of the pesticide. It provides the proper storage temperature.

9. **Preparation data and group –** This states who prepared the MSDS and when. An MSDS must be updated at least every three years.

# Sources of Labels and Material Safety Data Sheets

When pesticides are sold, a complete and readable label should be attached to each container. Pesticide labels often refer to the product's MSDS. Applicators should have a copy of and review the MSDS for any product they use.

An MSDS will sometimes be supplied at the time of product purchase. The pesticide vendor or product manufacturer can supply replacement labels and MSDS. Other sources of labels and MSDS include:

- **Pest Management Regulatory Agency – provides a searchable index of all labels for pesticides registered in Canada.**
  **www.hc-sc.gc.ca/pmra-arla/english/index-e.html**

- **Crop Life Canada – provides links to the Web sites of its members (agricultural chemical manufacturers), where particular labels and MSDS may be available.**
  **http://www.cropro.org/english/aboutcpi/members.cfm**

- **Canadian Centre for Occupational Health and Safety (MSDS only)**
  **http://www.ccohs.com/**

# Case Study: The Consequences of Using Off-label Rates

Robert is a former tobacco farmer. Lately, he has been branching out into new crops and is planning to grow potatoes. He is renting 100 hectares of land for his potato crop.

Robert does not know the best way to deal with some potato pests. He needs advice to control European corn borer. He has heard about the problems and damage caused by this insect. Robert knows that insecticides are a common option. He is not familiar with all insecticides registered for use on potatoes. Robert also knows that insecticides can be harmful if they are not used properly.

Robert checks the Internet. He looks at a number of web sites for major agri-chemical companies. He hopes to find information or reviews on insecticides registered for use on potatoes. Most web sites provide a sample label of each available insecticide.

Robert reads the labels of a number of common insecticides and finds useful information. Each label lists:

- The active ingredient of the pesticide
- Proper application rates for various crops
- Safety precautions when using the pesticide

Based on this information, Robert decides that he will buy a carbamate insecticide to control European corn borer in his potato crop. However, before buying this product, Robert attends a provincial grower meeting. At the meeting he talks to Joe, a local potato farmer with 20 years of experience. Joe is well known in the industry. Robert asks Joe for his thoughts on controlling corn borer. Joe is not familiar with the product that Robert has chosen and suggests another carbamate insecticide. He also recommends that Robert use a bit more of the product than the application rate called for on the label. Joe agrees that the product is cheap, and a higher application rate might give better corn borer control.

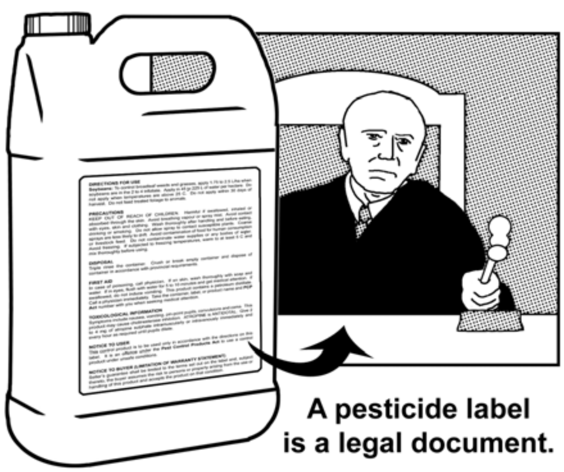
One of Robert's fields soon reaches the threshold level for corn borer. He is getting ready to make his first insecticide application. However, Robert feels nervous about the information Joe gave him. To double check, Robert contacts a professional crop consultant for more advice.

The crop consultant points out that a pesticide label is a legal document. Using a product outside of the label directions is not legal. The consultant also tells Joe that he must never use an application rate different from that on the product label because:

1) Off-label rates can cause pesticide residues in potato tubers to exceed safe limits. This will result in a crop that is a risk to human health or cannot be sold.

2) Off-label rates, especially when lower, can result in insecticide resistance in an insect population. This will make it more difficult to control insects in the future.

3) Off-label rates can be a hazard to non-target organisms like fish or beneficial insects. Runoff water can carry the pesticide into watercourses. Pesticide particles can also drift off target.




Based on this information, Robert decides not to follow Joe's advice. He will not increase the label application rate. Robert now knows that the label rate is provided to reduce risk to humans and the environment. Applied at the label rate, the insecticide will still provide a good level of pest control.

Robert decides to use the approved label rate and monitor his field to see if another insecticide application is needed. If it is, he will use a product from a different chemical family. Robert contacts Joe to advise him that it is not legal to exceed the label application rate. He points out that it also shows poor crop management.

Robert understands that there are risks involved in using pesticides. He does not want to cause a fish kill, environmental damage, insect resistance, or a human health hazard. Robert knows that label application rates are based on sound scientific research. Following label rates is both a legal requirement and a good idea.

# Self-study Questions

*Answers are located in Appendix A of this manual.*

1. Pesticide labels display hazard symbols and warning signal words. Match each hazard symbol with its proper warning signal words by placing the correct letter a, b, c, d, or e) in the blank space accompanying each of the four symbols below.

    a) poison
    b) caution flammable
    c) caution explosive
    d) caution corrosive
    e) warning corrosive

 ______________

 ______________

 ______________

2. Match the word with the correct definition (not all definitions will be used).

    a) formulation
    b) tank mix
    c) adjuvant

____ the form in which a pesticide is typically purchased
____ combinations of different pesticides in the same spray tank
____ a substance designed to reduce drift
____ a substance that enhances a pesticide’s qualities or promotes its more effective application

3. The parts of the pesticide label include:

   a) the front or primary display label
   b) the material safety data sheet (MSDS )
   c) the back or secondary display panel
   d) all of the above
   e) a and c only

4. A pesticide label is lost or you can no longer easily read it, you must:

   a) dispose of the remaining product in a safe manner
   b) store the product until a hazardous waste pick-up is arranged
   c) contact your supplier for a replacement label and place the new label on the package
   d) contact your local agriculture representative for appropriate uses and use rates
   e) refer to provincial guides or trade sheets for appropriate uses and use rates

**5.** Pesticide labels may contain instructions to minimize drift. If a label states Do not spray in winds exceeding 10 km/hour you should:

   a) ignore the instructions because provincial regulations allow the application of pesticides up to a wind speed of 25 km/hour
   b) follow the label instructions because the label is a legal document and it always takes priority over any other document or legislation
   c) consult the MSDS for additional information about wind speed limits
   d) contact the PEI Department Environment, Energy and Forestry for advice

Chapter

4

# HUMAN HEALTH

Most pesticides are poisonous to people. A good pest control plan will protect the health of all who come in contact with these products. You should know the risks of pesticide use, and how these products enter the body.

You should know how to use toxicity information to make decisions on pesticide use. You should also know the symptoms of pesticide poisoning.

An applicator should protect him/herself and others from the health risks of pesticide use.

## Learning Objectives

**Completing this chapter will help you to:**

- **Identify the routes and sources of pesticide exposure.**
- **Identify the causes of pesticide poisoning.**
- **Interpret and apply pesticide label information on toxicity.**
- **Calculate and assess risk (exposure X toxicity).**
- **Recognize the symptoms of pesticide poisoning.**
- **Identify how toxicity relates to pesticide families.**
- **Identify the value of a cholinesterase blood test.**

# Pesticide Risk

Risk of exposure exists any time that a pesticide is handled. You should know how to measure, assess, and reduce risk.

**PESTICIDE RISK = Level of exposure to a pesticide X toxicity of the pesticide.**

- **Exposure** is the amount of contact with a pesticide.
- **Toxicity** is a measure of how harmful or poisonous a pesticide is (e.g., how it can cause human injury, sickness, or other unwanted effects).

Risk increases with product toxicity or level of exposure. Risk decreases as product toxicity or level of exposure is reduced.

Risk can be reduced by choosing a less toxic product, reducing exposure to the product, or both. Product toxicity cannot be changed. You will have to reduce exposure to a product to reduce the risk associated with its use. Selecting and using proper personal protective equipment (PPE) will also help to reduce exposure.

To assess the risk of a pesticide, you will need to interpret product toxicity information. Toxicity can be acute or chronic.

## Routes and Sources of Exposure

The three routes of exposure are:

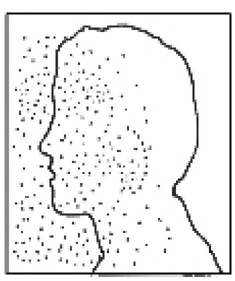
- Absorption through the skin (dermal) or eyes (ocular)
- Ingestion or oral exposure
- Inhalation or respiratory exposure

| *Type of contact* | *Route of exposure* |
|---|---|
| Absorption | Taken in through the skin (dermal) at any place on the body |
| | Taken in through the eyes (ocular), nose, or other mucous tissue |
| Ingestion | Taken in through the mouth |
| Inhalation | Breathed in through the nose and mouth |

**Table 4-1: Routes of pesticide exposure.**

## Absorption

Some pesticides can be absorbed when they contact the skin or eyes. They can then travel throughout the body. This depends on body chemistry and the health of the exposed person. The absorption rate is the speed at which the body absorbs a pesticide.



### DERMAL (SKIN) EXPOSURE

The most common exposure route involves pesticides getting into the body through the skin. The amount of pesticide absorbed depends on:

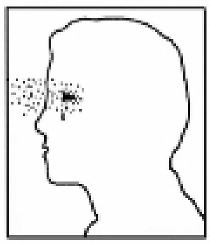
- Skin condition
- The body part exposed to the pesticide
- The type of pesticide

The absorption rate is often faster if the pesticide enters the body through cuts, scrapes, or other breaks in the skin. It is also faster if the skin is wet or sweaty. Absorption tends to be greater the longer you are exposed to the pesticide.

Human skin varies in thickness and sensitivity. This gives some parts of the body a faster absorption rate. The head, small of the back, armpits, and groin are the most absorptive. Some pesticide formulations are more readily absorbed than others.

Using proper personal protective equipment can reduce risk of dermal exposure. Wash your hands often when handling or applying pesticides. This minimizes exposure. Measures to reduce dermal exposure are discussed in **Chapter 5: Pesticide Safety.**

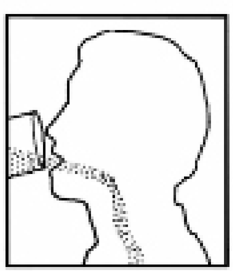
## OCULAR (EYE) EXPOSURE



Eyes absorb pesticides very easily. Your eyes need special protection. Some pesticides only irritate the eyes. Others can cause short- or long-term damage, including blindness. Eye damage can result from product spills, splashes, or drift. Pesticides can get into the eyes when you rub them with contaminated hands, gloves, or clothing.

Wear proper eye protection such as goggles or a splash shield. This will help to prevent ocular exposure. Concentrated products are often handled when moving pesticides or loading application equipment. These activities pose a particularly high risk to the eyes. Measures to prevent eye exposure are covered in **Chapter 5: Pesticide Safety.**

## Ingestion (Mouth)



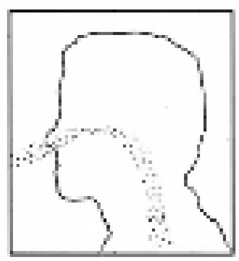
Poisoning can occur when pesticides are swallowed or enter the body through the mouth. This happens when a pesticide is placed in food or drink containers, and is then consumed by mistake. Smoking, eating, or drinking while you are applying a pesticide can also lead to ingestion. Poisoning can result when pesticide splashes into the mouth during mixing, application, or cleanup. Wiping the mouth with a contaminated hand, glove, or clothing can poison an applicator.

Ingestion poses a serious poison hazard because the stomach and intestines quickly absorb chemicals. Ingested pesticides can burn the mouth, throat, and stomach.

The best way to reduce the risk of ingesting pesticide is to make sure that products are stored in original, labeled containers. Wash your hands often when using pesticides. Measures to prevent ingestion are covered in **Chapter 5: Pesticide Safety**.

## Inhalation

Poisoning can result if pesticides enter the body through the airways and lungs.



Most pesticide particles are too large to enter the lungs. But, they can build up in the nose and nasal passages. Pesticide particles can also enter the body through saliva in the mouth. Small spray droplets pose a greater hazard than large droplets when inhaled. These can be breathed into the lungs. Once a pesticide enters the lungs, it is almost fully absorbed into the bloodstream. Inhalation is the greatest poison hazard when using fumigants.

Use a well-maintained respirator when handling pesticides, and avoid smoking. This will reduce the risk of breathing in chemicals. Safety measures to prevent inhalation are covered in **Chapter 5: Pesticide Safety.**

### In Review

**Pesticides can enter the body by being absorbed through the skin and eyes. They can be ingested through the mouth. They can be inhaled into the lungs. Pesticide exposure can occur at any stage of pesticide use. This includes:**

- **Moving**
- **Storing**
- **Handling**
- **Mixing**
- **Loading**
- **Application**
- **Equipment cleanup**
- **Equipment maintenance**
- **Entry into a treated area**

Those at risk include applicators, farm workers, and others in the area. Take care at all stages of pesticide use. This reduces the risk of exposure.

**The greatest risk of pesticide exposure occurs when mixing and loading concentrated products.**

## Toxicity

Toxicity is the ability of a product to cause injury or sickness. Toxicity can be described as acute or chronic.

### Acute Toxicity

Acute toxicity results from one or more exposures to a pesticide in less than 24 hours. Effects are often short-term. Acute toxicity symptoms include nausea, headache, dizziness, rash, and vomiting.

### Chronic Toxicity

Chronic toxicity results from a number of exposures to small pesticide doses. This takes place over a period of more than one day (24 hours). Chronic effects are often permanent. These may not show for many days, months, or years after exposure. Chronic effects include cancer, tumors, reduced body weight, skin irritation, and birth defects.

**Acute toxicity**

- **Exposure less than 24 hours**
- **Can be reversed**

**Chronic toxicity**

- **Exposure more than 24 hours**
- **Often permanent**

Chronic effects often occur:

- As a complication of acute exposure
- As a condition with slow progress
- As harmful effects years after exposure

A number of small acute pesticide poisonings can lead to long-term damage or life threatening illness. You will need to reduce product exposure to avoid pesticide poisoning. One way to do this is by using personal protective equipment.

# Label Information

Pesticide labels often use symbols and words to warn the applicator of acute effects of product exposure. (See **Topic 3: Labelling.**) Symbols on the label do not give information on chronic pesticide toxicity. The label does provide information on the product's acute toxicity level. It can also have a written warning on the chronic effects of product exposure.

## Lethal Dose 50% ($LD_{50}$)

Lethal Dose 50% is the dose that will kill 50% of exposed test animals within a given time (24 hours to 7 days). This is a measure of pesticide toxicity.

Pesticides can enter the body by three routes. The $LD_{50}$ for each route must be measured and given in proper units for the method of exposure. For a given pesticide, toxicity can be low for one route of entry, yet high for another. You will have to know these values to find a pesticide's toxicity.

**Inhalation $LC_{50}$** is the concentration (in parts per million) of vapour that will kill 50% of test animals when inhaled over a given time period.

**Oral $LD_{50}$** is the amount of substance (mg per kg of body weight) that will kill 50% of test animals when ingested (swallowed).

**Dermal $LD_{50}$** is the amount of substance (mg per kg body weight) that will kill 50% of test animals when applied to the skin.

Information on $LD_{50}$ levels is printed on a product's Material Safety Data Sheet (MSDS). It can also be obtained from the manufacturer.

| Type of $LD_{50}$ | Method of Exposure | Expressed as: |
|---|---|---|
| Oral $LD_{50}$ | Swallowing | mg/kg* |
| Dermal $LD_{50}$ | Absorption through skin | mg/kg* |
| Inhalation $LC_{50}$ | Breathing into lungs | parts per million |

***Milligrams of active ingredient (a.i.) per kilogram of body weight.**

***Example***

**Look at the Oral $LD_{50}$ values for the pesticides below:**

- **Metam (Vapam) is a highly toxic pesticide when swallowed. It requires only 97 mg/kg (of body weight) to kill 50% of test animals in a given time period.**
- **MCPA is less toxic. It requires 700 to 1,000 mg/kg (of body weight) to kill 50% of test animals in a given time period.**
- **Glyphosate (Roundup) is the least toxic pesticide listed. It requires 4,320 mg/kg (of body weight) to kill 50% of test animals in a given time period.**

| Pesticide (active ingredient) | Oral $LD_{50}$ (mg/kg) | Toxicity |
|---|---|---|
| Metam (Vapam) | 97 | high |
| MCPA | 700 – 1,000 | medium |
| Metribuzin (Sencor, Lexone) | 1,937 – 2,345 | low |
| Glyphosate (Roundup) | 4,320 | low |

**Some people believe that insecticides and fungicides pose a greater danger than herbicides. However, the acute poisoning risk from a pesticide cannot be judged only on the target pest group. A product's $LD_{50}$ is the <u>only</u> good measure of toxicity.**

## Product Formulation

A pesticide's formulation can affect its level of risk. Some adjuvants, such as emulsifiers, will quicken the rate at which pesticides pass through the skin.

Emulsifiable concentrates (EC) have solvents that can increase their rate of absorption into the body. This makes them easier to absorb than granular pesticides.

Stickers will allow spilled product to stick to skin, clothing, and PPE. This can result in longer periods of human exposure. Spreaders and wetting agents often cause a pesticide to spread out quickly. This will contaminate larger surface areas.

### In Review

**Many pesticides can be poisonous to people. Products vary in toxicity. Toxicity can be acute or chronic. The measure of acute toxicity is expressed as the lethal dose 50% ($LD_{50}$). This measure is used to assess the risk of a pesticide product. The pesticide formulation can also affect its level of risk. The label provides a product's toxicity information. Check the label to assess risk.**

# Pesticide Poisoning

When handling and using a pesticide, steps should be taken to avoid exposure. However, accidents will still happen. You should review poisoning symptoms on the pesticide label before using any pest control product. This will help you to identify and interpret signs of poisoning. You can then react properly. Each product can affect a person differently. You should know the poisoning symptoms for each pest control product that you use.

**Always read the toxicological section of the label before using a pesticide. This lists poisoning symptoms. Knowing these symptoms will help you to quickly identify a poisoning. You will then be able to take proper action if a poisoning should happen.**

Pesticide poisoning can be confused with symptoms of food poisoning, asthma, flu, heat exhaustion, or another illness. If someone is exposed to a pesticide, and any of these symptoms begin to show, **seek medical help at once**.

Acute pesticide poisoning can occur after one exposure to a product. Symptoms can appear within a few minutes, or they may not show for up to 96 hours after exposure. Chronic poisoning occurs after a number of exposures to a pesticide over a long time.

## Sensitivity Response

Some people are sensitive to pesticides. One person might show symptoms from a single exposure. Another person might not be affected. Likewise, a person might show no effect from a pesticide when first exposed. Months later, when exposed again, that person can become ill. Keep track of the chemicals that you use or to which you are exposed. This will help you to tell if you are developing sensitivity to any of them.

Sensitivity can show through rashes, headaches, watering eyes, itchy skin, or breathing problems. For example, some pesticides cause dermatitis (skin irritation) when used in bright sunlight. Watch for this reaction if using pesticides such as captan, trifluralin, and atrazine.

Those at risk of exposure include the applicator and anyone in or around the application area. This includes fellow workers, neighbours, people passing by, and persons who enter the treated area (e.g., crop scouts).

Read the toxicological section of the label before using a pesticide. This will help you to recognize symptoms of pesticide poisoning. You can then react in the proper way. Poisoning symptoms can be acute or chronic. Symptoms of acute poisoning appear up to 96 hours after exposure. Symptoms that appear much later are signs of chronic poisoning.

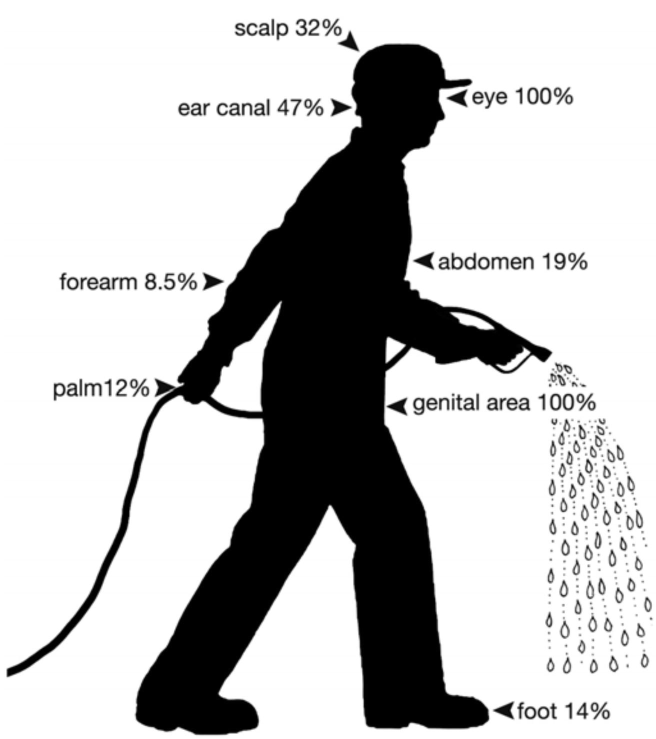



**Figure 4-1: Pesticide absorption rates vary depending upon the body part exposed.**

## Common Symptoms of Pesticide Poisoning

### Mild Symptoms

| | |
|---|---|
| Headaches | Perspiration |
| Fatigue (feeling tired) | Diarrhea |
| Loss of appetite | Loss of weight |
| Dizziness | Thirst |
| Weakness | Moodiness |
| Irritation of the skin, nose, or throat | |

### Moderate Symptoms

| | |
|---|---|
| Nausea | Stomach cramps |
| Trembling | Vomiting |
| Loss of muscular co-ordination | Diarrhea |
| Excess saliva | Mental confusion |
| Blurred vision | Sweating |
| Tightened throat or chest | Rapid pulse |
| Laboured breathing | Cough |
| Flushed or yellow skin | |

### Severe Symptoms

| | |
|---|---|
| Vomiting | Pinpoint pupils |
| Loss of reflexes | Convulsions |
| Increased breathing rate | Unconsciousness |
| Inability to breathe | Thirst |
| Muscle twitching | Fever |

### In Review

**Pesticide poisoning symptoms can vary from person to person. Symptoms will also depend on the:**

- **Product involved**
- **Level of exposure**
- **Route of exposure**
- **Source of exposure**
- **Health of the person involved**

**Some people can show poisoning symptoms after only a limited exposure.**

# High Risk Pesticide Families

Pesticides are often grouped into chemical families. Products within the same family can produce similar toxic effects. Some families are more toxic than others. Applicators should know the chemical families of the pesticides they are using. This will help them to handle and use them properly.

## 1. Chlorinated hydrocarbons (CH)

**Examples**: methoxychlor (Methoxychlor, Marlate)
endosulfan (Thiodan, Endosulfan)

Chlorinated hydrocarbons can produce chronic poisoning by building up in fatty body tissue. Often, this results from a number of small exposures over time. The time it takes for poisoning to occur depends on the dose, frequency, and duration of the exposure. Chlorinated hydrocarbons are known to act on the nervous system. It is not yet known how this occurs.

## 2. Organophosphates (OP)

**Examples:** azinphos-methyl (Guthion, AZM, Sniper)
chlorpyrifos (Lorsban, Pyrinex),
diazinon (Basudin, Diazinon)
malathion (Malathion),
dimethoate (Cygon, Lagon)
methamidophos (Monitor)

Organophosphates can cause acute poisoning. They can also cause chronic poisoning in some individuals. These products affect the nervous system by reducing cholinesterase levels in the blood. (See **Cholinesterase Blood Testing** later in this chapter.) The degree of poisoning depends on the rate that the pesticide is broken down in the body. A pesticide will not cause severe damage if it breaks down quickly. There is little long-term effect unless exposure continues. Chronic poisoning is most likely to occur from working in a poorly ventilated pesticide storage area.

## 3. Carbamates (C)

**Examples**: carbaryl (Sevin),
methomyl (Lannate),
carbofuran (Furadan)
pirimicarb (Pirimor)

Carbamate insecticides can cause acute poisoning. These also affect the nervous system by reducing the level of blood cholinesterase. Cholinesterase levels recover quickly after carbamate exposure and the effect is short-lived. Both carbamates and organophosphates affect blood cholinesterase levels. However, organophosphates create a longer and more detrimental effect.

## Other Pesticide Families

Some pesticides that do not belong to the three chemical families above can also have high acute toxicities. The herbicides diquat (Reglone) and paraquat (Gramoxone) belong to the **bipyridylium** family. These can cause death if enough product is swallowed, inhaled, or absorbed through the skin.

Pesticides from the same chemical family often have similar toxic effects. Products from three chemical families are frequently involved in pesticide poisonings. You should be able to recognize those chemical families that can cause severe toxic effects and know how to prevent or deal with poisoning.

## Cholinesterase Blood Testing

Cholinesterase is an enzyme found in the blood. Interfering with the levels of cholinesterase will affect messages being sent by the brain to various parts of the body. This can cause trembling, twitching, convulsions, or trouble with breathing and the heart. It can even cause death in severe cases.

Some chemical families (organophosphates and carbamates) can reduce the work of cholinesterase in the body. People who regularly handle or apply pesticides from these families should be familiar with their normal cholinesterase levels. Have a doctor arrange blood tests to measure the level of this enzyme in the body. The first test should be taken before handling, using, or being exposed to these pesticides. This provides a normal (or base) level of cholinesterase.

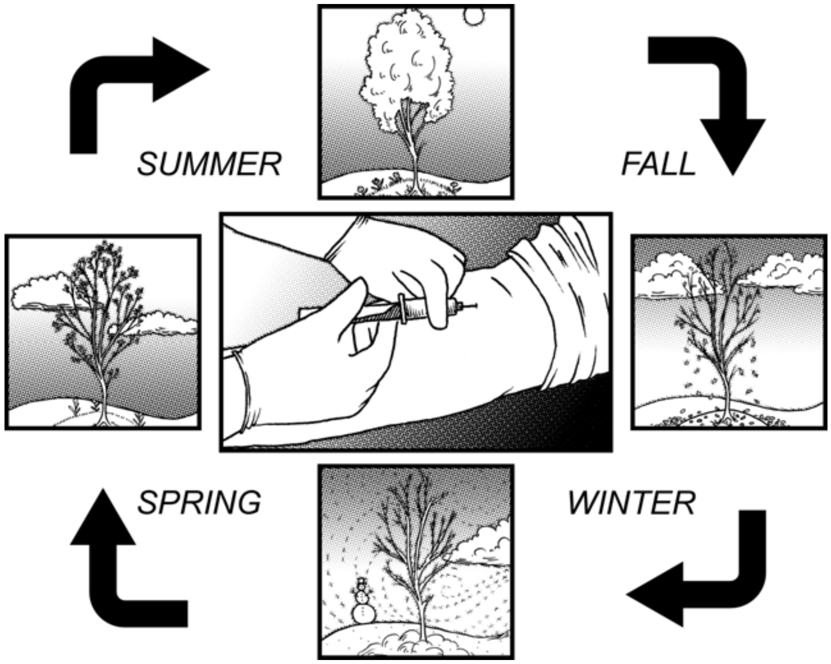



**Figure 4-2: Regular monitoring is needed to assess the levels of cholinesterase in blood.**

**Have a cholinesterase blood test every seven to 10 days if applying organophosphate or carbamate insecticides regularly for a number of weeks.**

Early detection of unacceptable exposure avoids chronic poisoning and its symptoms. If the cholinesterase level after exposure is less than one-half of the baseline level, individuals may be showing signs of poisoning. These people must be removed from further exposure to organophosphate or carbamate insecticides. They should wait until their cholinesterase blood levels return to normal. To determine this, they should continue to regularly monitor their blood.

## In Review

**Cholinesterase is an enzyme needed for proper nerve function. Organophosphate and carbamate insecticides affect the body's level of cholinesterase. Take extra care if using these products, and have regular blood tests to check cholinesterase levels.**

# Case Study: Preventing Human Exposure to Pesticides

Tom is a young man with a keen interest in farming. He has taken a summer job at a local vegetable farm that grows 100 hectares of cole crops. As his first task, Tom cares for transplants in the greenhouse. When the transplants are mature, he helps to plant them in the field.

Trays of young transplants are routinely drenched with insecticide. The trays are then allowed to drip-dry in the greenhouse before they are moved to the field. This pesticide application is needed to prevent insects from destroying the small plants.

The insecticide used to drench the transplants is an organophosphate (OP) chemical. Part of Tom's job is to load the damp trays of plants for shipment to the field. His boss has not advised him of the risk of handling this pesticide. Tom is not aware of the precautions that he should take when working around this chemical. Not knowing the risk, he does not wear protective gloves or an apron when handling the wet transplants.

During his work, Tom's clothes often become wet with the pesticide solution. One day, after loading plants to go to the field, Tom feels quite ill. His symptoms include nausea, headache, and dizziness. From time to time, other field workers also complain of feeling sick. Their symptoms include dizziness, stomach pain, nausea, itching hands, and headache.

Once he is aware of Tom's condition, the farm owner calls the Poison Control Centre at once.  He wants to see if exposure to this pesticide might be the cause of Tom's illness.

The farm owner identifies the chemical to the Poison Control Centre. Staff there confirm that the insecticide could indeed be causing the symptoms in the workers. They advise the farm owner to take Tom and the other workers to the hospital. There they can be observed for a few hours. All the workers are released from the hospital later that day. However, they are told by the medical staff to avoid contact with all OP insecticides for at least six months.

The farmer is relieved that no one was seriously poisoned. He is determined that an accident like this will not happen again. Later he talks to provincial Pesticide Regulatory Program personnel. He confirms that all staff involved in applying pesticides on his farm are trained and certified. Each applicator also wears the proper personal protective equipment.

Because they do not apply product, the farmer did not expect other workers to be exposed to pesticides. Tom and his co-workers were exposed when handling treated plants and trays. They should also have been provided with the proper protective clothing. Proper protection will reduce the risk of pesticide poisoning.

The farm owner then looked for other ways to reduce worker exposure. Rather than applying insecticide in the greenhouse, he decides to apply it as a drench when the transplants are planted in the field. The insecticide can be applied mechanically, just before planting. This will provide more safety for workers handling plants in the greenhouse and on the transplant machinery.

The farmer wants to better understand why the insecticide caused a health problem in his workers. OP insecticides often cause acute poisoning symptoms. However, chronic poisoning can occur in some cases.

Medical personnel tell the farm owner that OPs reduce cholinesterase in the blood. This causes improper nerve function. The degree of poisoning depends on how fast the pesticide is broken down in the body. If it breaks down quickly, the pesticide will not cause severe damage. Long-term effects are minimal unless exposure continues. This is why the doctor told the affected workers to avoid further contact with OP products for the next six months.

The medical officials advise Mr. Johnson that medical staff should monitor those who regularly handle or apply OP insecticides. As Mr. Johnson later tells his workers, this will involve them having a cholinesterase blood test to establish the level of this enzyme. The first test should be done before they are exposed to these pesticides. This will provide a normal or base level of cholinesterase in their blood. During the spray season, employees who regularly come in contact with OPs should have a cholinesterase blood test every seven to 10 days. They should stop working with these pesticides if their cholinesterase levels change significantly.

Mr. Johnson hopes that having this information, and knowing more about the dangers of OP chemicals, will help him and his workers avoid poisoning accidents.

# Self-study Questions

*Answers are located in Appendix A of this manual.*

1. On a hot day you splash herbicide from a leaky container onto you bare hands while loading the container into a truck. If you should later rub your eyes, you may become poisoned by:

    a) inhalation
    b) dermal exposure
    c) ingestion
    d) ocular exposure
    e) none of the above because you cannot be poisoned from just a splash
    f) b and d only

2. The following are the acute LD50 values of five (5) pesticide products. Which product is the <u>least</u> toxic when ingested?

    a) 1 mg/kg
    b) 10 mg/kg
    c) 100 mg/kg
    d) 1,000 mg/kg
    e) 10,000 mg/kg

3. Match the word with the correct definition

    a) acute toxicity
    b) absorption
    c) chronic toxicity
    d) cholinesterase

    ____ The movement of a substance into an organism or structure.
    ____ A toxic response resulting from a single exposure to a pesticide.
    ____ A toxic response resulting from repeated exposure to small doses of pesticide over a long period of time.
    ____ An essential enzyme present in the blood that affects the nervous system.

4. The risk potential of any pesticide can be described by the following equation:
   a) risk = toxicity X formulation
   b) risk = toxicity X exposure
   c) risk = exposure X formulation
   d) risk = LD50 X concentration
   e) none of the above

5. The highest level of user exposure occurs:

   a) during the mixing of pesticides
   b) during the application of pesticides
   c) during the transportation of pesticides
   d) during the loading of pesticides.
   e) a and d only
   f) all of the above

# Chapter 5

# SAFE PESTICIDE USE

## SECTION A: HUMAN SAFETY

Safety is always a concern when pesticides are being handled or used. You will have to take care to protect yourself, others around you, and the environment. To do this, you will need to:

- Select and use personal protective equipment (PPE)
- Meet the requirements for handling and applying pesticides safely in the field, in storage, and during transport

### Learning Objectives

**Completing this section will help you to:**

- **Identify and select proper personal protective equipment.**
- **Use dermal and respiratory protective equipment.**
- **Clean, maintain, and store personal protective equipment.**

**The proper use of personal protective equipment is the user's responsibility.**

# Personal Protection

You can absorb pesticides when they contact your skin and eyes, or by swallowing or breathing in a product. Exposure to a pesticide can happen any time you handle the product, for example during:

- Transport
- Storage
- Mixing and loading
- Application
- Cleanup and disposal
- Equipment repairs
- Re-entry to the treated area

The greatest risk of exposure occurs during mixing and loading of pesticides, because concentrated product is being handled. Handling contaminated application or personal safety equipment can also result in exposure.

Wearing protective clothing is a good way to reduce pesticide risk. Although personal protective equipment (PPE) is sometimes awkward and uncomfortable, its use is important. (See **Chapter 4: Human Health** for details on pesticide exposure.)

## Selecting Personal Protective Equipment

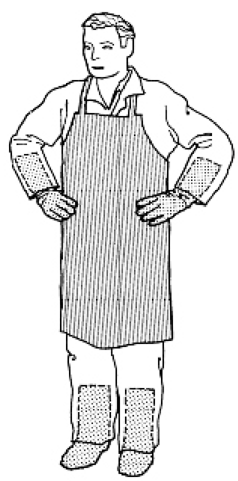
To reduce exposure, personal protective equipment and clothing will need to meet the demands of the work and length of pesticide exposure. Equipment should be well maintained, fit correctly, and be comfortable. Protective clothing and equipment used when handling pesticides should never be used for any other purpose.

The pesticide label is the best source of information on the type of protective equipment you will need. Information in the “Precaution” section gives the level of toxicity and the risk from exposure to the pesticide.

**Always read the label on the pesticide container and follow all directions on personal protective equipment.**

**Wear the following protective equipment when working with pesticides:**

- **Unlined coveralls**
- **Unlined chemical-resistant boots**
- **Unlined chemical-resistant gloves**



Sometimes the label will not specifically mention what equipment you need. It will simply imply that protection is needed. For example, a label might say, "do not breathe dust or fumes", "avoid skin contact", or "keep out of eyes". Statements like these mean that protection is needed. The label does not name a particular protective device. However, it implies the type of equipment needed by suggesting a possible route of exposure.

Always check the precautionary symbol on the pesticide label. A "Danger", "Warning" or "Caution" symbol indicates the toxicity of the pesticide. This can help you to select proper protection. You will often need more protective clothing than is mentioned on a product label.

**If a pesticide label has a "Danger – poison" symbol, always wear full protective equipment including an approved respirator.**

Information on PPE for a given pesticide can be found by:

- Checking the Material Safety Data Sheet (MSDS)
- Speaking with the product manufacturer or vendor
- Checking product pamphlets and applicator handbooks
- Consulting safety equipment suppliers, government extension workers, and crop consultants

## Dermal (Skin) Protection

The skin is the main route through which the body absorbs pesticides. The skin on hands is the most exposed part of the body. Skin exposure is greatest when mixing, loading, and applying pesticides.

The face, ear canals, neck, arms, and legs are also prime targets for exposure. Skin can be protected with gloves, body covering, boots, hats, goggles, and a face shield. You will have to use dermal protection properly for it to be effective.

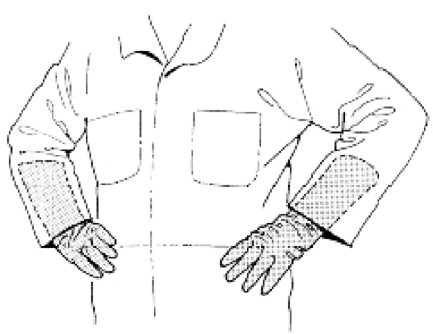
### GLOVES

Always wear gloves when:

- Handling or applying pesticides
- Rinsing or disposing of pesticide containers
- Washing contaminated application or safety equipment
- Fixing contaminated equipment

Gloves must be:

- Clean
- Chemical resistant
- Unlined
- Made of non-absorbent material (neoprene, nitrile, butyl rubber, or PVC-supported)



Leather or cloth gloves do not protect hands from pesticide exposure.

Gloves should be long enough to cover the wrists. Always keep gloves clean and free from holes and rips.

Wear gloves tucked under shirtsleeves. This keeps spilled pesticide from running into the gloves. Turn the edges of the gloves down to create a cuff. This will catch any pesticide that runs down your arms when you are working with your hands over your head. Keep your hands contaminant-free by washing gloves and rinsing them well with clean water before taking them off. Turn your gloves inside out as you remove them. To avoid contaminating other equipment, like a tractor steering wheel, always wash your gloves after mixing or loading a pesticide.

## Body covering

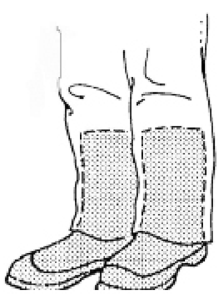
Anyone who handles pesticides should wear a long-sleeved shirt and long-legged pants. Coveralls will provide added body protection.

Clothes should be:

- Pesticide free
- Made of tightly woven fabric
- Waterproof (especially if pesticides may wet the work clothes or coveralls)

A waterproof apron should also be worn when measuring, mixing, or loading pesticides. The apron should cover your body from chest to knees.

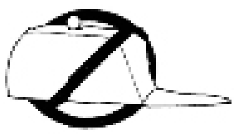
## Boots



Boots should always be worn when handling pesticides. They should be unlined and made from chemical-resistant material, such as rubber.

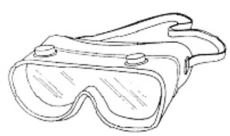
However, rubber boots should not be used when handling fumigants. These can absorb the chemical. Do not wear leather or cloth footwear (e.g., sneakers). These absorb pesticides and cannot be properly cleaned. Boots should be at least ankle height and worn tucked under pant legs.

## HATS



The head can absorb pesticides faster than most other parts of the body. Always wear a hat when handling pesticides. The hat should be wide-brimmed, non-absorbent (not cloth or leather), and easy to clean. Baseball caps and straw hats do not protect you from pesticide exposure.

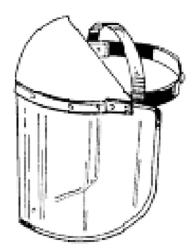
## GOGGLES AND FACE SHIELDS



The eyes can quickly absorb pesticides. Eyes are easily damaged by pesticide exposure. Face and eye protection is important when mixing and loading pesticides. Wear a full-face respirator, goggles, or a face shield any time pesticide splash, spray, or dust could be a risk to the face or eyes.

Goggles should:

- Be tight-fitting
- Have only indirect air vents
- Be fitted with a rubber or plastic headband
- Be clean



## Respiratory Protection

Pesticides that enter the lungs are quickly absorbed into the blood. Pesticides can also damage the nose, throat, and lungs. Breathing protection is important to your health and safety.

A respirator is a unit that covers the mouth and nose. It prevents the lungs from taking in pesticide spray droplets, particles, and vapours. Wear a respirator when the pesticide label tells you to, and when there is a risk of exposure to harmful levels of airborne pesticides.

Respirators should:

- Be MSHA-NIOSH or BHSE approved [*]
- Come with organic vapour cartridges
- Fit properly
- Contain unsaturated cartridges
- Be clean

Respiratory protection includes:

- Dust masks
- Cartridge respirators
- Canister respirators
- Air-powered purifying respirators
- Self-contained breathing equipment
- Some tractor cabs

**Dust masks, cartridge respirators, canister respirators, and air-powered purifying respirators do not supply oxygen. These should never be used in an area that lacks oxygen.**

[*] MSHA - Mines, Safety, Health Association

NIOSH - National Institute of Occupational Safety and Health

BHSE – British Health and Safety Executive

## DUST MASKS

Dust masks only protect you from dust particles. They do not keep pesticide vapours from entering your lungs.

## CARTRIDGE RESPIRATORS

Cartridge respirators are the most common respiratory protective equipment. They can use a half-face or full-face mask. One or two cartridges filter out pesticide vapours from air that is breathed in.

The full-face mask provides eye and breathing protection at the same time. Cartridge respirators can also have a dust, mist, or fume pre-filter. Pesticides emit organic vapours, so use cartridges that protect against these.

Cartridge respirators will protect you only against low pesticide concentrations. Some cartridge respirators are disposable. Others accept replacement cartridges and filters.

## CANISTER RESPIRATORS

Canister respirators have a full face piece. Canister respirators also contain more charcoal than do half-face cartridge masks. Because of their larger cartridges, canister respirators are more suited for use in higher vapour concentrations (where cartridge respirators should not be used). Use a canister that protects against organic vapours.

Canister respirators are often used for escaping from enclosed spaces. For example, if a pesticide was being applied in a greenhouse by lighting a smoke bomb, the applicator should wear a canister respirator to provide protection from pesticide vapours.

## FITTING A CARTRIDGE OR CANISTER RESPIRATOR

Respirators come in a number of shapes and sizes. For proper protection, select one that fits securely. A tight seal cannot be achieved if the wearer has a beard or other facial hair. Hair prevents direct contact between the face and the edge of the respirator.

Do a fit test each time you put on the respirator. Follow the manufacturer's instructions, or use one of the following tests:

Place the palm of your hand over the exhalation valve cover. Breathe out gently. If the face piece bulges slightly, and there are no air leaks between the face and face-piece, you have a proper fit. If there is a leak, take off the respirator and put it on again or readjust the tension of the elastic straps. Do this until the leaking stops. Repeat the fit test.

Place a flat piece of paper or the palms of your hands over the open area of the cartridge cap. Breathe in gently and hold your breath for 5 to 10 seconds. If the face piece collapses slightly, you have a proper fit. If air leaks out, take off the respirator and put it on again or readjust the tension of the elastic straps. Do this until the leaking stops. Repeat the fit test.

## AIR-POWERED PURIFYING RESPIRATORS

Air-powered purifying respirators use an electric pump to draw air through a charcoal cartridge. The purified air is brought to a tight-fitting facemask or loose-fitting helmet. Air-powered purifying respirators cost more than other types of respirators and are not commonly used.

### SELF-CONTAINED BREATHING EQUIPMENT

Self-contained breathing equipment supplies air through a tube from a tank on the wearer's back. It works like a scuba tank and mouthpiece. This type of equipment should be worn while applying fumigants or fighting fires in pesticide storage areas.

### TRACTOR CABS

Some tractor cabs have activated carbon and organic vapour cartridges. These remove pesticides from the air in the cab during field spraying. If you apply a pesticide using a tractor that does not have cartridges, ventilate the cab by keeping the door and windows open.

Tractor cabs equipped with only dust filters or air conditioners do not provide adequate protection from pesticides. Dust filters and air conditioners may collect airborne spray droplets inside the cab. If the tractor's blower unit is not fitted with an organic vapour cartridge, the operator should use a respirator fitted with a proper cartridge (even when in an enclosed cab).

## Maintaining Protective Equipment

During use, pesticide residue collects on all PPE. Any protective equipment should be handled with care to prevent contamination during removal and cleanup. When taking gloves off, be careful to keep your hands from being contaminated.

Always clean PPE after applying a pesticide or after each day of use. Follow the manufacturer's maintenance guidelines. Cleanup should be done at the application site if possible.

## Gloves

Always leave your gloves on while taking off and cleaning PPE. When you finish with this, wash the gloves with strong soap and water, rinse them, and then take them off. Check the state of your gloves frequently and replace them often. Throw away gloves that are damaged.

## Body Covering

Always rinse off waterproof clothing before removing it. Store contaminated clothes in disposable plastic garbage bags before washing. Wash contaminated clothing daily. **Discard clothing contaminated by heavy pesticide residue.** Follow the manufacturer's instructions for care and dumping of disposable coveralls.

### LAUNDRY INSTRUCTIONS:

**General:**

- Handle contaminated clothing with chemical-resistant gloves.
- Use a pre-wash additive on contaminated areas.
- Presoak and wash contaminated clothing apart from normal laundry.
- Do not overload the washing machine.

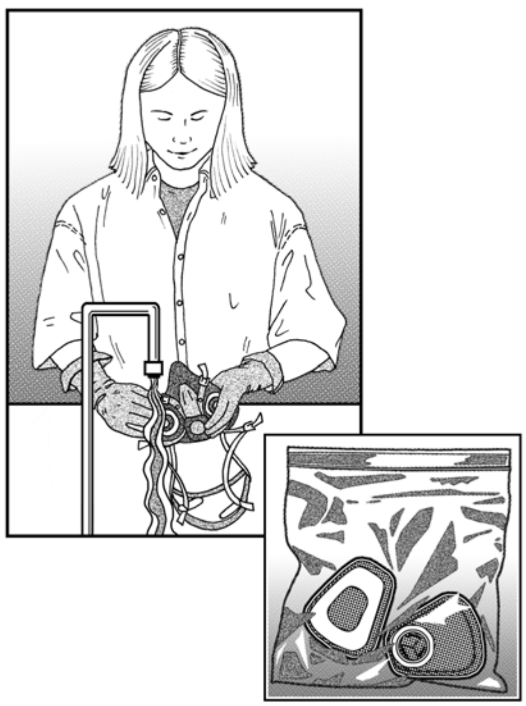
**Specific:**

- Before washing, rinse clothing using the presoak cycle.
- Fill the machine completely with hot water and use the normal wash cycle.
- Use a heavy-duty detergent, bleach, or household ammonia; **do not mix these cleaners.**

- Repeat wash cycles, if needed, to remove stronger chemicals.
- Hang clothes to dry outside to prevent contaminating the dryer.
- Rinse the washing machine after cleaning contaminated clothing. Use hot water and detergent. Run the empty machine through a full cycle.

## Respirators

Check respirators regularly for damage. Make sure all valves, mechanical pre-filters, and charcoal cartridges are properly attached and sealed. Remove pre-filters and cartridges/canisters after each day of use, or when they are not in use. Keeping filters and cartridges in clean, sealed, plastic bags will extend their life. Wash the respirator face-piece in warm water. Use a mild detergent and rinse well.



Over time, respirator cartridges, canisters, and filter pads break down. They should be replaced when breathing becomes difficult or a pesticide odour is noticed. As a minimum change the filter at least once a year, at the start of the season. If there is a high concentration of airborne pesticides, change the cartridges after several hours of use. Do not over-saturate filters. Write the date of first use on the cartridge. Change the pre-filter dust pads when cartridges are changed.

## Storing Protective Equipment

Do not store PPE in the pesticide storage area or with street clothing. Store protective equipment close to where pesticides are stored, in a cool dry storage area. This extends the life of protective equipment and allows quick access in case of an emergency. Keep waterproof clothing (e.g., gloves, boots, and hats) away from sunlight to extend its life. Keep charcoal cartridges and canisters in clean, airtight containers or sealed plastic bags.

### In Review

**There is always risk of exposure when you handle pesticides. The degree of risk depends on the toxicity of the product and the amount of exposure to it. By using proper personal protective equipment, exposure can be reduced.**

**The type of protective equipment needed for a pesticide application has to fit with the product. It will depend on the formulation of the pesticide, its toxicity, and how easily it is absorbed into the body.**

**Different types of protective equipment may be required when applying different types of pesticides. To ensure its effective operation, clean, maintain, and store protective equipment properly.**

# SECTION B: SAFE PESTICIDE TRANSPORTATION, HANDLING, AND APPLICATION

Safety is critical for all actions that involve pesticides. Always keep human health and environmental safety in mind when:

- Choosing
- Buying
- Storing
- Moving
- Mixing and loading
- Applying
- Cleaning up, or
- Disposing of pesticides

Pesticides can poison people, pets, and livestock. Pesticides can also harm the environment. Safe use of these products will reduce risk to the applicator, other people, domestic animals and wildlife, and the environment.

Remember, pesticides pose a risk any time you handle or move them. Federal and provincial guidelines have been developed for the safe transport, handling, and application of pesticides.

## Learning Objectives

**Completing this section will help you to:**

- **Transport pesticides safely.**
- **Handle and apply pesticides safely.**
- **Clean up safely after a pesticide application.**

# General Guidelines for Safe Transport

Following these guidelines when moving pesticides can help to reduce the risk of personal or environmental contamination:

- Transport only those pesticide containers that have clear, readable labels.
- Pack containers securely and upright to reduce the risk of upsets, leaks, or spills.
- Do not move broken bags, cartons, or leaky containers. If bags are broken, repack the contents or dispose of the pesticide according to provincial guidelines. Make sure caps and plugs are tightly closed.
- Prevent contamination by transporting pesticides away from food, feed, fertilizer, clothing, or household goods. If you have to move pesticides in a car, put them in the trunk. If moving product by truck or van, do not let anyone (including pets) ride in the same area of the vehicle (e.g., the back of a truck). Harmful fumes or spills can cause poisoning or contaminate the vehicle.

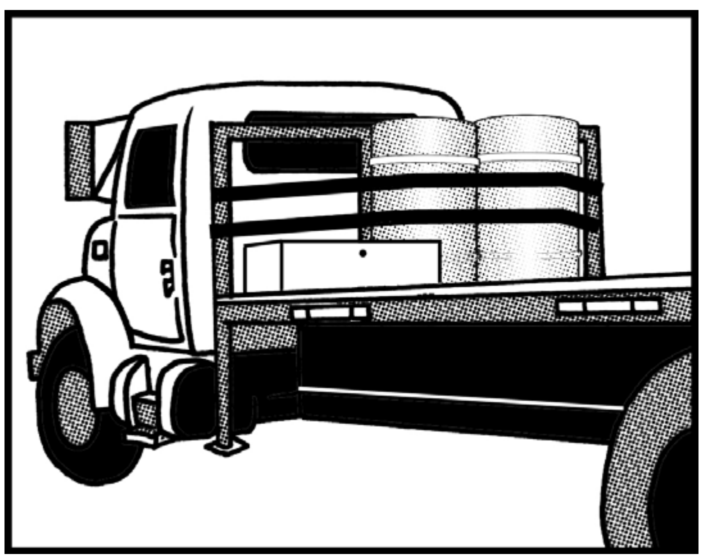


**Figure 5-1: When transporting large pesticide containers, ensure that they are properly secured to the transport vehicle.**

- Do not transport pesticides on a wooden truck bed. The wood will absorb spilled product and can contaminate future loads. Place pesticide containers in a metal or plastic storage box, or on a waterproof tarp.

- Protect paper and cardboard containers from rain, snow, or high humidity. Keep plastic containers away from direct sunlight.

- Never leave pesticides in an unsupervised vehicle. Keep product locked and away from the passenger area.

- Always carry a shovel, absorbent material, and safety equipment in case of a pesticide spill.

## *Transportation of Dangerous Goods (TDG) Act*

The ***Transportation of Dangerous Goods Act*** (*TDG Act*) governs the movement of dangerous good, including commercial and restricted class (non-domestic) pesticides. This law is the responsibility of Transport Canada. If you fail to follow the *TDG Act* and its regulations, you may be subject to a fine. In the following cases, an exemption to the *TDG Act* will apply.

### 1. Exemption for Personal Use

*TDG Act* regulations do not apply if the pesticide is contained in its original package, and if each package is less than or equal to 30 kg. Also, the pesticide must be for personal use only, and it must be in a quantity and concentration available for purchase by the general public at a retail outlet. This exemption allows for the transport of a pesticide between:

- a retail outlet and the residence of the purchaser
- a retail outlet and the purchaser's place of use
- the residence of the purchaser and a place of use, or
- two residences

### 2. <u>500 kg Exemption</u>

*TDG Act* regulations do not apply to a properly labelled and packaged pesticides if:

- the total quantity being transported is less than or equal to 500 kg
- all transport occurs on land, and
- individual containers are less than or equal to 30 kg

### 3. <u>1,500 kg Agriculture Exemption</u>

*TDG Act* regulations do not apply to pesticides in a quantity less than or equal to 1,500 kg being transported in a licensed farm vehicle if:

- the pesticides are transported solely on land for a distance less than or equal to 100 km
- the pesticides are to be, or have been, used for agricultural purposes, and
- the pesticides do not include explosives or toxic gasses (methyl bromide)

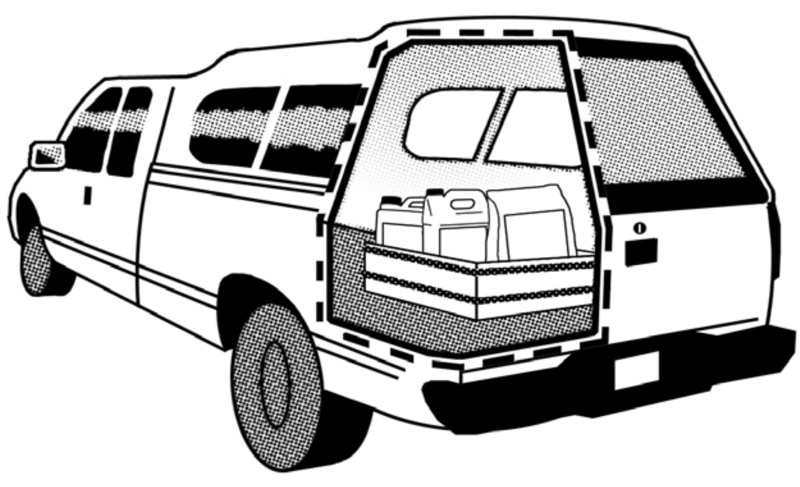


**Figure 5-2: Never carry pesticide containers in the passenger compartment of a vehicle. Protect pesticide containers from theft or accidental spills by transporting them in a locked cargo compartment.**

### 4. <u>3,000kg Agricultural Exemption</u>

*TDG Act* regulations do not apply to pesticides in a quantity less than or equal to 3,000 kg being transported on a road if:

- the pesticides are transported solely on land between a retail outlet and the residence of the purchaser or the place of use, for a distance less than or equal to 100 km
- the pesticides are to be, or have been, used for agricultural purposes
- the pesticides are in a container that is designed, constructed, filled, closed, secured, and maintained so that under normal conditions of transport, including handling, there will be no accidental release of the pesticides that could endanger public safety, and
- the pesticides do not include explosives or toxic gases (methyl bromide)

### 5. <u>6,000 L Exemption</u>

Dangerous goods safety markers are not required if:

- the pesticides are transported solely on land for a distance of less than 100km
- the pesticides are in a container with a water capacity of less than or equal to 6,000L, and
- the container is used to prepare pesticides for application or to apply pesticides

## In Review

**The *TDG Act* deals with the transport of dangerous products. This includes many pesticides. Following the *TDG Act* and its regulations can reduce the risk of human exposure or environmental contamination. The transportation of pesticides from a retail outlet or pesticide spray mixtures to the field by growers are generally exempt from regulations under the *TDG Act*.**

# Handling and Applying Pesticides Safely

The risk of exposure to pesticides is greatest when mixing and loading product. (See **Chapter 4: Human Health** for more details on the health risk of pesticides.)

This risk can be greatly reduced by using caution. People who handle pesticides should use personal protective equipment (PPE) and follow proper safety measures. Product labels explain how to handle and use pesticides safely. The labels list precautionary symbols, warnings, and toxicological information.

## Before Mixing or Loading

When mixing and loading pesticides, you should wear the following protective clothing and safety equipment:

- Coveralls
- Head protection
- Chemical-resistant gloves and boots
- Face shield or goggles
- Waterproof apron

More protection (e.g., a respirator) can be required when handling some pesticides. If in doubt, check the product label.

Practicing good safety measures can help to minimize pesticide accidents when handling a product. Before mixing or loading a pesticide:

- Read the label to make sure the pesticide is registered for the planned use. Check safety precautions. Review poisoning and first aid information. Confirm mixing directions, application rates, and limits to use.

- Calculate the amount of pesticide needed for each tank. Prepare only the amount of spray mixture required for the job.

- Make sure clean-up and first aid equipment is nearby and easy to access.

- Put on protective clothing and equipment.

- Choose a mixing and loading site that minimizes your risk of exposure and any risk of contaminating the environment.

**A good preparation site should be located away from other people, livestock, and pets. Spilled pesticide or tank mix overflow should not be able to get into a water supply.**

**Never mix or load pesticides near a drinking water well, pond, stream, ditch, or other waterway.**

# Mixing and Loading

Guidelines for safe pesticide mixing and loading include:

- Mix and measure pesticides on a strong, level bench or table. Cover the table with heavy-duty plastic or a material that will not absorb pesticides. **Do not use this bench or table for any other purpose.**
- Do not mix pesticides under windy or adverse weather conditions. This will increase your risk of exposure.
- Hold the pesticide container below eye level when pouring product.
- Use proper tools to open pesticide containers. Open bags with a sharp knife. Do not tear or rip them open. **Clean the knife well after each use**.
- Use scales, measuring cups, and premixing pails to measure product. **Use these devices only with pesticides. Store them in a locked area.**
- Keep a shovel, absorbent material, and safety equipment nearby in case of a product spill. If there is a splash or spill, stop and clean up at once.

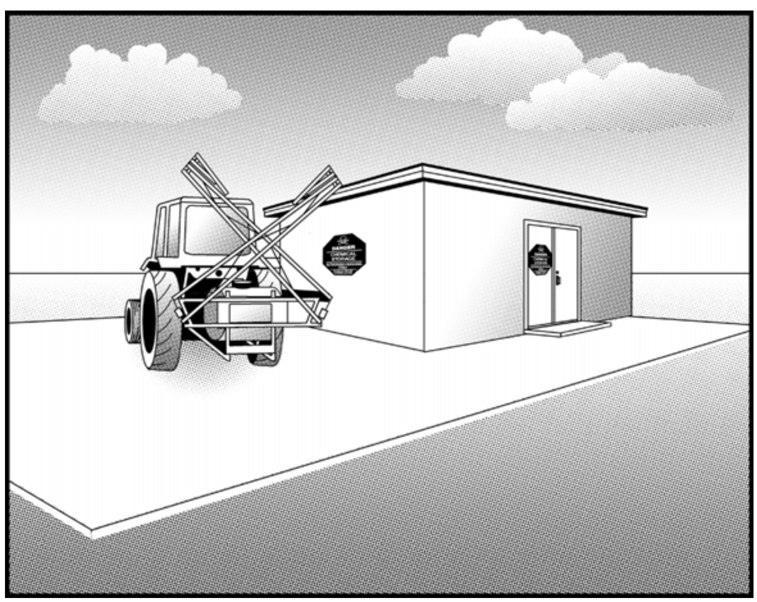


**Figure 5-3: A good pesticide mixing and loading area will be located outdoors, on a level site, near the pesticide storage area, and away from drinking water wells and surface waters.**

## Preparing a Tank Mix

When mixing a pesticide solution in a spray tank, follow these steps in order:

1) Fill the tank half full with clean water.
2) Turn on the tank agitator (if there is one). Slowly add the pesticide to the tank. Hold the container below eye level. Stand on the ground or a strong, level platform when loading pesticide into a sprayer tank.
3) Triple rinse or pressure wash empty pesticide containers. Add the rinse water to the spray tank. Wash the measuring equipment used, and add this rinse water to the spray tank.
4) Fill the tank to the desired level without overfilling it. Do not leave a tank unattended during filling.
5) Wash gloved hands before leaving the site.


To prevent water contamination, always fill sprayers away from open bodies of water. Use a nurse tank if possible.

When adding water to a spray tank, keep the filler hose above the water line in the tank. Use an anti-backflow device when possible. Keep the mixing, loading, cleaning, and application equipment at the application site during the job. This reduces the risk of exposing a second site.

Take all equipment with you when you leave, and clean it properly.

**Figure 5-4: Check pesticide labels to ensure that tank mixing of two or more products is approved.**

## Additional Ways to Reduce Exposure Risk

The risk of exposure during pesticide mixing and loading can be further reduced by using premix slurries, soluble packaging, or closed loading systems.

**Premix slurries** involve diluting concentrated pesticide solution before loading product. This limits contact with airborne particles of wettable or soluble powders. To prepare the premix slurry, mix a small amount of pesticide and water in a separate container. Carefully add this slurry to the spray tank. Triple rinse the slurry container and add the rinse water to the tank. Then, add enough water to the tank to dilute the powder to the desired concentration.

**Soluble packaging** eliminates the problem of getting rid of empty pesticide containers. The applicator places pre-weighed PVC packages of pesticide into the sprayer tank. These packages then dissolve in the water.

Soluble packages are often used to hold dry flowable and wettable powder formulations. Applicators must follow label instructions and take care to ensure safe and proper product use.

**Closed loading systems** remove the pesticide from the container and rinse the container. Chemical contents and rinse solution are then transferred to the sprayer tank at the correct rate. These systems greatly reduce the risk of applicator exposure when using very toxic pesticides.

# Safe Pesticide Application

To reduce your risk of exposure when applying a pesticide:

- Carry a supply of clean water with you while at the application site. Clean water tanks can be attached to application equipment. This provides water to clean items (e.g., gloves and nozzles) and to rinse small spills.

- Cover up or remove items such as animal feed, water containers, toys, or food utensils. These can be contaminated by product drift.

- Livestock and pets should be removed from the application area to protect them from exposure.

- Advise bystanders to leave the area.

- Avoid working alone when handling pesticides under hazardous conditions. If you must work alone, make sure someone else knows:

    - What products you are using
    - Where you are working
    - When you should finish the application

- Apply pesticides outdoors, in good weather. Use equipment that is calibrated for the type of application. Use and maintain the settings (e.g., travel speed and pressure) chosen during calibration.

- Keep application equipment in good working order. Clean it properly, especially before switching to another pesticide.

- Plan an application route that avoids passing through spray or vapour drift. Stay out of freshly treated areas. Stop the application when moving over an area that does not require treatment. Shut off spray nozzles on the boom when turning.

- If application equipment breaks down, stop and repair it at once. Wear proper safety equipment and clothing when repairing broken equipment.

- Always wear gloves and goggles when changing or cleaning nozzles. Use a soft brush and clean water (or compressed air) to clean a blocked nozzle. Using a sharp object to remove the blockage can damage the nozzle. <u>Never</u> blow out a nozzle with your mouth.

## In-field Safety

The **pre-harvest interval (PHI)** (days-to-harvest interval) is the time between the last pesticide application and the harvest date. The PHI for a pesticide is often measured in days.

For example, an insecticide may have a PHI of seven days. This means you cannot harvest the crop until at least seven days after applying the insecticide. If the crop is harvested before seven days have passed, residues in the crop can exceed the **maximum residue level (MRL)** for that crop.

People can be exposed to pesticides and poisoned when they enter a treated area too soon after a product application. The time between application and the safe time to return to a treated area is known as the **re-entry interval (REI)**. The pesticide applicator should ensure that anyone who might enter a treated area is aware of the re-entry time.

If you do have to enter a treated area before the re-entry interval has passed, wear proper protective equipment and clothing. Don't stay in the area any longer than necessary.

Re-entry times are listed on some pesticide labels. Other products may not provide re-entry periods. In these cases, you can reduce your risk of exposure by staying out of the treated area until the spray dries. Follow any provincial re-entry guidelines for the pesticide you are using.

## Discarding Mixed, Old, and Unused Pesticides

You can avoid having leftover spray mix by:

- Taking accurate measurements of the area to be treated
- Using label application rates
- Calibrating application equipment

If excess spray mix remains after a treatment, use it according to the label. If no recommendations are given, contact your provincial pesticide regulatory agency for advice. Never re-spray a treated area with undiluted spray mix. This will double the recommended application rate.

Plan pesticide purchases with care to avoid being left with too much concentrated product. Use old stock before buying new product. However, if you plan to use old stock, make sure it is safe to apply and has not lost its effectiveness or become unusable. When in doubt, contact your local pesticide vendor or the product manufacturer for details. Dispose of pesticide concentrates according to label or regulatory requirements. Unopened containers can often be returned to your vendor.

Buy only the amount of pesticide needed for one season. The following calculations can help you to estimate the amount of pesticide needed.

**1. The total amount of pesticide needed = pesticide rate X treatment area X the number of treatments per year.**

**2. The number of containers to purchase = total amount required divided by the contents of one container.**

## In Review

**People who handle or apply pesticides can be exposed to product from spills, splashes, and particle or vapour drift. Mixing and loading, which often involve concentrated product, present the greatest risk of exposure.**

**Individuals can also be exposed to pesticides when handling contaminated personal protective equipment, mixing utensils, or application equipment. Careful planning and attention to safety can reduce the risk of human poisoning when:**

- **Mixing and loading pesticides**
- **Applying product**
- **Cleaning personal protective or product application equipment**
- **Discarding excess pesticides or empty product containers**

# Cleanup After Application

Proper care of pesticide application equipment and product storage areas can reduce the risk of human exposure. Poorly maintained equipment can cause:

- Accidents
- Product spills
- Personal safety hazards
- Environmental contamination
- Loss of money from down-time
- High labour costs for replacement parts and repairs

## Handling Application Equipment After Use

When pesticide mixes are left in application equipment, chemicals can penetrate hoses, gaskets, and plastic parts. This can cause corrosion and mechanical problems. This happens most often when suspensions settle out or granular formulations absorb moisture and harden into clumps. These clumps can be difficult to break up. Pesticide left in equipment can also lose its effectiveness.

Application equipment should be emptied and cleaned:

- After each day of use
- When changing pesticides
- Before off-season storage

To clean sprayers or other application equipment, fill the tank with clean water to dilute the spray residue. Flow this water through the sprayer.

Always wear proper personal protective equipment when cleaning pesticide application equipment. Protective equipment will often include a hat, eye goggles, long-sleeved coveralls, chemical-resistant gloves, and boots. A waterproof apron will provide additional protection.

Details on caring for application equipment are covered in **Chapter 8: Application Technology**.

# Cleaning and Discarding Pesticide Containers

An empty pesticide container can contain enough pesticide to pose a risk to human health and the environment.

Rinse and wash pesticide containers as soon as they are emptied. Pesticide residue is hard to remove once it has settled or hardened.

Proper pesticide container disposal is important because:

**Figure 5-5: Store empty pesticide containers in a secure location.**

- Poorly rinsed containers cannot be recycled.
- Containers contaminated with pesticide residues can harm people. Children might play with these containers and be put at risk of poisoning.
- Residues from contaminated containers can pose a risk to the environment, particularly surface water. For example, container residues can move into a stream and kill fish and other aquatic life.
- Poor container disposal is unprofessional and creates a poor image.
- Pesticides and money are wasted when containers are not properly emptied. As much as three per cent of the pesticide concentrate can remain in a non-rinsed container.

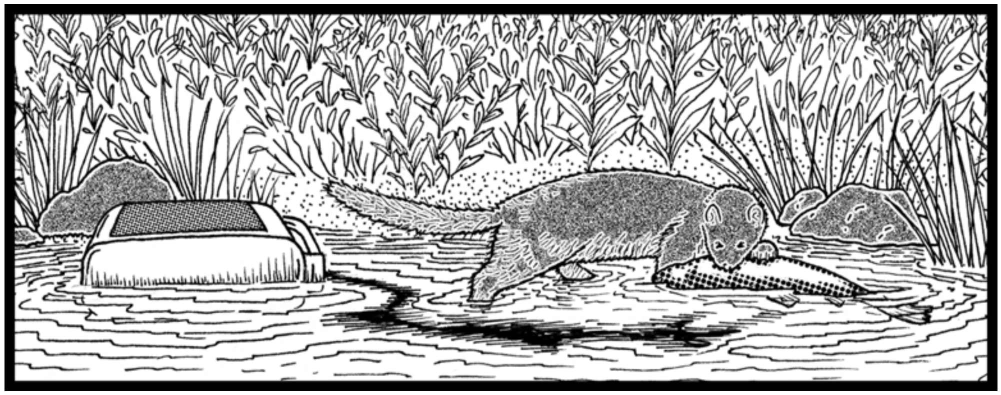
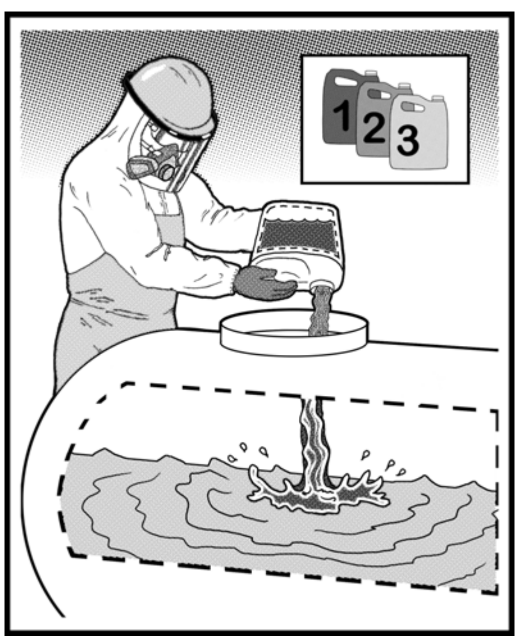


**Figure 5-6: Residue from discarded pesticide containers can contaminate soil and water resources, and harm fish and wildlife.**

To dispose of pesticide containers:

1. Drain the container into the spray tank until drips can no longer be seen. Shake out bags into the tank or hopper.

2. Clean plastic or glass containers by draining and triple rinsing (or pressure rinsing). Gently rinse bags once (single rinse) if possible.




After cleaning the container, prevent it from being used for other purposes. Cut, puncture, or crush plastic, metal, or paper containers. Break glass containers in a plastic bag.

Discard the container and cap according to label directions or provincial laws. If you cannot dispose of the containers right away, return them to a locked storage area to await disposal.

**Figure 5-7: Triple rinse plastic or glass pesticide containers.**

**To triple rinse pesticide containers follow these steps:**

1) **Fill the empty container at least 10 per cent full with water. The amount of rinse water required can vary. The label may tell you how much water to use.**

2) **Shake or roll the container so that inside surfaces are well rinsed.**

3) **Pour the rinse water into the spray tank.**

4) **Repeat this two more times.**

**To pressure rinse pesticide containers follow these steps:**

1) **Pressure rinse for 60 seconds.**

2) **Pour the rinse water into the spray tank.**

## In Review

**Safety should be the first thing you think about when handling or moving pesticides. The risk of pesticide exposure is highest when handling a concentrated product.**

**Hazards also exist when moving tank or spray mixes. These mixes pose the greatest risk when they are being transported on public highways.**

**Federal and provincial laws cover the safe use of pesticides. Be aware of and comply with these laws.**

**Use personal protective equipment to protect yourself during pesticide use and handling. Keeping it clean and in good repair will reduce your risk of exposure.**

**You should be aware of and follow the guidelines given in this chapter for safe mixing of product, cleaning of application equipment, and cleaning and disposal of empty containers.**

# SECTION C: STORING PESTICIDES

Improperly stored pesticides can poison people (especially children), pets, and livestock. They can also harm the environment.

Learning Objectives

**Completing this section will help you to:**

- **Store pesticides safely.**
- **Identify the features of a good pesticide storage area.**

## Characteristics of a Good Storage Area

Proper pesticide storage can reduce the risk of poisoning accidents or environmental damage. Good storage can extend the shelf life of pesticides. It can also prevent cross-contamination of products.

Only one approved site should be used to store pesticides on-farm. A good storage site should be located:

- In an area that can be reached all year round by emergency personnel and vehicles
- Away from:
  - Human work, living, and play areas
  - Livestock pastures, barns, and feeding or watering areas
  - Machinery storage facilities
  - Wells, ditches, or other bodies of water
  - Highly porous soils
  - Areas where flooding can occur

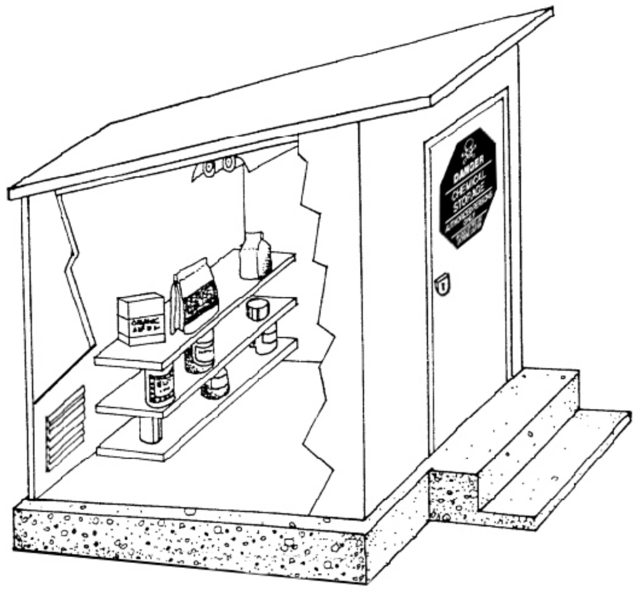



**Figure 5-8: A proper pesticide storage area incorporates many safety features.**

A proper pesticide storage area will have:

- A floor made of concrete or another material having a smooth surface (This will make it easier to clean. It will also help to prevent product from seeping into the ground.)
- A curb or sill designed to hold 1½ times the volume of stored product
- A floor without drains or other openings
- Good ventilation in all weather conditions

The facility should be a stand-alone building. It should be designed and used solely for storing pesticides.

If you plan to change or construct a new pesticide storage building, follow the Canadian Farm Building Code. Check provincial or municipal building and fire codes for other structural or placement requirements.

One person should be responsible for the pesticide storage area. This person should:

- Post a warning sign on each entrance to advise that chemicals are stored in the area.
- Ensure that shelves will not burn and that they are easy to clean.
- Equip the storage area with the proper number and type(s) of fire extinguishers.
- Ensure that only pesticides and related equipment are placed in the storage area.
- Ensure that material needed to contain pesticide spills is maintained on site.
- Regularly check for leaking containers. If a leak occurs, all affected areas should be properly decontaminated.
- Maintain an up-to-date list of all stored pesticides. The list should include their trade name and Pest Control Product number. It should also include the maximum amount of pesticide that could be on hand at any time. Keep a second copy of the list at a location away from the pesticide storage area.
- Ensure that the storage area is locked and off limits to unauthorized persons.

## Storing Pesticides Safely

The following can help ensure the safe storage of pesticides. These apply to both permanent and temporary storage facilities.

- Never store pesticides with or near livestock, human food, animal or pet feed, seed, veterinary supplies, wells, water supplies, or in a home (e.g., garage or basement).

- Read and follow the storage instructions given on product labels and Material Safety Data Sheets. Keep an up-to-date copy of the MSDS on hand for each stored product. Give the MSDS to emergency response or medical personnel upon request.

- Store pesticides in their original containers. Make sure that the labels are intact. Never store pesticides in containers that once held food, drink, or medicine.

- Keep pesticide containers upright and off the floor. Check them regularly for leaks, tears, rust, or loose lids.

- Store pesticide products in a way that will eliminate cross-contamination. Store herbicides away from insecticides and fungicides.

- Ensure proper lighting in the storage area. This will make pesticide recognition easier. It will also help to avoid product mix-ups.

- Keep proper protective clothing and equipment near (but not in) the storage building.

- Enforce no-smoking rules in and around the storage area. Post proper signs.

- Post a list of emergency contact numbers where it will be easily seen.

- Ensure that only authorized personnel have access to pesticides. Keep the storage building locked.

**Consult the Appendix B – Nova Scotia Pesticide Regulations for additional requirements for user pesticide storages.**

## In Review

**A proper storage facility will help to reduce pesticide exposure. Responsible product storage can reduce the risk of human poisoning. It can also reduce the risk of environmental damage. Your pesticide storage facility should protect you, other people, pets and livestock, and your surrounding environment.**

**A well-maintained storage facility can reduce the chance of a fire or product spill. Good records and emergency contact information will also help you respond in case of emergencies.**

# Case Study: Safe Pesticide Use

Sara is a young high school student. She is excited about her class project on workplace safety. As the first part of the project, Sara must choose a job that involves dealing with workplace hazards. Then, she will have to research the risks involved with the job. Finally, she will have to outline safety guidelines designed to reduce these risks.

Sara has grown up on a farm. Because of this, she decides to research workplace safety for pesticide applicators. Sara's father, Bill, has worked with pesticides on his farm for over 40 years. She asks him for information. Bill tells Sara that anyone who handles or applies a pesticide should always know the risks involved and follow good safety practices.

Bill explains that pesticides are developed and sold to control pests. However, these products can also harm plants and animals that are not the targets of the application. This includes people. Bill stresses that it is important to protect non-target organisms when applying a pesticide. This is key to safe and responsible pesticide use.

Bill adds, "Safety begins long before you handle, measure, or mix the pesticide." Bill tells Sara he begins by reading the product label and Material Safety Data Sheet (MSDS) for each product. He looks for information on personal protective equipment (PPE) that should be used. The "Precautions" section on the label will help him to decide what equipment should be used when working with each pesticide. Bill stresses to Sara that PPE is a 'must' when handling pesticides.

Minimal personal protective equipment includes:

- A water-repellant hat
- Long-sleeve shirt and pants or coveralls
- Chemical-resistant gloves
- Rubber boots

Added equipment might be required when working with some products and applications.

A spill or splash of full-strength pesticide can happen when product is being moved, loaded, or mixed. Exposure to concentrated product can cause more harm than contact with a diluted spray. Added protective equipment required to safely work with concentrated chemicals will include:

- A water-repellant apron or rain suit
- Goggles
- A face shield
- A respirator

Bill explains that this additional equipment can be a good idea, even if it is not called for on the product label.

He tells Sara that the protection needed during a pesticide application will vary. The type of protection will depend on whether the chemical being applied is a liquid, powder, granular, or gas. The application equipment used to apply the product can also play a role.

Anyone applying a pesticide using an open tractor will need more protective equipment (e.g., a respirator) than someone applying the same product using a tractor with an enclosed cab. An enclosed cab might be equipped with an air filtration system. This removes spray droplets, dust particles, and organic vapours from the air.

Bill finishes by telling Sara that protective equipment is of little or no value if it is not used properly. Equipment and clothing has to be cleaned and inspected regularly. If it has tears or holes, or just doesn't work properly, it should be replaced. Only then will the equipment provide proper protection.

Sara presents her pesticide safety project to her class. By talking with her dad, she has come to respect the importance of safe and responsible pesticide use.

# Self-study Questions

*Answers are located in Appendix A of this manual.*

1. If a pesticide label does not specify a re-entry time, how long should you wait before re-entering a treated area?

    a) until the spray dries
    b) 24 hours
    c) 8 hours
    d) 48 hours

2. Clothing that has been heavily soaked by a toxic pesticide should be:

    a) stored in disposable plastic garbage bags prior to washing
    b) pre-soaked and washed separately from normal laundry
    c) discarded
    d) treated with a pre-wash additive prior to being washed

3. The recommended method for disposing of plastic pesticide containers is:

    a) clean them and then take them to a provincial landfill site
    b) clean them and return them to a licensed pesticide vendor
    c) bury them on a farm site
    d) burn them on a farm site

4. When planning to build a new farm pesticide storage facility, you should be familiar with recommendations from the:

    a) *Transportation of Dangerous Goods Act*
    b) *Pest Control Products Act*
    c) *Pesticide Regulations*
    d) *Environmental Protection Act*

5. A potato producer wants to plant a different crop in last season's potato field. Which of the following is the best information source to help the producer decide if a different crop can be grown safely in this field?

   a) other potato producers
   b) his pesticide application records for last season
   c) provincial crop specialists
   d) the pesticide label
   e) all of the above.

Chapter

6

# ENVIRONMENTAL SAFETY

Everyone shares responsibility for protecting the natural environment. Pesticide applicators must protect land and water resources from contamination.

The pest control measures and pesticides you choose will impact the environment. To make the best choices, you will need to know the short- and long-term effects of pesticides on the environment.

## Learning Objectives

**Completing this chapter will help you to:**

- **Identify and interpret environmental risk.**
- **Manage environmental risk by planning and problem solving.**

# Environmental Risk

Pesticides need to remain active after application if they are to work. The chemical and physical properties of pesticides affect the length of time that they remain active. These properties also determine the risk that a product can pose to the environment.

Pesticide applicators should select and apply pesticides that will cause the least harm to the environment. To do this, you need to know the key factors that determine environmental risk.

Environmental damage costs associated with improper pesticide use can be long-term and widespread. For the applicator, these can include loss of money, loss of reputation, and legal issues. Longer-term impacts can show up as damaged land and water. Loss of public support for farming can also result.

## Key Factors Associated with Environmental Risk

Any pesticide use poses a risk to the environment. The degree of risk depends on:

- Volume of product used
- Persistence of the pesticide in the environment
- Product movement
- Toxicity to non-target organisms

**Degree of environmental risk =**
**volume x persistence x mobility x non-target toxicity**

## Volume

Volume is the total amount of pesticide used. The larger the volume of product applied, the greater the risk of environmental damage.

The type of crop will often dictate the volume of pesticide applied. For example, potatoes require more pesticide than cereal crops. This increases the environmental risk due to potato production.

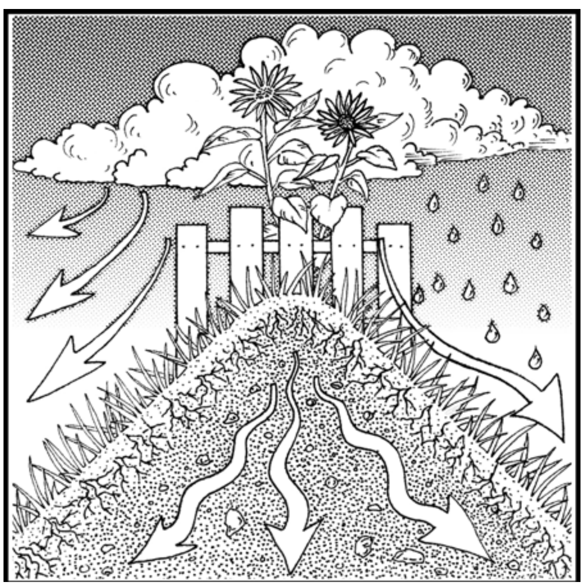
## Persistence

Persistence is the length of time a pesticide remains active in the environment.

Persistent pesticides remain active for a long time. They can remain on the target site, or be carried elsewhere by wind or water. The more persistent the pesticide, the greater the risk it poses to the environment.

*Atrazine* and *Treflan* (trifluralin) are persistent pesticides.

## Mobility



Pesticides will not always stay where they are applied. Mobility refers to the ability of a pesticide to move away from the application site. A product may be able to travel through soil, in water, or through the air. This depends on its structure. Mobile pesticides are more likely to damage the environment.

*Temik* (aldacarb) and *Atrazine* are pesticides that often move (leach) through the soil.

**Figure 6-1: Pesticides can travel through soil, in water, or through air.**

### Non-target Toxicity

Pesticides are applied to control a single pest or group of pests. Non-target toxicity is the risk of a pesticide causing damage to non-target organisms.

For example, an insecticide might be applied to target one insect that is damaging a crop. However, it might also harm beneficial insects in the area. Birds that feed on the treated crop or insects can also be poisoned.

### In Review

**Your selection and use of pesticides will impact land, water, air, and wildlife resources around you. A pesticide has four environmental risk factors (volume, persistence, mobility, and non-target toxicity). These should be considered when making pest management decisions. The degree of risk decreases when any one of the risk factors decreases. You should act to maximize pest control and minimize environmental risk.**

# Pesticide Fate

Pesticide fate refers to what happens to products after they are applied. Chemical and physical factors impact pesticide fate.

## Chemical Processes

Chemical processes that affect pesticide fate include:

- Degradation – the breakdown of a product
- Bioaccumulation – the buildup of a product in animal tissue

- Biomagnification – the buildup of a product in the food chain, or in the natural environment (e.g., in water)
- Adsorption – the binding of a product to soil particles
- Desorption – the release of a product from soil particles
- Absorption – the movement of a product into plants, animals, soil, or structures
- Volatilization – the evaporation of a product

## Degradation

Degradation is the breakdown of a pesticide into simpler parts. The rate of pesticide breakdown is affected by environmental factors such as temperature, moisture, and pH. Degradation can be:

- Microbial
- Chemical
- Photodegradation

**Microbial degradation** is the most common type of pesticide breakdown. It occurs when soil microorganisms use the pesticide as a food source. The pesticide is broken into basic compounds such as water and carbon dioxide. Microbial breakdown is affected by:

- Temperature
- Soil pH
- Soil moisture
- Soil fertility
- The presence of oxygen
- Chemical or physical properties of the pesticide

**Chemical degradation** is a chemical reaction between a pesticide and the environment. It often breaks a pesticide into less hazardous compounds. Rate of chemical degradation depends on temperature, pH, moisture, and the pesticide itself.

**Photodegradation** is the breakdown of a pesticide by sunlight. Photodegradable products have to be mixed into the soil shortly after they are applied to work effectively.

Speed of degradation is measured by the pesticide's half-life. This is the time it takes for half of the initial amount of pesticide to break down in the environment. *Roundup* (glyphosate), for example, has a half-life in soil of less than 14–21 days. If applied at a rate of 2 L/ha, there would be 1 L/ha of product left in the environment 14–21 days later.

| ***Degradation of Roundup Applied at 2 L/ha*** | |
|---|---|
| Day 1 | 2 L per hectare |
| Day 21 | 1 L per hectare |
| Day 42 | 500 ml per hectare |
| Day 63 | 250 ml per hectare |
| Day 84 | 125 ml per hectare |

**Table 6-1: Degradation of *Roundup*.**

## Bioaccumulation

Bioaccumulation is the buildup of a pesticide in the body tissues of animals. Pesticides build up when they enter tissues faster than they are excreted (passed through the tissue) or metabolized (changed into energy).

The more pesticide in animal tissue, the more harmful it is. If enough pesticide builds up, it can cause long-term damage or death.

## Biomagnification

Biomagnification is the buildup of a pesticide in the food chain. Persistent pesticides can build up to hazardous levels in some plants and animals. When other animals eat these plants and animals, the pesticide moves up the food chain. Biomagnification can even happen when a product is applied according to label directions.

For example, a pesticide is applied to a field at the label-recommended rate for a given insect. Thousands of insects eat the insecticide. Frogs eat hundreds of these contaminated insects in a few days. The pesticide then builds up in the tissues of the frogs.

A snake eats a number of contaminated frogs. The insecticide is now further concentrated in the snake's body. If a hawk eats a number of contaminated snakes, the hawk will consume a high quantity of pesticide.

Biomagnification can also occur in water. Water and food sources for water-based organisms can be contaminated.

Biomagnification of persistent pesticides led to the ban of chlorinated hydrocarbon pesticides such as DDT.

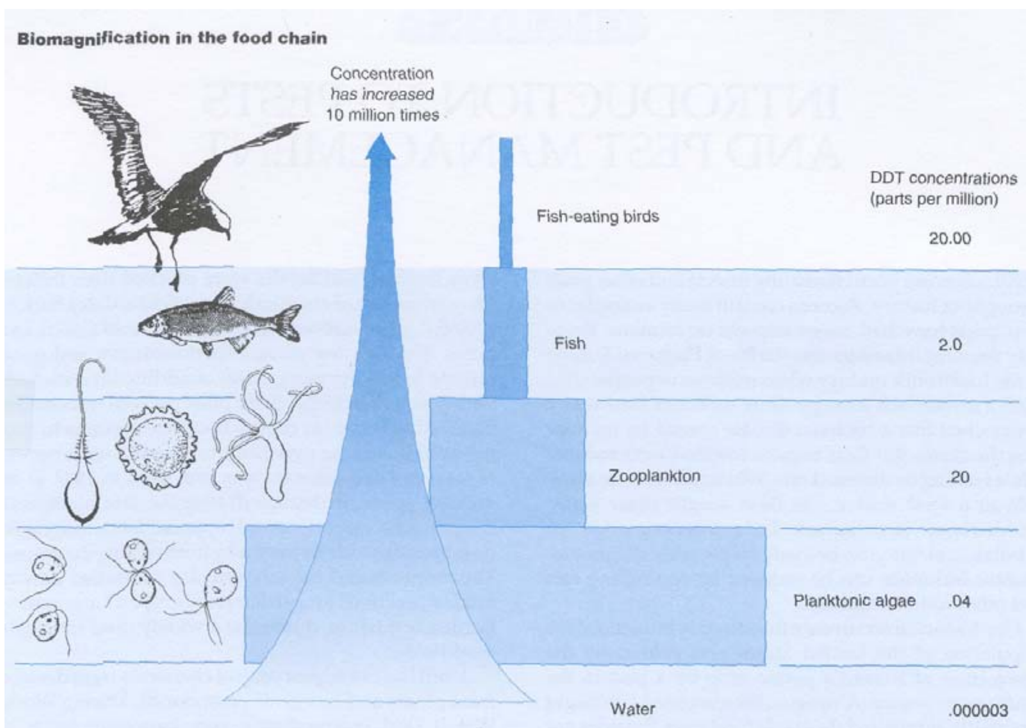



**Figure 6-2: Biomagnification in the food chain.**

## Adsorption

Adsorption is the binding of chemicals to soil particles or other materials. Clay and soils high in organic matter are the most adsorptive. Soil-bound pesticides are less likely to leach or be broken down by microbes. However, pesticides can be easily moved by wind or water erosion when bound to soil particles.

## Desorption

Desorption occurs when bound pesticides are released from the soil or other materials. Desorbed chemicals can move over great distances. The risk they pose to the environment should be carefully considered.

## Absorption

Absorption is the movement of a pesticide into organisms (e.g., plants and animals) or structures (e.g., wood and soil). Absorption of a pesticide can harm an organism.

Pesticide absorption may not be harmful if the organism can break the pesticide down into non-toxic compounds.

## Volatilization

Volatilization is the process by which solids or liquids evaporate (become gases). The rate of volatilization depends on the pesticide formulation. Weather conditions (temperature, relative humidity, and wind speed) will also affect the rate of volatilization.

**Hot, dry, windy conditions increase volatilization. Small spray drops are more likely to evaporate than large droplets.**

# Physical Processes

Physical processes that impact pesticide fate include:

- Leaching – the movement of a pesticide in water through soil
- Soil erosion and surface runoff – the movement of a pesticide with soil particles or in water over the soil
- Drift – the movement of a pesticide by wind

## Leaching

Leaching is the movement of a pesticide in water through the soil. Water can leach downward, upward, or sideways. The risk of leaching increases when:

- Pesticide solubility is high; this results in more product in the water
- Adsorption is low; this makes more pesticide available
- Desorption is high; this also makes more pesticide available
- Soil has little organic matter; less pesticide is trapped and held
- Water (e.g., rain or irrigation) is added to the application site
- The soil has a coarse structure (e.g., sandy soils); the pesticide can travel freely and quickly in water through coarse soil

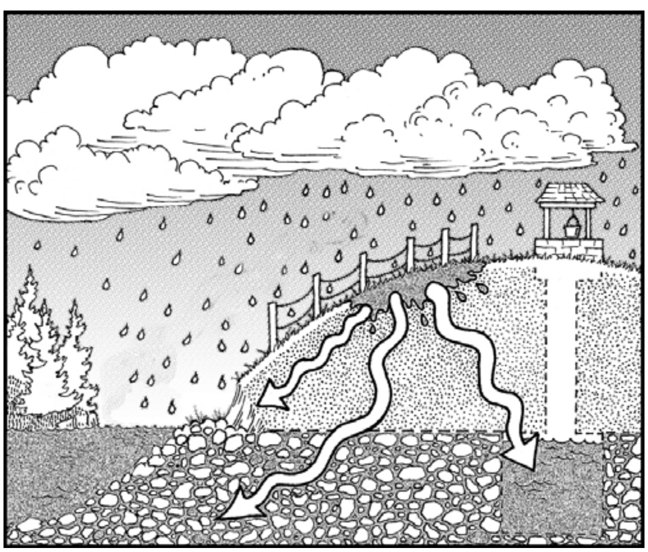


**Figure 6-3: Pesticides can leach in water through the soil. Leached pesticides can contaminate ground water and drinking water wells.**

When you know the likelihood for a pesticide to leach, you can reduce the risk of environmental contamination. Pesticide labels often give information on ways to reduce leaching. A product may be suitable for use only with certain soil types. It might be suitable for use under a number of soil conditions. Check the label for directions.

## Soil Erosion and Surface Runoff

Surface runoff occurs when water flows over a sloped surface. This water often picks up (erodes) some of the soil as it moves. Pesticides can become mixed with the runoff water or be carried in the water as soil-bound particles. Pesticide characteristics (e.g., formulation and solubility) affect the amount of pesticide in runoff. The amount of runoff is determined by:

- Degree of slope on the soil surface
- Soil texture and type of surface (bare soil, grass buffer, etc.)
- Ability of the soil to absorb water
- Moisture content of the soil
- Volume of moisture added (rainfall or irrigation)
- Type and amount of surface vegetation

Pesticide runoff can occur when it rains before an application of liquid product has had time to dry. Heavy rain can also carry persistent granular or liquid pesticides and those bound to soil particles. This can result in pesticide-laden runoff days or weeks after product application.

**Even a year after application, melting snow or spring rains can carry a moderately persistent pesticide such as *atrazine* in runoff water.**

Wind can erode or wear away surface soil. Eroded soil particles can then end up in wetlands, waterways, and ditches. Pesticides bound to these soil particles will also be carried with wind erosion. This can move pesticides far from their target site.

You must follow label directions to reduce the risk of pesticide movement from runoff and soil erosion. You should also consider:

- The slope of the application area
- The type and adsorptive ability of the soil
- Near-by plant life
- Any additional water (e.g., rain) that might be expected

If one or more of these factors poses a high risk of runoff, you will have to plan to reduce the risk. When developing your pest management plan, you will have to consider:

- The type of product used
- Other control options
- The time of application

## Spray Drift

Spray drift is the airborne movement of pesticide particles from the treatment site during application. Off-target drift can pose an environmental risk. Spray drift is affected by:

- **Spray droplet size** - The smaller the droplets, the more likely they are to drift. If you increase droplet size (e.g., nozzle design), you will decrease drift.

- **Air Movement (wind)** - The stronger the wind, the greater the risk of drift. Look on the product label for recommended wind speeds for safe pesticide application.

- **Stable, or atmospheric inversion conditions** - Inversions occur when the wind is calm and the air temperature at ground level is lower than that of the air above it. When this happens, the pesticide will remain in the air much longer than normal. Airborne droplets can then move off target with the wind.

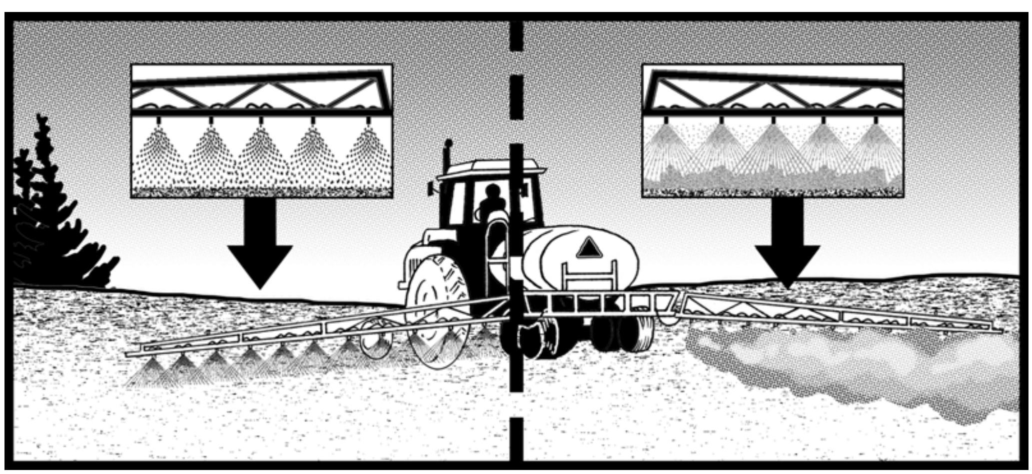


**Figure 6-4: Droplet size plays a significant role in spray drift.**

- **Distance between the nozzles and the target** - The greater the distance between the sprayer nozzles and the target, the greater the risk of drift.
- **Speed of application equipment** - The faster the application equipment moves, the greater the risk of drift.

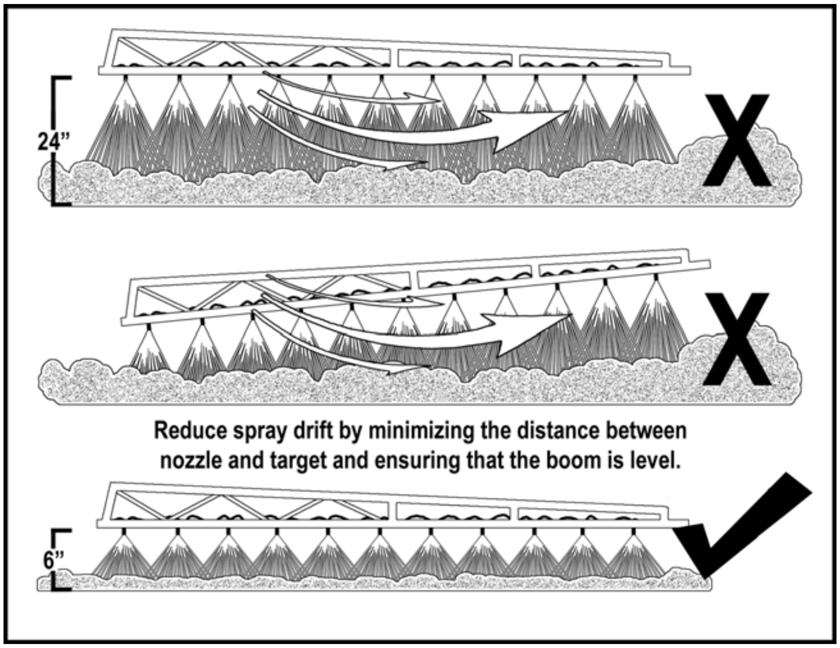



**Figure 6-5: To reduce pesticide spray drift, minimize the distance between the nozzles and the target crop.**

Pesticide applicators can control drift by:

- Using low-drift nozzles that produce large droplets
- Keeping nozzles close to the target
- Applying products under proper weather conditions

Best practises for controlling spray drift are covered in **Chapter 8: Application Technology**.

## In Review

**The physical and chemical properties of a pesticide will affect how it behaves in the environment. They can also affect the degree of environmental risk posed by a product.**

**You cannot change the chemical makeup of a pesticide or how it behaves. You can influence how and when you apply pesticides. Good planning and practise will reduce the movement of pesticides into the environment.**

**You should choose pesticide products that provide required pest control with the least amount of risk to the environment. Keeping pesticides out of the environment is your responsibility as an applicator.**

# Managing Environmental Risk

Farm applicators are responsible for the impact of pesticide use on the environment. You will have to consider and manage risk to the environment any time you use a pesticide.

Environmental risk can be managed. To do this, you must consider pesticide selection, application, and storage.

## Pesticide Contamination

There are two kinds of pesticide contamination. Both can occur in water, soil, or air. They are often caused by product drift or runoff. Contamination can be:

- Point source
- Non-point source

**Point source contamination** is the release of a large amount of pesticide into a small area. Examples include pesticide fires, spills, or poor product disposal.

**Non-point source contamination** is the release or use of pesticide over a large area. Examples include drift to a non-target location or runoff from a treated area.

## Protecting Water Resources

Water is a valuable natural resource. Today, water is increasingly threatened around the world. Pesticide contamination of water is a growing concern. Care must be taken to prevent damage to drinking water, waterways, and aquatic life.

Pesticides can get into water a number of ways. They can contaminate groundwater (water in saturated zones below the soil surface). Pesticides can also contaminate surface water (open bodies of water such as streams, ponds, lakes, and oceans). Contaminated water can affect fish, wildlife, domestic animals, and humans. Contaminated irrigation water or runoff can damage sensitive crops some distance away. It is both difficult and costly to clean contaminated water.

### Points of Pesticide Entry

Pesticides can enter surface water and groundwater through:

- Physical processes such as runoff, leaching, and erosion
- Spray or vapour drift during application
- Pesticide spills during moving, mixing, loading, storage, application, or disposal
- Atmospheric fallout (e.g., rain or snowfall containing pesticides)
- Overflowing spray tanks or back siphoning of pesticides from spray tanks into wells and other water sources when filling equipment

### Preventative Practises

Applicators can help to avoid water contamination by:

- Following all product label directions
- Properly disposing of wastewater from equipment cleanup
- Properly disposing of excess spray mix, unwanted pesticides, or pesticide containers
- Storing all pesticides in approved facilities
- Creating buffer zones

**Buffer zones are untreated areas left around fields that have been treated with a pesticide. Buffer zones can protect nearby areas and waterways from pesticide hazards. They can also slow runoff and reduce surface water contamination.**

## APPLICATION PRACTICES

To avoid water contamination when using pesticides:

- Mix and apply pesticides as directed on the label.
- Prepare tank mixes and fill application equipment far from water sources.
- Travel on roads only when application equipment is empty (if possible).
- Maintain application equipment. Check regularly for leaks in tanks, hoses, and nozzles.
- Apply product only under suitable weather conditions.
- Use a nurse tank to fill application equipment.
- Use an anti-backflow device when filling application equipment (if the use of a nurse tank is not possible).
- Wash application equipment and protective clothing where they will not contaminate water sources.
- Dispose of extra pesticide mixture away from wells and waterways.
- Keep people, farm animals, pets, and wildlife away from puddles of wash water.

## Protecting Soil Resources

Pesticides can contaminate soil when:

- The recommended product application rate is exceeded
- Product is spilled during mixing and loading
- Application equipment overflows
- Containers or surplus spray mixtures are poorly disposed of

Soil characteristics play a major role in pesticide contamination. Spills on sand or sandy loam soils can contaminate groundwater through leaching. Spills on clay soil can remain on the soil surface before being absorbed. This allows them to spread to other areas by surface runoff.

### PERSISTENCE

The length of time a pesticide remains active (persistence) also plays a role in soil contamination.

Pesticide persistence in soil is affected by:

- The chemical class or family of the pesticide
- The type of pesticide formulation
- The ability of the pesticide to form persistent by-products in the soil
- Weather conditions
- The soil conditions (e.g., organic matter, pH, texture)

Examples of persistent pesticides include the herbicides *metribuzin*, *atrazine*, *simazine*, and *metolachlor*. There is a risk of water contamination as long as a pesticide remains in the soil. This can happen through leaching or surface runoff. Persistent pesticides can even damage susceptible crops planted the next season.

Guidelines to prevent soil contamination are similar to those discussed earlier to prevent water contamination.

## Protecting Air Resources

Pesticides can enter the air through spray drift, vapour drift, or when contaminated soil erodes and is carried by wind. Airborne pesticides often fall far from where they were applied. They can come down on their own, or fall with rain or snow. Pesticide residues have been found in snow and in the tissues of animals in the Arctic and Antarctic regions.

To prevent air contamination through drift, you should:

- Limit spraying to proper weather conditions. These are outlined on the product label.
- Use the lowest spray pressure possible.
- Use low-drift nozzles that produce larger droplets.
- Reduce travel speed. Drift increases with higher travel speed.
- Ensure the boom is at the proper height above the target.
- Match the boom height setting to the nozzle type.

Limiting pesticide drift will help to protect natural resources. You should also practice good pesticide selection and follow environmental safety guidelines.

## Managing Non-target Exposure

Beneficial organisms are important to the environment and must be protected. Some pesticides can harm beneficial species. A small amount of a very toxic pesticide can present an extreme danger if it reaches the environment.

To manage exposure of non-target plants, animals, and water, keep the following in mind:-

- Birds, bees, and wildlife are at risk from pesticides. They move freely and can enter treated areas.

- Knowing common beneficial species (plants, animals, insects) in the area will help you take steps to protect them.

- Knowing the movements and lifecycles of non-target species will help you to reduce their exposure during key life stages.

- Prevention is the best protection. Follow label directions and precautions. Know where, when, and how non-target life can be harmed.

## BENEFICIAL INSECTS

There are a number of beneficial insects. For example, bees are important to some crops. They pollinate tree fruits, small fruits, legumes, and vegetables. Pesticides can affect bees:

- **Directly** - exposure during product application
- **Indirectly** - pollen contaminated with pesticide is gathered and stored in the hive

The impact of pesticides on bee populations is influenced by product toxicity and persistence. Symptoms of possible poisonings include:

- Large numbers of dead bees in front of hives
- Aggressive or slow-moving bees
- A sudden drop in the number of bees

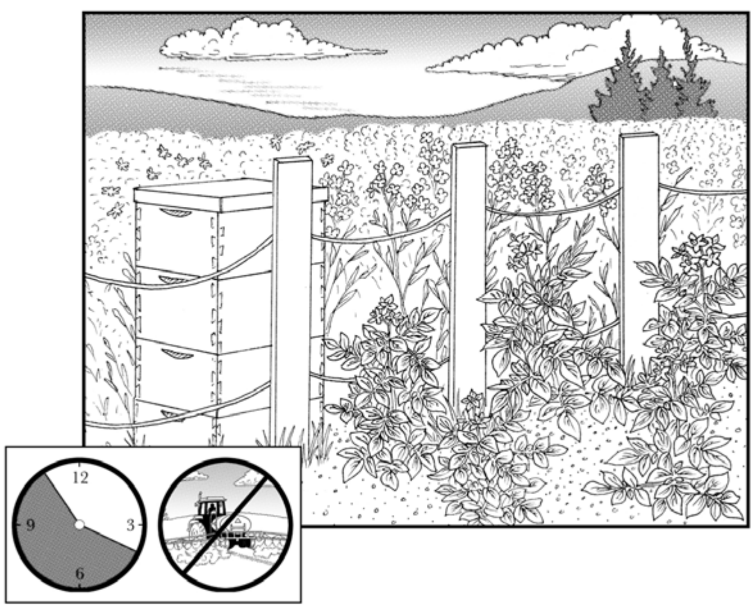



**Figure 6-6: Restrict pesticide applications during the active foraging times of beneficial insects.**

There are a number of ways to reduce pesticide exposure to bees. These include the following:

- Do not apply insecticides while tree fruits and other crops are in bloom or when bee activity is high.
- Use pesticides that pose little risk to bees (if possible).
- Apply pesticides early in the morning or in the evening, when bees are not active (if possible).
- Inform nearby beekeepers of planned pesticide applications.
- Reduce drift and avoid spraying insecticide on non-crop field edges or borders.

Beneficial insects, such as the praying mantis, ladybird beetle (ladybug), and assassin bug, prey on pests. They are natural pest controls.

Widespread use of pesticides cuts down on the number of beneficial insects. This upsets the natural balance and can lead to greater pest problems.

Beneficial insects often play a major role in integrated pest management (IPM). Maintain the health and safety of beneficial insects to reduce the need for chemical pesticides.

Beneficials can be protected from pesticide poisoning by following guidelines set out to protect bees. (See C**hapter 7: Integrated Pest Management** for information on protecting beneficial organisms.)

## FISH

Some pesticides are very toxic to fish and other aquatic species. If enough pesticide gets into fish habitat, fish and smaller organisms that provide food for fish can be killed.

Even low pesticide levels can affect the ability of fish to reproduce. Pesticides can also build up in fish. This can make them unfit for people or animals to eat.

Damage to the aquatic environment or streamside plants can impact fish health. The death of plants near a stream can cause:

- An increase in water temperature

- A decrease in dissolved oxygen content
- Increased runoff (This can leave silt in spawning beds.)
- Erosion of stream banks
- Loss of food sources
- Loss of protective cover (This leaves fish more at risk from predators.)

The only way to protect aquatic environments from pesticide contamination is to reduce drift and runoff into streams, rivers, and other waterways. This can be achieved by following a number of safe practices:

- Identify all water sources and waterways on the farm, and create and maintain proper aquatic buffer zones.

- Mix and apply all pesticides according to label directions.

- Prepare tank mixes and fill application equipment away from water sources.

- Apply product only under suitable weather conditions.

- Use a nurse tank to fill application equipment.

- Use an anti-backflow device when filling application equipment (if there is no nurse tank).

- Wash application equipment where runoff cannot contaminate water sources.

- Properly dispose of extra pesticide mixture.

## WILDLIFE

Wildlife, birds, and domestic animals can be harmed by exposure to pesticides. Exposure can affect their health, impede reproduction, or cause death.

For example, birds can be poisoned when they eat granular insecticides or treated seed that has been thrown away or poorly stored. Indirect exposure can occur when food sources or water is contaminated with pesticides.

### PLANTS

Phytotoxic chemicals damage or injure plants. When these are used, injury can occur to both target and non-target plants. Herbicides cause most pesticide plant damage. However, damage to non-target plants can also result from insecticides or fungicides.

Pesticide applicators should be aware of non-target sensitivities given on the product label. You can protect non-target plants by taking steps to prevent spray or vapour drift.

Wildlife and fish use streamside vegetation. These plants:

- Serve as food
- Provide shelter
- Stabilize stream beds or banks
- Retain moisture

Damage to plants along a stream will harm food and habitat for wildlife. Herbicide damage to streamside plants can affect:

- Stream bank stability
- Water temperature (by removing shade)
- Food sources for fish

This damage can have a long-term effect even outside the treatment area.

## Legal Implications

There are a number of federal acts that address contamination of the environment. The *Fisheries Act*, the *Canadian Environmental Protection Act*, and the *Migratory Birds Convention Act* deal with damage by pesticide contamination. They cover things like fish or fish habitat, migratory birds, and the environment. These acts and other federal laws are described in **Chapter 2: Pesticide Regulations.**

Provincial laws also regulate and protect the environment. All pesticide applicators must work within the law.

# Label Warnings

Pesticide labels can also provide information on environmental hazards. For example, the risks associated with a product are often listed. Precautions to be taken when applying the pesticide are also given. Statements may read:

- “This product is very toxic to fish and aquatic organisms.”
- “Do not apply when weather conditions favour drift from target area.”
- “Do not contaminate ponds, lakes, streams, or rivers during sprayer filling operation or while spraying.”
- “This product is very toxic to bees; avoid spraying when bees are foraging. Spray deposit should be dry before bees commence foraging in treated crop.”
- “This product is toxic to fish, aquatic invertebrates, and marine/estuarine organisms. Runoff from treated areas may be hazardous to aquatic organisms in neighbouring areas. Do not apply directly to water.”
- “Keep out of lakes, streams, and ponds. Do not contaminate water by cleaning equipment or disposing of waste. Do not apply where runoff is likely to occur. Do not apply when weather conditions favour drift from areas being treated.”
- “A buffer zone of 15 metres must be observed for ground applications to protect bodies of water including lakes, streams, ponds, and sloughs from drift.”
- “Do not apply with ground equipment within 15 metres of productive fisheries, water sources, or waterfowl habitats.”
- “Spray only when winds are less than 10 km/h.”
- “Use spray nozzle tips and spraying pressure that provide larger droplets.”

Other things that you can do to reduce the risk of environmental pesticide contamination include:

- Use non-chemical control measures if possible. These reduce the amount of pesticide needed. Examples include tillage and crop rotation.
- Calibrate application equipment. This ensures that the proper spray volume is delivered.
- Read product labels and follow all directions. Never exceed the application rates called for on the label.
- Use crop rotation to reduce crop-specific pests.
- Choose the least toxic and least persistent pesticide that will control the pest.
- Handle and mix pesticides with care. Never transport or mix pesticides near water or any sensitive area.
- Clean and store empty pesticide containers in pesticide storage areas until you can properly dispose of them.

## Pesticide Spills

Pesticide spills pose a hazard to humans, animals, and plants. Product often spreads quickly from the spill site to further contaminate the environment.

Spills during mixing and loading operations are very dangerous. This is when pesticides are at their highest concentrations.

Pesticide applicators can minimize environmental damage by dealing with spills quickly and properly. (See **Chapter 9: Emergency Response** for directions on dealing with pesticide spills.)

To reduce the chance of a pesticide spill:

- Check pesticide containers and packages frequently for leaks.
- Practise good pesticide storage habits. Consider stacking height and lighting.

- Secure containers and packages when moving pesticides.
- Avoid travel near sensitive areas (e.g., public dwellings or waterways) when moving concentrated or mixed product.
- Make sure that you are familiar with field obstructions (e.g., ditches, washouts, and berms) that might hinder safe movement.
- Provide buffer zones as called for on labels or by law.
- Use an anti-backflow device when filling the sprayer from a body of water.

## In Review

**A healthy environment is key to the future of any farming operation. The farm environment connects to the larger community of farms, homes, and businesses. Pesticide use on the farm can pose a risk to the environment. It can also pose a risk to the neighbouring community.**

**The safe handling and use of pesticides will help to ensure that waterways, soil, and air are not contaminated.**

**Many organisms live in the environment where pesticides are applied. These include both pests and beneficial species. All can be harmed by pesticides. Responsible pest control will help to keep beneficial insects, fish, wildlife, non-target plants, and humans from harm.**

**Pesticide applicators must meet federal and provincial legal requirements to protect the environment. Careful management can protect non-target areas from pesticide contamination. It can also help applicators to avoid legal action should they accidentally damage the environment when farming.**

**Product labels and Material Safety Data Sheets are the best sources of**

# Case Study: Reducing Environmental Risk

Ted is a potato producer. He grows over 500 hectares of potatoes each year. This year he has been finding it hard to control fungal pests in his crop.

So far, the growing season has been wet, cool, and very windy. Poor weather often disrupts Ted's fungicide application schedule. Crop experts there advise him that the late blight severity index is high in his area.

Ted has 30 hectares of potatoes that have not been sprayed for seven days. Current weather is sunny. The wind is blowing close to the legal maximum allowed for a pesticide application.

Environment Canada has predicted that the remnants of a tropical storm could strike the province early the next morning. With this storm, up to 100 millimetres of rain could fall over the next three days. Ted is concerned about this weather, but the risk of late blight is still high and 30 hectares of his crop are not well protected.

To beat the storm and rain, Ted decides to apply a liquid fungicide. First, he must consider the geography of the field:

- On the north side, the field slopes slightly toward a nearby watercourse.
- On two sides, young hedgerows border the field.
- On the other side of one of the hedgerows, there is a small housing subdivision.

Ted believes that the hedgerow will provide shelter, and drift to the nearby subdivision won't be a problem. That afternoon, he applies a fungicide to his potato crop. Winds gust close to 23 km/h. At times, the wind is so strong that the fungicide does not even reach the crop canopy. It just drifts off toward the subdivision.

Before Ted has finished, a provincial pesticide inspector arrives at the field. The inspector tells him to stop the pesticide application. He has noticed product drift from the field while driving past the subdivision. The wind speed is below the legal maximum and a proper buffer zone is in place. Ted asks why the inspector has stopped him.

The inspector agrees that Ted is not breaking any laws. However, he is causing serious risk to human health and the environment. These risks should have been taken into account before applying pesticide that day.

The inspector points out two major problems with Ted's fungicide application. First, there was a lot of off-target drift. Much of the product is not even reaching the crop. The wind is moving the product up and over the hedgerow and leaving it in the nearby subdivision. This could expose children and pets in their yards, and people in their homes.

The product that Ted is using poses a low health risk to humans. However, exposure to any pesticide should be kept to a minimum. Some people are very sensitive to pesticides and can show poisoning symptoms from even slight exposure. Applying pesticides in high wind, with visible drift, reflects poorly on both Ted and the farming industry.

The second problem raised by the inspector is the risk of product runoff. The runoff could get into the watercourse. The coming rainstorm could wash the fungicide into a nearby stream. The fungicide that Ted is using is very toxic to fish and other aquatic life. Even if a small amount of product reaches the watercourse, it might cause a fish kill.

Ted is annoyed and worries about the cost to his crop if he stops the application. However, he admits his poor judgment. He and the inspector discuss other pest control options. Ted learns that there are a number of options for him to consider:

**Product selection -** Some fungicides are less toxic to humans and fish. Choose the least toxic product when applying a pesticide close to a watercourse or public dwelling.

**Public notification** - Ted should inform neighbours before a pesticide application. They can then keep their children and pets indoors, close their windows, or leave the area for a few hours if they are sensitive to chemical use.

**Application equipment** - Ted can reduce off-target drift by lowering application pressure, driving the tractor more slowly, and keeping a proper boom height. A shroud around the nozzles will further reduce product drift from the application area.

The inspector mentions that since a watercourse borders Ted's field, the risk of erosion can be reduced by:

- Keeping the crop off steeply sloped land
- Increasing the size or width of the buffer zone along the watercourse
- Checking weather forecasts to make sure that dry weather follows a pesticide application

Ted is still concerned that his crop is not protected from late blight. However, he now understands the need to respect the health of his neighbours and nearby surface water.

Ted agrees to stop spray activity that day. He will wait until the storm passes and the strong winds decrease. A later fungicide application will still allow him to reduce the risk of disease.

Ted then drives to the subdivision and speaks to homeowners. He agrees to inform them by phone in the future before a planned pesticide application. Ted decides that next year he will increase his buffer zone to 30 metres, strip crop across the slope, and look into buying a shroud for his sprayer. This will further reduce the environmental impact of pesticide use on his farm.

# Self-study Questions

*Answers are located in Appendix A of this manual.*

1. Select three processes from the following list that can affect the fate of pesticides after they are released into the environment.

   a) adsorption
   b) transfer
   c) weather conditions
   d) degradation
   e) buffer zones

2. Degree of environmental risk depends on four factors. They are:

   a) volume
   b) weather
   c) buffer zones
   d) persistence of the product
   e) mobility

3. Which one of the following scenarios presents the greatest degree of environmental risk?

   a) An applicator sprays a potato crop with two applications of a fungicide. Following one of the applications, a small amount of spray drifts to a nearby field.
   b) An applicator sprays a potato crop with two applications of a fungicide and two applications of an insecticide. After each application the weather is sunny and warm.
   c) An applicator sprays a potato crop with two applications of a fungicide and two applications of an insecticide. Following one of the applications, pesticide residue is noticeable on plants several hundred metres from the field that was sprayed.

d) An applicator sprays a potato crop with two applications of a fungicide and two applications of an insecticide. Crows are often spotted close to the sprayed field.

4. If pesticides are applied very near to a river, pond, or lake, the pesticide can damage food, aquatic organisms, and streamside vegetation. What are the expected effects on the fish populations in these watercourses?

    a) There will be no effect on the fish populations.
    b) Fish populations will suffer due to loss of food and oxygen sources.
    c) The loss of streamside vegetation removes shelter and plant root systems, increasing the possibility of runoff and soil erosion.
    d) There will be no effect on streamside vegetation.
    e) b and c

5. You are applying a liquid herbicide formulation to a field in July. The temperature is 25 degrees Celsius, and the forecast is calling for three sunny days. Which of the following practices can help you decrease the potential for environmental risk?

    a) Apply the pesticide at label-recommended rates.
    b) Calibrate your equipment properly.
    c) Use a pesticide having a high toxicity to maximize pest control results.
    d) All of the above
    e) a and b only

Chapter 7

# INTEGRATED PEST MANAGEMENT (IPM)

## SECTION A: DEVELOPING AN IPM PROGRAM

Integrated pest management (IPM) is a decision-making tool. It involves planning and acting to control pests. To follow IPM, you will have to think about a variety of control measures. These should be effective, affordable, and environmentally safe.

The prevention of pest problems is the first step in IPM. If pest control is needed, IPM can involve physical (mechanical), cultural, biological, genetic, or chemical measures. These can be performed alone or in combination. The goal is to maximize pest control, while minimizing environmental and health risks.

With IPM, pest control is only used when it is called for after careful monitoring. With planning, IPM will avoid the use of pesticides when they are not needed. This keeps crop production costs down.

Economic measures can be used to judge the success of IPM. Evaluate your IPM program each year. This will allow you to achieve the long-term economic and environmental benefits of IPM.

### Learning Objectives

**Completing this section will help you to:**

- **Identify the steps involved in integrated pest management (IPM).**
- **Manage and reduce pest resistance.**

# General Steps of an IPM Program

An individual must answer many key questions before putting a pest management program in place.

- Are there pests in the crop?
- What types of pests (e.g., insects, weeds, diseases, or animals) are present?
- How many pests are there per plant or per area?
- How much damage are the pests doing?
- Are conditions suitable for pest problems to grow?
- Is the pest at a stage where it can be controlled?

A good IPM program will first try to prevent pest problems. Changing the management of plants and crops can limit pest problems. Pest management should be effective, safe, and not too expensive. It often involves keeping pest numbers down to acceptable levels. It does not result in the total elimination of a pest population.

**Injury Threshold**

**This occurs when a pest population reaches numbers such that it causes unacceptable injury or damage sufficient to justify treatment.**

Before starting an IPM program, applicators must:

**Step 1 –** Find out what pests are present. Beneficial species in the same area should also be identified.

**Step 2 –** Closely monitor pest and beneficial species populations. Look for pest damage. Monitor the environment.

**Step 3 –** Use injury and action thresholds. This will show the best time to treat pests.

**Step 4 –** Choose needed pest control measures. Use a combination of measures. This will control pests with the least environmental impact.

**Step 5 –** Evaluate the effectiveness of the pest management plan.

**Action Threshold**

**This is the point at which treatment should take place in order to prevent the pest from reaching the economic injury threshold.**

## Identify Pests

**Step 1 – Find out what pests are present. Identify beneficial species in the same area.**

Identifying pests and beneficial species is important to IPM. Correct pest identification is needed to understand pest biology. To protect beneficial species that live in the same area, they must not be mistaken for pests.

Identification can show that active treatment is not required. For example, enough of a beneficial species may be present to naturally control the pest.

**Beneficial species are often most important when managing insect pests. However, they can also suppress weeds and animal pests.**

Pesticide applicators should know the biology of both pests and beneficial species. This can help in deciding how to manage them both. Important biological information includes the following:

- Know the life cycle and growth stages of the pest. This allows applicators to treat the pest when it might be best controlled. The level of control can depend on the growth stage of the pest.
- Know the rate at which pest species reproduce. This helps in planning the timing and number of treatments to control current and future pests.
- Know the life cycle of the host (e.g., a plant in a crop or an animal). Some treatments can harm the host if applied at the wrong stage of the pest's life cycle.
- Know the behaviour of the pest. The pest may only be present in an area during certain times of the day or night. Some only appear in certain places. This can affect the timing or choice of treatment.

**Examine the pest and the damage it causes. This helps with pest identification.**

## Information Sources

If pest identification cannot be made easily, there are information sources to help. Information on pest and beneficial species can be obtained from government fact sheets and scientific publications.

Diagnostic services include crop scouting firms and pest control representatives. Government pest management experts can also be contacted. The Internet and other electronic references can help.

Once the pest is identified, the applicator must find the development stage where pest control will best work.

Pests are often easier to control during a certain life stage. For example, annual weeds are best managed with herbicides when they are seedlings. Insects are often best controlled during early life stages.

# Monitor Pests

**Step 2 – Closely monitor pest and beneficial species populations. Look for pest damage and monitor the environment.**

Good pest monitoring (scouting) will provide information for pest control. Conduct regular field inspections. Count pests. Record the results. (See **Chapter 5: Pesticide Safety and Chapter 11: Traceability** for information on keeping records.)

Monitoring will help to show:

- The extent of pest damage to crops
- The presence, species, and number of pests (Does the pest population exceed the injury threshold?)
- Weather that favours or hinders pests
- The life stage when pests are susceptible to a given control method
- The suitability of action considering the host’s life stage and condition
- The presence, species, and number of beneficial organisms (Are there enough of these to keep the pest population below the injury threshold?)

**Helpful pest management information can come from a number of sources. Try to provide the resource person with a sample of the pest or with a damaged plant or animal.**

## Visual Inspection

Watch for signs of pest problems. This involves looking for conditions that favour pests. Inspections should be regular. Clear notes should be kept.

The value of observations depends on the knowledge of the inspector. Visual inspections are good to check for the presence of pests, damage symptoms, and beneficial species.

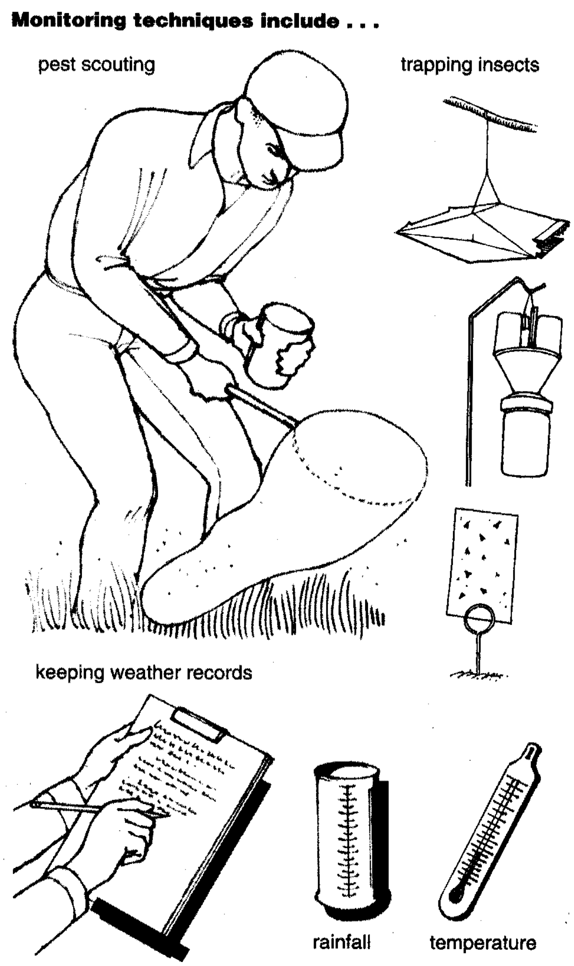
Inspections can show growing conditions, plant health, and environmental conditions that attract pests or provide them with shelter, food, or water.

## Counting and Measuring

Counting and measuring provides information on pest populations or levels of damage. Data can be gathered over time. Results can be compared from year to year.

Counting and measuring will be used to:

- Estimate the number and spread of pests
- Compare records from other sites
- Determine injury and action levels
- Evaluate the effect of treatments




When counting and measuring, the following information should be recorded:

- The number of pests on leaves, and/or signs of pest damage on leaves or plants
- The number of pests (e.g., weeds or insects) in a measured area (per square metre or per plant)
- The number of pests caught in traps
- The size of an area affected (e.g., diseased areas on leaves or turf, or the area of an infected field)
- The number of days when weather favours pests (e.g., development of plant disease, insect hatching, etc.)

**Figure 7-1: Pest monitoring involves a number of activities.**

## Record Keeping

Written records are needed to monitor pests. Records provide a history of IPM results from a number of inspection dates. They also allow results to be compared between seasons. Good monitoring or scouting:

- Reduces the need for chemicals
- Improves pest management
- Reduces treatment costs

A good monitoring schedule will:

- Find the cause of a pest problem (This helps define the actions needed to prevent future outbreaks.)
- Locate the centre of a pest infestation (The treatment can then be directed at this area. This limits the spread of the pest and the number of future treatments needed.)
- Set and adjust action thresholds for better pest control
- Assess treatment results
- Improve pest management and allow it to work better in the future

Monitoring methods can include visual inspection, or counting and measuring.

# Injury Level and Action Thresholds

**Step 3 – Use injury and action thresholds to find the best time to treat pests.**

The aim of integrated pest management is to keep the pest population at a level that avoids economic loss. A certain amount of pest damage may not pose a problem. Thresholds help the applicator decide the level of damage that requires pest control, and when to begin treatment. Keep track of the amount of damage that occurs. Information from monitoring can be used to decide if pests require control measures. Control often does not involve elimination of the pest.

## Economic Injury Level

The economic injury level is the point at which the cost of pest damage equals the cost of pest control. IPM should begin before the economic injury level is reached. Economic injury may include lost crop yield or quality, extra labour costs, or increased pest control costs. Some pest species cause more economic injury than others.

## Action Threshold

This is the point at which you must take action to control pests to avoid reaching the economic injury level. You should control the pest when the action threshold is reached. Each pest has its own action threshold. This depends on the control measure to be used and the biology of the pest.

Once you know the action threshold for a particular pest, the pest population must be monitored so that you will know when that threshold is reached.

**Thresholds are only guidelines.** They can be changed to reflect local conditions and market demands.

**Step 4 – Choose the pest control measures that you will need. Use a combination of measures when possible.**

IPM involves using a number of monitoring and control measures. These include the following:

## Physical (Mechanical) Controls

Physical controls involve either removing a pest that is in place, or preventing it from getting into a crop.

Physical controls include:

- Using screens to keep out insects
- Using mulches to suppress weeds
- Cultivating fields to control weeds

## Cultural Controls

Cultural controls are practices common to good soil, seed, crop, and environmental management. Cultural controls include crop rotation and the use of certified seed (e.g., low in weed seeds and disease).

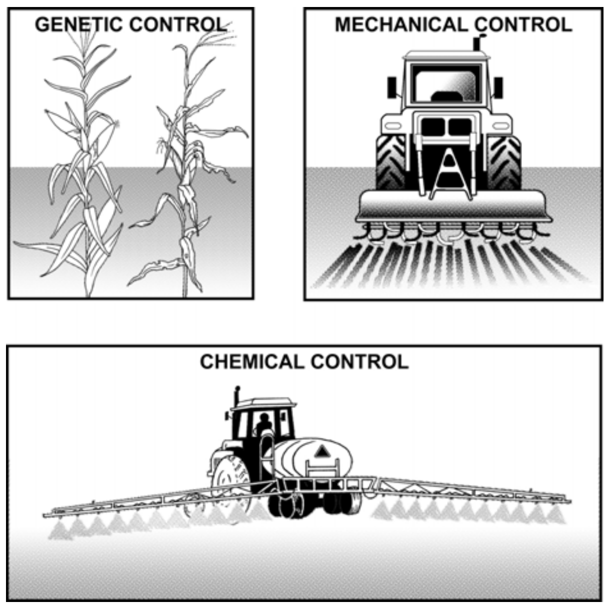



**Figure 7-2: A good IPM program will use a variety of pest control measures.**

## Biological Controls

Biological controls use other organisms to control or kill the pest. Measures include releasing sterile insects, beneficial parasites, or predators (e.g., parasites to control whitefly in a greenhouse).

## Genetic Controls

Genetic controls involve planting modified seeds and crops. These can resist pests. Genetic controls include using genetically engineered crops (e.g., Bt-corn and Bt-potatoes), or choosing plant varieties that resist disease.

## Chemical Controls

Chemical controls involve using pesticides such as herbicides, insecticides, fungicides, or repellents. These control, suppress, or repel pests. Chemical controls include using an insecticide on potato plants to control aphids, or using herbicides to control weeds.

Using a number of these measures promotes good pest control. It also minimizes environmental and health risks. Pest controls should only be used when monitoring shows that they are needed.

With planning, applicators should avoid using pesticides when they are not needed. This will help to lower the cost of pest control.

**Chemical control is not always needed or economical. Consider using pest control measures that do not require chemicals. Good IPM includes using a number of control measures, alone or in combination.**

# Evaluate Management Strategies

**Step 5 – Evaluate the effectiveness of the pest management plan.**

It is important to evaluate the effects of IPM. The only way to do this is to keep good records. Detailed records of pest management strategies you have used in the past will help you know if they were effective or not. (See **Chapter 11: Tracebility.**)

This information can be used to:

- Evaluate current pest management programs
- Adjust the program for future years
- Forecast pest problems
- Defend against legal suits

Integrated pest management is only part of a crop management program. Other parts of an IPM program include seed quality, varieties, soil health, nutrition, water and soil management, climatic effects, post-harvest handling, and marketing.

### In Review

**Integrated pest management (IPM) uses a number of pest control measures. It is not limited to the use of pesticides.**

**When threatened with crop damage, growers should identify all pests in the crop, and know their population numbers. The type of pest may dictate the control measure.**

**Look at all information sources before developing a plan for pest management. Once the best control program is chosen, regularly monitor for results and effects.**

## IPM and Pest Resistance

Resistance occurs when a pest (e.g., weed, insect, fungus, or animal) survives a pesticide application that once controlled it. This can happen if pesticides are used improperly or too often. Resistant weeds, insects, or diseases may have to be controlled using an IPM plan that includes non-chemical methods.

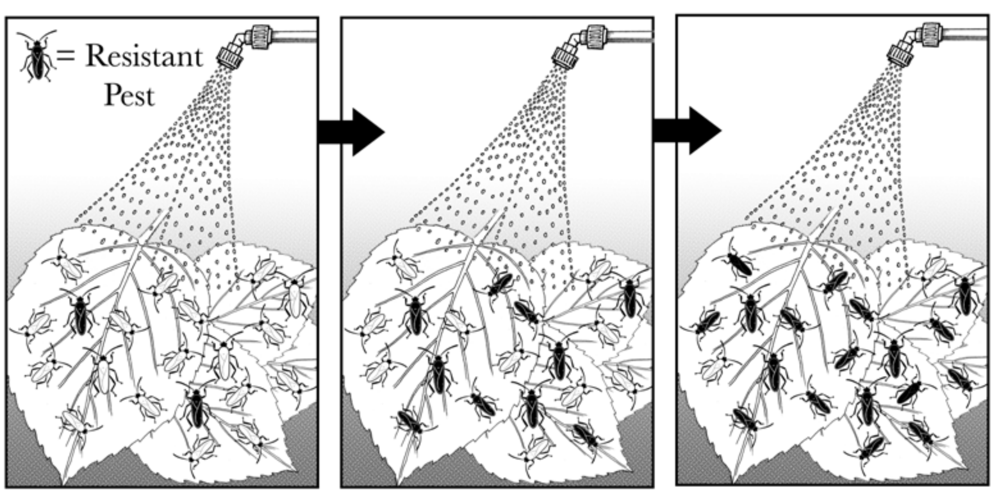



**Figure 7-3: Some pests can develop a resistance to chemical control. To avoid this, rotate the use of pesticides from as many chemical families as possible.**

**The best way to manage pest resistance is to prevent or delay it. An IPM program with a variety of control measures will help to avoid resistance.**

IPM does not guarantee that pest resistance will not happen. Remember, research has found that a number of control measures in a well-planned program will reduce or avoid resistance.

Research has also found that repeated use of the same pesticide (or pesticides from the same chemical family) may promote resistance. To avoid this, rotate the use of pesticides from as many families as possible. Only use chemical control when pests exceed economic thresholds.

## How to Delay Pest Resistance

To minimize or prevent pest resistance on the farm:

- Scout all fields regularly to identify pests. Consult crop management advisors and experts (e.g., weed, insect, and disease specialists). They can help identify resistant pests.
- Use physical (mechanical), cultural, biological, or genetic pest control measures.
- Rotate crops. Some pest problems are more easily controlled in certain crops. Pests may not survive a change in crops. Crop rotation can allow a switch to a new pesticide family for the new crop.
- Alternate chemical products from different families when pesticides are needed. Use registered tank mixes of two or more pesticides when possible.
- Keep records of crop rotations and pesticides used with each crop. This helps with long-term IPM planning.
- Talk with grower organizations and crop-management experts. Learn about resistant pest populations in the area and how to manage them.

**Crop resistance can be positive. Herbicide resistance can provide another weed control option. Through a number of breeding methods, crops have been developed that resist certain herbicides.**

**Some corn and soybean hybrids resist common herbicides. *Roundup*-Ready soybeans have been developed with biotechnology. The herbicide *Roundup* can be safely applied to them after the plants have emerged from the ground. This controls weeds and leaves the soybean crop intact.**

## In Review

**Any pest management strategy can result in pest resistance. Some pests come to tolerate chemical control measures. This restricts the benefits of IPM.**

**The best way to avoid resistance is to know the physical characteristics of the pest. This helps when selecting a control measure.**

**Using a variety of control measures will reduce pest resistance. These include physical (mechanical), cultural, biological, genetic, or chemical pest control.**

# SECTION B: IPM AND WEED CONTROL

A weed is any plant that grows where it is not wanted. Weeds compete with cultivated plants for light, water, and nutrients. They can:

- Reduce crop yield or quality
- Harm livestock
- Become hosts for other pests

Learning Objective

**Completing this section will help you to:**

- **Identify and control weed pests.**

## Weed Identification

Weeds are present in most crops. Each year, new weed seeds will be added to the soil. Only five to ten percent of the new weed seeds are likely to germinate in any given year. Weed seeds can, however, remain dormant but viable for many years. Over time, they build up in the soil. Each year brings a new weed crop.

Applicators should expect both weed and crop seeds to germinate when conditions suit (e.g., proper fertility, moisture, and heat).

A good weed control plan begins before the crop is planted. Monitor fields for weeds. Identify weed varieties, life cycles, and characteristics. When a weed problem is identified, choose the best measure of control.

Weed control measures include:

- Sanitation
- Cultural
- Physical
- Mechanical
- Biological
- Chemical (These will be discussed in another section of this chapter.)

Record keeping is a big part of weed control in IPM. Records should show:

- Crops planted
- Predominant weeds that developed
- Control measures taken
- Results of the control measures

This information will help select proven control measures for each crop.

## Weed Monitoring

You must continue to monitor or scout for weeds during the growing season. Weeds must be identified and counted. This will help you to choose and time proper control measures.

Begin to monitor fields in the spring, when weeds first appear. Weeds may be confined to a small area. Therefore, scouting patterns and sites should be varied to ensure that most of the field is covered. Weed species and the numbers of each should be recorded.

## Weed Identification

Each weed has its own life cycle and growth habits. These can change the effect of control measures. To select the best time for control, you must first identify the weeds.

Publications that can help you to identify weeds include:

- *Ontario Weeds* – Available from the Ontario Ministry of Agriculture, Food and Rural Affairs
- *Identification Guide to Weeds of Quebec* (1-800-859-7474)
- *Weed Identification Guide* – Published by Agriculture Canada, the Nova Scotia Department of Agriculture and Marketing, and the New Brunswick Department of Agriculture

## Weed Life Cycles

Weeds can be grouped or classified by their life cycle. This is the time from seed germination to seed production. Life cycles can be annual, biennial, or perennial. Knowing the life cycle of each weed will help you identify, plan for, and apply proper control measures.

### Annual Weeds

Annual weeds complete their life cycle within one year. They produce many seeds during this time. This ensures that they will survive.

Annuals fall into two groups:

- **Summer annuals**:
    - Germinate in the spring
    - Drop seeds and die each summer

Examples are lambs quarters and wild mustard.

- **Winter annuals:**
    - Germinate in the fall
    - Spend the winter as seedlings
    - Drop seeds and die the next season

Examples are shepherd's purse and stinkweed.

## Biennial Weeds

Biennial weeds take two seasons to mature and produce seeds.

- **Year 1** - Seeds germinate in spring. A rosette of leaves forms (*see* section on weed growth habits). Food is stored in short, fleshy roots over the winter.

- **Year 2** - The plant uses stored food to grow and produce seed. It then dies.

Examples are wild carrot, burdock, and tansy ragwort.

## Perennial Weeds

Perennial weeds live more than two years. Many perennials reproduce through seeds. They can also spread using aboveground runners or underground rhizomes and roots (vegetative reproduction).

- Seed reproduction
  - Reproduce mainly by seeds each year

    Examples are dandelion and Canada thistle.

- Vegetative reproduction
  - Reproduce mainly by runners, rhizomes, or roots

    Examples are quackgrass and goldenrod.

# Weed Characteristics and Growth Habits

Plant features can be used to identity weeds. These include:

- Leaf types
- Leaf appearance and arrangement
- Stem shape
- Flower type
- Root structure
- Growth habits

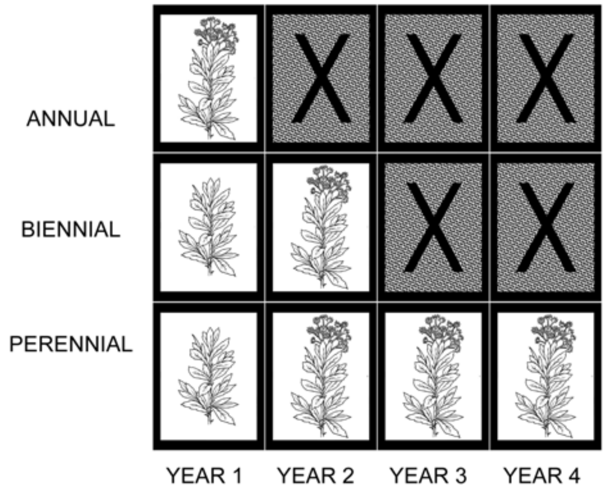



**Figure 7-4: Weed types**.

## Leaf Types

Weeds can be classified as grass-type or broadleaf.

### GRASS-TYPE LEAVES

Grass-type leaves include:

- One single leaf that comes from the ground
- Leaves that unfold from a central whorl
- True leaves that alternate along the stem
- Leaves that are long, narrow, and upright

### BROADLEAF WEEDS

Cotyledons, or seed leaves, are the first to show with broadleaf weeds. They are often a different shape from the true leaves that follow. Cotyledons are not always seen. They can dry up and disappear, or stay beneath the soil.

True leaves include the second set of leaves and all that come after. These appear on plants other than grasses. True leaves are often used to identify plants.

## Leaf Appearance

Leaf appearance can be used to identity weed species. Broadleaf weed characteristics include leaf shape, leaf margin, and leaf surface.

- **Leaf shape –** This refers to the outline of the whole leaf. True leaves come in many shapes. Common shapes include:

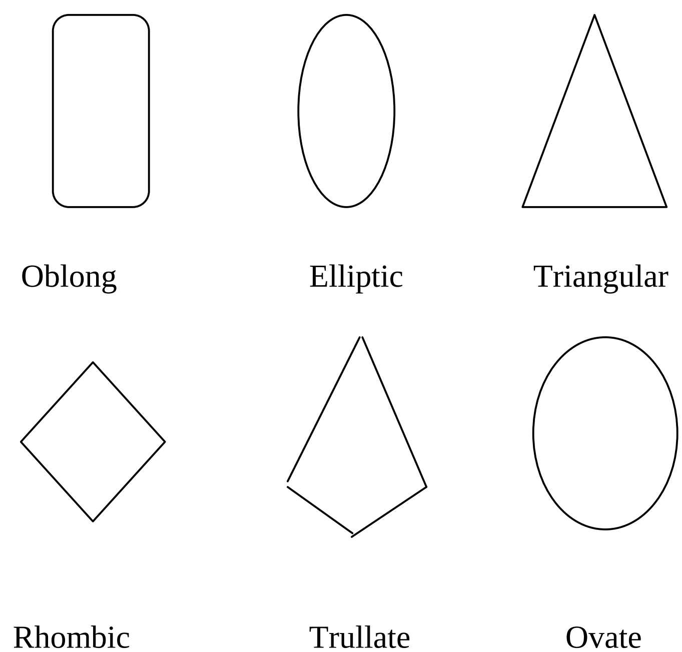



**Figure 7-5: Leaf shapes.**

- **Leaf margin –** The outer edge or margin of the leaf has certain features. These can be used to identify a given weed species.

- **Leaf surface –** This feature can be used to determine weed species. Some leaves are hairy (pubescent). Others are shiny or waxy. For example, leaves of St. John's wort have tiny holes that can be seen when a leaf is held up to light.

## Leaf Arrangement

The way leaves are arranged on the stem can also be used to identify a weed species. Broadleaf plants feature three arrangements of leaves:

Alternate leaves:

- Grow singly at each node on alternate sides of the stem
- Are not directly opposite one another on the stem

Opposite leaves:

- Grow in pairs from the same node
- Are directly opposite one another on the stem

Whorls:

- Groups of three or more leaves come from the same stem node

## Stem

Stem types vary among weed species. Noting the type of stem can help with identification. Stems can be herbaceous or woody. In most weeds, a stem cut crosswise in half will be round. Weeds in the mint family have square stems. Sedges (grass-like weeds) have triangular stems.

## Flowers

Flowers vary among weed species. Flower characteristics include:

- Colour
- Number of parts
- Stem arrangement
- Type of fruit or seed produced

## Root Structure

The root structure of weeds often falls into one of two types.

- **Taproots** are long and tapered roots. They grow deep into the soil. Smaller side roots branch out from the taproot. These anchor the plant in the soil.

- **Fibrous roots** grow in clusters or clumps. They form a network of similar sized roots, which are fibre- or sting-like and spread out over a large area.

Some species of plants (such as perennial grasses) produce rhizomes. These are underground stems that form buds. You should know whether a plant produces rhizomes when choosing a pest control product. Rhizomes grow new plants from each bud on the roots.

## Growth Habits

The growth habits or shape of the plant may help you to identify weeds. Some weeds lie close to the ground. Others grow tall.

### In Review

**Weeds grow in most crops. They become pests when they:**

- **Interfere with crop growth and reduce production**
- **Threaten other organisms**
- **Host other pests**

**Weed identification is a major part of IPM weed control. Weeds have different life cycles. They can live one, two, or many years. Weeds can reproduce through seeds or by vegetative methods.**

**Weeds can be broadleaf plants or grasses. Distinguishing features include:**

- **Leaf shape and appearance**
- **Stem shape**
- **Root system**
- **Shape and growing habit of the plant**
- **Flowers**

**Identify all weeds in your crop and know their life cycles. This will help in planning when and how to apply control measures. It will also promote good weed management.**

# Weed Management

**Control of weed pests is key to Integrated Pest Management.**

Weed management starts with planning before crops are planted. Weeds should be controlled before they:

- Compete with the crop for water
- Compete for sunlight
- Compete for soil nutrients
- Produce seeds

Methods of weed management include the following controls:

- Sanitation
- Cultural
- Physical
- Mechanical
- Biological
- Chemical

Avoid non-stop cultivation or reliance on one control measure for a given crop. These can lead to increased weed problems.

## Sanitation Control

Sanitation measures reduce the spread of weeds. Farm sanitation keeps new weed seeds from being added to the field. It can also limit the start of a new weed problem.

Sanitation measures for weed control include the following:

- **Plant certified seed.** Purchase and plant certified seed that is free of weed seeds.

- **Clean farm machinery.** Clean soil and plant matter from farm machinery. Do this before moving equipment from the field. This prevents the spread of weed seeds or rhizomes.
- **Apply well-rotted manure.** Make sure manure is well rotted if it is to be used. This will reduce the number of viable weed seeds in the manure.
- **Control nearby weeds.** Control weeds in non-crop areas such as hedgerows and ditches. This helps curb the spread of wind-borne seeds to crops.

## Cultural Control

Cultural weed control involves managing crops so they can compete with weeds. These measures include the following:

- **Crop rotation** ensures soil health. This promotes better crop growth.

  Vigorous crops can compete with weeds. A healthy crop will limit the number of weed plants and the need to control them.
- **Intercropping systems** involve the use of crop rotation with optimal tillage methods. This can also include proper row widths and harvesting methods.

  Intercropping can alter and reduce weed growth cycles. Cover crops are integral to crop rotation. Plow-down crops (e.g., rye, clover, winter wheat, and forage stands) suppress weed growth. These also protect the soil from erosion.
- **Minimizing tillage** reduces the number of new weed seeds brought to the surface where they can then germinate.

## Physical (Mechanical) Control

Physical or mechanical control involves the use of machinery or manual techniques to control the growth and spread of weeds. Methods include the following:

- **Pre-emergent (blind) harrowing** is done after the crop seed has germinated, but before plants have emerged from the soil. The harrowing process kills small weed seedlings that emerge more quickly than the crop. This gives the germinated crop a chance to grow before the next generation of weeds comes along. This type of weed control is not suited for crops underseeded with grass or legumes.

- **Rotary hoes** lift and mix the soil as they uproot small weeds. They also tend to cause less crop damage than harrows. Rotary hoes can be used to incorporate surface-applied herbicides.
- **Inter-row cultivation** uproots small weeds and cuts off larger ones. This is an important weed control for the production of potatoes and other row crops. Inter-row cultivation may have to be repeated for long-season crops. The applicator should consider the size of the crop relative to the number of weeds. Any method of cultivation can chop up the roots of perennial weeds and spread them through the field. This can increase the weed problem.
- **Mowing** is often used in orchards and along roadsides. It prevents seeds from forming. Mowing can reduce the spread of weeds and leave a vegetative cover.
- **Mulch** can suppress weed germination and growth. It denies weed seeds the light and moisture needed to germinate.
- **Hand weeding and hoeing** controls annual plants. This measure is less useful with deep-rooted biennial and perennial species. The roots of these weeds may be too deep to be removed in this way. Hand weeding is better suited for small areas. Make sure that all removed weeds are destroyed to prevent the spread of their seeds.

## Biological Control

Biological weed control uses certain insects or fungal pathogens. These feed on or infect the weed seedlings. They do not harm the crop. Biological control is often pest or crop specific. Examples include:

- **Release of fungal pathogens** can suppress or control a number of crop weeds. For example, one fungal strain has been developed into a herbicide to control joint vetch in soybeans. Fungal, nematode, and bacterial pathogens can be used to control a variety of weeds in Canada (e.g., field bindweed, broad-leaved mallow, and ragweed).

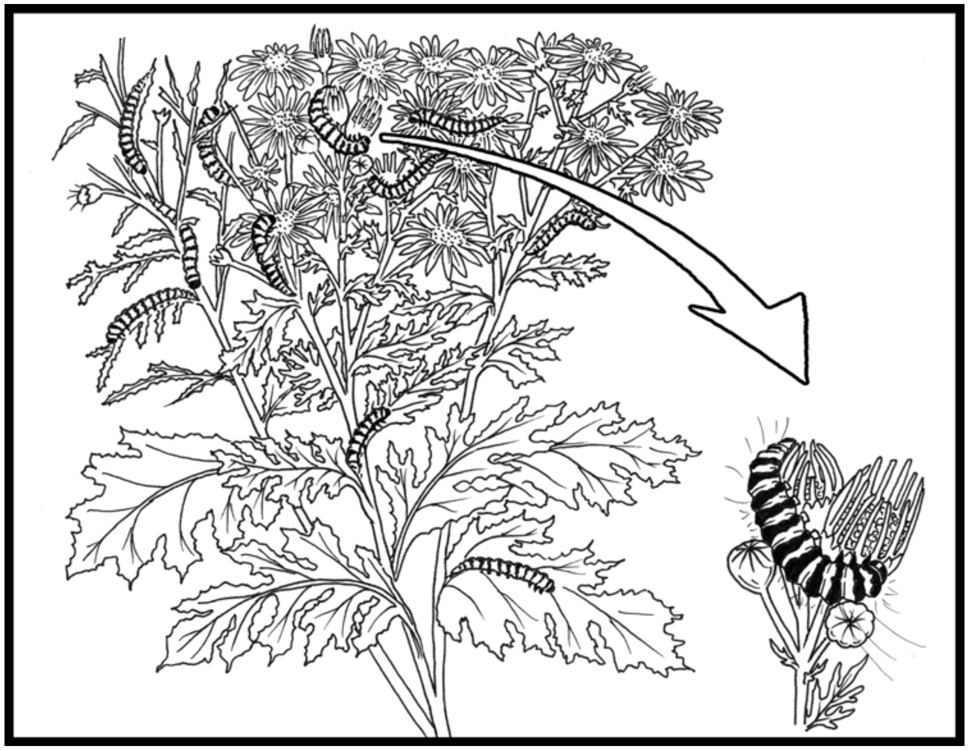


**Figure 7-6: Cinnabar moth larvae will help to control tansy ragwort, a common weed pest.**

- **Release of insects** can control certain weed pests. Naturally occurring insects can reduce some weeds (e.g., cinnibar moth larvae on tansy ragwort). Insects can also be reared and released to suppress weeds.

- **Herbicide-resistant crops** can provide genetically modified biological controls. Weeds can be controlled by a herbicide without causing crop damage.

- **Grazing animals** can remove weeds before they produce seeds.

## Chemical Control

Chemical weed control involves the use of herbicides. With IPM, herbicides should only be applied when non-chemical methods fail. Knowing how a herbicide works will help you to choose the right product.

Herbicides differ by their:

- Mode of action
- Pest or crop selectiveness
- Timing of application
- Residual effect

## Mode of Action

Mode of action refers to how the herbicide kills a plant. Herbicides are grouped as either contact or systemic:

### CONTACT HERBICIDES

- Contact herbicides reach the plant through exposed surfaces. They do not enter the plant's system.

- Contact herbicides only kill plant parts that make contact with the product.

- Contact herbicides have little or no movement (translocation) within the plant.

- Contact herbicides are not usually suited for the control of perennial weeds. The chemical only "burns off" the tops. Roots can still produce new top growth.

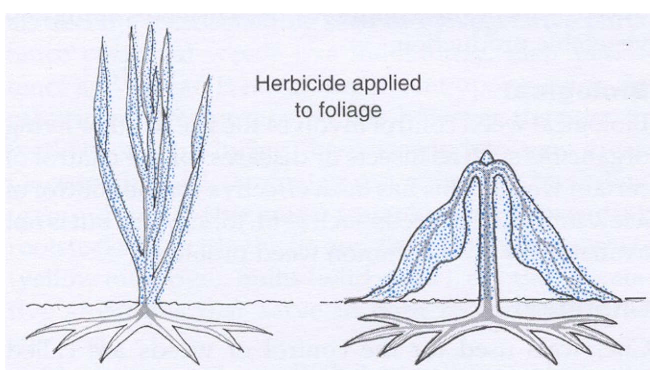



**Figure 7-7: Action of a foliar – contact – selective herbicide.**

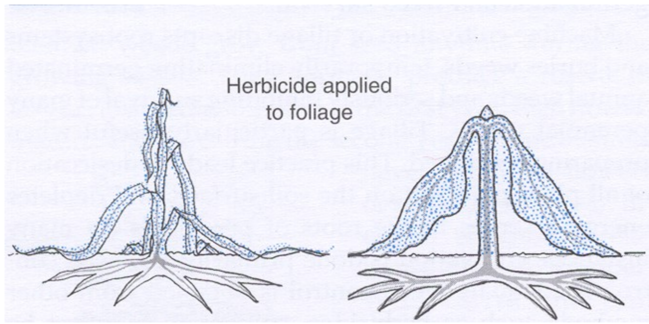



**Figure 7-8: Action of a foliar – contact – nonselective herbicide.**

*Reglone* and *Gramoxone* are common contact herbicides.

## SYSTEMIC HERBICIDES

- Systemic herbicides enter the plant via roots or leaves.
- Systemic herbicides move through the plant by translocation. This kills the whole plant.
- Systemic herbicides may not show control effects for a week or more after treatment.
- Systemic herbicides do not work as well if too much product is applied to the leaves. Leaf cells can die too quickly and prevent translocation.
- Systemic herbicides can be used to treat annual, perennial, and biennial weeds.

**Translocation:**

**A process where the herbicide enters the weed via roots or exposed plant parts and then moves in and through the plant.**

*2,4-D* and *Roundup* are common systemic herbicides.

## Selectivity

Herbicides can be selective or non-selective.

### SELECTIVE HERBICIDES

- Selective herbicides kill or damage only certain plants or plant types.

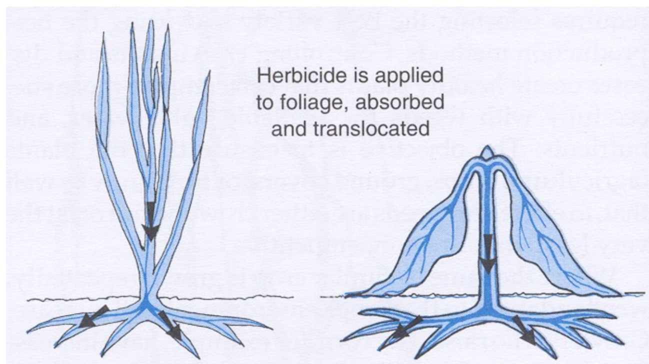



**Figure 7-9: Action of a foliar – systemic – selective herbicide.**

*Fusilade II* only controls grass-type weeds. Only broadleaf (non-grass) weeds are affected by *2, 4-D.*

### NON-SELECTIVE HERBICIDES

- Non-selective herbicides kill or damage all plants on contact.

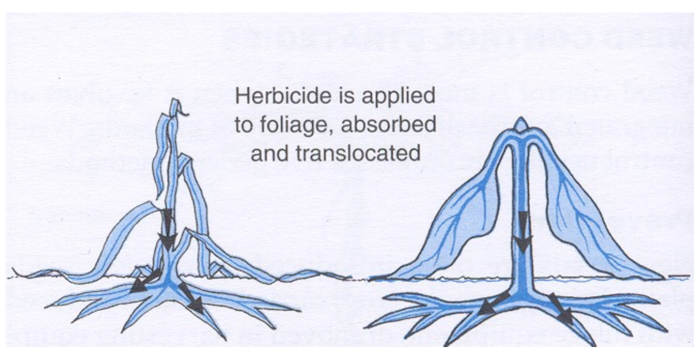



**Figure 7-10: Action of a foliar – systemic – nonselective herbicide.**

*Roundup*, *Touchdown*, and *Gramoxone* are non-selective herbicides.

## Timing of Application

Herbicides can be grouped by the timing of their application for best effect. Groups include:

### Pre-plant herbicides

- Pre-plant herbicides are applied to the soil before seeding or transplanting.
- Pre-plant herbicides can be used as pre-plant treatments. They are mixed in the soil after application.

*Rival*, *Frontier*, and *Treflan* are pre-plant herbicides.

### Pre-emergence herbicides

- Pre-emergence herbicides are applied to the soil after planting.
- Pre-emergence herbicides are applied before the crop or weeds emerge.
- Pre-emergence herbicides control weeds as they germinate or emerge from the soil.

"Pre-emergence" can refer to the emergence of either the weed or the crop. Check the pesticide label for instruction.

*Pursuit* and *Linuron* are pre-emergent herbicides.

### Post-emergence herbicides

- Post-emergence herbicides are applied after the crop or weed appears.
- Post-emergence herbicides control weeds that are established in the soil.

Post-emergence herbicides can be applied soon after emergence, or when a given plant height or leaf number is reached.

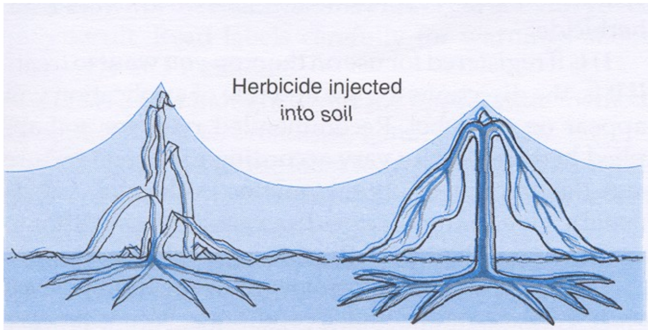



**Figure 7-11: Action of a soil applied – short-term residual – nonselective herbicide.**

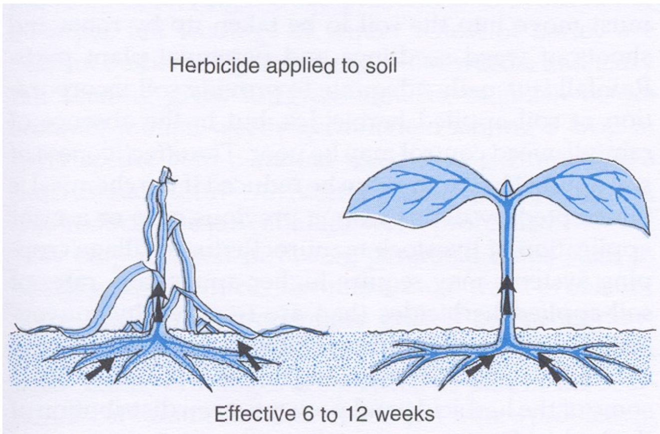



**Figure 7-12: Action of a soil applied – short-term residual – selective herbicide.**

*Fusilade* and *Poast* are post-emergence herbicides.

Some herbicides can be applied as pre-plant, pre-emergence, or post-emergence treatments. An example of this is *Sencor*.

## Residual Effectiveness

Residual effectiveness refers to the time a herbicide continues to work after application. These are grouped as:

## NON-RESIDUAL HERBICIDES

- Non-residual herbicides break down quickly.
- Non-residual herbicides become inactive in the soil soon after application.
- Non-residual herbicides do not affect future crops.

*Roundup* is a non-residual herbicide

## RESIDUAL HERBICIDES

- Residual herbicides do not break down quickly.
- Residual herbicides control weeds for weeks or months after application.
- Residual herbicides require special safety precautions.
- Residual herbicides can affect future crops.
- Residual herbicides can impact the environment.

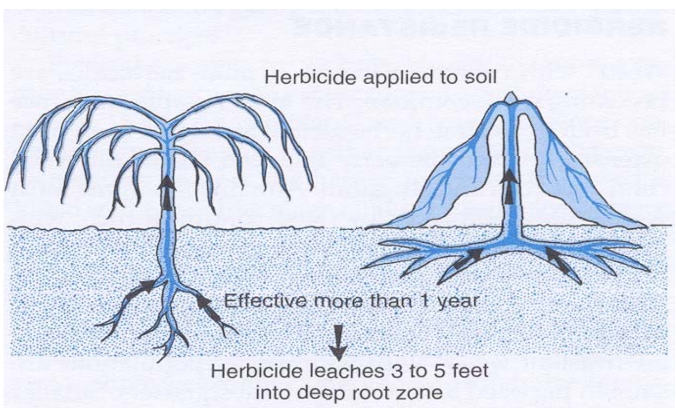



**Figure 7-13: Action of a soil applied – long-term residual – nonselective herbicide**

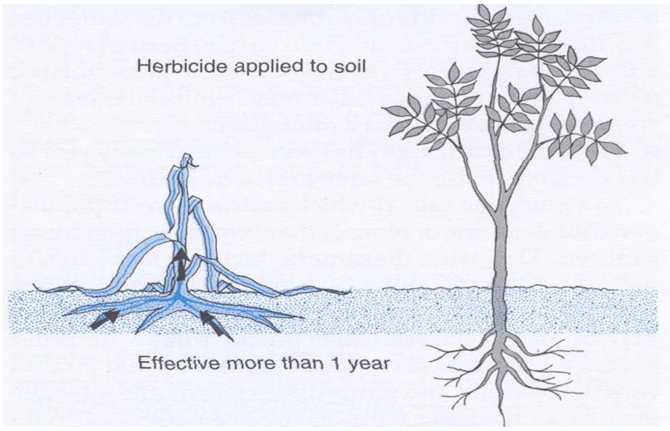



**Figure 7-14: Action of a soil applied – long-term residual – selective herbicide.**

*Sencor* and *Atrizine* are residual herbicides.

## In Review

**There are a number of control measures you can use as part of an overall Integrated Pest Management program. These include the following:**

- **Physical (mechanical) controls remove the pests that are in the crop, or prevent them from entering the crop in the first place.**
- **Cultural controls use practices such as crop rotation and planting certified seed (low in weed seeds and disease).**
- **Biological controls introduce organisms that control or kill the pest.**
- **Genetic controls use practices such as planting genetically engineered crops or selecting disease-resistant plant varieties.**
- **Chemical controls use pesticides such as herbicides, insecticides, fungicides, repellents, and other registered products to control, suppress, or repel pests.**

**Using a combination of these measures as part of an IPM program can maximize pest control. It should also limit human health and environmental risks. IPM will reduce reliance on the use of chemical pesticides.**

# Herbicide Effectiveness

If herbicides were always used under ideal conditions, you would be able to predict their action and final result. There are a number of factors, however, that can change the effect of a herbicide application. These include:

## Leaf Shape and Surface

The shape and surface of leaves affects how much herbicide stays on and is absorbed by the plant. Thin, upright leaves are hard to fully coat with herbicide sprays. The product can quickly run off the leaves.

Adjuvants can improve the effect of some post-emergent herbicides. They allow spray droplets to better cover or stick to leaves. Adjuvants should only be used with herbicides when they are called for on the product label.

## Environmental Factors

Temperature, humidity, rain, and wind can affect the action of a herbicide.

Herbicides tend to work better under moderate temperatures, rather than extreme heat or cold. Cool temperatures slow translocation in a plant. This reduces the movement of systemic herbicides. Hot weather causes herbicides (and/or adjuvant) to evaporate quickly from weed leaves. This reduces the effect of the pesticide application.

Herbicides can target certain sites. This is often the leaves or root system. Rain during or after the use of a foliar herbicide can wash the product from the target (the leaves). This will make a foliar herbicide useless. Soil-applied herbicides on the other hand may require rain to reach their target, the weed's underground root system.

Wind can also impact herbicide effect. It can cause spray drift and prevent the herbicide from reaching the target. Drifting herbicide can also damage non-target plants or crops. Most herbicide labels state maximum wind speeds for their use.

## Weed Age

Herbicides tend to work better on small, quick-growing weeds. The age of a weed can impact a herbicide's effect. Systemic herbicides travel through the plant's system. They work best with young weeds because these are growing faster. Herbicide moves through a young plant more quickly.

Herbicide labels can call for one or more application rates. These can be based on the age or growth stage of the weed. Herbicides are less likely to kill plants that are mature, in full flower, or producing seed.

Perennial weeds often become tolerant to herbicides with age. They can later become susceptible to herbicides again in the bud or early flowering phase. During this stage, the plant's food is being stored in the root system or rhizomes. This allows the herbicide to be translocated to these sites. It can then kill the entire plant.

## Soil Texture and Moisture

Soil texture and moisture can impact herbicide performance. Product labels can call for herbicide application rates based on differences in soil.

More herbicide may be needed on fine-textured (clay or silt) soils. Sandy soils often require less herbicide use.

Soil temperature or moisture can also impact herbicide effectiveness. Systemic herbicides work best on healthy, growing plants under moist, warm conditions.

## Cultivation

Cultivation can improve herbicide effect. Cultivation weakens weeds and makes them more vulnerable to chemical control. However, cultivation can promote weeds that reproduce vegetatively.

Some plant species (e.g., many grasses) produce rhizomes or underground buds that produce new plants. This can happen even when the rhizomes are cut from the parent plant. Cultivation can then spread weeds when each piece of rhizome results in a new plant. Read the product label to see if cultivation is recommended.

The stale seedbed technique involves cultivating unseeded soil. This allows dormant weed seeds to germinate. Weeds are sprayed with a non-selective herbicide as they appear. Crop seeds or transplants can then be planted. This weed-control measure works well with crops planted in late spring or summer.

## Weed Resistance

Resistance occurs when a herbicide becomes less effective in controlling a given weed than it was before. Some weeds have a natural tolerance to certain herbicides.

When a herbicide is applied, resistant weeds survive. These produce a new generation of weeds with resistance to that pesticide. Each generation of weeds treated with the same herbicide can produce a greater number of new weed plants with resistance to the product.

Resistance can occur if the same herbicide is applied a number of times or is applied at lower than label rates. You can avoid herbicide resistance by doing the following:

- Use crop rotation. This allows a variety of weed control options.
- Use a number of chemical and non-chemical control measures.
- Use herbicides only when they are needed.
- Use herbicides from different chemical families and those having different modes of action.
- Apply herbicide at the label rate.

These practices can help discourage weed resistance when used together.

A good weed control program has a number of steps. First, identify the weeds that are present. Pesticide applicators must know the characteristics and growth habits of weeds. Different weeds require different management plans.

The next step is to monitor weed populations. This helps determine:

- The need for weed control
- The timing of control application
- The effectiveness of controls that have been used

A good crop weed control program uses a number of measures to prevent weeds. These can be physical, biological, or chemical.

A number of factors impact the effect of herbicide weed control measures. These include temperature, moisture, plant life stage, plant health, and weed resistance. Weed resistance to chemical controls is a growing concern. Careful use of herbicides can limit weed resistance.

# SECTION C: INSECT IDENTIFICATION AND CONTROL

Some insects serve a valued function by preying on harmful insects or by pollinating crops. These are known as beneficial insects or 'beneficials'. However, most insects that infest crops are considered pests. They will need to be controlled when their numbers pose an economic threat.

### Learning Objective

**Completing this section will help you to:**

- **Identify and control insect pests.**

## Steps for Insect Control

An insect control program should have two goals. It should reduce pest damage and minimize harm to beneficial species.

To choose and time a control measure, you will have to identify both pest and beneficial insects.–

First, you will have to identify the insect species present. Then, consider the level of threat that they pose to the crop.

# Insect Identification

Insects can be hard to identify because they:

- Move around (This is more of a problem at certain life stages.)
- Colonize (set up communities) in irregular patterns in a field

Insect identification and management requires a good knowledge of insect anatomy. Adult insects have three main body parts: the head, thorax, and abdomen.

## Head

The head supports the insect's sensory organs:

- Eyes. The eyes can be:
  - **Simple** and only detect light
  - **Complex** and detect movement, shapes, and colours (Complex eyes are made up of thousands of eyelets.)
- Antennae
- Mouthparts

## Thorax

The thorax is the upper portion of the body next to the head. This supports:

- Legs; three pairs (These are often highly developed for activities such as running, jumping, digging, or swimming.)
- Wings; one or two pairs (Some insects have no wings.)
  - Insects can be flightless because they have simple, underdeveloped wings.
  - Insects can have highly developed wings that allow fast, powerful flight.

### Abdomen

The abdomen can take a number of forms. In an adult insect, the abdomen lacks true legs or wings. Instead, feeler-like appendages can be found at the rear end. The abdomen houses reproductive organs in male and female insects.

## Adult Insects

Adult insect bodies have:

- A segmented external skeleton
- Six jointed legs
- One pair of antenna
- Complex mouthparts

Adult insects often have two pairs of wings. Features of the wings, mouthparts, and exoskeleton can be used to identify each species.

### Wings

When trying to identify an insect, examine the number of wings and their colour. In adult insects, look for:

- Two pairs of wings (e.g., bees and wasps)
- One pair of wings (e.g., houseflies)
- No wings (e.g., silverfish and fleas)
  - Simple and transparent wings (e.g., flies)
  - Coloured scales or coverings (e.g., beetles, moths, or butterflies)

### Mouthparts

Mouthparts are specific to insect species. Insects can be grouped by how they feed:

- Biting and chewing (e.g., caterpillars and many beetles)
- Piercing and sucking (e.g., aphids and mosquitoes)
- Sponging (e.g., many flies)
- Lapping or siphoning (e.g., adult butterflies and moths)
- Chewing and lapping (e.g., adult bees and wasps)
- Rasping (e.g., thrips)

### Exoskeleton

All insects have an external skeleton. This covers the entire body. The exoskeleton protects the insect by making it rigid. It also supports soft, internal body parts such as muscles, nerves, the blood system, organs, and glands. The insect sheds this skeleton from time to time (moulting).

The shape, size, and colour of the exoskeleton can be used to identify the insect. Consult an insect identification guide for more details.

## Insect Life Cycles

Most insects begin life as an egg. Later stages depend on the life cycle of the species. An insect will complete three or four stages in a life cycle. Each change is called metamorphosis. There are three kinds of insect life cycles:

**Metamorphosis**

**Stages or changes that an insect completes during its life cycle.**

### Complete Metamorphosis

Some insects complete four life stages:

- **Egg**
- **Larva**
    - Wingless
    - Feeding-stage

Examples of larvae include caterpillars, loopers, grubs, and maggots.

- **Pupa**
  - Resting stage
  - A complete change of shape occurs
- **Adult**

Beetles, ants, butterflies, and moths undergo complete metamorphosis.

## Incomplete Metamorphosis

Other insects complete three life stages:

- **Egg**
- **Nymph** (naiad)
  - The insect moults and grows a new exoskeleton. (There can be several nymph stages, each a little larger than the previous one.)
  - It often looks like the adult, but is smaller
  - It can lack wings.
- **Adult**

Grasshoppers undergo incomplete metamorphosis.

## No Metamorphosis

Here, the insect passes through three life stages:

- **Egg**
- **Youth**
  - Insects look like adults, but are not as developed.
- **Adult**

Silverfish do not undergo any metamorphosis.

# Insect Monitoring

Finding a small number of insect pests in a crop does not mean that there is a problem. IPM requires that you monitor pests in order to make a decision on control measures.

Monitoring for pests determines:

- If the number of pests is high enough to require control (economic threshold)
- The life stage of the insect (This can determine the level of susceptibility to possible control options.)

Monitoring involves finding, identifying, and counting crop insects. A history of previous pest activity in the field or orchard will show the pest pattern. This information can be combined with knowledge of insect biology. This will help you to predict how an insect may behave. It can also help you to predict when and where the insect may occur in the future.

Insect monitoring should include scouting and record keeping. Monitoring must be performed throughout the season.

## Scouting

Scouting involves:

- Examining a crop or field
- Locating, identifying, and counting insects, noting beneficial species
- Estimating the presence and extent of crop damage

You must know where to look on the host for different life stages of the pest. Eggs are often found under leaves. Feeding adults can be seen on the top of a leaf or on the plant stem.

Insect traps can improve scouting accuracy and save time. Most traps are simple to use. However, they must be checked and maintained regularly.

## Record Keeping

Once you have scouted a field, you should record what you find. Written records should include:

- Pest identification
- Identification of any beneficial insects
- An estimate of the numbers for each insect
- The location and pattern of infestations
- An estimate of current and projected crop damage

Monitoring (scouting and recording what you find) should be consistent and frequent throughout the growing season.

**The method of monitoring you use depends on the crop and the insect.**

# Insect Control

Insects can reduce the quality and yield of crops. They can feed on the roots, stems, leaves, or fruit of growing plants. Insects can spread disease from plant to plant and field to field. They can also attack the harvested crop while in storage. The main concern in insect control is economic. The value of crops must be maintained.

Insects are often best controlled during their early life stages (larvae or nymph). Adults can be controlled to a lesser extent. Insecticides tend not to affect pupae.

Insect management can include cultural, physical, biological, and chemical measures. IPM should include more than one control measure.

## Cultural Control

Some activities that are part of normal crop management can be thought of as cultural or sanitation pest control. These measures are in keeping with IPM because they often prevent pest problems from occurring. Cultural or sanitation controls include the following practices:

- Choose plant species that are suitable for the area. Healthy, vigorous plants are better able to withstand insect attacks and resist damage. Many insects are attracted to unhealthy plants. Keeping plants healthy will reduce pest attacks.

- Choose plant species that resist insects. Some crop hybrids resist certain insects. Other crop hybrids control insects that feed on them. One example is Bt corn. It makes a toxin that is poisonous to and kills some insect larvae.

- Mow and prune. Maintained crops are cleaner and provide fewer places for insects to live and hide. Maintained crops are also less likely to allow insects to quickly multiply and cause problems.

- Till and cultivate fields. Tilling and cultivating can bury crop litter or uncover insects in the soil. This disrupts their life cycle and leaves them exposed to weather.

- Use good sanitation methods. Removing dead plant material, alternative host plants, and over-wintering sites will reduce or eliminate insect shelter. Good sanitation can greatly reduce insect numbers.

## Trapping

Trapping is a common physical control for the management of insect pests. There are many types of traps that capture or kill insects. Some actually attract insects; others are placed in the way of traveling insects.

**Pheromone**

**A chemically produced odour that mimics the scent of female insects and is designed to attract males of the same species.**

Traps are placed where insect pests are a problem. They are also placed where pests are likely to contact the trap. Sticky substances can be applied to trap crawling insects. This prevents them from reaching and causing damage to plants. Sticky strips can be hung where flies are a problem.

Other traps can be used to attract insects. Pheromone traps emit chemically produced odours. These mimic the scent of females to attract males. Such traps disrupt normal mating.

Some traps are designed in shapes and colours that attract certain pests. Traps such as sweep nets capture insects from the air or from crop foliage.

## Biological Control

Biological control involves the use of predators, parasites, or pathogens to control insects.

Predators are not the best control agents for outdoor farm use because they can move off site. However, some insect control can be achieved through the mass release of predators. An example would be the mass release of ladybird beetles against aphids or lacewing larvae, which cannot move easily. Predators and parasites can work well indoors (e.g., greenhouses) where they can be contained.

Pathogens are the most common commercial biological control agents for farm use. The bacterium *Bacillus thuringiensis* or Bt is a stomach poison that must be ingested to work. It is often used to control caterpillars. Bt is very selective and will only affect caterpillars.

## Chemical Control

In the past, chemical insecticides have been the most common type of insect control used. A number of products have been developed to manage crop pests. Insecticides work under a number of conditions. Often, they are grouped by:

- Mode of action
- Selectivity
- Residual effect
- Chemical classification

The chemical control used often depends on the pest to be controlled and the situation.

## Mode of Action

The mode of action refers to how the insecticide kills or controls an insect. Modes of action include the following:

### STOMACH AND CONTACT POISONS

- Stomach poisons kill insects that eat treated crops. The first insecticides were stomach poisons.
- Contact insecticides kill insects when they touch them. Dust or liquid spray can hit the insect or be picked up as the insect moves through a treated area. The poison then moves into the insect's body.

Most insecticides today use both stomach and contact routes to control pests. Good crop coverage is needed when using these. Complete coverage ensures a greater chance that insects will touch or eat the pesticide.

### SUFFOCATING INSECTICIDES

- Suffocating insecticides clog insect breathing systems. These products can also affect eggs (e.g., dormant oil to control scale insects).

### FUMIGANTS

- Fumigants work as gases or vapours. Pests are controlled or killed when they breathe in the poisonous fumes. Fumigants are often used to kill pests in soil or enclosed spaces (e.g., grain bins).

### GROWTH REGULATORS

- Growth regulators mimic insect growth hormones. These disrupt normal insect development. Insects die before they become adults and reproduce.

## ATTRACTANTS

- Attractants draw egg-laying female insects to an area where they can be captured or killed. Attractants can also be used to attract male insects to traps and thus disrupt breeding patterns.

## REPELLENTS

- Repellants use odour to keep pests away from the host. They are often used to combat mosquitoes and biting flies. Mothballs are a common repellent.

## STICKY PASTES

- Sticky pastes are ointments containing a pesticide. They lure insects into traps where they become stuck in the paste and are poisoned. Insect strips are an example of sticky pastes.

## MICROBIAL INSECTICIDES

- Microbial insecticides contain microbes (tiny organisms). When eaten, the microbes kill the insects. Other insecticides use microbes that produce toxins, which kill insects when these are eaten. Microbial insecticides are generally sprayed on plants. They only poison certain insects.

## SYSTEMIC INSECTICIDES

- Systemic insecticides are applied to one part of the plant (e.g., the root or the leaf). They then move through the entire plant. Systemic insecticides make the entire plant toxic to insects.

When using systemic insecticides, remember that:

- Some systemic insecticides require a certain application method to work. For example, a product like *Admire* must be applied to the root area at planting time if it is to protect a plant from many pests throughout the whole season. Other systemic insecticides are sprayed on the leaves and must be absorbed into the plant to work.

- Proper control can only be achieved by using the right amount of insecticide. Follow product label directions.
- Time lapse is important. For effective pest control, allow enough time for the insecticide to move through the entire plant.

### NON-SYSTEMIC INSECTICIDES

- Non-systemic insecticides stay where they are applied on the plant. Insects must eat or touch the insecticide to be killed.

## Selectivity

- Insecticides can be selective or non-selective.

### SELECTIVE INSECTICIDES

- Selective insecticides control only certain insects. Generally, they do not harm non-target insects.

### NON-SELECTIVE INSECTICIDES

- Non-selective insecticides control all insects. They will harm both target and non-target insects.

**Protect beneficial insects when using non-selective insecticides.**

## Residual Activity

Residual activity is the length of time a pesticide remains effective after application. Residual insecticides control insects for a number of weeks or more after application. Check product labels for residual activity information.

## Chemical Family

Insecticides can be grouped using their chemical family. Those in the same family have the same chemical characteristics. They will work in a similar way.

Common insecticide families and example products include:

| ***Chemical Family*** | ***Insecticide Example*** |
|---|---|
| Synthetic Pyrethroids | Ripcord, Decis, Cymbush, Matador |
| Carbamates | Pirimor, Furadan, Sevin, Temik |
| Organophosphates | Guthion, Monitor, Malathion, Diazinon |
| Organochlorines | Thiodan, Methoxychlor |
| Biological | Dipel, Novodor |
| Botanicals | Rotenone, many dusts |
| Nicotinyls | Admire |
| Insect Growth Regulators | Governor |

**Table 7-1: Common chemical families.**

# Insecticide Effectiveness

Under ideal conditions, an insecticide should perform as expected. Under actual field conditions, a number of factors can influence insecticide effect. These factors include:

- Timing of the application
- Environmental conditions
- Insect resistance

## Timing of the Application

Proper timing of insecticide application is needed to achieve good pest control. Many insects are susceptible to control only during certain stages in their life cycle.

Maximum control is most likely during early insect life stages. This is when insects are most vulnerable.

Good control will require careful monitoring of pest numbers. You may be tempted to use chemical controls on more visible older insects. However, mature insects are often more tolerant to pesticides. They may have already laid the eggs that will produce even more insects.

It is hard to control insects in egg or pupal stages. Often, insects are not active or feeding during these stages. They can be hidden underground or in cracks and crevices. They can also have coverings that protect them (e.g., silken cocoon). This makes it hard for an applied insecticide to contact the insects.

## Environmental Conditions

Environmental factors can alter the rate of an insect's growth by interfering with its life cycle. Such factors include humidity, temperature, and food supply. Better conditions (e.g., warm and humid) can reduce the time needed for the insect to grow from an egg to an adult.

Insect susceptibility to treatment can be very brief. This can vary from year to year and often depends on weather.  For example, wireworm larvae damage the roots of germinating grasses, cereal grains, and other plants. They move up through the soil to feed in spring, when soil temperature rises. When the soil becomes hot and dry, the larvae burrow down and become inactive. Chemicals applied too early or too late will miss the wireworm's short period of susceptibility to such control.

Cool temperatures slow the breakdown of most insecticides. This makes them effective for a longer time.

Some insecticides behave differently when temperatures change. For example:

- *Deltamethrin* works best at 5 degrees Celsius. It is less effective when the temperature rises above 25 degrees Celsius.
- The effect of *Endosulfan* increases with temperature.
- *Malathion* works best at about 21 degrees Celsius.

A heavy rain shortly after an insecticide application will often reduce its effect. The insecticide can be washed off the treated surface. Insecticides applied to control soil-dwelling insects, however, require rain to move the product into the soil.

## Insect Resistance

Pesticide resistance in insects can reduce the effectiveness of an insecticide. Chemical resistance builds up over generations. Insects that have a high reproductive rate (e.g., Colorado potato beetle and aphids) go through a number of generations in one season. They can quickly develop resistance.

Resistance is most likely to occur when insecticides from only one or two chemical families are regularly used.

You can delay resistance by rotating insecticides from different chemical groups, or between different modes of action. For example, the Colorado potato beetle has come to resist carbamate or organophosphate insecticides in some places. Pesticides from other chemical families can be used to achieve better control.

### In Review

**Insect pests damage plants and crops. Proper insect identification and monitoring will allow you to identify:**

- **What insects (pests and beneficials) are present in a crop**
- **Where the insects are located**
- **When insects might be subject to control measures**

### In Review, cont'd.

**Knowing insect anatomy, behaviour, and life cycle will be helpful when making control decisions. The mode of action of an insecticide must be taken into account when choosing a product.**

**Insecticides are designed to provide necessary insect control. Factors such as weather and temperature can impact their effectiveness.**

**Insects can also come to resist insecticides. This will make them hard to control. Choosing pesticides from a number of chemical families can delay the onset of resistance in insects.**

# SECTION D: IPM AND DISEASE CONTROL

Disease pests can attack healthy plants. An established disease will progress without intervention. IPM includes knowing the signs of disease and the steps needed to control disease in a crop.

### Learning Objective

**Completing this section will help you to:**

- **Identify and control disease pests.**

# Identifying Diseases

Healthy plants can become diseased when they are under environmental stress or when disease organisms attack them. Disease, unlike injury, cannot heal itself. As long as the right conditions exist, the disease will progress and further harm the plant.

Disease symptoms result from:

- Environmental stress
- Pest infection

## Environmental Stress

Poor environmental conditions will stress plants. This can cause abnormal growth or disease symptoms. These conditions can include extreme levels of light, temperature, water, nutrients, or air pollutants. Plants weakened by environmental stress are more likely to be affected by pests.

You should recognize stress symptoms. Then you can take steps to correct problems before the plants are put at risk from disease. Environmental stress cannot be managed with pesticides.

## Pest Infection

Disease causing organisms include:

- Fungi
- Bacteria
- Viruses
- Nematodes

All these pests can carry plant disease to crops. They are often too small to see, so their identification must be based on visible symptoms in the plant. For example, fungi cannot be seen. The “damping off” they cause is quite apparent, however.

## Fungi

Fungi are the largest group of organisms that cause plant disease. They include moulds, mushrooms, and rusts. Fungi feed on living or rotting organic matter. Most fungi reproduce using tiny spores. The spores germinate and produce threadlike filaments. These can infect the host plant, absorb nutrients, and give off toxins that cause disease.

Common fungal diseases include:

- Rusts on cereal crops
- Late and early blight on potatoes
- Powdery mildews
- Snow moulds on turf grass
- Apple scab

Most fungi follow a similar lifecycle:

- The fungus stays on a diseased plant over winter.
- When the weather becomes warmer, the fungus becomes active and produces spores.
- Spores are released into the environment. These move with wind or water. Fungi can also be spread when tiny pieces break off from the original organism. When infected plants, plant parts, or soil are moved, fungi will spread also.
- Some spores will land on healthy plants.
- Fungus spores will germinate when conditions are favourable. When environmental conditions do not support spore germination, they will die, be washed off by rain, or remain dormant. Spores tend to resist fungicide treatments during this stage.
- Infection begins when the fungus enters plant tissue. Fungicides work best when they are applied after the spore has germinated, but before infection develops.

- Infected plants grow abnormally (e.g., galls or lumps on stems; malformed leaves, roots or stems; cankers). Plants showing these symptoms are likely diseased.

Fungi thrive and are hard to control once they are inside plant tissue. Systemic fungicides will travel throughout the plant. These can work if they are applied before infection becomes too severe.

Some fungi (e.g., rusts) need two different hosts to survive and reproduce. The disease lives on one host for part of its life cycle. It then lives on another plant for the rest of its life cycle. The removal of one host plant is enough to kill the fungus.

Disease symptoms of fungi include:

- Cankers
- Dieback
- Galls
- Leaf spots
- Rots
- Rusts
- Wilts

## Bacteria

Bacteria are microscopic, one-celled organisms that can cause plant disease. Bacteria often enter a plant through openings or wounds. Under the right conditions, they quickly reproduce and use the plant as a food source.

Bacteria are spread by wind, rain, groundwater or surface water, or through contact with contaminated animals or equipment.

Common bacterial diseases include:

- Some vascular wilts in vegetables
- Black rot of crucifers
- Bacteria soft rot of Brassicas
- Wheat scald

## Viruses

Viral diseases reduce plant vigour and crop yields. Viruses are too small to be seen with an ordinary microscope. They only reproduce in living host cells, but can be spread by:

- Mechanical means (e.g., pruning or harvesting)
- Propagation material (e.g., seeds, tubers, and other plant parts)
- Outside vectors (e.g., insects, mites, nematodes, or fungi)

A vector carries a virus but is not affected by it. For example, an insect (the vector) will carry the virus to a new site. The insect is not affected by the virus it carries.

You cannot directly control a virus using a pesticide. You may, however, be able to control the vector that carries the virus.

Examples of viral diseases include mosaics, ringspot, and leaf roll.

Common viruses include:

- PVY and leaf roll in potatoes
- Barley yellow dwarf

## Nematodes

Nematodes are very small, worm-like organisms. They feed on plant roots, stems, and leaves. Nematodes can affect the movement of water and nutrients in a plant. They can also cause wounds through which fungi and bacteria can enter a plant. Nematodes produce eggs and are spread through the movement of contaminated plants, animals, seeds, soil, or water.

# Disease Control

Diseases progress quickly and are hard to detect. A visual crop inspection should be performed often to look for signs or symptoms of infection. Watching local weather also offers growers a way to predict disease outbreaks. Rainfall, temperature, and relative humidity should be monitored to estimate when an infection might develop. Diseases are most likely to occur under cool, moist conditions.

Three factors are needed for an infectious disease to occur. These are:

- A disease-causing organism (pathogen)
- A host that is susceptible to the disease
- An environment that supports the disease organism

Eliminating any one of these factors will prevent disease. Disease management measures include cultural and chemical controls.

## Cultural Control

Cultural practices for disease control include:

- Growing plant varieties that resist diseases known to be active in the area
- Getting rid of debris and other plant material that can carry the disease
- Removing plants known to host certain diseases (e.g., cedar trees near an apple orchard)
- Keeping plants healthy by ensuring proper nutrients, water, and soil pH
- Using crop rotation (This prevents the buildup of certain disease pathogens.)
- Using soil drainage and irrigation techniques

## Chemical Control

The use of a pesticide may be necessary to protect or treat your crop for disease. The pesticide required will depend on the disease or its vector.

Chemical controls for virus and bacteria are generally not available. Fungicides are the only pesticides used for disease control in agriculture.

## Mode of Action

Fungicides can be classed by how they work to kill or control a disease. Known as the mode of action, these include:

- Protectant
- Eradicant
- Systemic
- Curative
- Antisporulant

### PROTECTANT FUNGICIDES

- Protectant fungicides cover potential host plants with a film that prevents fungal spores from germinating. These products must be applied before the fungus has entered the crop. They can protect the plants from further infection. Additional applications may be required to protect new growth. Fungicides can be applied to seeds, foliage, flowers, fruit, or roots.

### ERADICANT FUNGICIDES

- Eradicant fungicides kill fungal organisms that have infected the plant but are not well established. These have limited effect on advanced infection.

### SYSTEMIC FUNGICIDES

- Systemic fungicides are absorbed by plants. They move to areas of new growth. Systemic fungicides can act as protectants, eradicants, or both.

### CURATIVE FUNGICIDES

- Curative fungicides move within the plant to the site of infection. They prevent further pathogen development. Curatives can be used shortly after infection.

### ANTISPORULANT FUNGICIDES

- Antisporulant fungicides can prevent spores from being produced. They disrupt life cycle processes that would normally occur in the fungus.

## Fungicide Effectiveness

There are a number of factors that determine fungicide effectiveness. These include:

- Timing of the application
- Fungus life cycle
- Rates of plant growth
- Weather
- Resistance

### Timing of the Application

Depending on the type of fungicide being used, timing of the application is critical to its effectiveness. For example, protectant fungicides do not kill fungi. They prevent infection from occurring. Therefore, protectant fungicides must be applied before a fungal infection occurs. Antisporulant fungicides must be applied before spores are formed.

Fungicides that break down quickly must be applied more often than those that persist.

### Fungus Life Cycle

Different types of fungi have different life cycles. Therefore, treatment may be effective only at certain times. For example, late blight in potatoes has a short life cycle, with many infection periods. The control of late blight typically requires frequent fungicide applications.

## Rates of Plant Growth

If plants are not growing or they are growing slowly, fungicides can protect a plant for a long time. When plants are growing rapidly, new growth is constantly being exposed to disease. Protectant fungicides prevent disease only on plant parts that are present at the time of application. They will not protect new leaves that grow later.

Within a plant, there may not be enough of an eradicant fungicide to allow the product to move to areas of new growth. Additional applications may be needed.

## Weather

Tracking environmental conditions plays a role in planning for disease control. Hot, dry weather slows the growth of fungus. Fewer fungicide applications may then be required. If rain follows a treatment, fungicide may need to be re-applied to ensure adequate pest control.

## Resistance

Resistance occurs when the same fungicide or products from the same chemical family are frequently applied. For example, late blight in potatoes has come to resist the systemic fungicide *Ridomil* (metalaxyl).

### In Review

**Disease can damage plants and crops if it is not controlled. To develop a good disease management plan, look for:**

- **Signs of infection**
- **Crop stress**
- **Potential threats and damage**
- **Disease symptoms**

**Fungi, bacteria, viruses, and nematodes can cause disease. These can be controlled using a well-planned IPM program. This program should include monitoring, as well as control measures and the conditions that will impact their effectiveness.**

# SECTION E: IPM AND VERTEBRATE CONTROL

Vertebrate animals can become pests when they damage crops. When these pests reach economic thresholds, control may be needed.

You must look at environmental and economic factors when planning and using an IPM-based control program for animal pests.

### Learning Objective

**Completing this section will help you to:**

- **Identify and control vertebrate pests.**

## Vertebrate Pest Control

Animals can become pests when they carry disease or damage property, crops, or livestock. Common vertebrate pests include:

- Rodents
- Birds

# Rodent Pests

Mice and rats often live at ground level. They nest under buildings, in rubbish, and under litter. Rodents are very mobile. They are able to climb, swim, and jump. They become pests when they move indoors. Typically, they cause damage in barns, granaries, and livestock facilities.

Rats and mice tend to stay within 15 to 30 metres of their nests. They are most active at night. Daytime movement is kept to narrow, concealed, out-of-the way routes. Rodents are creatures of habit. They tend to follow the same pathways. Rodents will change their feeding habits when necessary.

The first step in rodent control is to monitor pest numbers. You must find:

- Where they are
- The location of their shelter and nesting sites
- Their sources of food

Guidelines for a rodent control program are as follows:

- Each live rodent that you see generally indicates the presence of at least 10 to 20 more.
- Partially eaten, newly killed rodent bodies indicate the presence of many live rodents.
- Droppings are the best and most frequent indication of rodent infestation. Fresh droppings nearby indicate an active nest.
- Smears and marks left on walls and floors show runaways and hiding spots. Rodent tracks can be seen in soft or powdery materials.
- Food that is chewed by rodents loses its freshly gnawed appearance within one day. Evidence of chewing on wood disappears in about one week.
- Rats produce an odour that lingers when they leave an area.
- Domestic animals and livestock often become agitated when rodents are present.

## Rodent Control

An IMP program to manage rodents includes a number of control measures. Rodent management starts with preventing their presence before they appear.

### SHELTER AND NESTING SITE REDUCTION

Rodents will develop shelter and nesting sites in a number of places. They will often enter farm buildings. Preferred spots include:

- Double walls
- Spaces between floors
- Spaces beneath a floor that rests directly on the ground
- Refuse heaps and caches of stored materials
- Pipes
- Piles of lumber, brushwood, or firewood
- Stored equipment
- Dark, undisturbed places

When looking for rodents, check undisturbed or hidden spaces. Look for places where animals can nest or travel without being seen.

Keep lumber and equipment neatly stacked or stored 30 to 45 cm above ground. This eliminates common nesting sites. Piled or stacked firewood is a good place for rodents to hide.

### RODENT PROOFING

Rodents are always looking for places to nest. Buildings can be kept free of rodents as long as you constantly guard against them. Even small openings should be covered with tin or hardware cloth. Keep coverings well maintained.

Propping doors and windows open, or damaging rodent proofing materials during construction, will invite rodents to move in.

### ELIMINATION OF FOOD

Reducing or eliminating access to food sources can help to control rodents. Mice and rats scavenge a wide range of foodstuffs—grain, pet foods, livestock feed, seeds, eggs, young poultry, and any human food.

## GARBAGE HANDLING

Garbage attracts rodents. Waste should be stored in sealed containers and disposed of regularly.

## TRAPS

It is hard to trap rodents in farm settings. However, it can be safer than using chemical controls (rodenticides). When setting traps:

- Try to think like a rodent when finding a place to set a trap. Choose protected and sheltered areas where rodents can travel or nest.
- Find out what rodents are eating and drinking. This will help in choosing trap bait (often meat, grain, or eggs).
- Place snap traps at right angles to walls so that rodents will pass over the trigger.
- Cover traps to create an enclosed space and attract rodents. Covers also increase the life of glue boards. Make sure traps are out of the reach of children or pets.

## CHEMICAL CONTROL

Rodenticides are pesticides developed to control rodents. Most common rodenticides are baits. Once they have eaten treated bait, rodents will die from internal bleeding within three or four days.

When using any rodenticide, follow label directions. These products affect pets and humans in the same way as they do their intended targets.

Construct rodent bait stations. This will help prevent other animals from feeding on the bait. Keep bait stations indoors unless the label says that the product can be used outside.

**Any animal that consumes enough of a rodenticide will eventually bleed to death. Ingestion may be direct or occur as a result of eating contaminated rodents. For example, animals that prey on rodents (e.g., snakes, hawks, raccoons, and house cats) can consume enough rodenticide to be poisoned. Never broadcast rodenticide where it can be eaten by wildlife or domestic animals.**

## Bird Pests

Birds are rarely considered to be pests. In some cases, however, they can pose an agricultural threat.

Atlantic Canada's primary bird pests include house sparrows, starlings, and feral pigeons. At certain times of the year, and when they occur in great numbers, other birds can become a problem in farming situations. These can include swallows, crows, ducks, geese, and grackles.

Gulls sometimes become a nuisance on farmland. However, they are a protected species. The use of pesticides to control them is not allowed.

**It is an offence under the *Migratory Birds Convention Act* to harm a protected species or its nest, once eggs are laid. You may use some repellent or exclusion methods that do not harm the birds. The use of mist nets requires a permit from the Canadian Wildlife Service.**

Birds are pests when:

- Droppings build up to the point where they deface or mar structure surfaces
- Droppings create a safety hazard on walkways, fire escapes, or steps
- Large flocks pose a hazard to aviation
- Roosting or nesting birds produce noise problems

- Nest materials disrupt machinery mechanisms, such as awnings
- Large flocks consume a large amount of newly planted seed or seedlings
- Food, fruit, and berry crops are damaged
- Droppings from roosting birds contaminate feed or food (This can happen in livestock or food processing facilities or warehouses.)
- Birds and their droppings spread harmful fungi, bacteria, and protozoa (These pose human health risks.)
- Native birds (e.g., songbirds) are displaced from nesting sites by non-native species (For example, starlings are a major factor in the decline of bluebird and red-headed woodpecker populations.)

## Bird Pest Management

A management program may be required when a bird population becomes a pest. Control can include mechanical or chemical (avicides) measures. Choosing between these will require a good knowledge of the bird species involved.

In the first step of a control program you will need to:

- Identify the bird species present and their population numbers.
- Determine the problem posed by a given bird species.
- Identify flock flight paths, behaviour patterns, and habitats at different times of the day.
- Monitor roosts, rest sites, and feeding and water sources.
- Identify factors that contribute to the problem (e.g., building design, distance from natural habitats, and feed sources).
- Assess the attitudes of people whom you need to work with, and the local community (e.g, will the public accept a control program).

This information will help you to choose a proper control method.

# Bird Control

Birds can require control when they threaten farm operations, crop storage and management, or human health. Control options include mechanical and chemical measures.

## MECHANICAL METHODS

Mechanical methods are preferred for controlling bird pests. Such measures include the following:

### Nest Removal

Remove nests and destroy young. This helps suppress populations. Reaching most nests is hard and takes time.

### Frightening Devices

Frightening devices include visual and sound tools. These work well with some species. However, they may not disturb other species. For example, pigeons have a strong sense of territory. They are less responsive to noise repellents than are other birds. Scare devices (e.g., stuffed owls or snakes) also do not affect pigeons.

Flags, hanging pie plates, dangling paper, foil strips, flashing lights, or strobe lights tend to work with pigeons for only a short time period. These can work well for other bird species.

### Trapping

Pigeon colonies tend to use regular feeding and roosting areas. Because of this, they can be controlled through intensive trapping. Large, walk-in traps are better than smaller traps. Traps should remain baited at all times. Baits include whole or coarse-cracked corn, wheat, oats, millet, popcorn, and sunflower seeds.

### Exclusion

Most birds use the same feeding and resting places. Exclusion involves keeping birds out of these areas. This will make them less likely to return.

Exclusion includes blocking openings to lofts, silos, vents, and eaves. This can be done with wood, sheet metal, glass, masonry, or wire mesh. Nylon netting can be substituted for wire mesh, but it will have to be replaced more frequently.

Pigeons can be discouraged from roosting on ledges by changing the ledge angle to 45 degrees or more. Sheet metal, wood, or concrete can be formed and fastened to ledges. This will achieve the desired angle.

Ornamental architecture can be screened with wire mesh to prevent roosting and nesting. However, this may not look attractive.

In tool or machinery sheds, barns, and hangars, use netting or wire mesh to screen below the rafters. This will eliminate roosting sites.

## CHEMICAL METHODS

Chemical controls can be used when birds pose a major threat or are hard to control with mechanical methods. Avicides are pesticides designed to control birds. The most common avicides repel birds. They do not kill them.

### Repellents

Commercial repellents often take the form of sticky materials. These can be applied to ledges or rafters where birds roost. The sticky material will repel pigeons by entangling their feet and feathers.

You should protect porous surfaces with tape or silicone spray undercoating before applying a repellent. These substances can leave stains.

Products with bitrix compounds can be used to treat surfaces where pigeons land. Always spot-check small areas of painted surfaces, plastics, or fabrics for possible damage before placing bitrix on them.

# Legislation Affecting Control of Vertebrate Pests

Wildlife laws may prevent the destruction of some pests. They may also require special permits for pest control. Shooting, trapping, and using pesticides may be limited to certain times of the year or to specific places.

**Check with federal, provincial, and municipal authorities before using any animal pest control measure.**

## In Review

**Control of rodent or bird pests can involve a lot of work. This begins with a survey to identify pest animals and their damage. Continuous monitoring and maintenance activity is required to prevent pests from re-establishing. Follow sanitation guidelines to minimize pests. Remove any nesting, shelter, or feeding sites. Mechanical or chemical control measures may be needed to protect crops or human health.**

# Case Study: Integrated Pest Management

Joan has been operating a market garden for over 10 years. She is well known for producing quality vegetables. Given the trend toward organic produce, she is concerned with the high volume of pesticide she must use, especially on her sweet corn and cole crops.

Joan follows the pesticide label with care. Both application rates and pre-harvest intervals are provided. She regularly (weekly or more often) applies insecticide when she thinks that insects might be present. This makes for attractive produce, but it is expensive. Also, her vegetables could show unacceptable levels of pesticide residue. She needs to balance her goals of reducing pesticide use and maintaining the crop quality expected by her customers.

After attending a vegetable growers' meeting on Integrated Pest Management (IPM), Joan decides to hire a crop consultant. She hopes that the consultant can teach her to monitor insect populations and to identify non-chemical control methods. This person can also help her to decide when pesticide use is necessary.

As a first step in her new IPM program, Joan's crop consultant suggests that she avoid 'calendar-spraying' each week. Pesticide applications should be based on insect population numbers. To find these numbers, some type of field scouting is needed. In the sweet corn, Joan decides to use pheromone traps to monitor insect numbers. These traps capture insects, such as corn borer moths, as they move into a field.

Instead of using a pesticide as soon as a pest is found in the field, Joan's crop consultant suggests that she use action thresholds to determine if, and when, control is needed. Thresholds are based on pest numbers and the growth stage of the plants.

For the cole crops, they decide on a similar approach. Again, Joan will base her pest control program on weekly scouting and the use of action thresholds.

Joan’s new IPM program also includes caring for natural pest enemies. When required, only selective pesticides will be used. Resistance management (e.g., rotating pesticide families) is always a goal. She learns that perimeter trap cropping can be used to protect cole crops from damage by diamondback moth and flea beetles. Perimeter trap cropping involves establishing a plant species that is attractive to the pest. This plant species must completely surround the main crop. The attractive plants then function like a fortress to protect the crop.

Joan’s crop consultant advises that trap cropping might reduce the need for pesticides by up to 75 per cent. Joan decides that next year she will plant collards around her cole crop fields.

Throughout the next growing season, Joan keeps detailed pest management records for her crops. She is able to reduce the number of pesticide applications in most of her sweet corn fields. Chemical pesticide applications are well timed and give better control for insect pests. She is also able to reduce the amount of culls in the corn by almost ten percent. IPM reduces fuel costs for spraying, and reduces labour costs from grading and culling wormy corn ears. Since the quality of her produce improves, Joan charges a bit more for her corn and increases her profits.

Joan sees real benefits from using scouting methods and trap crops in her cole crop production. The trap crops reduce the need for pesticide use. This lowers product costs. Reduced pesticide application leads to fewer human health and environmental concerns. Using less pesticide will also delay the onset of pest resistance in her fields.

Joan is pleased with the early results of her IPM program. She looks forward to greater benefits, as she needs to use fewer chemicals to control insects, disease, and weed pests in her vegetable crops.

# Self-study Questions

*Answers are located in Appendix A of this manual.*

1. Which of the following actions forms part of an integrated pest management (IPM) program?

   a) Use different types of pest control methods
   b) Learn about a pest's life cycle and habits
   c) Keep records of control actions and the results
   d) Compare the cost, risk, and benefits of using a pesticide before you apply it
   e) all of the above

2. The action threshold is:

   a) the point at which the pest needs to be controlled to avoid reaching the economic injury level
   b) the point at which the pest needs to be controlled after the economic injury level has been reached
   c) the point at which the pest can no longer be controlled by any method
   d) the point at which you must use chemical control methods to control the pest

3. You have noticed and recorded symptoms of leaf roll virus in your potato field. Which of the following can be said regarding virus control.

   a) Viruses can be controlled with similar chemical controls as those used for other disease pests.
   b) Viruses cannot be directly controlled with any pesticide, but insects, nematodes, and fungi that may carry a virus can be controlled.
   c) Viruses can reproduce in living or dead plant cells, making the virus very difficult to control.
   d) Viruses cause diseases that do not affect crop yield, and do not require the same level of control as bacteria.

4. Match the following herbicide types with the proper description:

a) applied to the soil after planting, but before the emergence of the specific weed.
b) applied after the specific crop or weed has emerged.
c) applied to the soil before seeding or transplanting.
d) only kill or damage the targeted weeds.
e) kill and damage all plant near the target weeds.
f) kill plant parts contacted with the herbicide.
g) enter the roots, leaves, or stem of the plant, moving through the plant by translocation

_____ Contact herbicides
_____ Post-emergent herbicides
_____ Pre-plant herbicides
_____ Pre-emergent herbicides
_____ Selective herbicide
_____ Systemic herbicide
_____ Non-selective herbicide

5. Which of the following practices will help delay or prevent pest resistance?

a) scouting all your fields regularly for pest populations
b) rotating your crops often
c) using physical, cultural, biological, and genetic control methods in an IPM program
d) using only the strongest chemical control product against the pest
e) a, b, and c

Chapter

8

# APPLICATION TECHNOLOGY

## SECTION A: APPLICATION EQUIPMENT

When you decide to use a pesticide, you will then have to choose the proper equipment to apply the product. This chapter covers types of pesticide application equipment. Information on how to adjust and use equipment safely is included. Environmental factors that you should consider are also discussed.

### Learning Objectives

**Completing this section will help you to:**

- **Identify types and parts of pesticide application equipment.**
- **Clean application equipment.**
- **Maintain application equipment.**
- **Identify and interpret environmental factors for choosing application equipment.**

# Types of Application Equipment

Pesticide application equipment can be very simple (e.g., hand-operated aerosol cans) or very complex (e.g., self-propelled boom sprayers).

**Pesticide application equipment should be chosen based on:**

- Size and type of area to be treated
- Crop
- Type of pest
- Pesticide formulation
- Method of application called for on the label

**Most commonly used pesticide application equipment can be classed as follows:**

- Liquid applicators (sprayers)
  - Hand operated
  - Motorized / mechanical
- Granular (solid) applicators
  - Hand operated
  - Motorized / mechanical

# Liquid Formulations

## Hand Operated

Spot spraying is often done using hand-operated sprayers. This lets you apply small amounts of pesticide to small areas. Most hand sprayers apply pesticides using compressed air. A hand pump is often used to provide the air. Common examples of hand sprayers include:

- **Pressurized aerosol cans** often contain less than one litre of pesticide. Aerosol cans produce very small spray droplets. They can only be used in small treatment areas.
- **Squirt-gun sprayers** force a pesticide through a gun nozzle. Squeezing a trigger creates pressure. Squirt-gun sprayers do not use a separate pressurized air source. These sprayers give an uneven application. They are mostly used in small areas.
- **Hose-end sprayers** consist of a pesticide tank attached to a garden hose. A preset amount of pesticide is drawn from the tank by suction. It is then mixed with water flowing from the hose. These sprayers can be used to treat larger areas than aerosol cans or squirt-gun sprayers. However, they can be unreliable. Dirty nozzles or changes in water pressure can vary the amount or concentration of pesticide applied.
- **Hand-pump sprayers** have plungers that force air out of a cylinder and into a tank. The pressure in the tank pushes the pesticide mixture out of the sprayer. This group of sprayers includes backpack sprayers.

A major problem with hand-operated sprayers is that pressure and output rate can vary. The risk of applicator exposure can also be high because the applicator works close to the spray.

## Motorized and Mechanical

Motorized sprayers are used to apply liquid pesticide mixture to large areas. Pressure is achieved using a power-driven pump. There are several types of motorized and mechanical sprayers.

**Field sprayers** are generally used to treat large areas. Tank sizes range from 250 to 4,000 litres. Boom widths can be six metres or more. The tank and booms can be mounted several ways:

- On a three-point hitch frame
- On a separate trailer
- Carried on a self-propelled spraying unit

Field sprayers can be equipped with devices to improve control, accuracy, and safety. For example, electronic rate controllers adjust application rate by ground speed. Pesticide injection systems add pesticide to water during an application.

**Air-assist sprayers** are similar to field sprayers. However, they use an air stream to propel spray to the target. Boom widths are often similar in length to field sprayers. Air-assist sprayers produce finer spray droplets. This improves pesticide penetration and coverage without causing more spray drift. An air-assist sprayer can be more expensive than a field sprayer.

**Air-blast sprayers** are often used in orchards or on small fruit crops (e.g., apples and blueberries). Tank sizes range from 400 to 3,000 litres. Air-blast sprayers have nozzles placed in the air stream of a high-speed fan. The air stream propels fine spray droplets to the target.

The air stream frequently creates leaf movement. This allows for better pesticide coverage. Air-blast sprayers pose a greater risk of spray drift and applicator exposure than field sprayers.

**Soil fumigation equipment** is used to apply liquid fumigants. This equipment is similar to small field sprayers with respect to tank and boom size. It uses hose shanks rather than nozzles.

Hose shanks inject liquid fumigant into the soil where it will become a gas (volatilize). Toxic gases can be released during fumigation. Use extreme caution when handling fumigants and fumigation equipment.

# Granular Application Equipment

Granular applicators are used to apply granular pesticide formulations. Granules do not drift. Granular application equipment comes in two types:

- **Hand shakers** are designed like saltshakers. These are often used in small areas, or for spot treatment applications.

- **Mechanical applicators**, which spread granules using:

  - Forced air
  - Spinning discs (fertilizer spreaders)
  - Multiple, gravity-feed outlets (lawn spreaders, seed drills)
  - Soil injectors (furrow treatments)
  - Air (aircraft application, pneumatic spreaders)

Granular applications can be used for broadcast work, furrow application, or soil incorporation (drilling or soil injection).

# Other Application Equipment

There are a number of other types of pesticide application equipment. These include:

- **Wick applicators** are used to selectively apply liquid herbicides to weeds. The herbicide is poured into a long pipe wrapped in rope or other absorbent material. The herbicide seeps out of the pipe and is absorbed by the wicking material. This can then be wiped onto weeds that grow taller than the crop or between rows. Wick applicators are often used where drift could be a problem.

- **Dust application equipment** is used to apply powders. For example, dust application equipment is used to apply seed treatments to potato seed. This equipment either drops dust onto a crop, or uses air power to propel dust onto the target. Dust treatments create a lot of residue. Drift can be a problem.

**When selecting pesticide application equipment, choose a type that will apply the proper amount of product to the target. You should aim for maximum pest control and minimum off-target drift.**

# Basic Sprayer Components

Sprayers are often complex and have many parts. Each part has a function. Applicators should know the basic parts of a sprayer. Knowing the equipment will help to ensure that pesticides are applied accurately, safely, and as the manufacturer intended. The following is a list of sprayer components:

## Tank

The tank holds the spray mixture. Tanks come in a range of shapes, sizes, and materials. A good sprayer tank should be as follows:

- The tank should be made of strong materials that resist reaction and corrosion. Materials can include fibreglass, stainless steel, or polyethylene.
- The tank should be shaped to aid in agitation (mixing).
- The tank should be easy to fill and clean.
- The tank should have graduated markings. This helps to measure the tank contents.
- The tank should have inside baffles to prevent liquid pesticides from sloshing or spilling out of the tank.
- Tank shapes are often oval and cylindrical. Rectangular and flat-bottomed tanks are harder to agitate and clean.
- Tank size should be suited to the sprayer boom width and output.

## Pump

The pump creates a flow of spray mixture from the tank to the nozzle. Choose a pump that meets the following application requirements:

- **Output and operating pressure –** Most pumps only work well within a given volume and pressure range. A pump should be chosen based on need. For example, roller pumps provide moderate volumes (100–300 L/ha) at low to moderate pressures (100–2,000 kPa). A centrifugal pump can provide high volumes (2,000 L/ha) at low pressures (50–350 kPa). Choose a pump that is larger than needed. While flow and pressure can be reduced, it is unsafe to exceed the manufacturer's stated range of use.

- **Pesticide properties (formulation type) –** Some pesticides (e.g., emulsifiable concentrates) are corrosive or can cause rubber parts (e.g., gaskets) to swell or break down. Wettable powders are abrasive and these can wear pump parts. When choosing a pump, consider the pesticides to be used.

**The power supply**

**Most tractor-mounted sprayers use a power takeoff (PTO) drive. Some pumps can run on electric power (12V) from the tractor. Others are powered from a ground-drive mechanism.**

A pump should be large enough to move the required volume of pesticide mixture to the nozzles at an even pressure. It should also provide enough agitation to keep the spray and carrier mixed.

**A carrier is a substance used to assist pesticide application. It dilutes a product to make it easier to apply (or spray).**

- **Water is the most common carrier used in liquid pesticide applications.**

- **Granular applications can use fertilizer or a similar product as a carrier.**

**Never run a pump dry. Pumps use spray mixture for cooling and lubrication. Never operate a sprayer pump at speeds or pressures greater than called for by the manufacturer. Pumps that are improperly used can wear out quickly. Improper use can also stress moving parts to the point of breakdown. Recommended pump speeds and settings will have to be followed to apply pesticides at the proper rate.**

Common pump types include the following:

- **Roller pumps** are widely used because they are not expensive. They can be made from materials like Teflon or nylon. They are best suited for use with emulsifiable concentrates, soluble powders, and other non-abrasive pesticides. Roller pumps provide output volumes between 30 and 190 litres per minute. Pressures range between 100 and 2,000 kilopascals (kPa).

- **Gear pumps** are composed mostly of metal parts, which make them hard to repair. They are best suited for use with oil-solution formulations. Gear pumps operate at an output volume between 20 and 245 litres per minute. Pressures range between 150 and 700 kPa.

- **Piston pumps** can be used for low- or high-pressure applications. Their solid construction resists abrasion and wear. Maintenance costs are often high. Piston pumps that are properly used and cleaned will last a long time. These pumps are most often used with wettable powder formulations. Piston pumps operate with an output volume of 7.5 to 224 litres per minute. Pressures range between 150 and 5,500 kPa.

- **Diaphragm pumps** are designed to use with abrasive pesticide formulations. These operate at a wide range of volumes and pressures. Diaphragm pumps have the same basic parts as piston pumps. However, they are more widely used because of their lower maintenance costs.

- **Centrifugal pumps** are used for a wide range of spray applications. They are not expensive. Output can be as much as 760 litres per minute. Pressures range between 50 and 350 kPa.

# Agitator

The agitator mixes the formulated pesticide and the carrier (often water). Agitators prevent suspended pesticides from settling out. The amount of agitation needed depends on the type of formulation. Too little or too much agitation can reduce pesticide performance.

Common types of agitation systems are:

- Mechanical
- Hydraulic
- Air sparging

**Mechanical systems** use paddles mounted on a shaft near the bottom of the tank. The paddles stir the contents of the tank. Careful maintenance is needed to ensure that shaft bearings do not wear. This can cause pesticide leaks.

**Hydraulic systems** return a portion of the pump output back to the tank. Return-line or bypass agitation is the simplest method of hydraulic agitation. It is also the least effective. Bypass agitation uses a return line from the pressure regulator valve. Hydraulic agitation does not always work well with wettable powders because they are hard to keep in suspension. To maintain proper mixing, a high-capacity pump should be used.

Good hydraulic agitation can be achieved by using a high-pressure flow of surplus spray mixture from the pump. This passes through a separate line and back into the spray tank.

Liquid usually flows through special nozzles (called jet agitators) in hydraulic agitation systems. These nozzles are found at the bottom of the spray tank. Hydraulic agitation tends to cause less trouble than mechanical agitation.

**Air sparging** is less common than mechanical or hydraulic agitation. However, it is an effective way to agitate a spray mixture. A compressor supplies air to a discharge tube at the bottom of the spray tank. Air bubbles are released and rise to the surface. The rising air bubbles mix the spray solution.

## Filter

The filter on a sprayer prevents debris or particles in the spray mixture from breaking the pump or plugging the nozzles. Plugged nozzles result when you use filters that are damaged or the wrong size for the formulation.

Filters can be installed in different places. Filters in the tank opening prevent debris from getting into the tank when it is being filled. Filters between the tank and the pump protect the pump from damage. Filters behind the pump remove fine particles before they enter spray lines. Filters in nozzle bodies prevent them from clogging.

Follow the manufacturer's guidelines on filter sizes to protect nozzles and pumps. Small nozzles require finer filters.

## Pressure Regulator Valve (PRV)

The pressure regulator valve controls the output rate on most sprayers. The PRV controls the pressure and quantity of spray at the nozzles. It protects pump seals, hoses, and other parts from damage due to too much pressure. The PRV generally controls pressure by sending excess pump output back to the tank through a 'return' or 'bypass' line. The pressure range and flow capacity of the regulator should match those of the pump.

**Electronic control systems** use sensors to monitor the flow of the spray and the ground speed of machinery (e.g., the tractor). The operating pressure or ground speed can then be changed to get the desired nozzle output. Changes should remain within the proper range for nozzle and other system components. On some systems, the electronic PRV adjusts the flow of pesticide on its own to suit the ground speed. It can also alert the operator if the production application rate is above or below preset limits.

## Pressure Gauge

The pressure gauge measures the sprayer's operating pressure. The pressure gauge is often set at a desired, initial pressure. Watch it closely for changes that can indicate application problems.

Gauges can be liquid-filled or dry. A liquid-filled gauge dampens pressure pulsations, and results in a steady reading. Dry gauges do not dampen pressure pulsations. This makes it hard to get a good reading. However, pulsation dampers can be used on dry gauges. The maximum pressure shown on the gauge should read to about twice the target operating pressure.

The best place to measure the sprayer's pressure is close to the nozzles.

## Pipes and Hoses

Pipes and hoses that are under-sized can reduce pump capacity. Flow restrictions cause a drop in pressure. In turn, this can result in an uneven nozzle flow rate. Flow will be hampered by:

- Under-sized boom plumbing, controls, or fittings
- Under-sized or clogged filters
- Kinked or bent hoses

Hoses that draw pesticide from tanks (suction hoses) should be strong enough to resist collapse. They should also have the same diameter as the pump inlet openings. All hoses and fittings have to be able to handle the maximum pressure and maximum output used. This includes those hoses on the return side of the pump.

**When replacing hoses and fittings, ensure that they are chemically resistant and able to handle maximum application pressures. Cheap or poor hoses can burst**.

## Nozzles

Nozzles are used to:

- Metre the amount of spray delivered (nozzle output)
- Break liquid into droplets
- Spread droplets in a given pattern

Nozzles come in a wide range of types and sizes. Check label directions to find out which nozzles are suited to the application of a given pesticide.

Common nozzle types include flat fan and hollow cone. Other nozzles are designed to deal with drift reduction, banding, or soil incorporation applications.

Most sprayers use nozzles that can be changed. Nozzle types vary by output capacity, spray pattern, and operating pressure.

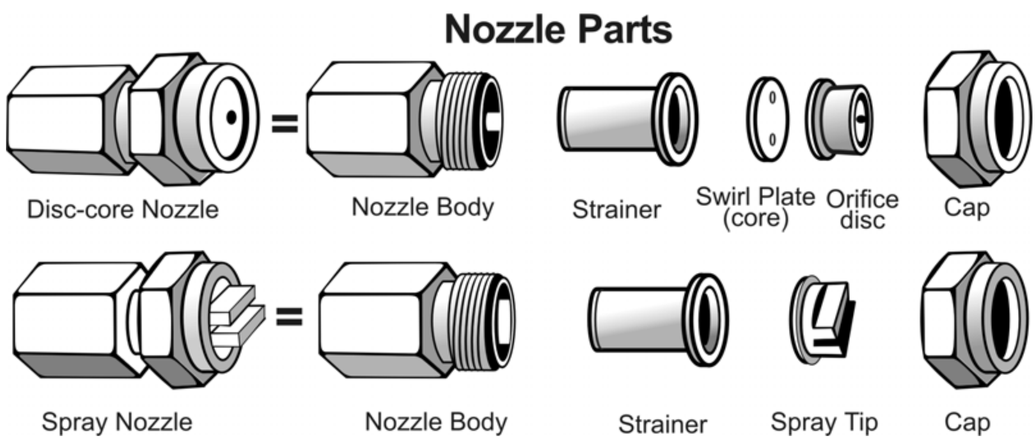



**Figure 8-1: Nozzle parts.**

Most nozzles are composed of four parts: the nozzle body, the strainer (screen), the tip, and the cap.

## Parts of the Nozzle

**Nozzle body** – The nozzle body holds the strainer and tip in place.

**Strainer (screen)** – The nozzle strainer or screen is placed in the nozzle body, just behind the opening. It filters out debris and prevents the opening from becoming clogged. Screens come in mesh sizes from 20 to 200. A larger number means that spaces in the screen are finer. For example, a 20-mesh screen will allow larger particles to pass through it than will a 100-mesh screen. To work properly, a screen should have mesh smaller than the nozzle opening. Screens should not be finer than 50-mesh when wettable powder formulations are used. Otherwise, they will quickly plug.

**Tip –** The tip of the nozzle creates the pesticide spray pattern. Tips are defined by their spray pattern. The most common tips used in farming applications are flat fan and hollow cone. Others include full cone, tapered edge, and flooding spray tips. Generally, tips can be inter-changed between nozzle bodies that are made by the same manufacturer.

**Cap –** The cap is used to secure the strainer and the tip to the body.

## Choosing the Proper Nozzle Tip

Nozzle tips are made from a variety of materials. Choice of material often depends on the abrasiveness of the spray mixture to be used. Wettable powders are more abrasive than emulsions. Nozzle materials that wear quicker tend to cost less. The nozzle materials in Table 8-1 are listed in order of increasing rate of wear and decreasing cost.

**The initial cost of nozzle replacement might seem high. However, replacing worn nozzles will pay off over time.**

## Nozzle Spray Patterns

Nozzles can be described by the shape of the spray pattern that they produce. There are many patterns available. Each nozzle type comes in a range of flow capacities and spray angles. Each is suited to a certain type of operation.

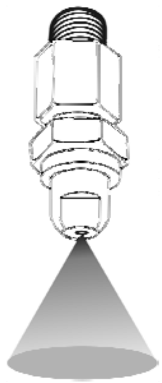
**Nozzles should be checked regularly for spray pattern and output. This ensures label rate and on-target application. (*See* Section B: Equipment Calibration.)**

| *Material* | *Characteristics* |
|---|---|
| Brass | Poor wear life; susceptible to corrosion (more so with fertilizers) |
| Polymer | Good wear life; good chemical resistance; orifice can be damaged if not properly cleaned |
| Stainless steel | Good wear life; excellent chemical resistance; durable orifice |
| Hardened stainless steel | Very good wear life; good durability and chemical resistance |
| Ceramic | Superior wear life; highly resistant to abrasive and corrosive chemicals |

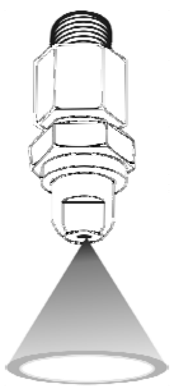
**Table 8-1: Nozzle tip types.**

As nozzle tips wear out, spray patterns change and the application rate increases. Replace a nozzle if flow varies more than ten percent from the manufacturer's specifications or five percent from the sprayer's average nozzle output. Worn nozzles:

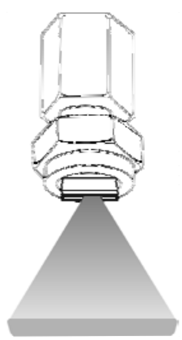
- Produce a poor spray pattern
- Waste chemicals and money
- Result in poor pest control
- Produce higher application rates



**Full or solid cone nozzles** are used where dense foliage requires a penetrating spray. Full or solid cone nozzles are most often used to apply fungicides or insecticides to row crop foliage when the plants must be fully covered with product.



**Hollow cone nozzles** are used when spraying at high pressures. They are often used for wettable powders, flowables, and suspensions. Hollow cone nozzles tend to produce a finer, more uniform spray than solid cone nozzles.



**Even flat fan nozzles** form a narrow oval pattern with a sharp cutoff at the edge. Even flat fan nozzles are used for band spraying. They are often used for applying herbicides. Boom height and nozzle spray angles affect the width of the band sprayed.

Other common nozzles types include the following:

- **Solid stream spray nozzles** vent a solid, directed spray. They are best suited for use when there is a large distance between the applicator and the target.

- **Flooding nozzles** vent a very wide spray pattern, and produce large, low-pressure droplets. They are best suited for general broadcast applications.

**Swirl (disc-core) nozzles have a swirl plate (core) between the strainer and an orifice disc. This helps govern droplet size.**

## Nozzle Performance Characteristics

Each sprayer nozzle is designed to do a specific job with a particular type of pesticide formulation. They should be used as per pesticide label instructions. Nozzles come with a wide range of performance characteristics. These include the following:

### SPRAY ANGLE

Spray angle is the measurement (in degrees) of the spray angle formed by a single nozzle at a given pressure. Nozzles can be purchased in a number of standard spray angles. The most common flat fan nozzle angles are 65°, 80°, and 110°.

Wider nozzle angles provide even application with lower boom heights. Proper boom height depends on the spray angle and the nozzle spacing. Check the nozzle manufacturer’s guidelines for the overlap required to achieve an even application.

### NOZZLE OUTPUT

Nozzle output depends on the size of the nozzle opening and the spray pressure. With most nozzles, output increases as pressure increases. It takes a large increase in pressure to get a small increase in nozzle output.

Manufacturers often supply tables that show the nozzle output at a number of pressures.

**Pressure must be increased four times to double the nozzle output.**

## VOLUME

The volume of spray to be applied per unit of area is often shown on the label of a pesticide. For example, when spraying a herbicide on a crop, the application rate may be in the range of 300 to 500 litres per hectare (L/ha). Fungicides and insecticides may be applied at 100 to 1,000 L/ha. Some treatments require drenches of at least 1,000 L/ha (e.g., to control cabbage maggot).

## DROPLET SIZE

Droplet size is the size of a particle of liquid (measured in microns) that is formed as the spray mix is forced through the nozzle.

**Micron**

**A unit of measurement one one-thousandth of a millimeter.**

A nozzle forms a range of droplet sizes, from very small to large. A nozzle pattern tends to be made up of fine to large droplets. More droplets become fine as spray pressure increases.

Pesticide coverage tends to be better and cheaper when using smaller droplets. Unfortunately, spray drift is more likely to occur with small droplets. Evaporation and wind can move the spray away from the target. To improve coverage, increase the volume of spray by changing the nozzles. This is better than increasing spray pressures.

**Refer to the manufacturer's specifications for detailed nozzle information. These specifications will provide a pressure range for nozzle use. Specifications will also provide the pressure range needed to maintain proper spray pattern, droplet size, and flow rate. Poor nozzle spray pressure settings, above or below optimum range, will decrease product efficacy and create an environmental hazard.**

| ***TeeJet brand nozzles*** | | ***Pressure (kPa)*** | ***Output (L/min)*** | ***Sprayer output at:*** | | |
|---|---|---|---|---|---|---|
| ***65º*** | ***80º*** | | | ***6 km/h*** | ***8 km/h*** | ***10 km/h*** |
| 6500067 | 8000067 | 200 | 0.22 | 43 | 32 | 26 |
| | | 275 | 0.25 | 51 | 38 | 31 |
| 6501 | 8001 | 200 | 0.32 | 64 | 48 | 39 |
| | | 275 | 0.38 | 76 | 57 | 45 |
| 65015 | 80015 | 200 | 0.48 | 97 | 73 | 58 |
| | | 275 | 0.57 | 113 | 85 | 68 |
| 6502 | 8002 | 200 | 0.64 | 129 | 97 | 77 |
| | | 275 | 0.76 | 151 | 113 | 91 |
| 6503 | 8003 | 200 | 0.97 | 193 | 145 | 116 |
| | | 275 | 1.13 | 227 | 170 | 136 |
| 6504 | 8004 | 200 | 1.29 | 258 | 193 | 155 |
| | | 275 | 1.51 | 302 | 227 | 181 |

**Table 8-2: Sample nozzle output table (TeeJet nozzles).**

# Granular Application Equipment

Granular application equipment is used to spread dry pellets or granules of pesticide. This equipment differs somewhat from the more traditional or liquid spray equipment. Basic components of granular application equipment include a storage hopper, metering mechanism, and distribution system.

## Storage Hopper

The storage hopper holds the granular pesticide. Storage hoppers come in a number of shapes, sizes, and materials. The storage hopper should be strong, resist corrosion, and be shaped to help the granules flow. The hopper should also be easy to fill and clean. It should have graduated markings on the side to measure product.

Agitators can be installed in hoppers to prevent bridging (blockage) of granules. When a number of granules bridge or stick together, they form a clump. Large clumps can block or disrupt the flow of pesticide. The risk of granular pesticide bridging depends on:

- Characteristics of the pesticide formulation
- Shape of the hopper
- Air temperature and humidity during application

Coarse screens can be installed on hoppers to keep out clumps of product, debris, or pieces of the pesticide container. This will keep the drive mechanism from clogging.

## Metering Mechanism

The metering mechanism commonly uses either gravity flow or positive mechanisms. These components release the required amount of product from the hopper at the desired rate.

**Gravity flow-metering mechanisms** simply drop pesticide down from the hopper. Openings can be adjusted in size to change the flow of pesticide. A hopper agitator is often used to provide a steady flow of granules to the opening.

**Positive metering mechanisms** use an auger or fluted-feed roll at the bottom of the hopper to control the flow of granules from the hopper. Positive metering mechanisms are more accurate than gravity flow-metering mechanisms.

## Distribution System

The distribution system moves the granules from the equipment to the field. The type of distribution system often determines its classification. Broadcast application equipment and banding application equipment are common distribution types.

**Broadcast application equipment** applies granules over a field using:

- A wide hopper with closely spaced gravity flow openings (e.g., Gandy-type spreader)
- A single flow opening with a mechanical spreader (e.g., a Vicon wig-wag spreader, or spinner spreader)
- A pneumatic delivery system (Using this type of system, granules are blown from the metering system through a boom to outlets. A powerful fan produces a stream of high-speed air to carry the granules.)

**Banding application equipment** applies granules in narrow bands that often line up with crop rows. Untreated areas are left between the rows. Banding helps reduce pesticide use, as only a small area is targeted.

Banding application equipment can use either:

- Simple spreaders to distribute granules across a desired band width on the soil, or

- Small drop tubes or soil openers (These place granules in well-defined bands under the soil near the seed.)

### In Review

**There are many types of pesticide application equipment. Hand-operated sprayers, motorized sprayers, and granular application equipment are the most common. Know the type of pest to be controlled and the pesticide formulation that you plan to use. This will help you to better select the proper application equipment. The pesticide label and equipment manufacturer will sometimes provide information on the best match between pesticide formulations and application equipment. Application equipment has a number of components to manage pesticide delivery. The proper choice of equipment is important for safe, economical pesticide use and effective pest control.**

# Cleaning Application Equipment

Cleaning and taking care of application equipment will help make sure future pesticide applications are effective. It can also extend the life of the equipment.

Poorly cleaned equipment can cause residues to accumulate in the tank (or hopper), hoses, and nozzles. Residues often harden with time. This makes the equipment harder to clean. A large accumulation of residue can cause the equipment to break down.

Leftover residues can also mix with new product when you use equipment the next time. This can alter the effect of the second pesticide and damage crops.

Always clean application devices before using them for the first time. New sprayers can contain dirt, oil, or chips of metal.

It can be hard to clean large spray booms and other equipment after each use. When it is being used often, smaller application equipment should be cleaned daily.

Always clean equipment before using a different pesticide, and before off-season storage.

**Measuring containers should be cleaned after each use. Residues left behind can contaminate the next spray mix.**

Read the product label for cleaning instructions. Some products provide specific instructions for cleaning application equipment.

## Good Practice Guidelines

A product label does not always provide instructions for equipment cleaning. However, there are a number of general rules to follow for cleaning sprayers or granular application equipment.

**Wear proper protective clothing when cleaning application equipment.**

**Remove excess pesticide and/or wash water in a place and manner that will not harm the environment.**

## Cleaning Sprayers

Detailed sprayer cleaning is required when changing the pesticide being used or getting equipment ready for storage.

Wash the outside of the tank with soap (or mild detergent) and water.

Remove nozzle tips and screens. Clean them in a strong detergent and water. Use a soft brush. Partly fill the spray tank with clean water. Flush this through the booms for at least ten minutes before draining. Boom sections should be flushed one at a time. This provides the high-pressure flow needed for thorough cleaning.

Repeat this rinse cycle if residue can still be seen.

Fill the tank nearly full with clean water. Add a cleaning agent such as household detergent (250 millilitres to 100 litres of water) or ammonia (1 L to 100 L of water). The pesticide product label may call for a certain cleaning agent. Circulate this product through the system. Agitate for at least 15 minutes. Spray out and drain completely.

Repeat the wash cycle.

Rinse twice with clean water and drain.

**Make sure that cleaning solutions are completely rinsed from the tank. Detergent residues can mix with the next pesticide and change the effect of the product.**

**When cleaning equipment, wear chemical-resistant gloves, boots, hat, apron, and goggles. This prevents contact with pesticides.**

### Winter Storage

Residues can freeze if they are left in equipment that is stored at temperatures below $0^0$C. This can crack and damage tanks, hoses, and pumps. Equipment should be drained and rinsed with alcohol if it is to be stored where it might freeze.

Pumps and hoses should also be flushed with antifreeze. Nozzles should be removed, cleaned, and stored in a warm, dry place. This avoids damage from freezing.

## Cleaning Granular Application Equipment

Granular application equipment should be cleaned after each use. Hoppers, metering mechanisms, and distribution systems require thorough cleaning to work properly.

When cleaning granular application equipment:

- Remove all pesticide from the device. This might require taking off some parts of the equipment.

- Clean the inside of the hopper.
- Clean and oil the flow-control slides or valves.
- Wipe off excess oil if there is risk of it coming into contact with pesticide during the next use.

### Winter Storage

At the end of the season, extra cleaning should be done. This will help ensure the equipment works properly next year:

- Protect plastic parts from direct sunlight during storage. This will extend their life.
- Use sandpaper or a wire brush to clean rusted parts. Paint the cleaned parts.
- Coat the inside of the hopper and metering system with oil. This prevents rust and corrosion.
- Oil or grease the bearings.

## Protecting Human Health and the Environment

Cleaning pesticide application equipment can pose a hazard to human health and the environment. Pesticide applicators can use the following guidelines to keep personal and environmental risk to a minimum:

- Never blow out nozzle tips using your mouth. Use a toothbrush or soft material to clean nozzle tips.

- Never use a piece of wire, nail, or metal object to clean nozzle tips. These can damage the opening, distort the spray pattern, and increase nozzle output.
- Wear protective clothing and equipment when cleaning sprayers and measuring containers.
- Clean up puddles of rinse or wash water. These can be hazards to children, pets, farm animals, or wildlife.
- Do not injure plants with wash or rinse water.
- Clean the sprayer away from waterways, ditches, wells, or other water sources.
- Do not contaminate natural waterways with wash or rinse water.

## In Review

**Clean and take care of pesticide application equipment to ensure it continues to work properly. Poorly cleaned equipment can apply the wrong amount of pesticide to the target area. This can result in crop damage or poor pest control. Proper cleaning will protect the applicator and the environment from contamination.**

**Equipment should be cleaned:**

- **At the end of each workday**
- **When changing products or crops**
- **At the end of the season when equipment is being stored**

**Many types of application equipment have specific cleaning instructions. Check with the manufacturer for details.**

# Maintaining Application Equipment

Taking care of pesticide application equipment can save you time and money. Good maintenance reduces hazards and the cost of accidents and breakdowns.

Maintaining equipment also protects the environment and the applicator.

Equipment care starts at the time of purchase. Select equipment that fits the required application. Equipment wears out quickly when it is not suited to the job or if it is overworked. Some equipment parts require more frequent attention than others.

## Pumps

Pumps are designed to provide even pressure during product application.

Pressure changes in the pump can result from plugged lines or screens, or from valve or piston wear. Pressure changes can also mean that the pump is too small for the volume of product required.

If you see a pressure change during application:

- Check and clear plugged lines or screens.
- Repair or replace pistons.
- Increase pump capacity.

## Screens

Screens filter product before it enters the nozzles.

Screens should always be kept clear of residue and debris. They should also be sized properly for the nozzles used. This ensures that nozzles can handle the size of the product delivered.

Constant plugging of nozzles and poor spray patterns can indicate that the wrong screen size is being used.

If you notice poor spray patterns, you should:

- Check screen size to ensure that it suits the nozzles.
- Clean debris from the nozzles.

## Agitators

Agitators are designed to mix the product. They can be hydraulic or mechanical. Mechanical agitators require more care than hydraulic agitators. Mechanical agitators have moving parts (e.g., shaft, bearings, paddles) that wear. Hydraulic agitators tend not to have moving parts.

If product is not mixing properly:

- Check agitators for wear.
- Replace worn components.
- Confirm that the problem has been solved.

## Plumbing

Plumbing in a sprayer includes the hoses and fittings that bring product to the nozzles.

Damaged plumbing can leak or spill product. Sprayer plumbing should be checked regularly.

If a leak is noticed:

- Check hoses and fittings for cracks, leaks, or wear.
- Replace hoses or fittings that show excess wear or holes.

# Nozzles

Nozzles deliver product to the target. Nozzles should be calibrated at least once a year.

The applicator should watch for uneven spray patterns during use. To maintain an even spray pattern:

- Check the pesticide label for information on proper nozzle types and sizes.
- Regularly check and clean nozzles.
- Replace worn or damaged nozzles.
- Ensure that the nozzle type used will properly spread the pesticide.

# Other Preventative Maintenance

Preventative maintenance is sometimes needed throughout the year. If equipment is used for a long period of time, it will need to be maintained more often. If left unused for a long time, it may require more detailed care before its next use.

To keep application equipment working well:

- Overhaul the pump annually.
- Check the tires for proper inflation. Air pressure will affect the size of the tire. This will alter application rate. Over-inflated tires increase bouncing. This causes uneven product application.
- Paint corroded equipment parts. Do not paint inside the tank or hopper.
- Store the equipment under cover.
- Drain and rinse the tanks and/or hoppers when not in use.
- Use gaskets and washers made of materials such as Teflon. Pesticide residues do not break these down.

- Add environmentally safe antifreeze to the pump in the off-season. Flush antifreeze through the sprayer lines and booms.

### In Review

**Taking care of application equipment will help to ensure its proper function. It will also help to maintain even pesticide application rates. Good maintenance prolongs equipment life. It also protects the applicator and the environment.**

**Check the manufacturer's specifications and guidelines for more details on equipment care.**

**A pesticide application should control pests with little risk to human health and the environment.**

## Application Technology and the Environment

Application can be affected by:

- Choice of equipment
- Product choice
- Time and place of application

These factors are under the applicator's control.

Factors such as temperature, wind speed and direction, and site conditions are beyond the control of the applicator. However, they must be taken into account when making pesticide application decisions. You should understand the role that each factor plays in pest control.

## Application Equipment and Pesticide Drift

Wind or air movement will cause pesticide drift. Drift from a target site can reduce the effectiveness of an application. It can also harm nearby plants and animals.

There are two types of pesticide drift:

**Spray drift** (particle drift) is the movement of spray droplets away from the target area. This occurs when the wind is strong enough to pick up and carry droplets. Small spray droplets are more likely to drift than larger, heavier droplets. Granules and powders can also drift to some degree.

**Vapour drift** is the movement of pesticide vapours. Some pesticides change to a vapour after spending time in the air or on a plant. This vapour can be carried to other areas and harm susceptible plants. Vapour drift depends on the state of the pesticide rather than the application method used.

## Application Equipment and Droplet Size

To reduce spray drift, you must know how spray droplets behave.

The most important factor affecting drift is the initial size of the droplet. Large droplets are heavier and less likely to drift than smaller droplets. “The bigger they are, the harder they fall.” Equipment manufacturers commonly take this into account when designing low-drift nozzles.

**Atomize**

**To form droplets by forcing liquid under pressure through a small opening, like a nozzle.**

The most common nozzle is the flat fan. Hydraulic pressure is used to “atomize” spray into a wide range of droplet sizes. This range of droplet sizes provides a consistent result over a number of spray conditions.

Small droplets provide better coverage on plants. However, they are more likely to evaporate or drift because they fall quite slowly once they leave the nozzle.

Applicators may prefer large droplets. Because these don't evaporate so quickly, the product can stay longer on the target. Large droplets do, however, pose problems. They have more momentum when leaving the sprayer and are more likely to bounce off the target. This means less coverage.

| ***Droplet size*** <br> ***(Diameter in microns*** | ***Time it takes for the droplet to fall three metres in still air*** |
|---|---|
| 1 (fog) | 28 hours |
| 10 (fog) | 17 minutes |
| 100 (fog) | 11 seconds |
| 200 (fine spray) | 4 seconds |
| 400 (coarse spray) | 2 seconds |
| 1,000 (coarse spray) | 1 second |

**Table 8-2: Effect of droplet size on drift potential.**[1]

For each application, you must consider the range of droplet sizes that will be best for a given situation. Insecticides and fungicides tend to require smaller droplets for good coverage on leaf surfaces. A medium or coarse droplet size is often used for foliar herbicide application.

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[1] (Source: Ross, Merrill A. and Carole A. Lembi. 1985. Applied Weed Science. Burges Publishing Company, Minneapolis, MN.)

## Measuring Droplet Size

Droplet sizes are often measured in microns (micrometres). One micron equals 0.001mm (one-thousandth of a millimetre). One dime is about 1,270 microns thick.

Droplets smaller than 100 microns are most likely to drift.

## Factors Affecting Droplet Size

Managing droplet size is a simple way to reduce drift. Pesticide applicators can change the nozzle type or the spray pressure to manage droplet size.

### Nozzle type

The nozzle type plays the greatest role in determining droplet size. Applicators should select a nozzle type based on the:

- Pesticide used
- Type of pest
- Location of the pest
- Type and size of the target plant
- Weather at the time of application

Nozzles that work with higher outputs (greater volumes) apply a coarser spray. These often produce less drift. Higher outputs will mean that the tank will have to be refilled more often. However, the increased volume of water or carrier will improve coverage and increase pesticide effectiveness.

**Manufacturers often include tables that define nozzles by flow rate at a given pressure. Colour-coding of newer nozzles follows a standard system. This allows an applicator to quickly identify the nozzle output (flow rate) by the colour of the nozzle. Older colour-coded nozzles might not match the new standard coding system.**

## COMMON NOZZLE TYPES

The TeeJet® nozzle, made by Spraying Systems Co., is a common brand. Each nozzle has a number that describes its characteristics. Features include spray angle, output, and the materials used to make the nozzle.

The **TeeJet® 11002VS** is a flat fan nozzle often used to apply herbicides.

**"110"** describes the spray pattern angle at an operating pressure of 40 pounds per square inch (psi). 65° and 80° angles are also available.

**"02"** describes the output in U.S. gallons per minute at 40 psi (02 = 0.2 gal/min.).

**"VS"** describes the nozzle material (V = the colour code, S = stainless steel).

TeeJet® flat fan nozzles also have a letter system that appears before the nozzle number. The letters further describe nozzle features (*see* table below).

All nozzles operate within a range of pressures. Some have a wide range (Turbo Jet); others have a narrow range (Drift Guard).

Wider range nozzles provide the applicator with more choice of droplet sizes. This helps when coverage and drift are a concern.

| *Prefixes* | *Description* | *Features* |
|---|---|---|
| XR | Extended Range | Provides a good spray pattern between 15 and 60 psi |
| DG | Drift Guard | Uses a pre-orifice design to create a coarse spray at standard pressures of (30 to 60 psi) |
| AI | Air Induction | Uses a venturi to draw in and mix air with spray liquid Coarse droplets are formed. |
| TJ | Twin Jet | Contains two orifices. One points slightly back and the other slightly forward. This provides a finer spray at a given nozzle rate |
| TT | Twin Jet | A swirl chamber and turbo-flood jet design are used to create a wide angle coarse spray under a pressure range of 15 to 90 psi. |

**Table 8-3: Prefixes of Spraying Systems Co.® Flat Fan Nozzles.**

## Spray Pressure

Changes in spray pressure will affect droplet size. Pressure affects the way droplets are formed when they leave the nozzle. Lower pressures create larger droplets. Higher pressures create smaller droplets.

Some applicators believe that they get better spray penetration into the crop canopy when pressure is increased and the initial speed of the droplets is faster. **This is not the case.** Droplets will move faster at first, but this increased speed does not last.

**Always operate a nozzle at the lowest pressure possible for the job. This will help to cut down on pesticide drift.**

## Environmental Factors Affecting Pesticide Drift

Applicators should plan around a number of environmental conditions at the application site. These include:

- Temperature and humidity
- Wind speed
- Wind direction
- Air turbulence
- Temperature inversion

The best way to prevent drift is to make sure the sprayer:

- Has the proper settings
- Is fitted with the proper nozzles
- Is adjusted to the environmental conditions

## Temperature and Humidity

Temperature and humidity affect pesticide evaporation. High temperatures and low humidity increase the rate of pesticide evaporation. Small droplets can fully evaporate and leave pesticide particles in the air. Particles can then be carried up to several kilometres away from the treatment site (vapour drift).

## Wind Speed

Wind speed affects pesticide drift. High wind speeds increase the risk of pesticide drift. Drifting pesticide can settle on pastures, wildlife habitat, or waterways. This can then injure livestock, wildlife, beneficials (e.g., pollinators), fish or other aquatic life.

Pesticides that drift to residential property can harm people or pets. These can also damage lawns, trees, ornamental landscaping, and gardens.

Applicators can be held liable for any injury, property damage, or monetary loss resulting from pesticide drift on non-target areas. Always apply pesticides within recommended wind speeds to reduce drift. This limits the risk of damage to sensitive plants or animals. It also limits inhalation and contact risk to applicators and bystanders.

Many pesticide labels state the maximum wind speed for legal application. Provincial laws may also provide maximum wind speeds for product application. **Always follow the lower of these two wind speeds.**

## Wind Direction

Wind direction is a major factor in off-target drift. Pesticides should not be applied if the wind is blowing toward:

- Susceptible crops
- Environmentally sensitive areas
- Residential or recreational properties

Apply a pesticide only when the wind is stable and blowing away from sensitive areas.

## Air Turbulence

Air turbulence is caused when there is a large difference between the temperature of the air at ground level and the temperature of the air layer above. Air turbulence can also cause pesticide drift.

Upward air currents begin when air just above the soil is warmer than the air higher up. The larger the difference between these air temperatures, the stronger the air currents.

Air currents can carry spray droplets and pesticide particles far from the treatment area. Do not apply pesticides during turbulent air conditions.

## Temperature Inversion

A temperature inversion occurs when the air near the soil surface is cooler than the air above it. Temperature inversions often happen at night when the earth cools. Warm air blocks the upward air movement that would otherwise disperse airborne chemicals. Wind will promote air mixing and reduce inversion conditions.

Low-level winds during a temperature inversion can cause small spray drops to remain in the air. These can then move out of a treatment area as a concentrated cloud. Do not apply a pesticide during inversion conditions. Wait until morning. If the temperature at ground level rises, the inversion should end.

# Product Volatility

Each pesticide has its own level of volatility. A volatile product will quickly change into a vapour or gas. Volatile products pose a higher risk of off-target drift.

The temperature during application plays a major role in product volatility. You can help to reduce evaporation by spraying only when temperatures are low.

Low volatility formulations reduce off-target drift. For instance, *2, 4-D* is sold in amine or ester formulations. Ester formulations are volatile. Only amine formulations should be applied near sensitive areas.

## Practices to Reduce Pesticide Drift

There are a number of other ways to prevent spray drift.

### Adjuvants

Use of adjuvants will impact droplet size. Adjuvants can also change physical properties, such as viscosity and the surface tension of the spray mix.

Each adjuvant affects droplet size in a certain way. This can depend on the formulation of the pesticide. Some adjuvants increase droplet size. Others have the opposite effect and may not produce expected results. Some adjuvants can have no effect on droplet size. Do not use adjuvants unless they are registered for use with a given pesticide product.

### Buffer Zones

Buffer zones protect non-target areas from pesticide drift. Buffer zones are an untreated boundary around a treated area.

Never apply a pesticide on the edge of a water body or other sensitive area. Leave a strip of untreated natural vegetation to protect the environment.

Some product labels provide buffer zone statements, or directions for use near sensitive areas.

## Individual Nozzle Hoods

Individual nozzle hoods shield spray droplets from wind for the first part of their journey from the sprayer. Some shroud the top portion of the spray stream. Other hoods cover the whole boom.

A near-perfect seal will have to be maintained at the front and back of the shields. This prevents air movement beneath the shields. Some boom hoods do not allow you to see sprayer nozzles during application. A monitoring system should be used to ensure proper application.

## Timing of Application

Timing of application can affect pesticide drift. Product application during early morning or early evening can reduce the risk of pesticide drift. Wind speed is often lower and humidity higher at these times of day.

Avoid pesticide application during the middle of the day. This lowers the contact danger to wildlife such as birds, mammals, and pollinators that visit crops during this time.

## Precipitation

Precipitation can also affect a pesticide. Spray applications should not be made just before rain. If rain falls right after application, the pesticide is likely to wash off. Pest control can then be lost.

Severe rain can cause runoff. This can wash pesticide onto non-target or sensitive areas. Nearby property, crops, or wildlife can then be harmed.

## Specialized Application Equipment

Specialized application equipment includes wipers or wick-weeders that can be used to apply herbicide. No droplets are formed. There is no risk of spray drift.

For these applications to work, weeds should be higher than the crop. Weeds should also be the only plants wiped with the herbicide. Two passes, in opposite directions, are often needed to apply the herbicide.

**Always read and follow pesticide label directions. Information will sometimes include directions to reduce drift. It can also provide steps to follow when using a product near environmentally sensitive areas.**

## In Review

**Product drift is always a concern. There are a number of steps an applicator can take to reduce off-target drift.**

**Application equipment should be well maintained and calibrated. Choosing proper nozzles will reduce product drift. Attention to these factors will:**

- **Ensure proper product application rates**
- **Provide better pest control**
- **Help protect the environment**

**Environmental factors are always a concern. Key concerns to plan for include wind speed, wind direction, temperature, humidity, air turbulence, inversion, and volatility. These will impact how and when you apply product, and the effectiveness of the application.**

## Summary

**Pesticide application equipment can be very simple or very complex. The type of equipment you choose to apply pesticides at any one time should be based on the:**

- **Size and type of area to be treated**
- **Crop to be treated**
- **Type of pest you want to control**
- **Pesticide formulation**
- **Label recommended application method**

**Application equipment can be designed to apply either liquid or solid pesticide formulations. Either type of equipment is made up of a number of components. Knowing these components and how they work will help you make the most of your equipment. Cleaning and maintenance also helps the equipment work properly. The product will then be delivered as planned.**

**Calibration is used to determine output based on the:**

- **Area to be covered**
- **Speed of delivery**
- **Rate of product required**

**Equipment will have to be calibrated to deliver product to the target at the recommended rate. If product is delivered at a different rate than recommended, it will not be as effective.**

**Product drift or runoff is always a concern when applying pesticides. There are a number of steps the applicator can take to reduce drift and runoff. These include choosing proper nozzles and taking wind, temperature, precipitation, and timing into account. Maintain buffer zones to protect sensitive environmental areas.**

# SECTION B: EQUIPMENT CALIBRATION

## Calibrating Application Equipment

Pesticide manufacturers conduct extensive research to find the rate at which pesticides should be applied to be both effective and safe. Only properly calibrated equipment will deliver product at the desired rate.

### Learning Objective

**Completing this section will help you to**

- **Calibrate application equipment**

## The Importance of Proper Calibration

Pests can only be controlled when the pesticide is applied on target at the right rate. Calibration of application equipment will help:

- Ensure that pesticide will be applied uniformly
- Ensure that nozzle pressure forms droplet sizes that limit spray drift
- Result in the proper equipment output
- Meet label requirements
- Determine the amount of product and carrier to add to the spray tank

The wrong amount of pesticide can be applied if equipment is not calibrated. This can happen even if the amount of product required to treat an area has been properly calculated.

The application of too much pesticide can:

- Contaminate food crops

- Damage the environment
- Increase risk to human health

The application of too little pesticide can:

- Fail to control the pest
- Promote pest resistance
- Waste time and money
- Waste product

When equipment wears out or fails to perform, pesticide delivery rates will change. Faulty equipment parts can be identified during calibration.

Application equipment should be calibrated:

- Before it is used for the first time
- At the start of the season
- When travel speed, nozzle spacing, or nozzles are changed
- When equipment output changes
- When equipment is changed in any other way

## Pre-calibration Sprayer Check

Application equipment needs to be in good repair before it is calibrated. A pre-calibration check includes the following:

- Repair and replace faulty hoses.

- Clean all screens and nozzles with a soft brush.

- Ensure that all nozzles on the boom are the same type and size. Nozzle spacing should be the same across the whole boom.

- Set the pressure gauge at the pressure that will be used. Run water through the system. Make sure that water flows through all nozzles.

- Check individual nozzle output. Make sure that each nozzle on the boom delivers the same volume of water (within 10 percent) over a given time. Make sure that spray patterns for each nozzle are even and consistent.

- Make sure the boom is level along its entire length. Set it at the desired height above the target (soil or plant). Check the nozzle manufacturer's specifications for proper nozzle height.

- Run the sprayer slowly over a dry, level surface. Check the spray pattern of clean water on the soil or surface. The pattern should be uniform.

# Sprayer Output

Before using any pesticide, find out how much product needs to be delivered to the target. Each pesticide has its own application rate.

## Liquid Formulations

Pesticide labels often give sprayer output as the amount of spray to be applied per unit of area.  Some labels state exactly what the sprayer output should be.

For example, this can be expressed as:

***600 L of spray per hectare***, or ***Apply in 200 to 600 L of water per hectare***.

## Granular Formulations

Labels state application output as weight per unit of area.

For example:

***Output should be 100 kg of product per hectare***.

## Calculating Output

The label will not always dictate the exact output. It may tell you to:

***Apply until runoff***, or ***Apply product to thoroughly wet foliage.***

In these cases, you will have to calculate the needed output to get the desired results. To do this, you will need to determine the amount of product that will need to be mixed and applied. Then, you will have to decide on the output for delivery.

Take the following into account when using liquid formulations:

Coverage required – Spraying to product runoff requires much more spray solution than spraying to wet the surface.

Surface to be treated – Dense foliage or porous surfaces can require more spray solution. There will have to be enough product to pass through and reach the pest.

Droplet size – A high sprayer output tends to mean that a coarser spray can be used. Coarser sprays use larger droplet sizes.

Mixing requirements – A high sprayer output means more water and more tanks of spray solution will be used. Frequent stops will be required to refill the tank(s).

## Calibrating Sprayers

You can calibrate the sprayer once the pre-calibration check has been finished and output has been determined.

There is more than one way to calibrate a sprayer.

One method of calibration is given below. This method assumes sprayer output in litres per hectare (L/ha).

To complete this equation, the applicator must know:

- The time it takes the tractor to travel 50 metres (measured in seconds)
- The average nozzle output (in millilitres)
- The nozzle spacing (in metres)

**Step #1 - Measure the time**

- Mark a 50-metre distance in a field.
- Select the tractor gear, RPM (throttle), and the speed that you will drive when spraying.
- Drive the 50-metre distance three times. Time each pass. Make sure the tractor is moving at the desired spraying speed for the whole distance.
- Calculate the average time of the three passes (measured in seconds).

**Step #2 - Measure the average nozzle output**

To determine the amount of product that will be delivered through each nozzle:

- Park the sprayer with the PTO engaged and the throttle set to the same RPM as in the test run.
- Adjust the pressure regulator to the desired working pressure with full flow to the boom.
- Collect the output from each nozzle for the average length of time needed to travel the 50 metres in the test run. Measuring output from each nozzle takes time, but it allows you to find those that need to be cleaned or replaced.
- Add the totals for each nozzle. Divide by the total number of nozzles.

For example, if you have 20 nozzles and a total of 10 litres of water, the nozzle output equals 0.5 litres per nozzle (10 litres divided by 20 nozzles = 0.5 litres per nozzle).

If the output from a nozzle is over or under the average by five percent, clean or replace the nozzle and screen.

For example, if the average nozzle output is 0.5 litres, a five percent change would be plus or minus (+/-) 25 ml or more per nozzle. A difference of less than 25 ml is acceptable in this example.

For nozzles that test outside the +/- five percent range, you should measure nozzle output again after the change is made.

**Step #3 - Measure nozzle spacing**

By this time, you know the average output per nozzle over the 50-metre test run. Now you need to know the spacing of the nozzles. This will help you to calculate how much product will be applied with each pass of the sprayer.

- Measure the distance (in metres) between two nozzles on the spray boom. The following formula will provide the output in litres per hectare:

$$\text{Sprayer output (L/ha)} = \frac{\text{average nozzle output (ml)}}{\text{nozzle spacing (m)}} \times 0.2^*$$

*** 0.2 is a constant factor to change units to L/ha.**

Use the following guide if you need to convert litres per hectare to another unit:

**To determine:**

| | |
|---|---|
| **Litres per acre:** | **Litres per hectare x 0.4** |
| **Imperial gallons per acre:** | **Litres per hectare x 0.09** |
| **U.S. gallons per acre:** | **Litres per hectare x 0.11** |

## Example #1 – Calculating sprayer output in litres per hectare

1. **Time to travel 50 m:** (1,800 rpm in 6th gear)

   run 1 – 25.06 sec.
   run 2 – 25.39 sec.
   run 3 – 24.79 sec.

   Total = 75.24 / 3 runs

   **Average = 25.08 sec.**
   Travel time = 25 sec

2. **Nozzle #**

| | |
|---|---|
| 1 | 325 ml |
| 2 | 320 ml |
| 3 | 330 ml |
| 4 | 325 ml |
| 5 | 315 ml |
| 6 | 315 ml |
| 7 | 330 ml |

Total 2,260 ml / 7 nozzles
**Average = 323.75 ml**

95 percent of average = 323.27 x .95 = **307.56 ml**
105 percent of average = 323.75 x 1.05 = **339.94 ml**

All nozzles should output between 307 ml and 339 ml. Since all nozzle outputs fall within the +/- five percent range, there are no problem nozzles.

3. **Nozzle spacing** was 50 cm (19 inches). Change this amount to metres using a conversion table. 50 cm or 100 cm in 1 metre = **0.5 metres**

4. **Sprayer output (L/ha)** = $\frac{323.75 \text{ ml} \times 0.2 \text{ (constant factor)}}{0.5 \text{ m}}$

   **Total = 129.5 L/ha**

The sprayer output is 129.5 L/ha, or 130 L/ha. (It is safe to round values up to avoid fractions or decimals.)

## Adjusting the Sprayer Output

Calibration can sometimes show that your equipment is not delivering the right output. Adjust the sprayer and test it again.

Sprayer output can be adjusted in one of three ways:

- **Change the pressure –** Lower pump pressures deliver less spray than higher pump pressures. Any change in pressure will change the size of the spray droplets and the nozzle pattern. Keep changes in pressure small to maintain droplet size and nozzle pattern.
- **Change the nozzle size –** Changing the nozzle size is the best way to make a greater change in sprayer output.
- **Change the travel speed –** Driving more slowly will deliver more spray per unit of area. Changing the travel speed is an easy way to make small changes to sprayer output.

Use the following formula to determine the speed required to output the correct amount of product:

$$\textbf{Required speed} = \frac{\textbf{present speed (km/hr) x present sprayer output (L/ha)}}{\textbf{desired sprayer output (L/ha)}}$$

**If you adjust pump pressure or change nozzle size, you should measure the nozzle output again. If you change travel speed, you do not have to re-measure nozzle output. Make sure that pump pressure does not change after a change to throttle RPM.**

# Calibrating Granular Application Equipment

Granular application equipment can use gravity feed, whirling discs (spinners), or air-blast methods to apply granules. Product output in kilograms per hectare (kg/ha) depends on the travel speed of the equipment, and the output of granules per minute (kg/min.).

Equipment output per minute will depend on:

- The size of the adjustable hopper openings
- Size, weight, and shape of granules
- The roughness of the field

Granular application equipment will need to be calibrated for each batch of product used and for changing field conditions.

Consult the equipment manual for initial settings. Use the output settings called for, based on the type of granules to be used. Use the advised speed unless the surface is soft, muddy, or uneven. Use a lower speed in these cases.

Use the following steps to calibrate most types of granular spreaders:

**Step #1 - Check the width of the application and application pattern**

- Fill the hopper with granules.
- Drive a short, measured distance at the desired speed.
- Measure the width of the application area. Check that granules are evenly spread along the area.
- If the granule pattern is uneven, you may need to adjust the speed of the spinner. Or you may have to change the place on the spinner where the granules land. Follow the manufacturer’s guidelines to do this.

**Step #2 – Find the applicator output by measuring the actual amount applied to a measured test area**

- Fill the hopper to half full with granules.
- Mark out a distance of 200 m or more.

- Collect the material discharged from the spreader in a bag or box as the tractor travels 200 m.
- Weigh the contents of the container. Calculate the applicator output per hectare using the following:

$$\textbf{Output} = \frac{\textbf{amount applied to test area (kg)} \times \textbf{10,000 m}^2\textbf{/ha}}{\textbf{distance travelled (m)} \times \textbf{width of application (m)}} \ \textbf{(kg/ha)}$$

**Step #3 - Adjust the applicator output**

If you calibrate the equipment and discover it is not delivering the required rate, adjust the output. To change the applicator output:

- Adjust the granule output setting on the spreader. Repeat calibration.
- Adjust the travel speed.
- Use the following formula to calculate the speed required to obtain a desired output:

$$\textbf{Required speed (km/hr)} = \frac{\textbf{present speed (km/hr)} \times \textbf{present applicator output kg/ha)}}{\textbf{desired applicator output (kg/ha)}}$$

**Use these same steps to calibrate pneumatic spreaders. In this case, measure output in grams, not litres.**

**Pneumatic spreaders are highly specialized. The manufacturer will provide detailed calibration instructions. Consult these instructions for more information.**

# Calculating Pesticide Rate

The pesticide rate is the amount of product applied per unit of area or per plant**.** In Canada, the pesticide rate is displayed on the label as either litres per hectare (L/ha) or kilograms per hectare (kg/ha).

Proper calibration of application equipment by itself does not guarantee the correct amount of pesticide will be applied to a given area. Calibration only ensures uniform output at the target speed. To make sure the pesticide is delivered exactly as required, you will also have to prepare the correct amount of pesticide to treat a given area.

Directions for mixing pesticide are given on the product label. Labels also provide application rates. A few simple calculations will help you to plan for, buy, and mix the right amount of pesticide for each job.

**A pesticide label is a legal document. Applicators must use the product only for the pests and crops (livestock) listed. The given application rate must be used.**

What happens when too much or too little pesticide is applied? Too much pesticide can damage crops or harm other plants or animals. Extra pesticide can stay on the target as residue or run off into the soil.

Too little pesticide may not control the pest problem. It can also lead to pest resistance. In this case, both time and money are wasted.

Use the following steps to calculate the amount of pesticide and water to add to the spray tank. You will need to know the output of the application equipment.

**Determining how much product you need –** Before you purchase pesticide product, you will need to know:

- The size of the area to be treated
- The application rate
- The number of applications to be made to the area

This will help you to determine the amount of pesticide needed.

**Step #1 – Area to be treated**

To determine the area of square or rectangular fields, measure the width and length of the area to be treated. Multiply these measures to determine the area in hectares or acres, as below:

$$\textbf{For hectares} = \frac{\textbf{length (m) x width (m)}}{\textbf{10,000 m}^2\textbf{/ha}}$$

$$\textbf{For acres} = \frac{\textbf{length (feet) x width (feet)}}{\textbf{43,560 ft}^2\textbf{/acre}}$$

**Step #2 – Number of applications**

Decide how many applications of each product you expect to make during the season. Do not buy more product than you plan to use in one season. This will reduce the amount of pesticide product on site. It will also limit the storage space required.

Check the product label to find the pesticide application rate recommended for the given pest and crop.

**Example # 1 – Determining how much product you need**

**Imagine that you need to apply the same insecticide for control of aphids to two fields this season. The first field is 700 m by 225 m in area. The second field is 325 m by 530 m in area.**

**The label application rate is 2 L/ha. The label states the maximum application is two applications per season. You expect to need two applications this season.**

1. **Area: Field # 1** $= \dfrac{700\text{ m x }225\text{ m}}{10{,}000\text{ m}^2/\text{ha}} = 15.75\text{ ha}$

$+$

**Field # 2** $= \dfrac{325\text{ m x }530\text{ m}}{10{,}000\text{ m}^2/\text{ha}} = 17.23\text{ha}$

**Total area 32.98 ha**

**Example # 1 Cont'd.**

2. **Application rate = 2 L/ha**

3. **Number of applications in one season = two applications**

4. **Quantity of product required =**

**2L/ha x 32.98 ha x 2 applications = 131.92 L**

**The total amount of pesticide required is 131.92 L (132 L). Purchase an amount closest to this.**

**Step #3 – Determining the area covered by one full tank of product**

You now know the amount of pesticide you need. Next, you must calculate the area one full tank will cover. You will need to know the calculated sprayer/spreader output to do this.

To determine the area covered by one full tank, divide the tank capacity by the sprayer or spreader output. **Output is found by calibrating your sprayer or spreader.**

**Area covered by one full tank of product:**

$$\frac{\textbf{tank size (L)}}{\textbf{sprayer output (L/ha)}} = \textbf{number of hectares one tank will cover}$$

$$\frac{\textbf{tank size (gal)}}{\textbf{sprayer output (gal/ha)}} = \textbf{number of acres one tank will cover}$$

Be sure you know whether your sprayer is measured in U.S. gallons or Imperial gallons.

1 U.S. gallon = 3.79 litres

1 Imperial gallon = 4.55 litres

**Example #1 – Determining the area one full tank will cover**

**A farmer has a 1,000 kg hopper. He wants to know how many hectares can be covered when spreading a granular herbicide at the label-recommended rate of 175 kg/ha.**

$$\textbf{Number of hectares (ha)} = \frac{\textbf{1,000 kg (full tank)}}{\textbf{175 kg/ha (rate)}} = \textbf{5.7 ha}$$

**One full tank will deliver product at the recommended rate to 5.7 hectares.**

**How much product to add to a full tank –** You now know the area covered by a full tank. Next, you can calculate how much pesticide mix needs to be prepared.

Multiply the area covered by one tank of pesticide by the application rate that you will be using.

**How much concentrated product to add to a full tank:**

**Area covered by one tank (ha) x application rate (L/ha or kg/ha) = amount of concentrated product to add to the tank**

**Area covered by one tank (acres) x application rate (L/acre or kg/acre) = amount of concentrated product to add to the tank**

**Example #2 – Determining how much concentrated product to add to a full tank**

**A full spray tank covers five hectares. A fungicide needs to be applied at the label-recommended rate of 0.6 kg/ha. How much fungicide needs to be added to the tank?**

**Fungicide to add = 5 ha x 0.6 kg/ha = 3 kg**

**Three kilograms of product should be added to the tank.**

**How much product to add to a partial tank –** You may need to calculate a partial tank to finish an application.

Use the following formulae to find the amounts of water and product needed for a partial tank:

**Pesticide needed for a part tank:**

**Area to be sprayed (ha) x pesticide application rate (L/ha or kg/ha)**

**Area to be sprayed (acre) x pesticide application rate (L/acre or kg/acre)**

**Water needed for a part tank:**

**Area left to spray (ha) x sprayer output (L/ha)**

**Area left to spray (acre) x sprayer output (gal/acre)**

## Example - Determining all necessary spray application information

**A farmer's field is 550 m by 600 m. He plans to apply one herbicide using the label rate of 1.7 kg/ha. The label calls for a water volume of 200 to 300 L/ha.**

**The farmer has just re-calibrated the sprayer to an output of 250 L/ha. The sprayer tank holds 1,500 litres when full. The farmer must now calculate:**

- **The size of the treatment area**
- **How much herbicide is needed**
- **The area covered by one full tank**
- **How many full tanks need to be applied**
- **How much herbicide and water is needed to complete the field (if a part tank is needed)**

**The farmer uses the following formulae:**

1. **Treatment area** = length (m) **x** width (m)

   $= 550 \text{ m} \times 600 \text{ m} = 30{,}000 \text{ m}^2$

   and $\dfrac{30{,}000 \text{ m}^2}{10{,}000 \text{ m}^2/\text{ha}} = 33$ hectares

2. **Herbicide needed** = area to treat x application rate

   = 33 ha x 1.7 kg/ha = 56.1 kg

3. **Area covered by one tank** = $\dfrac{\text{tank size (L)}}{\text{sprayer output (L/ha)}} = \dfrac{1{,}500 \text{ L}}{250 \text{ L/ha}}$

   = 6 ha

4. **Amount of pesticide to add to one tank** = area covered by one tank **x** pesticide rate = 6 ha **x** 1.7 kg/ha = 10.2 kg

5. **Number of full tanks to mix** = $\dfrac{\text{total area}}{\text{area covered by one tank}}$

   $= \dfrac{33 \text{ ha}}{6 \text{ ha}}$

   = 5.5 (round to 5 full tanks)

## Example, cont'd.

6. **Area left to cover** = total area - (total area covered by full tanks **x** number of full tanks) = 33 ha - (6 ha **x** 5 full tanks) = 33 ha - 30 ha = 3 ha

7. **Amount of herbicide to add to part tank** = area left to cover x pesticide application rate = 3 ha **x** 1.7 L/ha = 5.1 L

8. **Amount of water to add to part tank** = area left to cover **x** sprayer output
= 3 ha **x** 250 L/ha = 750 L

**The farmer will need to buy 56.1 kg of herbicide to cover 33 hectares with one application. He will need to mix five sprayer tanks with 1,500 L water and 10.2 kg of herbicide. One partial tank with 750 L water and 5.1 kg of herbicide will also be needed to cover the entire field.**

**Example - Determining all necessary granular application information**

**A 2.5-hectare field of blueberries requires a granular herbicide application using a spinner spreader with a 200-kilogram hopper. The spinner spreader was calibrated to output at a rate of 10 kg/ha.**

**1. Total amount of herbicide needed = total area x herbicide rate**
**= 2.5 ha x 10 kg/ha = 25 kg**

**2. Area covered by one full hopper =**

$$\frac{\text{hopper size (kg)}}{\text{spreader output (kg/ha)}} = \frac{200\text{ kg}}{10\text{ kg/ha}} = 20\text{ ha}$$

**The total area to cover is less than the area of one full hopper. A partial hopper must be calculated.**

**3. Amount of pesticide needed to cover treatment area of 2.5 ha**
**= area to cover X herbicide rate**
**= 2.5 ha X 10 kg/ha = 25 kg**

**This blueberry field will require 25 kg of herbicide in the hopper to treat at a rate of 10 kg/ha.**

## In Review

**Calibration involves the checking and adjusting of delivery rates of pesticide application equipment. Equipment that is properly calibrated and used will deliver the correct amount of pesticide in an even pattern.**

**There are a number of calibration procedures you should be familiar with. You will have to use an accurate calibration method to suit the type of application equipment.**

**The manufacturer, or equipment professionals who offer calibration services, can provide more detailed information on calibration, sprayer pressures, choosing nozzles, and equipment output.**

# Case Study: Upgrading a Pesticide Sprayer

Mark recently inherited the family farm from his father. He produces forages, small grains, and corn. Mark has been thinking about taking out a loan to upgrade equipment on the farm. He has identified the ten-year-old pesticide sprayer as the first piece to replace. It is important to upgrade the sprayer because pesticides are very costly and they can harm the environment when applied incorrectly. Before buying a new sprayer, however, Mark called a local equipment specialist. He wanted to get an estimate of the cost to bring his old sprayer up to standard.

When the specialist arrived, he was sure Mark’s sprayer could operate much better after some basic maintenance. He first removed all of the nozzles and screens. These were cleaned using a strong detergent. Over time, nozzles and screens will become clogged with pesticide residue. This will affect both output and spray pattern. Nozzles and screens should be removed and cleaned at least once a year. Cleaning should be done more often when pesticide formulations that do not dissolve well (e.g., wettable powders) are used.

Mark had often left excess pesticide mixture in his sprayer. Over time, chemical residue had built up in the spray lines and the tank. This residue can be slowly released into future tank mixes. Even small amounts of residue can reduce the effectiveness of the pesticide being applied. It can also damage crops or the environment. To remove this chemical residue, the equipment specialist rinsed the tank and lines with water and detergent. This was followed by a clean water rinse. All rinse water was run through the system and sprayed out where it would not harm humans or the environment.

Now that the sprayer was clean, the nozzles and screens were put back together to check the spray pattern. The sprayer was partly filled with clean water. The desired pressure was selected, and the spray patterns were visually assessed. Nozzles will wear out over time and produce poor spray patterns. This can cause non-uniform droplets to reach the target. Any nozzle having a poor pattern was replaced.

Once the poor nozzles were replaced, the sprayer system was tested at multiple pressure settings. Mark tested the sprayer between the pressure ranges that he would most often use. He did this to see if the pump was in good order. During this pressure test, Mark also checked all lines and fittings for leaks.

Next, the sprayer was calibrated to find the output from each nozzle. If a nozzle output was found to be +/- ten percent of the average total output, it was replaced. Nozzles that do not provide the right pesticide output will result in a poor application rate. This will waste money. It can also reduce pest control and harm the crop or the environment.

Proper calibration is needed to find the total output of a sprayer. This will allow the correct amounts of pesticide and water to be added for a given treatment area. After cleaning, calibration, and nozzle replacement, Mark’s sprayer delivered an even, constant output across the width of the boom.

Mark was concerned about off-target drift. He was also concerned with using the correct amount of pesticide per hectare. The specialist suggested that Mark purchase a set of “new technology” nozzles that use lower pressure and create larger droplets. These nozzles reduce pesticide drift.

The specialist also suggested the purchase of an electronic sprayer controller, designed to keep the application rate constant. As the tractor moves through the field and changes ground speeds, the electronic controller will open or close the control valve. This provides a constant product application rate.

Mark was pleased with the results of his work. With the calibration of his sprayer, and the purchase of the sprayer controller and low-drift nozzles, he now has fewer worries about the function of his “ten-year-old sprayer”. He also has a sprayer that works very well, and he didn’t have to invest a lot of money. He knows that if he takes better care of the sprayer, it will last him for a few more years.

# Self-study Questions

*Answers are located in Appendix A of this manual.*

1. You wish to apply a pesticide at a rate of 45 L/acre. The forward travel speed is 8 km/h and the nozzle spacing is 50 cm. What nozzle capacity (L/minute) do you require?
   a) 7.40 L/min
   b) 0.74 L/min
   c) 1 L/min
   d) 0.074 L/min

2. Practices that will help to reduce pesticide drift include:

   a) avoiding early morning and early evening application
   b) using buffer zones
   c) spraying just before rain
   d) using individualized nozzle hoods
   e) b and d only

3. During a calibration test, you used a tractor with a 15-metre boom, and travelled 100 meters. How many hectares were covered in this test? How many acres were covered? (Use the following conversions)

   1 hectare = 10,000 square metres
   1 hectare = 2.47 acres

   a) 2.47 acres / 1.5 hectares
   b) 0.37 acres / 0.15 hectares
   c) 3.70 acres / 1.5 hectares
   d) 100 acres / 2.47 hectares

4. Which of the following droplet sizes will stay suspended in air for the longest period of time?

   a) 1 micron
   b) 10 microns
   c) 100 microns
   d) 1000 microns

5. Vapour drift can negatively affect off-target plants and animals. Which of the following practices will help to minimize vapour drift?

   a) apply a less volatile pesticide
   b) apply with a wiper or wick-weeder
   c) apply a pesticide with an adjuvant added
   d) apply a pesticide during weather conditions that limit evaporation (overcast, low humidity)
   e) a and d only

Chapter

9

# EMERGENCY RESPONSE

Hundreds of pesticide poisonings occur in Canada each year. These often involve children exposed to pesticides in the home. Other poisonings involve workers, bystanders, and those who enter treated areas too soon after pesticides have been applied.

There is risk of exposure any time a person comes into contact with a pesticide. This can occur during transport, mixing, application, or storage.

Anyone who handles or may be exposed to pesticides must be prepared to respond to accidental poisonings, burns, spills, or fires.

## Learning Objectives

**Completing this chapter will help you to:**

- **Prepare and use an emergency response plan.**
- **Assess the hazards of pesticide fires and apply emergency measures.**
- **Assess the hazards of pesticide spills and apply emergency measures.**
- **Secure pesticides and prevent theft.**
- **Assess pesticide emergencies and apply first aid.**

# Emergency Response Plans

An emergency response plan reduces the impact of a pesticide emergency on human health, safety, and the environment. Farms should have a response plan for each type of emergency.

**An emergency response plan can help to reduce the impact of an incident.**

Preparing an emergency response plan takes time and effort. A good plan should list the steps needed to deal with a range of pesticide emergencies. These include:

- Fire
- Serious injury
- Natural disasters (e.g., lightning, tornado, flooding) that can threaten storage structures
- Spills or incidents during transport
- Vapour and/or odour release

## Components of the Emergency Response Plan

An emergency response plan should include the following:


- Telephone list
- List of emergency assistance resources
- Site map
- Accurate pesticide inventory
- Step-by-step outline of emergency procedures
- Record of emergency equipment
- Emergency supplies list

## Telephone List

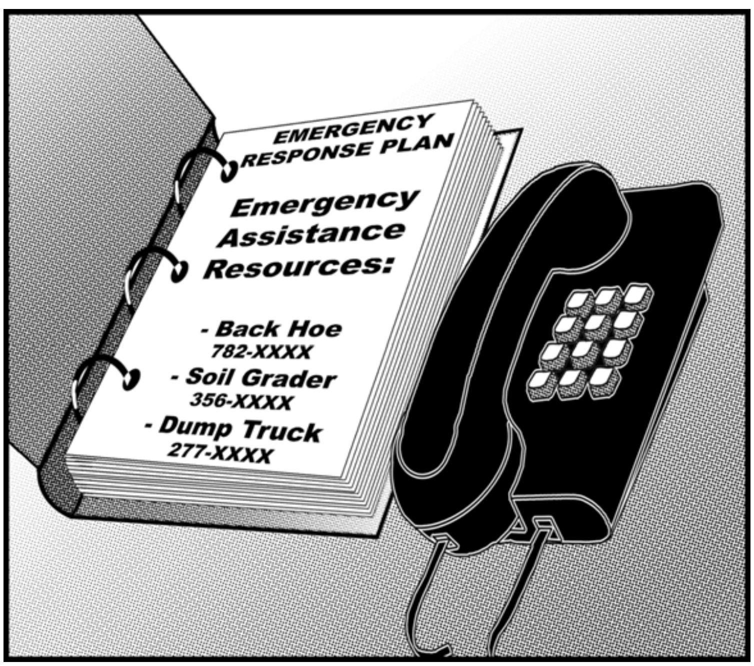
Create a list of names and telephone numbers for:

- All farm contacts (owner, manager, key staff, other sites)
- All provincial authorities who must be called in case of an emergency
- The provincial 24-hour environmental emergency authority
- The local fire department
- The nearest police department
- Neighbours
- The insurance agency

The list should include a place to make notes. In the case of an emergency, record the time each person or agency was called, by whom, and the action taken or recommended.

## List of Emergency Assistance Resources

Make a list of emergency resources that are present in the community.



Include contact and location information for nearby farms or businesses. These can provide materials, staff, skills, or equipment to address an emergency need (e.g., a backhoe to contain a spill). Include a 24-hour contact name for each resource. Make note of equipment that is available 24 hours a day.

## Site Map

Prepare a map of each pesticide storage structure and the area around it. Note features that will make response difficult. These features can include nearby buildings, wells, sewers, waterways and drains, fences, power supplies, and access routes.

## Accurate Pesticide Inventory

Keep an up-to-date list of pesticides stored on site. Include a list of:

- Common or trade product names
- *PCP Act* registration numbers
- Volume of each product stored
- Location of each product within the storage site

Product labels and MSDS should be kept with the plan. Make note of products that pose major health risks.

Keep the inventory list within reach in case of an emergency.

## Step-by-step Outline of Emergency Procedures

Emergency measures should be listed in the exact order in which they are to be performed during an emergency. A good outline will identify who should perform each action.

This outline should be clear and easy to read. It should be reviewed on a regular basis with farm family members and all staff.

### Record of Emergency Equipment

Make note of all emergency equipment on hand (e.g., fire extinguishers, protective clothing and equipment, containment equipment). This record can also serve as a checklist to review the location and condition of this equipment.

### Emergency Supplies List

Create a list of emergency supplies (e.g., spill cleanup kit, first aid kit). Make sure that there are enough listed supplies on hand.

**An emergency response plan will only work if equipment and supplies are on hand and staff is ready to respond.**

Once you have a complete emergency response plan on hand, make sure that you have a safe place to keep it. It should be easy to find. Copies should be stored in different places.

Update and review the plan at least once a year. Keep workers informed of any changes.

## Key Information for Emergency Response Personnel

In a pesticide emergency, complete information is needed on the products involved. Ambulance attendants, firefighters, and poison control or medical staff may need to use this. You should be able to quickly provide:

### Pesticide Information

- The common or trade name, and PCP number of any pesticide involved
- An estimate of the amount of each pesticide involved

- Information on products that can pose a hazard or risk, or require special treatment (e.g., corrosive or explosive products)

## Other Information

- The location and distance to any environmentally sensitive area
- The names, locations, and condition of people involved in the accident
- The names, locations, and condition of people near the emergency

### In Review

**All farms need a good emergency response plan. The plan should help farm workers and pesticide applicators deal with pesticide accidents.**

**A good emergency response plan gives step-by-step measures to deal with any pesticide emergency. It states who should perform each task. A good plan will include information on equipment, contacts, materials, and skills. The layout of each storage structure, and access routes, will also be provided.**

**It is important to have this information on hand to give the right directions to everyone during an emergency.**

# Emergencies Involving Pesticides

You can plan for some pesticide emergencies. These include:

- Fire
- Spills
- Theft

Steps can also be taken to prevent some emergencies. If an emergency does occur, risk and damage can be reduced by:

- Knowing what to do
- Having the right information on hand
- Contacting the proper authorities

## Pesticide Fire Emergencies

Fires involving pesticides can pose extreme danger. The burning pesticide can be a greater threat than the actual fire.

Many pesticides are flammable. A few are explosive. Some pesticides produce highly toxic fumes when burned. If a fire involves a number of pesticides, it is hard to determine the combined toxicity and hazard.

Fumes from a pesticide fire can poison people (e.g., firefighters), animals, or plants. Runoff water from fighting the fire can contain pesticide residue. This can contaminate soil, septic systems, wells, and other water sources.

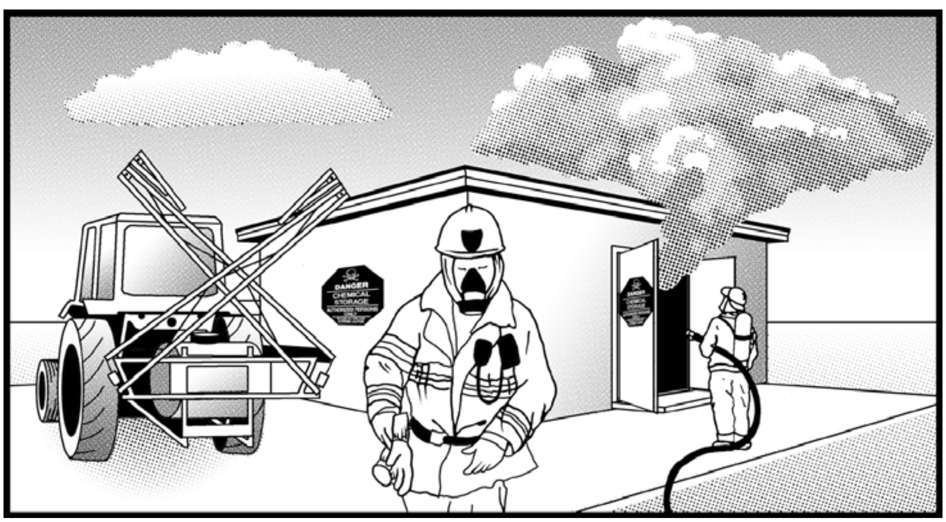



**Figure 9-1: Proper safety precautions must be taken when dealing with a fire that involves pesticides.**

## Preventing Fires

It is better to prevent a fire than have to fight one. Fire involving pesticides can be avoided by using these guidelines:

- Do not use open flame (e.g., welding, burning, cutting) in a pesticide storage facility.
- Follow required codes when storing pesticides (e.g., National Fire Code, National Building Code, and National Electrical Code).
- Secure doors and windows to the storage facility. This prevents unauthorized access.
- Do not smoke in or around a pesticide storage facility.

## Preparing for Fire Emergencies

You should be prepared to control fires that might occur. An emergency response plan should include the following fire control guidelines:

- Keep a list of all stored pesticides. Attach the Material Safety Data Sheet. Keep these within easy reach, away from the storage facility.
- Provide the fire department with the exact location of all stored pesticides.
- Post “danger” or “warning” signs at all points of access to pesticide storage facilities.
- Keep emergency telephone numbers on hand.
- Keep a fire extinguisher near the storage area. Make sure that it is approved for chemical fires.
- Have a step-by-step plan to respond to fires. This should tell who is to perform each task.

## Responding to Fire

You will also have to know what to do in case of a fire with pesticides. The emergency response plan should be put to work as soon as the incident occurs:

- Dial 911 at once to call the fire department.
- Confirm that all farm workers and family members are safe.
- Keep people and animals away from the fire. Keep them upwind. This protects them from toxic fumes, runoff, and explosions.
- Make sure that firefighters know there are pesticides on site.
- Give firefighters a list of all pesticides in the facility.
- Warn firefighters of the risk of pesticide contamination in runoff from water used to fight the fire. Control runoff water.
- Remind firefighters that foam or fog nozzles are best for fighting pesticide fires.
- Make dams or dikes to contain runoff water and foam. This prevents it from getting into waterways, wells, and other environmentally sensitive areas.

**Report any environmental emergency, including fires involving pesticides, to the**
**24-hour Environmental Emergencies**
**toll-free number**
**1-800-565-1633**

### In Review

**Pesticide fires pose a grave danger. They can produce toxic fumes or explode. While a fire is never planned, farm workers can take steps to avoid fires.**

**A good emergency response plan helps farm workers and emergency authorities deal with pesticide fires.**

# Pesticide Spill Emergencies

Pesticide spills can occur when product is being transported, stored, or handled. Spilled pesticides can contaminate soil, water, vehicles, or food and feed surfaces (e.g., wood or concrete). Take care to reduce the risk of spill hazards.

**The *NS Environment Act* and Regulations address spills of any kind of pollutant. If a spill occurs, you must notify your local office of the Nova Scotia Department of Environment and Labour and call the 24-hour Environmental Emergencies toll-free number at 1-800-565-1633.**

**Figure 9-2: Regularly check pesticide containers for leaks. Spilled pesticide poses a risk to people, animals, and the environment.**

## Preventing Spills

Spills and other emergencies with pesticides cost time and money. Farm workers or applicators can reduce the risk of spills by using the following guidelines:

- Regularly check pesticide containers for leaks, holes, and other signs of stress.
- Store pesticides in a proper storage facility. Keep containers off the ground. Do not stack containers.
- Keep stored containers away from sunlight. This prevents the breakdown of pesticide packaging.
- Take care when mixing, handling, or moving pesticide containers or loaded application equipment.
- Make sure that workers are trained to handle pesticides properly.
- Be careful. Do not rush when handling or mixing pesticides. Taking a little extra time when working with pesticides can save wasted cleanup time and the cost of lost product.

**It costs less to be careful when working with pesticides than it does to clean up spilled product.**

## Preparing for Spill Emergencies

Include the following steps in any emergency response plan for pesticide spills. These are added to the general steps in an emergency response plan.

- Keep personal protective equipment (PPE) maintained and on hand.
- Keep spill containment materials on hand. Include:
  - An adequate amount of absorbent material (e.g., vermiculite or pet litter)
  - A container for contaminated waste
  - Tools to pick up contaminated material

**Report any environmental emergency, including spills involving pesticides, to the**
**24-hour Environmental Emergencies**
**toll-free number at**
**1-800-565-1633**

## Responding to a Spill

Preventing spills will reduce the risk to people, animals, and the environment. However, spills will still happen. When they do, you must respond quickly and properly.

If a spill occurs, put your emergency response plan into action. Begin the following:

- Protect yourself and others from exposure to spilled pesticide. Put on proper PPE.
- Air out the area. Keep people and animals away from the spill area.
- Follow personal safety practices (e.g., do not smoke, eat, or drink during cleanup).
- Check the label and MSDS for instructions to contain the spill. The label may not give information to deal with a specific emergency. Look for the manufacturer's emergency phone number. Call for more information.
- Cover liquid spills with absorbent material (e.g., sand, vermiculite, or pet litter). This will help prevent the spill from getting into water. If cleanup guidelines are not given on the label, sweep or shovel absorbent material into a proper container. The container should be lined with a heavy-duty plastic bag.
- Clean up the spill quickly, but with care. Follow product disposal guidelines. These are given on the product label or MSDS, which should be included in the emergency response plan.

**If a spill greater than 5 kilograms or 5 litres of pesticide in concentrated form, or 70 litres of diluted pesticide occurs you must contact the 24-hour Environmental Emergencies Toll –free number at 1-800-565-1633.**

**Any amount of spilled pesticide can pose a hazard. However, large spills are more likely to contaminate people, livestock, buildings, or the environment.**

## Decontaminating the Spill Area

The applicator will have to decontaminate the spill area. This should be done after the spill has been contained and cleaned up. Pesticide residue left after cleanup can remain active. This can further contaminate soil, water, or hard surfaces. Hard surfaces include concrete floors, asphalt, concrete driveways or pads, or wooden surfaces.

To decontaminate soil:

- Contact the manufacturer or your local office of the Nova Scotia Department of Environment and Labour for information on decontaminating soil from pesticides.
- Refer to product MSDS and labels. These give information on minor pesticide spills during mixing, loading, transporting, or application.

To decontaminate hard surfaces:

- Use a small amount of wash water. Use only enough to extract the pesticide. Do not dilute it.
- Contain the wash water to the contaminated area.
- Only use bleach when called for on the label.
- Work the cleaning water and agent into the spill area with a coarse brush or broom.
- Absorb excess liquid with more absorbent material (e.g., pet litter or vermiculite). Sweep the used absorbent material into a waste container.
- Seal the waste container. Put a warning label on it. Store it until you are able to properly dispose of it.
- If you are unsure of how to dispose of the material, contact your local office of the Nova Scotia Department of Environment and Labour .

After decontamination, clean all equipment (e.g., shovels and brooms) and personal protective equipment. Make sure that everyone involved with the cleanup washes thoroughly.

### In Review

**Spilled pesticides pose a risk to human health and the environment. Spills can occur during any work that involves pesticides. Farm workers and applicators can act to avoid spills.**

**Use proper methods when mixing, loading, and moving pesticides. Work with care. If a spill occurs, an emergency response plan will give farm workers and authorities information needed to contain the spill.**

**Decontamination of the spill area protects people and the environment from further exposure. This should be done once a spill is contained and the area has been cleaned.**

## Pesticide Theft

Pesticide theft is not common. In the case of a robbery, however, the owner of the stolen product can be held liable for any related accident involving the pesticide.

Keep pesticides secured in a locked facility. Other steps to prevent pesticide theft include:

- Using a security system
- Ensuring proper outdoor lighting at the storage facility
- Limiting access to the pesticide storage facility at all times
- Remaining in the vehicle at all times when transporting pesticides (When possible, always lock the vehicle to limit access to the pesticides.)

If a theft of pesticide occurs, contact the proper authorities at once. These include the police, provincial pesticide regulatory agency, insurance company, and your pesticide supplier.

Stolen pesticides can be tracked using the supplier's batch or lot number. Include this information in your emergency response plan. This can be quickly retrieved in the event of a theft.

In Review

**Pesticide theft can lead to spills, release of toxic fumes, or fires. The owner of a stolen pesticide can be liable for any damage caused by the product. Maintain a safe and secure pesticide storage facility to prevent theft.**

# First Aid Procedures for Pesticide Exposure

Those who work with pesticides should be prepared to deal with chemical-related emergencies. Applicators should be trained to administer first aid to anyone exposed to a pesticide.

**First aid provides immediate assistance to help stabilize a person's condition and sustain life. First aid should be performed until medical help arrives or can be reached.**

**Pesticide applicators should take a certified first aid course. Courses are offered by a number of sources. These include the Canadian Red Cross or St. John Ambulance.**

## General First Aid Information

First aid training is good for a number of reasons. It allows you to help those exposed to pesticides. It also allows you to deal with many other accident situations.

First aid knowledge and skills can mean the difference between life and death. It can also mean the difference between short- or long-term disabilities.

First aid training provides guidelines to:

- Assess an emergency
- Act during an emergency situation
- Help the victim
- Monitor vital signs and provide accurate reports to medical personnel

First aid training gives you confidence. It also promotes safety awareness through learning what causes accidents and ways to prevent them.

## Legal Implications of First Aid

The law expects people to act in the best interests of the victim when giving first aid.

There is no legal obligation to assist in an emergency. In some cases (e.g., motor vehicle accidents), anyone involved must stop and assist others. They must also report the accident to the proper authorities.

The law requires that emergency help to a victim continue once it is started. Help must be provided until another qualified person (preferably with medical training) is able to take over. You may stop if you become too tired to carry on, or if personal risk is involved.

Before applying first aid:

- Identify yourself to the victim as a person trained in first aid.
- Ask the victim if he/she wants help. <u>Only</u> act if help is wanted.
- Extend needed emergency care to an unconscious victim.

You may legally provide emergency aid if a young child needs emergency assistance, and parental consent is not available.

**When giving first aid, provide the help that you would hope to receive in the same situation.**

# First Aid Kit

An emergency supply inventory should include well-stocked and maintained first aid kits (see Table 9-1. One kit should be kept in the pesticide storage facility. Another kit should be kept close to where pesticides are handled (e.g., mixed, loaded, transported).

An ideal location would be in a lunchroom or office. A first aid kit should be carried in the application equipment (e.g., tractor, sprayer vehicle). This will allow access to the supplies in the event of an accident in the field.

| | |
|---|---|
| Clean water (minimum 20 L) | To drink, wash skin, or rinse eyes |
| Detergent soap (e.g., dishwashing detergent) | To wash pesticide off skin |
| Spoon / tongue depressor | To induce vomiting if told to do so |
| Safety gloves | To protect the person giving first aid |
| Cup | To mix or drink slurry of activated charcoal |
| Plastic bag | To collect vomit |
| Nail brush / file | To clean up |
| Disposable overalls | To replace the victim's clothing |
| Telephone numbers | To call for help |
| Paper towel | To clean up |
| Blanket | To warm the victim |
| Waterproof bandages | To prevent pesticides from getting into wounds |
| Shaped plastic airway or face mask | To protect during mouth-to-mouth resuscitation |
| Syrup of ipecac | To induce vomiting |
| Activated charcoal | To absorb pesticide in the stomach |

**Table 9-1: A kit designed to deal with pesticide emergencies should contain these materials.**

# Pesticide Poisoning Response

People who work with pesticides should know the symptoms of pesticide poisoning. They should also know proper first aid techniques. Poisoning symptoms can be mild, moderate, or severe.

| | |
|---|---|
| **Mild Poisoning Symptoms** | **Headache; fatigue; loss of appetite; dizziness; weakness; nervousness; nausea; perspiration; diarrhea; loss of weight; thirst; moodiness; or irritation of the skin, eyes, nose, or throat** |
| **Moderate Poisoning Symptoms** | **Nausea, trembling, loss of muscle coordination, excessive saliva, blurred vision, tightened throat or chest, laboured breathing, flushed or yellow skin, stomach cramps, vomiting, diarrhea, mental confusion, sweating, rapid pulse, cough** |
| **Severe Poisoning Symptoms** | **Vomiting, loss of reflexes, trouble breathing, increased breathing rate, muscle twitching, tiny pupils, convulsions, unconsciousness, thirst, fever** |

When responding to a pesticide poisoning:

- Do not become a victim. Protect yourself from injury before giving treatment. Put on protective clothing and equipment before you go into a contaminated area or handle a contaminated victim.
- Check the victim’s breathing. Check heart rhythm and pulse.
- Move the victim away from the contaminated area. This stops pesticide exposure. Remove contaminated clothing. Use soap and water to wash any skin exposed to the pesticide.
- Call an ambulance and/or the Poison Control Centre. If there are bystanders, tell them to get help. Have them make calls while you perform first aid. If you are alone, shout for help and begin first aid.

If someone feels ill during or after handling or using a pesticide, seek medical help at once. If the victim is not breathing:

- Straighten the victim's airway. This can restart breathing.
- If not, tilt his/her head back with the chin forward to clear the airways. Give mouth-to-mouth resuscitation.
- Do this until the victim begins to breathe without help.
- Protect yourself from contamination. Use a face-shield airway with a one-way valve. The victim may have pesticide residue or vomit with chemicals in or on his/her mouth.
- If you are trained to do so, perform CPR if the victim's pulse cannot be found.

If the victim is breathing, but is not conscious:

- Place the victim in the recovery position. Lay him/her to one side. Turn his/her head slightly to one side.
- Make sure his/her airway is kept clear if the victim vomits.
- Start first aid treatment for the route of entry. See ***First Aid and Routes of Exposure*** below.
- Obtain the following information if possible. Supply it to emergency and medical responders:
    - The pesticide involved - Try to locate the label, container, or any leftover pesticide.
    - The amount of pesticide - How much product was the victim exposed to?
    - Route of entry - How did the pesticide enter the body? Did it enter through the mouth, skin, eyes, or lungs?

- The time period - How much time has passed since the victim was exposed to the pesticide? How long was the victim exposed? Were symptoms immediate or did poisoning occur over time?

- Make sure the victim gets medical aid. First aid should never be used in place of professional medical help.

# First Aid and Routes of Exposure

First aid will depend on the pesticide's route of entry. Pesticide can be taken into the body:

- Through the eyes (ocular exposure)
- By breathing it into the lungs (inhalation)
- By swallowing it (ingestion)
- Through the skin (dermal exposure)

## Ocular Exposure

When a pesticide contacts the eyes:

- Hold the victim's eyelid open. Wash or flush the eye with clean running water for 15 minutes or more.

- Get medical help.

## Inhalation

When a pesticide is inhaled, you should first protect yourself from exposure. Put on personal protective equipment. Once you are properly equipped:

- Move the victim to fresh air.

- Loosen the victim's tight clothing.

- Check for breathing. If the victim is not breathing, call for help or have someone call an ambulance. Begin artificial respiration.
- Place a blanket under the victim's shoulders. Tilt the head back with the chin forward. This clears the airways.
- Keep the victim warm (e.g., cover with a blanket or jacket).
- Try to keep the victim quiet.
- Get medical help.

## Ingestion

If a pesticide has entered the victim's mouth, but was spit out and not swallowed:

- Get medical help at once. Call the Poison Control Centre and an ambulance.
- Read the pesticide label for first aid instructions.
- Rinse the mouth with a large amount of water if the victim is conscious and not convulsing. Wipe the mouth with a damp cloth. Brush his/her teeth well.

If a pesticide was swallowed:

- Call the Poison Control Centre at once.
- Check the pesticide label for first aid information.

**Caution: Even if the first aid section of a pesticide label tells you to induce vomiting, confirm this with the Poison Control Centre before doing so.**

There are times when you should **not** induce vomiting for a pesticide poisoning:

- Do not induce vomiting if the victim is not conscious, is in a coma, or is convulsing.
- Do not induce vomiting if the victim has swallowed a pesticide with petroleum products (e.g., emulsifiable concentrates). This can be inhaled into the lungs during vomiting (aspirated). It can cause breathing distress and even death.
- Do not induce vomiting if the victim has swallowed a corrosive poison (e.g., strong acid or base/alkaline product). Strong acids and bases (or alkalines) will burn the throat and mouth during vomiting. They will also damage the lungs if the victim aspirates during vomiting.
- Do not induce vomiting if the victim has swallowed pesticide in one of the following classifications:

| *Classification* | *Trade and common names* |
| --- | --- |
| Chlorinated hydrocarbons (organochlorine insecticides) | e.g., Lindane, endosulfan (THIODAN) |
| Organophosphorus insecticides | e.g., diazinon, azinphos-methyl (GUTHION) |
| Carbamates | e.g., carbaryl (SEVIN); bendiocarb (TRUMPET) |
| Concentrated dinitrophenols | e.g., dinoseb |

**Table 9-2: Family classification of commonly used agricultural pesticides.**

Vomiting can sometimes reduce injury from pesticide poisoning.

If it is safe to induce vomiting:

- Give syrup of ipecac. Only do this as directed by the Poison Control Centre.
- Give 15 millilitres (one tablespoon) to children. Give 30 millilitres (two tablespoons) to adults.
- Never give syrup of ipecac to children under 12 months of age.
- Follow syrup dose with one or two glasses of water or fruit juice.
- Repeat within 15 minutes if the victim does not vomit.

**<u>Do not</u> give syrup of ipecac if you cannot speak to someone at a Poison Control Centre. If the victim is conscious and not convulsing, have him/her drink several glasses of warm water. If this does not induce vomiting, have the victim tickle the back of his/her throat with a finger.**

**These methods do not work as well as syrup of ipecac. They can also be dangerous.**

Keep the victim lying down with the head lower than the feet. This allows any vomit to drain away from airways.

If you are not sure what poison was ingested, collect some vomit for the doctor.

If the victim is having a seizure or convulsion, pillow their head to protect it. Do not try to restrain him/her.

## Dermal Exposure

If a pesticide contacts the victim's skin, protect yourself from exposure with personal protective equipment before helping. Once you are protected from the pesticide:

- Remove the victim's contaminated clothing. This includes footwear.

- Drench the victim's skin with water at once. Cold water is best. Hot water opens pores and speeds absorption of the pesticide.
- Wash the victim's skin and hair with soap and water. Clean under the fingernails and toenails.
- Get medical help.

For chemical burns:

- Stop the burning. Remove the chemical by wiping or rinsing the contaminated area with clean water.
- Remove the victim's contaminated clothing. Do not remove clothing that is stuck to skin.
- Wash the area with lots of running water.
- Cover the burned area with loose, clean cloth. Do not apply anything else to the burn.
- Get medical help at once.

**Seek medical help before the victim returns home or to work. Do this even if full recovery appears to have taken place after first aid is provided**.

## Label Information on First Aid

First aid information can be found on the pesticide label. Read the first aid section before handling any pesticide. If someone is working with you, review the information with him or her. Do this before you begin to apply the product.

The details and location of first aid information can change for each pesticide used. Read each label with care.

Maintain a binder with copies of all current and stored pesticide labels and MSDS. This should be part of an emergency response plan. Keep the binder near, but not inside, the pesticide storage structure. This makes it easy to find and use in an emergency. Have a first aid reference handy. This will provide more information in case of an emergency.

The sticker below and/or or an emergency telephone list should be attached to or beside all telephones near sites where pesticides are used.

EMERGENCY PHONE NUMBERS

Doctor ________________________________

**Fire** ________________________________

**Police** ________________________________

Ambulance ________________________________

**Poison Control Centre** ________________________

**Environmental Emergencies** ___________________

## In Review

**In the event of an emergency, first aid may prevent further injury. It eases victim pain and discomfort until medical help can be given. It can even save the lives of injured persons.**

**Pesticide applicators and farm workers should be trained in general first aid. They should know how to respond to pesticide exposure.**

## Summary

**When responding to a victim of pesticide exposure, protect yourself at all times. Use personal protective equipment.**

**First aid kits should be on hand. These should contain pesticide-specific materials. These include remedies and equipment to use on injuries from toxic fumes, poisoning, chemical burns, and skin contact.**

**Report a pesticide emergency to the proper authorities as soon as possible**.

# Case Study: Emergency Response

Rick operates a small mixed farm. He has been farming for a number of years and is doing well. However, Rick plans to make some changes to his operation this year to see if he can improve his profits. Several times a month he has been in contact with financial and crop specialists.

When Rick was driving back from town one day, he noticed smoke coming from the vents in his pesticide storage building. He headed for the building at once.

When he arrived, Randy, a farm worker, told Rick that he had dropped his cigarette on the floor of the storage building. The cigarette then ignited some cardboard from a pesticide container box. Randy had quickly searched a nearby workshop for a fire extinguisher, but could not find one. Rick told Randy to go to the house and call 911 to alert the fire department.

Rick ran to get the small extinguisher that he carried in the back of his truck. He entered the storage building and saw a pile of burning pesticide containers. Rick pointed the extinguisher at the flames and emptied it within a few seconds. This had little effect on the fire. A cloud of smoke and fumes from the burning pesticides quickly engulfed him. Rick choked and gasped for breath as he staggered to the entrance. He passed out before he got to the door.

A few minutes later, Randy arrived back at the site. The building was now engulfed with flames and smoke was pouring out the door. Randy found Rick lying unconscious just inside the door of the burning building.

Randy was upset when he saw his boss unconscious. However, he stayed calm and thought back to his recent pesticide training.

Randy first moved Rick upwind and away from the burning building. He then checked to make sure that Rick was breathing and looked for any external injuries. He did not find any wounds or bleeding. Randy covered Rick with his jacket to keep him warm. Rick's brother soon arrived and drove him to the local hospital. Randy stayed at the storage building to instruct the firefighters who were now arriving.

The firefighters needed information before they could do their job. Randy provided a copy of the current inventory sheet for pesticides stored in the building. Rick kept this list nearby in his home office. He had shown Randy earlier where to find it during an emergency.

When the fire chief arrived, Randy explained the hazards of the stored chemicals. He reminded the firefighters to use as little water as possible to avoid leaching or runoff. A small trout stream flowed nearby. Runoff from water used to fight the fire could be deadly to fish and other aquatic life.

To get further direction, the fire chief spoke with provincial Environmental Emergency staff. He then told Randy to take the loader tractor and create a berm to trap runoff water.

The tractor had an enclosed cab, but it was not airtight. To protect himself, Randy put on proper safety gear. This included a respirator.

The firefighters soon had the blaze under control. The process of site cleanup began under the guidance of Environmental Emergency officials.

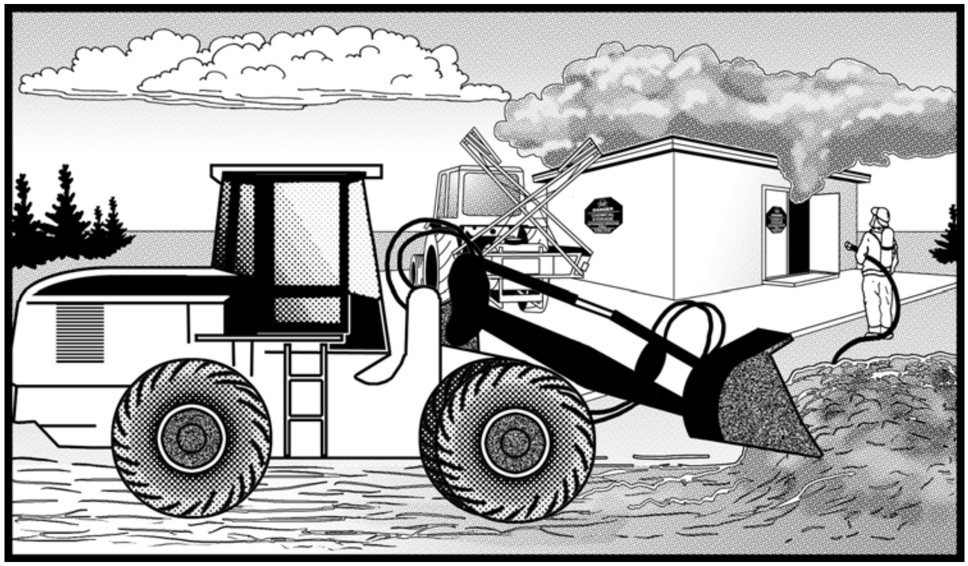
Rick was released from the hospital the next day. As he thought about the accident, he identified a number of things that led to the fire and his own poisoning. To plan for the future, Rick knew he would have to put some new rules in place to help keep everyone safe.

These rules would include:

1. *No smoking in the pesticide storage building.*
2. *The pesticide storage building will be kept clean. Highly flammable materials, like the empty pesticide bags and cardboard boxes, will not be left lying around.*
3. *A fire extinguisher approved for use with chemical fires will be kept just inside the pesticide storage building.*

Some measures that Rick and Randy took before and during the fire did help greatly. These included the following:

- Rick kept an up-to-date copy of his pesticide inventory nearby. Randy knew where to find it.
- Randy gave the inventory list to the firefighters. This provided emergency personnel with important information.



- Randy had knowledge of first aid that he gained from his pesticide applicator certification course. This helped him to quickly assess the situation and to rescue Rick.

- Randy informed the fire department of the nearby watercourse. He was able to construct a containment berm. This helped reduce runoff from the fire and aided the cleanup.

Over the following weeks, a new pesticide storage building was planned and built. Rick positioned the building well away from the stream. A chemical fire extinguisher was placed just inside the door of the facility. Randy and the other farm workers were trained in the safe handling of pesticides. A number of large "No Smoking" signs were also posted. Rick remained vigilant in keeping the storage clean, tidy, and locked when it was not in use.

His grandfather once told him that lightening rarely strikes the same spot twice. But Rick is not taking any chances.

# Self-study Questions

*Answers are located in Appendix A of this manual.*

1. If someone experiences symptoms of pesticide poisoning, you should:

   a) have them wash with lots of clean water
   b) have them drink a lot of water
   c) send the person home to recover
   d) consult with a doctor or a Poison Control Centre
   e) have the person "sleep it off" under supervision

2. Which of the following things should you do if a <u>liquid</u> pesticide formulation has been spilled?

   a) use a small amount of water to rinse and dilute the spilled product
   b) use an absorbent material in the area of the spill
   c) do not smoke, drink, or eat during the cleanup
   d) use bleach and hydrated lime to decontaminate the spill area, but only if suggested on the product label
   e) all of the above

3. When responding to a co-worker pesticide poisoning, the first thing you should do is:

   a) protect yourself so you are not poisoned as well
   b) remove the person from contamination
   c) check to see if the person is conscious
   d) call a doctor or Poison Control Centre
   e) keep the person quiet, warm, comfortable, and reassured

4. Match the following items of a first aid kit with its function.

| | | |
|---|---|---|
| a) syrup of ipecac | ___ | to induce vomiting |
| b) blanket | ___ | to keep the victim warm |
| c) safety gloves | ___ | to protect the first aid giver |
| d) activated charcoal | ___ | to prevent absorption of swallowed pesticide into the stomach |
| e) shaped plastic airway or face mask | ___ | to perform safe mouth-to-mouth resuscitation if necessary |

5. A co-worker accidentally spilled a liquid pesticide product on his hands, and is experiencing a chemical burn. Which of the following first aid procedures should be used to help the co-worker?

   a) stop the burning by wiping or rinsing the chemical off the skin using cool water
   b) remove the victim's contaminated clothing if it is stuck to the affected area of skin and cover the burned area with ointment
   c) cover the burned area with a loose, clean cloth
   d) seek medical attention
   e) a, c, and d only

Chapter

10

# PROFESSIONALISM

Relationships among pesticide applicators and the public are important. Pesticide applicators can build credibility and increase public trust by working in a professional way.  A professional pesticide applicator knows how to deal with a diverse public.

Pesticide applicators have to work to keep good relationships with clients, neighbours, and the public. These people have an interest in how pesticides are used in their neighbourhood. They have valid concerns about the environment and quality of life issues.

To be a professional, you have to work with skill and integrity. You should also be able to clearly explain your job to the public. It is also important that you keep up to date with changes in your area of work. Pesticide applicators should pay close attention to what is required of them by their jobs.

## Learning Objectives

**Completing this chapter will help you to:**

- **Identify and apply professional behaviour and attitudes.**
- **Identify and interpret the legal requirements of pesticide application.**
- **Use public relations and industry connections to improve professionalism.**

# What is Professionalism?

Three key factors show professionalism:

- Knowledge of your job
- Attitude and work habits (how you conduct yourself on the job)
- Communication with clients, staff, and the public about your work

## Knowledge

Knowledge involves knowing how to properly do all the work of a pesticide applicator. It also includes knowledge of safe application practices.

Your pesticide knowledge should cover:

- What training and provincial licensing is required for pesticide applicators
- Choosing, using, and taking care of pesticide application and personal protective equipment
- Health, public, and environmental concerns regarding pesticide use
- Proper response to pesticide-related emergencies
- Local and other resources that offer information on pesticide use (e.g., people, publications, and organizations)
- The latest information on pest control options (This includes integrated pest management.)
- Links between the pest, the host, and the environment
- Benefits and risks of pests and pest control methods
- Federal, provincial, and municipal laws that govern pesticide use

This knowledge will help you to safely handle and apply pesticides. It will also help you to make good pest control decisions.

If you have the right knowledge, you can better inform others about your work.

## Staying Up to Date

It is important to keep your pesticide knowledge current. Pesticides and their use change over time. Research adds to our knowledge of good pest control. Professional pesticide applicators should upgrade their knowledge of:

- Pesticide products
- Application equipment and techniques
- Pesticide laws
- Public concerns

Knowledge can be increased by:

- Attending seminars
- Talking to representatives at trade shows
- Taking courses
- Reading journals, papers, and other relevant publications

## Attitude

A professional attitude will help you plan and work in a safe and effective way. It will also ensure that your pest control plan provides good options. A professional attitude will help you to:

- Protect yourself and the environment when working with pesticides.

- Reduce the use of pesticides by practising integrated pest management.

- Respect public concerns regarding pesticide use.

- Respond quickly and properly to pesticide spills, emergencies, and requests (e.g., information, complaints, concerns).

- Promote good practice throughout the profession. This includes learning and extension activities.

## Work Habits

There are many good work habits that support professionalism. These include the following:

- Apply pesticides according to the label and in a proper manner. Always:
    - Inform those people who could be affected by an upcoming pesticide application.
    - Avoid pesticide applications near bystanders.
    - Use integrated pest management.
    - Apply pesticides only when the weather allows.
    - Keep pesticide application records.
    - Use safe application practices.
    - Keep application equipment clean and in good working order.

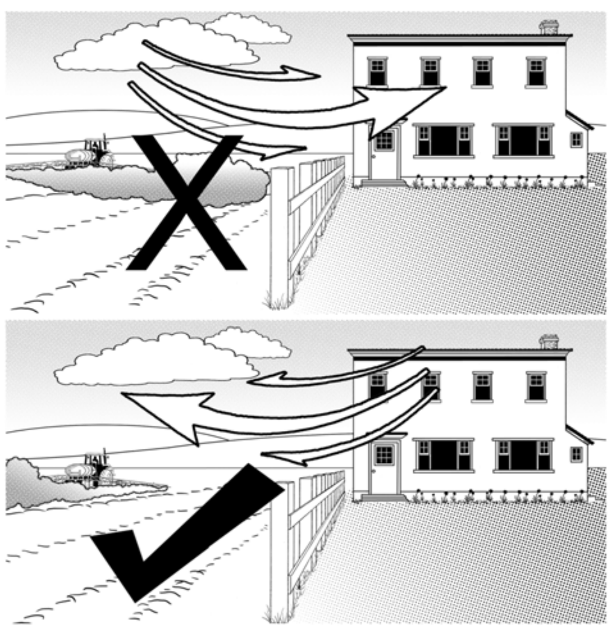


**Figure 10-1: A professional applicator will not apply pesticide when the wind speed or direction is likely to cause off-target drift of the product.**

- Be familiar with application equipment before using it.
- Prepare equipment before the application. Use only clean, well-maintained application equipment.
- Apply pesticide at the correct site.
- Use application equipment and vehicles in a safe and proper manner. Terrain, weather, road conditions, and speed limits must be taken into account.
- Stick to your plans (e.g., pest management, emergency response, and/or communication).
- Prevent the spread of pests by application equipment or people. Clean equipment before changing sites.
- Communicate well with other employees to ensure safe and proper pesticide application.

## Communication

Public concern about pesticide use is steadily increasing. This is most noticeable in farming because it involves food production. Pesticide use can also affect homes, water, and public facilities. The work of pesticide applicators can put them in conflict with the public.

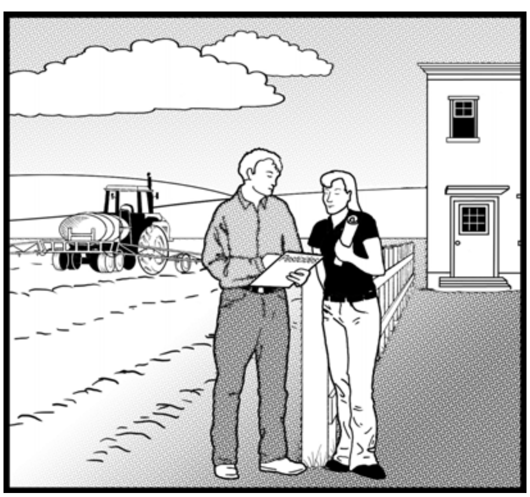


**Figure 10-2: Good communication can help pesticide applicators to build better relationships with their neighbours and the public.**

Good communication can prevent misunderstandings. It can also enhance public support for modern farming. Professional pesticide applicators must educate members of the public on pest control issues and the needs of modern farming.

There are a number of communication guidelines that can strengthen your relationships with neighbours and the public:

- Be honest, polite, and cooperative.
- Behave as a professional supporter of your industry.
- Provide timely and correct information.
- Respect public health and environmental concerns.
- Be quick to share information. For example, inform neighbours of planned pesticide applications that may impact them.
- Take part in industry-led communication efforts (e.g., mail-outs, forums, presentations).

## In Review

**Public health and environmental concerns about pesticide use are increasing.**

**Everyone has views on the use and risk of pest control products. Some of these views are based on science and experience. In fact, many pesticide products are toxic and pose a risk to human health and the environment**

**The farming community, media, and lobby groups foster even more concern by promoting differing points of view. This can lead to confusion and greater public scrutiny. It is important for applicators to behave professionally.**

**Knowledgeable applicators can improve public understanding of pesticide use by:**

- **Keeping a professional attitude**
- **Working to professional standards**
- **Using integrated pest management**
- **Fostering open communication**

# Legal Requirements

There are legal implications in the buying, handling, and use of pesticides. Federal, provincial, and municipal laws protect public health and the environment from pesticide misuse. These laws work to protect the applicator as well.

## Handling Complaints

The public often raises complaints and concerns regarding the use of pesticides. These can be legitimate if complaints arise from poor pesticide use. This includes:

- Applying pesticides in poor weather conditions
- Applying pesticides near sensitive areas
- Failing to inform nearby (or affected) people

Some complaints can also arise from proper and legal pesticide use. Other complaints are caused by misunderstandings. A lack of understanding on the legal requirements for pesticide use is very common.

### Preventing Complaints

Pesticide applicators can reduce public complaints by better communication. Always speak with those who may be affected by your work.

Acting as a professional when applying pesticides can help to prevent complaints. This includes:

- Using pesticides only during the right weather
- Avoiding drift to sensitive areas (e.g., beehives, organic fields, sensitive crops, and gardens)
- Notifying owners/residents of nearby properties before using pesticides

Provide information on:

- The product to be applied
- The time and method of application
- Safety precautions they can take

This will help to reduce public misunderstanding and nuisance complaints.

## Responding to a Complaint

Respond quickly and properly when a complaint is received.

Visit the affected area with the person who made the complaint. This will help you to visually confirm and assess damage.

Further site visits may be needed. Pesticide damage can take time to appear (e.g., lawn damage after herbicide use).

**Applicators are legally and financially liable for property, livestock, or crop damage that may result from their application of a pesticide.**

### In Review

**A professional approach to pesticide application can help to build public confidence. It can also address community concerns.**

**A professional approach to communication will help to deal with complaints.**

**Be open and honest about pesticide use before complaints arise.**

**Deal promptly with complaints. This ensures that neighbours and affected groups receive timely information.**

# Public Relations

Farm operators need a good relationship with the public. A solid relationship will enhance the farm's credibility. It will also promote faith in the farmer and their product(s).

Good public relations are best established by acting in a professional manner. Good public relations can be built through:

- Establishing professional memberships
- Practising good communication
- Doing hands-on work with the public and the media
- Finding and sharing information, including keeping good records (See **Chapter 11: Traceability**.)

## Professional Memberships and Affiliations

Grower groups, commodity associations, unions, and federations represent farmers and the industry. Being part of one or more of these groups will allow you to have input into the industry. It also provides a positive, professional image.

Membership in an industry group can also help you to keep up to date on public and consumer concerns about the industry.

Many groups or associations can nominate individuals to sit on other boards or to speak at conferences and meetings.

Most groups or associations speak in a united voice when dealing with the public or the media. A united voice can reduce conflicts. Should issues arise, your group or association may also support you or speak on your behalf.

### In Review

**Applicators must appreciate public concern about pesticide use. Maintain good communication with the public. Be available to discuss public concerns, and always show a professional image. This will help you to better explain the role of pesticides in producing safe and affordable food**.

# Case Study: The Importance of Professionalism

Peter has worked at many jobs. Today, he is president of one of Canada’s largest chemical companies. At a recent meeting, he was asked about staff. The question was, “What is the most important trait for an employee to have if they are going to be a valued asset to your business?

Before answering, Peter thought back to his own career. He remembered his time spent at Ellsworth Farms. On the farm, Peter worked with an excellent crew. After a moment’s thought he gave his answer to the question, “I value employees who show professionalism.”

Peter remembered that everyone he worked with at Ellsworth Farms had a great attitude. They worked and communicated well with each other. They also communicated well with the public. They were well trained in their duties. Ellsworth Farms was a great place to work.

Peter also noticed that the community viewed Ellsworth Farms as responsible and well managed. Thinking back, Peter credited much of the farm’s success to the way the workers handled themselves, in front of co-workers and in public.

One person in particular impressed Peter. Jason was responsible for all pesticide applications on the farm. Peter admired Jason for paying close attention to his responsibilities. He put high value on working well with others.

Peter remembered the many times when farm customers or neighbours would ask Jason about pesticides and how they were used. Jason knew the value of giving clear and accurate answers that anyone could understand. He would try to help others understand responsible pest control and the role of chemical pesticides on a modern farm. He would even explain the training and testing requirements of a certified pesticide applicator.

Jason sometimes had to address public or media concerns. When these came up, he paid great attention to the concerns people had about pesticides, human health, and environmental protection. He always had good resource information on hand. This included resources to help with pesticide use and the control of certain pests.

Jason spoke freely and correctly about pesticide use to anyone who asked. This inspired confidence in him and the farm.

In contrast, Peter remembered working at other jobs where people did not behave professionally. They did little to help others understand their work. They were sloppy in answering questions for the public or the media. They were even arrogant when people they met outside of work wanted to know more about the company. Often, they turned down the chance to develop new skills or keep up to date with industry changes.

Peter remembered having to let some workers go from his own company when they failed to understand the importance of professional behaviour. Their lack of professionalism hurt them and the company.

After responding to the question, Peter then went on to explain how professionalism builds public confidence in you, your work, and your organization.

# Self-study Questions

*Answers are located in Appendix A of this manual.*

1. The four (4) main factors that affect an applicator's level of professionalism include:

   a) knowledge, attitude, work habits, communication
   b) attitude, legal awareness, responsibility, knowledge
   c) communication, equipment, public relations, age
   d) work habits, knowledge, attitude, education

2. You want to upgrade your knowledge as a pesticide applicator. Which of the following are recognized ways to upgrade your knowledge?

   a) attending farm trade shows and expositions
   b) attending trade seminars and courses
   c) reading papers, magazines, and journals related to pesticide application
   d) speaking with government and industry experts
   e) all of the above

3. Being knowledgeable about your profession will help you to make responsible decisions about pest control. If a question has been asked of you, and you don't know the answer, you should:

   a) ignore the question
   b) explain that the question does not matter because you are a trained applicator
   c) acknowledge that you do not know the answer, but that you will obtain the information and get back to that person
   d) challenge the reason why the person asked the question

4. You were hired by a friend to apply a pesticide to his field. The friend usually applies the pesticide, but was injured last week and cannot make the application. Your friend is concerned that the pest population in the field is getting out of hand, because the weather for the past week has been

very hot and humid. Today, it is sunny but very windy. Your friend says the application must be made today due to forecasted rain for the next few days. What should you do?

a) apply the pesticide at a lower-than-recommended rate to prevent drift of the pesticide
b) remind your friend that weather conditions are not appropriate for the application, and refuse to apply the product
c) wait until tomorrow and apply the pesticide in the rain, which will prevent the off-target drift of the product
d) apply an adjuvant and apply the pesticide today

5. You applied a pesticide last month to a field next to your neighbour's home. Before you applied the pesticide, you made sure it posed the least amount of health hazard for the desired pest control. You notified your neighbour about the application and the type of product, and applied the pesticide at label recommended rates using properly functioning application equipment. You also kept good records of both application and results. However, you received a complaint from your neighbour, who said the pesticide damaged their lawn. What is the <u>first</u> thing that you should do?

a) use your records to prove you followed proper application directions
b) visit the area where the damage occurred to confirm that damage took place
c) respond to the neighbour's concerns with literature and facts about the product you used.
d) contact a government pesticide inspector

Chapter 11

# TRACEABILITY

Traceability is being able to show what pesticides were applied to a crop or product. It lets you answer when, where, how, and why a pesticide product was used. Pesticide use records are becoming more important as concerns increase about human health, food safety, and the environment. Applicators must keep records of all pesticide use.

Pesticide use records can serve a number of purposes. Good records can help you to:

- Set re-entry dates
- Set harvest dates
- Plan the time for the next application
- Choose equipment settings
- Set application rates
- Track health concerns

Pesticide use records can protect you and your crop investment. Records provide written proof (and some insurance) if questions or complaints are raised. Keeping accurate records is simply good planning.

Farmers may soon be required by law to keep records of pesticide use.

## Learning Objectives

**Completing this chapter will help you to:**

- **Identify the importance of good record keeping.**
- **Meet consumer and public needs for good information**.

# Keeping Good Records

Good pesticide use records can help you to become a better applicator. These records can help you to:

**Figure 11-1: Good pesticide use records will serve many purposes.**

- Improve pest control
- Evaluate the results of pest control activities
- Avoid pesticide misuse
- Buy only the amount of pesticide needed (This will reduce pesticide stocks on site.)
- Prove proper use in case of residue or crop-damage questions
- Solve application problems
- Prove pesticide use in case of complaints or questions
- Plan for future pesticide needs

## Components of Good Record Keeping

Good record keeping will provide information that you may need at a later date. Pesticide use records should be simple to develop and maintain. They should also be easy to understand.

Make sure that all records are accurate and complete. Pesticide use records should include the following:

- Date and time of the application
- Location of the application
- Pest(s) and host plant(s)
- Pesticide name and PCP number
- Rate of application
- Applicator name
- Equipment used

- Weather conditions
- Presence of nearby plants and animals
- Application results

## Date and Time of the Application

You should record the date and time of any pesticide use. This will help to calculate:

- Safe re-entry times
- Re-application schedules (if needed)
- Proper harvest times

As defined earlier, the pre-harvest interval is the time that must pass between pesticide use and crop harvesting. Record the application date and time. The pre-harvest interval can then be calculated.

## Location of the Application

Always record the location of a pesticide use. Include a field identifier (name or number). This will help you to avoid future mistakes (e.g., re-applying product to the same area or to the wrong field).

## Pest(s) and Host Plant(s)

Record the name and stage of growth of the target pest(s) and host plant(s). Information on these will help you to choose the best pesticide and application rate.

This information will show why the application was needed. Records can also explain why pesticide was chosen to deal with the pest(s).

## Pesticide Name

Record the trade name, PCP number, and formulation of all pesticides you use. In case of a fire, spill, poisoning, or complaint this information will help emergency personnel to respond.

## Rate of Application

For each application, record the rate at which the pesticide was applied. This will provide a record to be compared to past and future application results.

Recording application rates will also confirm that the pesticide was used at the label rate.

## Applicator Name

Record the name of the person making each application. This will document responsibility for the application.

Good records will also help to track applicator exposure and monitor health risks.

## Equipment Used

Record the equipment used for each pesticide application. Good records will help you to track the movement of equipment from field to field. This can also help to deal with issues of contamination.

Note the settings (operating pressure, travel speed, calibration) of the equipment used for each application. This will record the rate at which the product was applied. You can use this information in another season.

Record the nozzle type and size when using a sprayer. Note when these were last changed.

## Weather Conditions

Record the weather at the start and end of every application. Weather records can be used to address future concerns on property damage, drift, or runoff.

Record the air temperature, wind speed and direction, and relative humidity. Note sun and cloud conditions (e.g., partly cloudy, overcast, sunny).

## Presence of Nearby Plants and Animals

Record the presence of animals and plants near the application site.

Future pesticide use will have to be changed if damage occurs to nearby plants or animals.

## Application Results

Record the results of any pesticide use. Questions to answer include:

- Did the application control the pest?
- Were non-target species damaged?
- Did there appear to be any environmental damage?
- Did the pesticide drift?

Answers to these questions will be useful when planning future applications.

# Record Keeping Forms

Basic record keeping forms can be obtained from a number of sources. Your provincial pesticide regulatory agency should be able to provide or locate forms for you. These forms will provide you with a starting point for developing your own record keeping system.

### In Review

**A good pesticide use record keeping system uses a format that is easy to access and understand. There are many record keeping systems available. Do not trust your memory alone. Use a notebook to record information as it happens.**

**Keep a permanent record of all pesticide applications. A complete pesticide register includes application records, MSDS sheets, and a list of all stored products. Tell employees where this information is kept. They may need to access it in an emergency**.

# Consumers and Pesticide Information

Today's consumers are very demanding. This is especially true when it comes to the food they buy. They want to be assured that their food is safe and produced in an environmentally responsible manner.

Producers must respond to this increased consumer demand. Many producers are coming up with systems that show customers that the food they grow and sell is safe.

## Ensuring Food Safety

Food safety is a basic requirement of Canada's food system. If producers and processors cannot prove the safety of the food system, they risk:

- Major interruptions to their business
- Loss of export markets
- Harm to Canada's reputation as a supplier of safe, high-quality food

These concerns have led to new standards to promote food quality and safety. Hazard Analysis Critical Control Points (HACCP) programs and trace-back systems are becoming common in some parts of the food production industry. Programs like these ensure that proper food safety standards are applied from field to plate.

Processing and retail buyers are also demanding more information about food production methods. This includes pesticide use.

Pesticide use records are a chance to show consumers the quality of the product and the care taken with its production. Good record keeping will be an important part of responsible and successful farming in the future.

## In Review

**Increased consumer demands for food safety, quality, and resource sustainability are changing agriculture and agri-food sectors. Many new demands are being placed on producers and processors.**

**Being able to justify the use of pesticides on food crops will be important to the future of modern farming. Good record keeping will play an important role in this.**

# Case Study: The Importance of Traceability

Billy Hudson is an experienced farmer. He is always looking for ways to improve his farming operation. Over the years, his vegetable farm has grown from 10 hectares to over 70 hectares. During this time, Billy has changed his farming activity to make it more efficient.

As his farm got bigger, managing it became more complex. To better track his crop production several years ago, Billy began to use a record keeping system.

Today, tracking his farm inputs is becoming even more important. Billy's consumers want to make sure that their food is produced safely and with little environmental impact. Many of his customers demand evidence of this. Billy knows he has to have good pesticide use records. He must know the rate and frequency of all product applications. Without these records, a number of world markets would not accept his vegetables for sale.

Good pesticide application records are also important for other reasons. Billy knows that records can improve his control of pests and meet the province's new crop documentation requirements. With these records, Billy can prove that his vegetables are produced safely and responsibly.

Each year, Billy is faced with challenges in growing high quality produce. He has become an expert in what works and what does not work on his farm. This knowledge is important to his success. Billy does not want to lose the information and knowledge he and his workers have gained. He uses written records to keep track of this information and to plan for the next season.

Billy and his workers use a simple pesticide record-keeping program. This program includes:

- Date and time of pesticide applications
- Location of pesticide application
- Pests and hosts present in the application area
- Pesticide names and rates of application
- Weather conditions at the time of the application
- Application equipment used

- Presence of plants and animals nearby
- A brief description of the application results

When he first started keeping records, Billy and his workers found that it took a lot of time. Sometimes it was a nuisance. In time, however, Billy found that detailed records improved the efficiency of his farm's pesticide use. For example, he can now better estimate the amount of product that he will require for the year. This cuts down on inventory and storage needs. Good records also allow him to compare pest control results from year to year.

Giving his customers high quality produce and information has allowed Billy to capture profitable markets. Without good records, these markets would be out of reach.

# Self-study Questions

*Answers are located in Appendix A of this manual.*

1. As a pesticide applicator, it is the best practice to complete your application records:

   a) within 24 hours of the application
   b) within 48 hours of the application
   c) at the end of each week of the application
   d) at the end of the application season

2. Records provide the pesticide applicator with:

   a) a reference for next season's application
   b) a record to refute complaints or lawsuits against the applicator
   c) a reference to provide emergency personnel in case of an accident in the field
   d) all of the above

3. Jan applies a pesticide to a field on Thursday morning. She tells Dean, another pesticide applicator, that the product must be re-applied after the re-entry period of seven days. She gives Dean her complete application records. The following Thursday, Dean re-applies the pesticide as ordered. Which of the following statements about records is true?

   a) Dean should copy Jan's records word-for-word, because they both applied the same product in the same place
   b) Dean should make his own records, regardless of similarities between his and Jan's application
   c) Dean should write his name beside Jan's on her original record sheet, and write the date of his application beside his name
   d) Dean should remember the necessary information about his application, and use Jan's records as a reference to fill in the blanks

4. A pesticide applicator is using Roundup, a liquid herbicide with the common name glyphosate. What product information should the applicator include in their application records?

   a) the trade name of the pesticide
   b) the name of the pesticide vendor
   c) the PCP number of the pesticide
   d) all of the above
   e) a and c only

5. Last season, an applicator applied a liquid insecticide to control aphids in a field of potatoes. Which of the following information from the records will help the applicator determine pest management this season?

   a) the name of the insecticide used
   b) the equipment used to apply the pesticide
   c) the equipment settings used to apply the product last season
   d) all of the above

# APPENDIX A:

# ANSWERS TO SELF STUDY QUESTIONS

## CHAPTER ONE: GENERAL INFORMATION

1. d
2. a
3. c
4. d

## CHAPTER TWO: PESTICIDE REGULATIONS

1. c
2. b, d, a, c, no correct answer
3. f, b, f, e, d.
4. e
5. e

## CHAPTER THREE: LABELLING

1. e, b, c, d
2. a, b, c
3. e
4. c
5. b

## CHAPTER FOUR: HUMAN HEALTH

1. f

2. e

3. b, a, c, d

4. b

5. e

## CHAPTER FIVE: SAFE PESTICIDE USE

1. a

2. c

3. b

4. c

5. d

## CHAPTER SIX: ENVIRONMENTAL SAFETY

1. a, b, d

2. a, d, e, f

3. c

4. e

5. e

## CHAPTER SEVEN: INTEGRATED PEST MANAGEMENT

1. e
2. a
3. b
4. f, b, c , a, d, g, e
5. e

## CHAPTER EIGHT: APPLICATION TECHNOLOGY

1. b
2. e
3. b
4. a
5. e

## CHAPTER NINE: EMERGENCY RESPONSE

1. d
2. e
3. a
4. a, b, c, d, e
5. e

## CHAPTER TEN: PROFESSIONALISM

1. a
2. e
3. c
4. b
5. b

## CHAPTER ELEVEN: TRACABILITY

1. a
2. d
3. b
4. e
5. d

# APPENDIX B:

# NOVA SCOTIA PESTICIDE REGULATIONS

## Citation

**1** These regulations may be cited as the "Pesticide Regulations".

## Interpretation

**2** In these regulations

**(a)** "Act" means the Environment Act;

**(b)** "Administrator" means a person appointed pursuant to Section 3 of these regulations, and includes an acting Administrator;

**(c)** "animal" includes vertebrates, invertebrates and micro-organisms whether wild, domestic, living or dead, but does not include humans;

**(d)** "buffer zone" means an area where a pesticide shall not be directly applied;

**(e)** "certification" means a type of pest management activity for which a person can become certified by obtaining a certificate of qualification;

**(f)** "certified applicator" means a person who has obtained a certificate of qualification under these regulations to apply a pesticide;

**(g)** "commercial applicator" means a person, other than a private applicator, who uses or supervises the use of a pesticide;

**(h)** "commercial class" means a class of pesticides designated by the Federal Regulatory Authority;

**(i)** "contamination" means

(i) any significant adverse effect which the Minister believes on reasonable and probable grounds is or may be causing harm to any part of the environment, or

(ii) the presence of a hazard to an organism, other than the target organism, which the Minister believes on reasonable and probable grounds is or may be detrimental to the normal physiological functions of human, animal or plant life;

**(j)** "Department" means the Department of Environment and Labour;

**(k)** "Federal Regulatory Authority" means the Federal Minister responsible for regulating pest control products;

**(l)** "fumigant" means a chemical that, for uses regulated by the Federal Regulatory Authority, can exist in a gaseous state at a required temperature and pressure that is lethal to a given pest;

**(m)** "land" means surface land, land covered by water, subsoil, matter beneath the subsoil or any combination thereof, but does not include land inside a building or structure;

**(n)** "micro-organism" means a microscopic plant or animal, including a bacterium, virus, fungus, alga and protozoon;

**(o)** "Minister" means the Minister of Environment and Labour;

**(p)** "pest" means any plant, animal, micro-organism or any organic functions of a plant, animal, or micro-organism, including any insect, nematode, rodent, predatory animal, parasite, bacterium, fungus, weed, or other form of plant or animal life or virus, the Minister believes is or may be injurious, noxious or troublesome, but does not include a virus, parasite, bacterium or fungus in a living person or animal;

**(q)** "pesticide" or "pest control product" means

(i) any substance that is sold or represented for use in preventing, destroying, repelling, attracting, or mitigating, directly or indirectly, any pest,

(ii) any substance that is a pest control product within the meaning of the Pest Control Products Act (Canada) or is intended for use as a pest control product,

(iii) any substance that is a plant growth regulator, a defoliant or a plant desiccant,

(iv) a fertilizer within the meaning of the Fertilizers Act (Canada) that contains a substance referred to in subclauses (i), (ii), or (iii), or

(v) any other substance designated as a pesticide in the regulations, but does not include a substance that is intended for sale, sold or represented for use in potable water to prevent or destroy bacteria, parasites or viruses if the substance is not a pest control product within the meaning of the Pest Control Products Act (Canada);

**(r)** "pesticide research" means a limited pest control program authorized by the Federal Regulatory Authority;

**(s)** "pesticide storage facility" means a facility that is used to store pesticides and meets the requirements prescribed in these regulations;

**(t)** "plant" means an organism which usually derives part of its sustenance by photosynthesis and part by root sorption, and includes a parasitic plant, tree, shrub, weed, grass, fern, moss or micro-organism;

**(u)** "private applicator" means a person who applies or supervises the application of a pesticide on property owned, leased, or rented

(i) by the applicator,

(ii) by an employer of the applicator, or

(iii) by another person, if the pesticide is applied without monetary compensation or reward to the applicator other than trading services;

**(v)** "restricted class" means a class of pesticides designated as a restricted class by the Federal Regulatory Authority;

**(w)** "sell" includes sale, offer for sale, expose for sale, display or advertise for sale, or have possession of for the purpose of sale or distribution;

**(x)** "treatment site" means the area to which a pesticide is applied;

**(y)** "vendor of a pesticide" means a person who for hire or reward, sells, supplies or distributes directly to a user, or stores a pesticide, but does not include a farmer or other person who stores a pesticide for their own use and not for resale or distribution.

**Administrator**

**3** The Minister may appoint an Administrator to administer these regulations.

**Exemption from regulations**

**4** These regulations do not apply to the use or sale of a germicidal, disinfectant, veterinary, or sanitizing product registered under the Pest Control Products Act (Canada).

**Application of federal statutes**

**5** The requirements of these regulations are in addition to any applicable federal legislation, including the Fertilizers Act (Canada) and the Pest Control Products Act (Canada) and regulations made pursuant to those statutes.

## Part I - Certificates of Qualification

### Prohibitions

**6 (1)** No person shall apply a commercial class or restricted class pesticide unless that person holds a valid certificate of qualification.

**(2)** No person shall sell or store for gain or reward a commercial class or restricted class pesticide unless that person holds a valid certificate of qualification.

### Certificates of qualification

**7 (1)** The Minister or an Administrator may issue the following classes of certificates of qualification:

> **(a)** Class I - Vendor's Certificate which authorizes the holder to sell, supply, or distribute a pesticide directly to a pesticide user or to store, for hire or reward, a commercial or restricted pesticide;
>
> **(b)** Class II - Structural Certificate which authorizes the holder to use a pesticide, other than a herbicide or fumigant, for the prevention or control of pests in or around a structure, excluding plant pests in a greenhouse;
>
> **(c)** Class III (A) - Forestry Certificate which authorizes the holder to use a pesticide by ground application including site preparation, brushing, crop tree release, thinning, insect control, disease control and vertebrate control in a forest management operation, forest seed orchard, outdoor nursery, or plantation;
>
> **(d)** Class III (B) - Greenhouse Certificate which authorizes the use of a pesticide, other than the use of a restricted class fumigant gas in a greenhouse during the storage, display or production of an agricultural crop including vegetables, ornamental trees, mushrooms and forest tree seedlings and the use of pesticides on areas immediately surrounding a greenhouse;
>
> **(e)** Class III (C) - Industrial Vegetation Certificate which authorizes the use of a herbicide by ground application to control weeds in an industrial area including a roadside, powerline, pipeline, right-of-way, railway, well site, equipment yard, or non-crop land;
>
> **(f)** Class III (D) - Landscape Certificate which authorizes the use of a pesticide, other than a restricted class fumigant gas, for the maintenance of ornamentals, shrubs, flowers and turf on outdoor residential, recreational, commercial and public land, including the use of a pesticide in an outdoor nursery for propagation of landscape and garden plants;

**(g)** Class IV - Mosquito and Biting Fly Certificate which authorizes the use by ground application of an insecticide for control of mosquitoes or biting flies;

**(h)** Class V - Aquatic Vegetation Certificate which authorizes the use of a herbicide by ground application for the control of aquatic weeds in standing or running water in areas left exposed during periods of low water, including the use of a herbicide in a lake, river, irrigation canal, or ditch;

**(i)** Class VI - Fumigation Certificate which authorizes the use of a fumigant for soil fumigation or fumigation in an enclosed structure, including a grain bin, elevator, building, railcar, truck, or closed vault;

**(j)** Class VII - Aerial Certificate which authorizes the use from an aircraft of a pesticide on any land or water;

**(k)** Class VIII - Agriculture Certificate which authorizes the use of a pesticide, other than a restricted class fumigant gas, by ground application for the protection of an agricultural crop or livestock, including use for control of noxious weeds, birds and rodent control in a farm pond with no outflow, use on a Christmas tree plantation, use on livestock and poultry pests, use in farm seed treatment, use for soil fumigation and use around farm buildings associated with crop and livestock production, but not including use in a greenhouse or commercial seed treatment;

**(l)** Class IX - Business Operator's Certificate which authorizes the holder to carry on a commercial pesticide business or enter into contracts to handle, use, store or sell to a user a commercial class or restricted class pesticide; and

**(m)** Class X - Special Certificate which authorizes the use of a pesticide for a purpose not included in Classes II to VIII.

**(2)** A limited class [may] be created by the Minister or an Administrator for the application of a pesticide restricted to a certain activity within one certification class.

**(3)** A Class III or Class VIII certificate of qualification may be issued by the Minister or an Administrator to a private applicator or a commercial applicator.

**(4)** Subject to subsection (3), a certificate of qualification under subsection (1) may only be issued to a commercial applicator.

### Application process

**8 (1)** An applicant for a certificate of qualification shall complete an application in a form approved by an Administrator.

**(2)** An applicant for a certificate of qualification shall complete an examination and achieve a minimum standard of performance established by the Minister.

**(3)** A certificate of qualification shall be valid for a period of 5 years from the date of issuance with the exception of a Class IX Certificate which shall be valid for 1 year from the date of issuance.

**(4)** The holder of a certificate of qualification may be retested once in every 5-year period from the date of the issuance of the initial certificate of qualification.

**(5)** A certificate of qualification shall entitle the holder to perform only those uses that the class of certificate of qualification authorizes the holder to perform and no other uses.

**(6)** No certificate of qualification issued pursuant to these regulations is transferable.

**(7)** Unless agreed otherwise in writing by an Administrator, no person shall apply for a certificate of qualification under these regulations unless that person is at least 18 years of age.

**Supervisory restrictions**

**9 (1)** A private applicator who is a certified applicator in Class III or VIII may directly supervise a non-certified applicator where

> **(a)** the non-certified applicator performs the same use as authorized in the certificate of qualification held by the certified applicator; and
>
> **(b)** the non-certified applicator is at least 18 years of age.

**(2)** A commercial applicator who is a certified applicator may directly supervise a non-certified applicator where

> **(a)** the certified applicator holds a valid Class II, III, or VIII certificate of qualification;
>
> **(b)** the certified applicator is present at the treatment site at all times while the non-certified applicator is applying a pesticide; and

**(c)** an Administrator is notified when the supervision of the non-certified applicator will occur.

**(3)** A non-certified applicator may only be supervised by a commercial applicator under subsection (2) for one 30-day period.

**(4)** A certified applicator referred to in subsections (1) and (2) is responsible for all actions respecting the application of pesticide by the non-certified applicator.

**Business operator**

**10** The holder of a valid Class IX Business Operator's Certificate shall ensure that

**(a)** a person who is employed by the business operator and who is responsible for handling or applying a commercial class or restricted class pesticide has a valid certificate of qualification;

**(b)** a commercial class or restricted class pesticide is sold only to

(i) an applicator or business who holds a valid certificate of qualification, or

(ii) a person who has hired another person who holds a valid certificate, qualification;

**(c)** any activity of a person employed by the business operator complies with the pesticide label instructions for the proper and safe use of pesticides; and

**(d)** any instruction to a person employed by the business operator is in accordance with the Act, these regulations or any other requirements set forth by an Administrator.

**Records**

**11** An Administrator may require the holder of a Class IX Business Operator's Certificate to submit a record of the application or sale of a pesticide.

**Part II - Pesticide Approvals**

**Approvals**

**12 (1)** Pesticide application activities that require an approval under the Act are designated in the Activities Designation Regulations.

**(2)** Unless authorized in writing by an Administrator, an applicant for an approval shall apply at least 60 days prior to the intended starting date of the application of the pesticide.

**(3)** An approval holder shall keep and maintain equipment or supplies readily available to minimize the impact of any release of a pesticide.

**(4)** An approval holder shall notify an Administrator before commencing a spray program under an approval.

**(5)** An approval holder shall adhere to weather condition restrictions stipulated on an approval respecting the application of a pesticide.

**(6)** An approval holder shall ensure that the approval or a copy of the approval is available at the loading, mixing, or application area when the pesticide is being used.

**(7)** All boundaries of a treatment site where pesticide is used or applied and buffer zones shall be marked or identified so that they are known and visible to the applicator.

**(8)** An approval holder for aerial spraying of a pesticide shall either personally accompany, or provide a contractor or agent to accompany, a pilot on a pre-spray aerial inspection of a treatment site to ensure that the pilot is fully aware of the area to be sprayed, any buffer zones involved and the property boundaries of the treatment site.

**(9)** An approval holder shall keep and maintain a record of the information the Minister or an Administrator requires of each pesticide used or applied.

**(10)** Where there is no evidence that an adverse effect may occur or will occur, the Minister may waive or modify in writing the requirements prescribed in subsections (5), (6), (7), (8) and (9).

## Part III - General

### Public notification

**13 (1)** An approval holder shall undertake a public information and notification program as a term and condition of the issuance of an approval.

**(2)** Except for spot treatments to a utility corridor, utility right-of-way, street or highway right-of-way, no person shall apply a pesticide under an approval by any method unless the person gives public notification through a local newspaper or other means approved by the Administrator at least 20 days before the application commences identifying where and when the pesticide will be applied.

**(3)** No person shall apply a pesticide under a pesticide research program unless that person

> **(a)** posts signs approved by an Administrator identifying that pesticide research is en at the treatment site before the application commences; and
>
> **(b)** keeps the signs referred to in clause (a) in place for 20 days after the last application at the treatment site.

**(4)** No person shall apply a pesticide under an approval for crop tree release, site preparation or forest insect control unless

> **(a)** at least 30 days before the application commences, the person

(i) posts signs approved by an Administrator identifying when and where the pesticide will be applied,

(ii) ensures that the signs referred to in subclause (i) contain a space for coloured fluorescent decals which shall be applied to the signs when spraying commences at the treatment site, and

(iii) ensures that the signs referred to in subclause (i) are placed on all access roads leading to the treatment site and at the edge of the treatment site;

**(b)** at least 30 days before the application commences, the person delivers a written notice approved by an Administrator to the owner or occupier of any dwelling, business, school, public building, or any other inhabited structure which is located within 500 m of the treatment site, identifying when and where the pesticide will be applied; and

**(c)** at least 20 days before the application commences, when the total area under an approval or the area of the individual treatment site exceeds 200 ha, the person publishes a notice approved by an Administrator through a local newspaper identifying when and where the pesticide will be applied.

**(5)** If the applicant can provide reasons which are considered acceptable to the Minister or an Administrator, the Minister or the Administrator may waive, modify, or alter the notice requirements provided in this Section.

**(6)** No person shall remove or alter any sign required to be posted under these regulations unless authorized by these regulations or by an Administrator.

**(7)** Subject to subsection (9), no sign posted under these regulations shall be removed for a period of 7 days after the last application at the treatment site.

**(8)** Unless agreed in writing by an Administrator, any sign posted pursuant to an approval under these regulations must be removed by the approval holder no later than November 1st in the year that the approval was issued unless there is a conflict with subsection (7) in which case the approval holder shall remove any signs immediately after 7 days have elapsed from the last application at the treatment site.

**(9)** Unless agreed in writing by an Administrator, every person who for hire or reward applies a commercial class or restricted class pesticide to a lawn, tree or other area that surrounds a domestic residence, an apartment, a commercial building, or that is located in a public area, shall

**(a)** post a sign approved by an Administrator indicating that a pesticide application has taken place on the treatment site immediately after the last application of the pesticide; and

**(b)** not remove a sign posted under clause (a) for a period of 24 hours after the last application at the treatment site.

**Prohibitions**

**14 (1)** No person shall apply, handle, use, abandon or dispose of any pesticide, a mixture containing a pesticide or seeds treated with a pesticide unless the handling, use, abandonment or disposal is conducted in conformance with the product directions or limitations shown on the manufacturer's product label or in a manner approved by the Minister or an Administrator.

**(2)** Despite subsection (1), no person shall apply, handle, use, abandon or dispose of a pesticide, a mixture or a device containing a pesticide or a material treated with a pesticide in a manner that results or may result in contamination of the environment.

**Pesticide research**

**15** Any pesticide research shall be reported by the researcher to an Administrator in writing 15 days before application commences under the pesticide research authorization.

**Filling/flushing**

**16** No person shall fill, flush or clean a sprayer or equipment used for or in association with the application of a pesticide in a manner that results or may result in contamination.

**Contingency plan**

**17** The Minister or an Administrator may require contingency plans respecting a release of a pesticide to be prepared for approval by the Minister or the Administrator by a person who holds a Class IX certificate of qualification or by an approval holder who applies a commercial class or restricted class pesticide.

**Pesticide containers**

**18 (1)** No person shall dispose of a container that was used to hold a commercial class or restricted class pesticide except

**(a)** at a container collection site; or

**(b)** in a manner approved by the Minister or an Administrator.

**(2)** All pesticides shall be stored in the labelled containers supplied by the manufacturer unless otherwise authorized in writing by an Administrator.

### Buffer zones

**19** Where the Minister believes on reasonable and probable grounds that a treatment site may be sensitive to the application of a pesticide, the Minister may require a buffer zone be set aside in which no spray is to be directly applied, may determine the size of the buffer zone to be maintained, and may outline how the buffer zone is to be marked or identified.

### Cancelled registered pesticides

**20 (1)** Where the registration of a pesticide has been cancelled under the Pest Control Products Act (Canada), the person to whom the pesticide was registered shall

> **(a)** collect or accept return of all such pesticide supplied by the person to others; and
>
> **(b)** dispose of all such pesticide in a manner acceptable to an Administrator.

**(2)** No person shall use, apply, display, or sell a pesticide if its registration has been cancelled under the Pest Control Products Act (Canada).

### Protected water area

**21** No person shall apply a pesticide within a protected water area designated under Section 106 of the Act unless the person complies with any regulations regarding the use of pesticides within the protected water area.

## Part IV - User Pesticide Storage Facilities

### User pesticide storage

**22 (1)** Part IV of these regulations applies to a private individual or the owner, operator or person responsible for a commercial business who stores a commercial class or restricted class pesticide in excess of 25 l in liquid form or 25 kg in solid form, whichever is applicable, for their own use or business use in a user pesticide storage facility, but does not store the commercial class or restricted class pesticide for resale.

**(2)** No private individual or owner, operator or person responsible for a commercial business described in subsection (1) shall store a commercial class or restricted class pesticide unless the following conditions are met:

> **(a)** the pesticide is stored in a facility that prevents the uncontrolled release of the pesticide;
>
> **(b)** a list of pesticides stored in the facility and the estimated quantities normally held in storage is, upon request, supplied to the chief of the local fire department or the chief's designate;

**(c)** a placard is affixed and maintained on the outside of each door leading into the room where the pesticide is stored bearing the words "WARNING - CHEMICAL STORAGE - AUTHORIZED PERSONNEL ONLY" or words to like effect in block letters which are clearly visible; and

**(d)** emergency telephone numbers are displayed in the facility, including telephone numbers of the fire department, hospital, poison control centre, Department, police and Emergency Measures Organization.

## Part V - Vendor Pesticide Storage Facilities

### Vendor pesticide storage

**23 (1)** Part V of these regulations applies to the owner, operator or person responsible for a commercial business who for hire or reward, or for resale, stores a commercial class or restricted class pesticide in a vendor pesticide storage facility.

**(2)** Any person storing commercial class or restricted class pesticides for hire or reward, or for resale, must do so in a facility that meets a standard established, approved or recognized by the Minister under subsection 8(2) of the Act.

### Storage approval

**24 (1)** No person shall construct a new vendor pesticide storage facility or extend or modify an existing pesticide storage facility to store a commercial class or restricted class pesticide for hire or reward, sale, resale, or wholesale distribution unless the person receives an approval from an Administrator.

**(2)** An approval under subsection (1) shall be processed under the Approvals Procedure Regulations.

### General restriction on facility location

**25** No person shall construct or extend a vendor pesticide storage facility

**(a)** within 30 m of the bank of any surface watercourse or the ordinary high water mark of any surface watercourse, whichever distance is greater, unless approved in writing by an Administrator; or

**(b)** within 60 m of a well or surface watercourse used as a private water supply, unless approved in writing by an Administrator.

## Construction requirements

**26 (1)** The construction requirements described in this Section are in addition to all applicable federal, provincial, and municipal laws and regulations, including building, fire, and electrical codes and regulations.

**(2)** No person shall construct a vendor pesticide storage facility unless the following conditions are met:

> **(a)** in the area where pesticides are stored, the floor surface shall be made of steel, concrete or other similar durable material which is impervious to an absorbable liquid;
>
> **(b)** flooring in the area where pesticides are stored shall have a smooth surface and be capable of being cleaned and decontaminated of any pesticide stored in the facility;
>
> **(c)** in the area where pesticides are stored, there shall be a continuous, non-combustible curb on the floor which is integral with the floor and is at least 10 cm in height around the perimeter of the area and is capable of retaining liquids;
>
> **(d)** in the area where pesticides are stored, there shall be no floor drains, catch basins, sumps or other openings in the floor;
>
> **(e)** the facility shall have adequate ventilation by either natural or mechanical means to the outside atmosphere to prevent the accumulation of toxic or flammable vapours;
>
> **(f)** there shall be at least 2 entrances and exits to the facility located on opposite sides of the facility if the floor area of the facility exceeds 200 $m^2$;
>
> **(g)** there shall be a separate room or area at or near the area in which the pesticides are stored that contains adequate washing facilities for personal decontamination; and
>
> **(h)** a source of running water shall be readily available in or adjacent to the area where pesticides are stored.

## Storage requirements

**27** No owner, operator or person responsible for a vendor pesticide storage facility shall store a commercial class or restricted class pesticide unless

> **(a)** the area where the pesticides are stored is a separate locked room or compartment that is partitioned from the floor to the ceiling with building materials that conform with fire and building codes and has no openings except those required for ventilation and entrances;

**(b)** all permanent storage racks or shelves are constructed of non-combustible material that can be easily cleaned;

**(c)** all pesticides are stored according to the label storage requirements provided by the manufacturer;

**(d)** all pesticides are stored at least 10 cm above the floor;

**(e)** all herbicides, insecticides and fungicides are stored separately from each other in the facility;

**(f)** all pesticides are separated from any flammable materials by a fire resistant barrier or enough space to minimize risk of combustion of the pesticides;

**(g)** all pesticides are stacked in a manner that enables the pesticides to be readily inspected; and

**(h)** foodstuffs, including feed, are not stored in the facility.

**Access to site**

**28** No person shall own, operate or be responsible for a vendor pesticide storage facility unless

**(a)** the facility has sufficient outside lighting to be of use to emergency service personnel;

**(b)** any windows in the facility are locked to prevent unauthorized access when authorized personnel are not present;

**(c)** the facility has doors that remain closed and locked at all times when authorized personnel are not present; and

**(d)** access to the facility is restricted only to authorized personnel.

**Safety measures**

**29 (1)** No person shall own, operate or be responsible for a vendor pesticide storage facility unless

**(a)** protective clothing including gloves, hats, coveralls, boots, eye protection, a first aid kit and a respirator appropriate for use with the pesticide being stored are readily available, are properly maintained, and functional at all times at the facility and are free from pesticide contamination;

**(b)** eye wash and emergency showers are readily available at the facility;

**(c)** the chief of the local fire department or the chief's designate is provided annually with a list of pesticides stored in the facility and the estimated quantities normally held in storage and the chief or the designate is notified of any significant changes in stocks which occur during the year;

**(d)** a placard is affixed and maintained on the outside of each door leading into the room where the pesticide is stored bearing the words "WARNING - CHEMICAL STORAGE - AUTHORIZED PERSONNEL ONLY" or words to like effect in block letters which are clearly visible; and

**(e)** emergency phone numbers are displayed in the facility including the telephone numbers of the fire department, hospital, poison control centre, Department, police and Emergency Measures Organization.

**(2)** Every owner, operator or person responsible for a vendor pesticide storage facility shall ensure that "no smoking" signs are prominently displayed in an area where pesticides are being stored.

**(3)** No person shall use an open flame to conduct welding, burning, cutting, melting, heating or any other activity in a vendor pesticide storage facility unless appropriate safety measures are taken.

**(4)** Every owner, operator or person responsible for a vendor pesticide storage facility shall post or make readily available to employees or other persons any material safety data sheets that have been compiled and supplied by the manufacturer of the pesticide.

**(5)** No owner, operator or person responsible for a vendor pesticide storage facility shall place a pesticide in that facility unless it is equipped with

**(a)** a fully-operative fire alarm system;

**(b)** fire extinguishers which are approved by the fire department and are placed in strategic positions in and around the pesticide storage facility; and

**(c)** materials for containment and clean-up as required by an Administrator.

**(6)** Unless an Administrator directs otherwise in writing, every owner, operator or person responsible for a vendor pesticide storage facility shall ensure there is unobstructed access to the facility for emergency equipment and personnel.

### Maintenance and inspection of facility

**30 (1)** Every owner, operator or person responsible for a vendor pesticide storage facility shall

**(a)** comply with all relevant legislation respecting pesticide storage and the use of personnel protection equipment and clean-up techniques;

**(b)** inspect monthly the facility and repair or replace any parts that may be damaged or defective; and

**(c)** immediately secure any container or package found leaking a pesticide and clean up the area.

**(2)** Every owner, operator or person responsible for a vendor pesticide storage facility shall keep and make available for review upon request by an inspector, a book or report of monthly inspections and any action taken under subsection (1).

**(3)** The book or report described in subsection (2) shall be kept while the facility is in operation and for 2 years after operations cease.

### Abandonment

**31 (1)** No owner, operator or person responsible for a vendor pesticide storage facility shall abandon that facility or any part of that facility unless the person notifies an Administrator in writing at least 6 months before the date of the proposed abandonment.

**(2)** No owner, operator or person responsible for a vendor pesticide storage facility shall abandon that facility unless the facility is left in a condition approved by an Administrator.

**(3)** Unless approved in writing by an Administrator, an abandonment pursuant to subsection (1) does not relieve the owner, operator or person responsible for a vendor pesticide storage facility from any requirement contained in the Act, regulations made pursuant to the Act, or in an approval issued with respect to that facility.

#### Part VI - Effective Date

**32 (1)** Subject to subsection (2), these regulations shall come into force on, from and after April 11, 1995.

**(2)** With respect to private applicators, clauses 7(1)(c), (d), (e), (f), and (k), and clause 10(b) shall come into force on, from and after December 1, 1996.

# Appendix C: Glossary

# Glossary

**-A-**

| | |
|---|---|
| **Absorbent material** | Material that can take up chemicals and hold them. Sometimes used to clean up pesticide spills. Examples are clay powder and kitty litter. |
| **Absorption** | The movement of a substance into a living thing (e.g., plants and animals) or structure (e.g., wood and soil). |
| **Acaricide** | A pesticide that is used to control mites and ticks. Same as miticide. |
| **Action threshold** | The point at which treatment should take place to prevent pest numbers from reaching the economic injury level. |
| **Active ingredient** | The part of a pesticide product that controls the pest. |
| **Acute exposure** | A single exposure to a substance. |
| **Acute poisoning** | Poisoning that occurs after a single dose or exposure to a pesticide. |
| **Acute toxicity** | The toxic response from a single exposure to a pesticide. It is determined through oral, dermal or inhalation studies. |
| **Adjuvant** | A substance added to a pesticide to improve the effect of the active |

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| | ingredient, or to aid in its application. These include emulsifiers, wetting agents, and surfactants. |
| **Adsorption** | The binding of chemicals to soil particles and other materials. |
| **Aerosol** | Pesticide driven by an inert gas under pressure. Very fine solid or liquid particles hang in the air. |
| **Air-powered purifying respirator** | A respirator that uses an electric pump to draw air through a charcoal cartridge. The purified air travels to a tight-fitting face mask or loose-fitting helmet. |
| **Algicide** | A pesticide that is used to control algae. |
| **Alternate leaves** | Leaves that emerge singly at each node on alternate sides of the stem. They are not directly opposite each other. |
| **Annual weed** | A plant that completes its life cycle within one year. Many seeds are produced to ensure survival. Annuals can be divided into two groups: summer annuals, which germinate in the spring; and winter annuals, which germinate in the fall. |
| **Anti-backflow device** | A small piece of equipment attached to a filling hose. It prevents fill water from draining back into the water source. Example: check valve. |
| **Anti-foaming agent** | A substance that reduces foaming of spray mixtures. |

**Antisporulant fungicide** — A fungicide that prevents spore reproduction.

**Application rate** — The amount of pesticide applied to a given area (e.g., 5 kg per hectare). The application rate is found on the label.

**Attractant** — A chemical substance that may attract insects, mites, molluscs, or animal pests.

**Avicide** — A pesticide that is used to control birds.

**- B -**

**Bacteria** — Microscopic one-celled organisms. They may enter a plant through openings or wounds. Under the right conditions, they may reproduce very quickly, using the plant as food.

**Bactericide** — A pesticide that is used to control bacteria.

**Bait** — A mixture of large particles and an edible material. These are not pellets or granules.

**Beneficial** — An insect that helps to control pests in nature.

**BHSE** — British Health and Safety Executive

**Biennial weed** — A plant that lives more than one year, but less than two years. Biennials grow from seeds that often germinate in the spring. During the first year of growth, most biennials have only a rosette of leaves (see section on weed growth habits). Food is stored in short fleshy roots. In the next season, the plant uses the stored food to grow quickly and produce seed before dying.

**Bioaccumulation** — The build up of pesticides in the body tissues of humans and animals. This can only occur when pesticides are excreted (passed through the body) or metabolized (changed into energy) slowly.

**Biological control** — The use of living things, such as sterile insects, beneficial parasites, or natural predators, to control pests.

**Biomagnification** — The build up of pesticides in a food chain. The last animal in the food chain often receives a high level of pesticide. This can cause long-term damage or death.

**Buffer** — Any substance or chemical compound that keeps pH levels constant when adding acids or bases.

**Buffer zones** — Untreated areas around treatment sites. They serve to protect nearby areas (e.g., watercourses) by reducing the hazard of surface water or groundwater contamination.

**Buffer zone statement** — A label statement that dictates areas to be left untreated to protect an area next to a pesticide application site.

**- C -**

**Calibration** A process for checking and adjusting the delivery rate of application equipment.

**Canadian Farm Building Code** Industry recommendations that offer best practice guidelines for pesticide storage facilities

**Canister respirator** A metal or plastic container filled with absorbent material. It is designed to filter gases and vapours from the air. The canister may also contain a physical filter to remove solid or liquid particles.

**Carrier** Material added to a pesticide to dilute and promote even distribution. The carrier is often water, but may also be talc (dust), oil, or other solvents.

**Cartridge** The small, detachable part of an air-purifying respirator that absorbs gases and vapours from air.

**Cartridge respirator** This respirator may have a half-face or full-face mask. One or two cartridges filter out pesticide vapours. Cartridge respirators only protect against low concentrations of pesticides.

**Certified applicator** A person with a provincially approved pesticide applicator certificate bearing his/her name.

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| **Chemical control** | Control of pests using herbicides, insecticides, fungicides, repellents, and other registered products to suppress, repel, or kill pests. |
| **Chemical degradation** | A chemical reaction that occurs between the pesticide and elements in the environment, such as water. These often split the pesticide into less hazardous substances. |
| **Chemical family** | A group of pesticides with similar chemical makeup. Pesticides within chemical families often have similar modes of action, poisoning symptoms, and persistence in the environment. |
| **Chemical name** | The name given to the chemical structure of the active ingredient in a pesticide. |
| **Chemically resistant material** | Material that does not allow pesticide to move through it. |
| **Cholinesterase** | An essential enzyme in the blood that affects the nervous system and the way the brain sends messages to parts of the body. Changes in cholinesterase levels or activity will change the messages sent by the brain. Symptoms include trembling, twitching, convulsions (fits), breathing and heart distress, and death in severe cases. |
| **Chronic exposure** | Repeated exposure to a substance over a long period of time. |
| **Chronic poisoning** | Poisoning that occurs after repeated exposure to a pesticide over an extended period of time. |

**Chronic toxicity**

Toxic response from repeated exposure to small does of pesticide over a long time.

**Class designation**

Under the federal classification system, pesticides are grouped by their proper use. The class of a product appears on the label. Registered pesticides are grouped in four classes: domestic, commercial, restricted, or manufacturing class.

**Closed loading systems**

These all-in-one systems remove pesticide from, and then rinse, the container. Chemical contents and rinse solution are transferred to the sprayer tank at the correct rate.

**Commercial class**

Pesticides used in farming, forestry, industry, and other commercial operations. Active ingredients in commercial pesticides may be the same as those in domestic products. They are often packaged in larger containers or prepared with higher concentrations of active ingredient. This creates a greater risk to the applicator, the environment, and the public.

**Common name**

The name of the pesticide's active ingredient.

**Compatibility**

When two or more pesticides added to a spray tank mix and work well together.

**Compound leaf**

A leaf made up of separate leaflets.

**Concentrated product**

A pesticide that is sold to the user before dilution. These often contain a large amount of active ingredient.

**Concentration** — The amount of substance contained in a mixture. This is often expressed as a percentage by weigh or per unit of volume. It often refers to the active ingredient in a pesticide.

**Contact pesticide** — A pesticide that controls pests through direct contact.

**Cotyledons** — Seed leaves that are usually the first to form. They are often different in shape from true leaves. They may dry up and disappear or stay beneath the soil surface.

**Crop rotation statement** — A label statement that tells what crops can be safely planted after the treated crop has been harvested. Some pesticides can damage a crop planted in a field the year after product application.

**Cultural control** — Pest control method that uses practices common to good land management, such as crop rotation and planting certified seed.

**Curative fungicide** — A fungicide that moves within the plant. It goes to the site of infection, and prevents further pathogen development. Because of their systemic properties, curatives can be used shortly after infection.

**- D -**

**Degradation** — The breakdown of pesticides in the environment. The rate of pesticide breakdown is affected by a number of environmental factors. These include temperature, moisture, and pH and may occur through microbial degradation, chemical degradation, or photodegradation.

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| **Dermal** | Related to the skin. |
| **Dermal $LD_{50}$** | The amount of a substance (expressed as mg per kg of body weight) that will kill 50% of test animals when applied to the skin. |
| **Desorption** | The process of bound pesticides being released from soil or other material. |
| **Dilute** | To make a pesticide weaker by adding water, oil, or other substances; to “water down”. |
| **Domestic class** | Pesticides used in or around the home. When the label is followed, these can be handled safely with little personal protective equipment and without special training. |
| **Drift** | Airborne movement of pesticide droplets or particles away from the target area. |
| **Drift retardant** | A substance that reduces drift. |
| **Droplet** | A single, small amount of liquid. |
| **Droplet size** | The size of a particle of liquid created as a spray mix is forced through a nozzle. Droplet size is measured in microns. |

**Dry flowable (DF)**
Wettable powder formed into small pellets or spheres.

**Dust application equipment**
Equipment used to apply dust formulations. This equipment often meters the dust onto the crop (e.g., a seed treated for potatoes seed) or uses a powered-air system to carry the dust to the target.

**Dust mask**
A mask that protects from dust particles. It does not shield the lungs from pesticide vapours.

**- E -**

**Economic injury level**
The point at which the amount of damage caused by the pest is equal to the cost of controlling the pest.

**Emulsifiable concentrate (EC)**
A liquid formulation that contains the active ingredient, solvent and emulsifiers. These form milky sprays when mixed with water.

**Eradicant**
A fungicide applied to a plant infected with disease. It penetrates plant tissue and kills the disease organism.

**Eradication**
The total elimination of a pest problem.

**Exempt**
Not liable, excused.

**Exposure**
Contact by a person with a gas, liquid or solid. It can be oral, dermal or respiratory.

**- F -**

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| **Face shield** | A transparent piece of equipment used to protect the face from pesticide exposure. |
| **Fibrous roots** | Roots that grow from buds or stems. These form a network of similar sized roots. |
| **Flowable (F)** | A formulation of solid particles of active ingredient suspended in a liquid. These must be diluted and constantly agitated to remain mixed. *See* Suspension. |
| **Formulant** | Inert or other materials added to the active ingredient to make it suitable for storage, handling, or application. |
| **Formulation** | The form in which a pesticide is sold. This includes active ingredient, carriers, dilutants, or other materials. |
| **Fumigant** | A pesticide in the form of a volatile liquid. It is designed to control harmful micro-organisms, animals, and plants when absorbed or inhaled. |
| **Fungi (fungus)** | Small organisms that cause rots, mould, and plant disease. |
| **Fungicide** | Pesticides used to control fungal plant diseases. |

**- G -**

**Genetic control** — Pest control that involves planting genetically engineered crops.

**Groundwater** — Water found below the surface of the earth. Most groundwater occurs in zones of rock, sand, or gravel saturated with water. These zones are known as aquifiers.

**Growth regulator** — A substances that works by mimicking insect growth hormones. This affects normal development of insects. Insects die before they become adults and reproduce.

**"Guarantee" statement** — The name and amount of the active ingredient in a product This is stated on the label. It is often expressed as a percentage by weight or a weight per unit of volume.

**- H -**

**Half-life** — The time it takes for one-half of a given amount of a pesticide to break down in the environment.

**Hazard** — The danger of exposure when working with pesticides.

**Herbicide** — A pesticide that is used to control or kill unwanted plants.

**Herbicide-resistant crop** — A genetically altered crop that will not be damaged when treated with a weed control herbicide.

**- I -**

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| **Inert ingredient** | Liquids or solids added to the active ingredient to aid in storage, handling, or application. |
| **Ingest (ingestion)** | Take through the mouth and swallow. |
| **Inhale (inhalation)** | To take through the nose or mouth when breathing air into the lungs. |
| **Injury threshold** | When pests reach numbers that cause unacceptable injury or damage. This will justify treatment. |
| **Insect repellent** | A chemical that repels insect pests from hosts. These are often used to combat mosquitoes and biting flies. Examples include mothballs or crystals, and pet collars. |
| **Insecticide** | A pesticide that is used to control or prevent damage by insects. |
| **Integrated pest management (IPM)** | A pest management system that relies on a number of pest control methods. These include biological, cultural, physical, and chemical methods. |
| **Intercropping system** | The combination of crop rotation and optimal tillage methods, along with proper row widths and harvesting methods. This breaks weed cycles and reduce their build-up. |
| **Inter-row cultivation** | Cultivation that uproots small weeds and cuts off larger ones. |

**Inversion** — When the air near the soil surface is cooler than the air above it. The warm air forms a cap that blocks upward air movement. This hinders dispersal of airborne chemicals. Inversions tend to occur at night when the earth cools.

**Ipecac** — A medicine which is swallowed to stimulate the central nervous system and the stomach to cause vomiting.

**- L -**

**$LC_{50}$** — The concentration (in parts per million) of a vapour that will kill 50 per cent of test animals when inhaled over a set time period.

**$LD_{50}$** — The amount of a substance (mg/kg) that will kill 50 per cent of the test animals exposed to it. The smaller the number, the more toxic the pesticide.

**Leaching** — The movement of pesticides in water through the soil (downward, upward, or sideways). Leaching increases when pesticide solubility increases, adsorption is low, or desorption is high, the soil has a low water-holding capacity, the soil has a low organic matter content, extra water is added to the application site through sources such as rain or irrigation, or the soil has a coarse structure, like that found in sandy loam.

**Liability** — Legal responsibility.

**Limitation** Restriction.

**- M -**

**MSDS (Material Safety Data Sheet)** A datasheet that provides detailed information about a pesticide. The MSDS contains information about the chemicals in the pesticide, and detailed information about product identification, hazardous ingredients, physical data, occupational procedures and preventive measures, first aid and emergency procedures, fire and explosion hazard, toxicity and health effects, reactivity data, and preparation data and group.

**MSHA** Mines Safety and Health Association.

**Manufacturing class** Pesticides used in manufacturing, formulating, or repackaging. They are not to be used by the general public.

**Maximum Residue Limit (MRL)** The maximum amount of pesticide residue, at harvest, that may be safely contained in food products. This is set by Health Canada and expressed in parts per million.

**Metamorphosis** Stages or changes in an insect life cycle. There are three types: no metamorphosis, incomplete metamorphosis, and complete metamorphosis.

**Microbial degradation** Breakdown when microbes (microscopic plants or animals) use pesticides as a food source. The speed of degradation is influenced by soil factors (e.g., temperature and moisture) that alter the microbes present.

**Microbial insecticide** — An insecticide that contains microbes (tiny organisms). When eaten, these produce poisons that kill the pests. These are sprayed on plants and are often poisonous only to certain insects.

**Micro-encapsulated suspensions** — Small capsules of active ingredient suspended in a liquid. They slowly release the active ingredient.

**Micron** — One-millionth of a metre or one-thousandth of a millimetre.

**Mite** — A tiny animal, similar to a spider, having 8 legs.

**Miticide** — A pesticide used to control mites and ticks.

**Mobility** — The ability of a pesticide's active ingredient to move away from the application site through soil, water, or air. The more mobile the pesticide, the higher is the risk of environmental damage.

**Mode of action** — The way that a pesticide impedes the normal function of a pest, and eventually suppresses or even kills it. Common categories of pesticides, grouped by mode of action, include contact pesticides, systemic pesticides, protectant pesticides and stomach poisons.

**Molluscicide** — A pesticide that controls snails and slugs.

**- N -**

**Nematicide** — A pesticide used to control nematodes.

**Nematode** — A very small, round worm that feeds on plant roots, stems, and leaves. Nematodes can affect the movement of water and nutrients in a plant. They may cause wounds through which fungi and bacteria may enter. Nematodes multiply using eggs and are spread through the movement of contaminated plants, animals, seeds, soil, or water.

**Non-absorbent** — Unable to take up or hold chemicals.

**Non-residual** — A substance that breaks down quickly and leaves no biologically active material behind.

**Non-selective** — A pesticide that affects all plants on contact.

**Non-systemic** — A pesticide which stays on the surface of a plant. It does not enter or move through the plant.

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| **Non-target organism** | Life forms, such as bees, birds, fish, and plants, which are not targets, but may be affected by pesticides. |
| **Non-target toxicity** | Harmful effects on non-target life. The wider ranging the influence, the greater is the environmental hazard, associated with the use of the pesticide. |
| **Noxious** | Harmful |
| **Nozzle output** | The volume of spray produced by each nozzle per minute (L/min). Nozzle output depends on the size of the nozzle opening and the pump pressure. |

**- O -**

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| **Ocular** | Concerning the eyes. |
| **Oral** | Taken into the body through the mouth. |
| **Oral $LD_{50}$** | The amount of a substance (mg per kg of body weight) that will kill 50% of test animals when ingested through the mouth (swallowed). |
| **Opposite leaves** | Leaves that grow in pairs from the same node, but across the stem from each other. |

**- P -**

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| **Pathogens** | The most commercially developed biocontrol agents for pests. |

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| **Particle drift** | *see* Drift. |
| **Particulate** | *see* Bait. |
| ***PCP Act* registration number** | This number shows that the product has been registered with the Pest Management Regulatory Agency. Every pesticide sold or used in Canada must have a *PCP Act* Registration Number. The higher the number, the more recently the product was registered. |
| **Perennial weed** | A plant that lives more than two years. Most perennials reproduce through seed. Many also spread – some exclusively – by vegetative means. |
| **Permeable** | Absorbent. |
| **Persistence** | The ability of some chemicals to remain in the environment for a long time. |
| **Personal protective equipment** | Clothing and other gear that protects a person from injury or death when using pesticides. These include gloves, apron, shoes, coveralls, hat, cartridge, respirator, and gas mask. |
| **Pest** | Any harmful, noxious, or troublesome organism. Pests include weeds, insects, fungi, bacteria, viruses, rodents, or other plants or animals. |
| **Pesticide** | Any device, organism, or mixture used for preventing, destroying, repelling, killing, or mitigating |

problems caused by insects, rodents, weeds, nematodes, fungi, or other pests; and any other substance or mixture used as a plant growth regulator, defoliant, or desiccant.

**Pesticide classification** — *see* Class designation.

**Pesticide label** — A pesticide label is defined in the federal *Pest Control Products Act* to include: any legend, word, mark, symbol, or design applied or attached to, included in, belonging to, or accompanying and control product. The label includes information on the active ingredients in the pesticide, crops and pests to which the pesticide can be applied, pesticide rate, how to use the product safely and effectively, and the level and type of hazards present when the product is used.

**Pesticide rate** — The amount of pesticide, as called for on the label, applied per unit of area or per plant.

**Pesticide registration** — All pesticides must be registered with the Pest Management Regulatory Agency (PMRA), a division of Health Canada.

**pH** — A measure of the concentration of hydrogen ions.

**Pheromone** — A chemically produced odour that mimics the scent of female insects and attracts males of the same species.

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| **Photodegradation** | The breakdown of pesticides by exposure to sunlight. If they are to control pests, photodegradable products must be incorporated into the soil shortly after application, before they break down. Unlike microbial or chemical degradation, photodegradation may directly change the effectiveness of a pesticide. |
| **Physical (mechanical) control** | Control of pests by removing them or keeping them from entering the crop. Common examples of physical control include using screens to keep out insects, applying mulches to suppress weeds, and cultivating fields to control weeds. |
| **Phytotoxic** | Chemicals that damage or injure plants. |
| **Piscicide** | Pesticide used to control fish. |
| **Poison** | A chemical which, when taken in small amounts, causes illness or death. |
| **Pollutant** | Any form of contaminant that spoils the natural environment. |
| **Post-emergent** | A pesticide applied after the crop has emerged from the soil. |
| **Powdered air purifiers** | A helmet system respirator that has a motor-blower that forces air through a filter. |
| **Precautionary symbol** | A symbol with a shape and word to indicate the type and severity of the pesticide hazard. |

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| **Pre-emergent (blind) harrowing** | Harrowing after the crop seed has germinated, but before plants have emerged from the soil. |
| **Pre-emergent** | A pesticide applied before the crop has emerged from the soil. |
| **Pre-grazing interval** | The time between the last pesticide application and when animals are allowed to graze on the crop. Failure to wait this time may result in poisoning of the animal, or meat or milk from the animal being contaminated with pesticide. |
| **Pre-harvest interval (PHI)** | The amount of time between the last pesticide application, and harvesting of plants, grazing, or cutting for livestock food. Failure to wait this time may result in pesticide residue levels in excess of the maximum residue limit (MRL) for that crop. |
| **Pre-plant (herbicide)** | A herbicide treatment applied before the crop is planted. It may be applied when the land is being prepared for planting or just before seeding. |
| **Pre-slaughter interval** | The amount of time between treatment of an animal with pesticide and the slaughter of that animal for food. Failure to wait this time may result in contaminated meat that is not legal to market for human consumption. |
| **Premix slurry** | A mixed substance that dilutes the concentrated pesticide solution before loading. This limits the |

user's contact with airborne particles of wettable or soluble powders.

**Pressure rinsing** — Properly rinsing empty pesticide containers using force and water.

**Pressurized products** — Aerosols, sprays, foams, or dusts packed in a pressurized container. They may be liquids, solids, or gases.

**Principal display panel** — Front panel of a pesticide label.

**Product name** — The formulation, use, active ingredient, and brand or trademark of a pest control product.

**Protectant** — A fungicide that covers potential host plants with a protective film. This prevents fungus spores from germinating.

**- R -**

**Re-entry period or time** — The length of time that must pass before a worker is permitted to enter an area where a pesticide has been applied without proper protective clothing.

**Registrant** — The company to whom the product is registered, also known as the manufacturer.

**Registration number** — *See PCP Act* registration number.

**Regulated pesticides** — Under the Nova Scotia Pesticide Regulations, any non-domestic pest control product.

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| **Residual** | A pesticide that continues to work after application. Residual pesticides do not break down quickly in the soil. They may last for weeks, months, or years. |
| **Residue** | The amount of pesticide that remains on a crop, animal, or surface after treatment. |
| **Resistance or tolerance** | Genetic traits among pests that enable them to resist certain types of pesticides that are toxic to other members of the species. Resistance can develop if pesticides are used poorly or too often. |
| **Resistance management statement** | A statement that relates strategies to the user to be followed to avoid pest resistance to a given product. Resistance management statements may be listed on pesticide labels. |
| **Respirator** | A device used to protect the wearer from breathing in toxic air. There are three kinds: **quarter-face piece** (covers above the chin), **half-piece** (under the chin), and **full-face piece** (covers nose, mouth and eyes). |
| **Restricted class** | Pesticides that carry added use limits or restrictions on the label. These may be due to high toxicity, required application method, or level of risk to the environment. |
| **Risk** | The chance of exposure and the amount of harm that may result. Risk depends on the toxicity of the pesticide and exposure to it. |

**Rodenticide** — A pesticide used to control rats, mice, rabbits, and other rodents.

**Rotary hoe** — A hoe that lifts and mixes soil as it uproots small weeds. Rotary hoes tend to cause less damage to the crop than harrows. These can also be used to incorporate surface-applied herbicides.

**- S -**

**Secondary display panel** — The back or side panel of a pesticide label.

**Secondary pest** — A pest that is not causing the primary damage, but still causes damage.

**Seed treatment** — A finely ground, dry pesticide. It often contains a coloured dye and is applied to the surface of the seed.

**Sediment** — Any solid that settles out of a solution and goes to the bottom of the container.

**Selective** — Any pesticide that will control some pests but not others. Selective insecticides control only certain insects and tend not to harm non-target life. Non-selective insecticides control and harm all insects (non-target and beneficial).

**Self-contained breathing equipment** — A device that supplies air through a tube on a headpiece from a tank on the wearer's back. Respirators are often worn when applying

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| | fumigants or fighting fires in pesticide storage areas. |
| **Siphon** | The process of drawing a liquid "up-hill" from one container to another. The flow is started by suction and continues because of gravity and surface tension. |
| **Smoke bombs** | A pesticide which burns and releases aerosols, gases, and vapours. These are used to fumigate greenhouses and mushroom houses. |
| **Soil fumigation equipment** | Equipment for liquid fumigants with hose shanks instead of spray nozzles. These inject liquid fumigant into the soil where it evaporates and becomes a vapour. |
| **Soil sterilants** | Non-selective residual herbicides applied to soil to prevent plant growth for a long time (a few months to many years). |
| **Soluble packaging** | Packages placed directly into the sprayer tank. Soluble pesticide packages often contain dry flowable and wettable powder formulations. |
| **Soluble powder or granule (SP/SG)** | Dry, dust-like material that must be dissolved in a liquid. |
| **Solution (S or SN)** | A liquid formulation of an active ingredient dissolved in solvents. Solutions are clear in appearance. |
| **Solvent** | An organic liquid used to dissolve non-water soluble substances |

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| **Spores** | Tiny "seeds" which are produced by a fungus and spread in the air. When they germinate, some spores can infect certain plants. |
| **Spray drift (particle drift)** | Airborne movement of spray droplets away from the treatment site during application. Spray drift is affected by droplet size, air movement (wind), stable wind conditions, or atmospheric inversion conditions, distance between the nozzles and the target, or speed of application equipment. |
| **Spreader** | A substance that allows pesticides to form an even coating or layer over a treated surface. |
| **Sticker** | A substance that helps pesticides to stay on a treated surface. |
| **Sticky paste** | Pesticide-containing ointment that uses attractants (e.g., colour) to lure insects into traps. They become stuck in the substance. Examples include insect strips and wood preservatives. |
| **Stomach poison** | A pesticide that must be eaten by the pest to work. |
| **Suffocating insecticide** | A chemical poison that clogs the breathing system of insects. These may also affect egg survival (such as oils). |
| **Surface water** | Water at the soil surface in open bodies such as streams, rivers, lakes, and oceans. |

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| **Surfactant** | A substance that improves the spreading, dispersing, and/or wetting properties of a pesticide mixture. These cause it to spread out over a surface rather than "beading-up" in small droplets. |
| **Surplus** | Excess or extra (not needed). |
| **Suspension (or flowable)** | A cloudy liquid made up of solid particles of active ingredient (finely ground) in a liquid. Needs dilution. |
| **Symptom** | An outward sign of a disease or poisoning. |
| **Syrup of ipecac** | A liquid used to induce vomiting for certain cases of pesticide poisoning. |
| **Systemic** | A pesticide that is absorbed into a pest and moves throughout all its parts. |

**- T -**

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| **Tablets** | Active ingredients alone, or active ingredients and formulants. They are formed into small blocks or spheres. |
| **Tank mixes** | Mixtures of different pesticides blended in the same spray tank. |
| **Taproots** | Long and tapered roots that reach deep into the soil. Smaller side roots branch out from the taproot to anchor the plant. |

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| **Target** | Where the pesticide is to be applied – for example the soil surface, or the leaf of a plant. |
| **Temperature inversion** | This often occurs at night, when cool air near the soil surface is trapped under a layer of warmer air. |
| **Thickener** | A substance designed to reduce drift by increasing droplet size. |
| **Threshold limit** | The number of pests at which control should be carried out. |
| **Topography** | The physical features of a district or region such as those shown on a map, taken collectively; especially, the relief and contours of the land. |
| **Toxicity** | The ability of a substance to cause human injury, sickness, or other harmful effects. |
| **Toxicological information** | Important information needed by medical staff when treating people who have been poisoned or injured by a pesticide. This may include signs and symptoms of poisoning. This may inform the doctor of the antidote to use and any ingredients that can affect treatment. |
| **Trade or product name** | The name the manufacturer uses to identify a product. |
| **Translocation** | The process where a herbicide enters a weed via roots or exposed plant parts. It then moves in and through the plant. |
| **Triple rinsing** | A method of proper rinsing of empty plastic pesticide containers. |

They are filled to 10 per cent with diluent, capped and shaken. The rinsate is emptied into the spray tank. This is done three times.

**True liquid/solution** — When active ingredient is mixed with water and the water remains clear.

**- U -**

**Ultra Low Volume** — Application equipment and method for applying small amounts of concentrated pesticide. Application rates are only 5-6 litres per hectare or less.

- **V -**

**Vaporize** — Pesticides are applied to a crop and heated by sunlight. These may break down to produce gases that are lighter than air. These vapours can drift with air currents to other areas and cause damage.

**Vapour** — Mist.

**Vapour drift** — The movement of pesticide vapours.

**Virus** — A small organism that can only multiply within living cells of other organisms. These can produce disease symptoms in some plants and animals. Viruses may be spread by mechanical means (e.g. during pruning or harvesting), in propagation material (e.g., seeds, tubers and other plant parts), or by

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| | vectors (e.g., insects, mites, nematodes, or fungi). |
| **Volatility** | The ease with which a substance evaporates. |
| **Volitization** | The process whereby solids or liquids evaporate and become vapours (gases). |
| **Volume of use** | The total amount of the product used. The larger the volume of product used, the higher the risk of environmental damage. |

**- W -**

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| **Weeder harrow** | A harrow that uproots and covers smaller weeds without harming the crop. Timing, relative to the leaf stages of both the crop and weed, must be considered when choosing this method of pest control. |
| **Wetting agent** | An adjuvant added to pesticide to promote spreading. |
| **Wettable powder** | An active ingredient plus a powder. These contain wetting and dispersing agents, and are mixed with water to form a suspension. |
| **Whorls** | Groups of three or more leaves coming from the same stem node. |
| **Wick applicator** | An applicator that selectively applies liquid herbicides to weeds. |

The herbicide solution is often added to a long pipe that is wrapped in rope or some absorbent material. The herbicide seeps out of the pipe and is absorbed by the wicking material. The herbicide can be wiped onto weeds that grow taller than the crop, between rows, or where drift may be a problem.