

Ohio Pesticide Applicator Training

***A Study Guide for Commercial
Industrial Vegetation Applicators***

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<http://pested.osu.edu>

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A complete list of licensing and recertification procedures in Ohio for commercial and private applicators is available. This includes a comprehensive list of testing, recertification schools, and new applicator training dates as well as study materials for exam preparation. Visit:

<http://pested.osu.edu>

General Pesticide Information

Information concerning Ohio 24(c) registrations, Ohio recycling dates, and poison control centers is available at:

<http://pested.osu.edu>

Pesticide Licensing

For information on pesticide licensing, visit the Pesticide Regulation Section, Ohio Department of Agriculture:

<http://ohioagriculture.gov>

1-800-282-1955

Information on Specific Pesticides

For information on specific pesticides, visit the National Pesticide Information Center at:

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1-800-858-7378

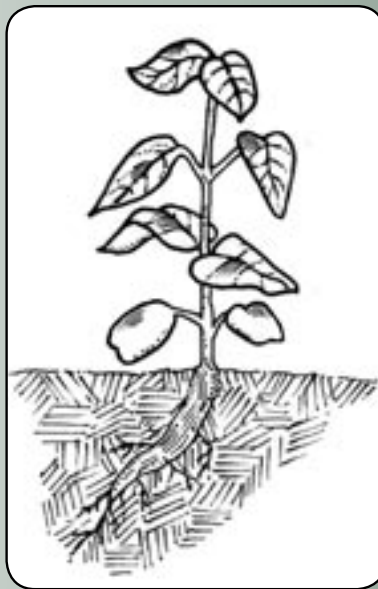
E-mail: npic@ace.orst.edu

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Pesticide Poisoning Information

For pesticide poisoning information, call the National Hotline for U.S. Poison Control Centers.

1-800-222-1222



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Chapter 1

Introduction to Industrial Vegetation



Photo courtesy of DuPont

Objectives for This Chapter...

1. List application sites identified in the Ohio Commercial Pesticide Applicator Category 5 — Industrial Vegetation.
2. Describe why vegetation management is necessary.
3. Identify methods of weed and brush control.
4. List information that may be found on the pesticide label.

Key Terms to Know...

Industrial Vegetation — Weeds and brush growing in publicly used areas, commercial and industrial areas, as well as transportation and utility corridors.

IPM — Integrated Pest Management (IPM); an approach to pest control that focuses on identifying pests before implementing control measures. IPM also combines pest management tools in a way that minimizes economic, health, and environmental risks.

Introduction to Industrial Vegetation

Serving the Public

We drive down roads that have wide grassy areas without brush encroaching on the roadway. Parking lots and other commercial areas are free of unsightly weeds. These and other similar areas are cared for by pesticide applicators who are involved in industrial vegetation control.

Industrial Vegetation Control

The ***industrial vegetation*** category involves weed and brush control in publicly used areas, commercial and industrial areas, as well as transportation and utility corridors. Industrial vegetation control is the application of herbicides to areas such as:

- Roadways
- Public water courses
- Utility rights of way
- Railroads
- Industrial sites
- Power substations
- Parking lots
- Areas around storage buildings
- Driveways



The industrial vegetation category also includes related places like parking lots and sports areas such as baseball diamonds and bleachers. Controlling weeds around buildings and fences is also part of industrial vegetation control.

Many companies and agencies may have employees who are licensed in industrial vegetation control. These licensed employees are responsible for spraying these areas or supervising crews that spray. The companies and agencies include public road and transportation agencies, utility companies, lawn-care companies, municipalities, county agencies, and companies that contract to control industrial vegetation.

Why Control Weeds and Brush?

Safety, visibility, and access are important benefits of industrial vegetation control. Weed and brush control management also keeps areas looking well cared for, an important by-product of controlling undesirable vegetation.

Roadside Safety

Weed and brush control along roadsides increases visibility for drivers. Motorists need to be able to see road signs and oncoming traffic on curves,

hills, and hazardous road areas. Roads also need wide recovery areas on the sides of the pavement for stranded motorists and emergency vehicles. Drivers need to have enough sight distances along roadways to see hazards such as wildlife and cars entering from driveways. Woody plants along the shoulders of a road need to be controlled. Otherwise, excessive shade from the trees will not allow sunlight to penetrate and evaporate rain, ice, and snow from the pavement. Large trees can also fall across the road and become an obstacle.

Access and Safety

Utility companies control weeds and brush in rights of way to provide access to utility lines. Trees and brush repeatedly grow too tall and become entangled in electric wires. This can cause electrical outages. Pipelines also have similar control concerns.

Substations must be kept weed free for the safety of utility workers and the proper functioning of the equipment. Each substation has a system of grounding grids which are buried. Weeds could potentially spread their roots onto these grounding grids.



Railroads also must be kept clear of encroaching vegetation to maintain train traffic. Weeds can degrade the ballast supporting the tracks. Weeds also become a fire hazard because of sparks from passing trains. It is also important to maintain visibility at road crossings for train and vehicle traffic safety.

Flooding Hazard

Brush and weeds can slow the progress of water. This can become a problem in flood-prone areas such as drainage ditches, parking areas, and roadsides. Controlling weeds and brush helps prevent flooding by allowing water to drain quickly.

Maintenance and Appearance

Weeds and brush can be destructive to parking lots, roadside structures, and fences. Controlling weeds and brush helps maintain the lifetime of these structures. Well-controlled areas look more pleasing than areas with out-of-control weed and brush growth.

Vegetation management also includes urban and landscaped areas. Weeds and brush are controlled around buildings and more manicured areas to improve appearance. Effective vegetation control is also needed for company roadways, driveways, and parking lots.



Photo: Dr. Harvey Holt, Department of Forestry, Purdue University

Laws and Safety

The state of Ohio has laws to prevent the spread of noxious and invasive weeds. Industrial vegetation management helps control these weeds. Out-of-control weeds and brush also can become a public-safety issue near parking lots and commercial areas.

Controlling Weeds and Brush

The method of vegetation control is usually chosen based on accessibility of the site, labor concerns, and the need for long-term control. **Integrated Pest Management (IPM)** may be utilized for control of vegetation with intensive management to reduce input costs. IPM focuses on identifying pests before implementing control measures, focusing on strategies that are most effective and cause the least harm to people and the environment.

Control Methods for Industrial Vegetation

Controlling weeds and brush has always been a priority for farmers, landowners, and government agencies. Several strategies are available for industrial vegetation management. This study guide will focus on chemical vegetation control to help you prepare for your applicator's license. However, it's important to know other vegetation control methods, in addition to chemical, to help you make vegetation management decisions. See the chart on next page for information on different control methods.

Study Questions

1. How does weed control affect the safety of roadsides?
 - a. Cars can be driven at higher speeds.
 - b. Drivers have more visibility and emergency lanes.
 - c. Weed control makes the roadside scenery more attractive.
2. What is an advantage for chemical control of weeds and brush?
 - a. Control is cost effective.
 - b. Control develops slowly.
 - c. Control is labor intensive.

Explanations

1. b – Controlling roadside weeds and brush gives drivers visibility and emergency lanes along the shoulder of the road.
2. a – Control is cost effective. Chemical control is cost effective because it reduces labor when compared to manual control. Chemical control is also timely.

Industrial Vegetation Control

Control Method	Tools Used	Advantages	Disadvantages
Mechanical	<ul style="list-style-type: none"> • Mechanical devices • Mowers • Weed eaters • Chain saws 	<ul style="list-style-type: none"> • Immediate control • Involves no chemicals 	<ul style="list-style-type: none"> • Short-term control • Expensive to maintain • Destroys habitat
Manual	<ul style="list-style-type: none"> • Hoes • Shovels • Machetes 	<ul style="list-style-type: none"> • Low-cost equipment • Low-profile workers 	<ul style="list-style-type: none"> • Labor intensive • Not practical for large sites
Chemical	<ul style="list-style-type: none"> • Herbicides • Growth regulators • Application equipment 	<ul style="list-style-type: none"> • Selective control • Long- or short-term control • Cost effective 	<ul style="list-style-type: none"> • Not appreciated by everyone • Requires training
Biological	<ul style="list-style-type: none"> • Insects • Grazing animals • Disease 	<ul style="list-style-type: none"> • Utilizes IPM approaches • Uses natural tools 	<ul style="list-style-type: none"> • Develops slowly • Few available • Cannot control wide variety of pests
Cultural	<ul style="list-style-type: none"> • Mulch • Fire • Lime 	<ul style="list-style-type: none"> • Utilizes IPM approaches • Uses natural tools 	<ul style="list-style-type: none"> • Not effective for large areas • Can be dangerous if left out of control
Native Plant Materials	<ul style="list-style-type: none"> • Wildflowers • Native species 	<ul style="list-style-type: none"> • Compete with undesired weeds • Aesthetic 	<ul style="list-style-type: none"> • Develops slowly • Requires some management

Preparing for Your License — The Label

Reading and understanding the label is an important step in the application process. Why is the label so important? The label contains essential information you need to know for the application. There are statements about applying the product and information to protect your health. Labels also contain phone numbers if you need more information about the product.



Also, the **label is a legal document**. As an applicator, you are **required by law** to use the product according to the label. The label information includes:

- Pests that the product is intended to control.
 - Application sites approved for the product.
 - Active ingredient.
 - Personal Protective Equipment (PPE) needed.
 - Product registration information.
 - Formulation of the product.
 - Hazards to avoid.
 - Emergency and first-aid information.
 - General directions for use.
- Mixing directions.
 - Precautionary statements.

The label is the basis of pesticide application and will be a theme of this study guide. We will discuss each subject area with the appropriate part of the label.

Study Questions

1. Why is the label important?
 - a. The label is entertaining.
 - b. The label is an opinion.
 - c. The label is the law.

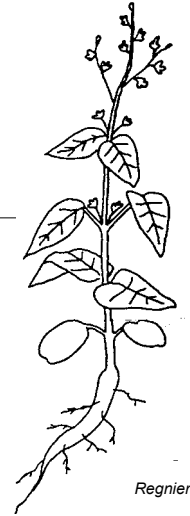
2. What is an item listed on the label?
 - a. Application sites approved for this product.
 - b. Telephone numbers of the regulatory department.
 - c. Information regarding your pesticide license.

Explanations

1. c – **The label is the law**. The label states the application sites, methods of application, and hazards associated with the specific pesticide product. All directions on the label must be followed.

2. a – Application sites approved for this product. Earlier in this chapter there was a list of items that will appear on every pesticide label. Application sites are included in this list. Information regarding your specific pesticide license is available through the overseeing regulatory agency in our state — the Ohio Department of Agriculture.

Chapter 2 Plants and Herbicides



Objectives for This Chapter...

1. Distinguish between major plant species.
2. Describe life cycles for plant species.
3. List reasons for herbicide selection.
4. Identify brand name, chemical name, and common name on a label.

Key Terms to Know...

Annuals — Plants that complete their life cycle in one year.

Winter Annual — Annual plants that germinate in the fall and flower in the early spring.

Summer Annual — Annual plants that germinate in the spring and flower in the summer.

Biennial — Plants that need two years to complete their life cycle.

Perennials — Plants that persist year after year.

Brand Name — Manufacturer's name for the pesticide.

Chemical Name — Complex name that identifies the chemical components and structure of the pesticide.

Common Name — Shorter name for the longer, complex chemical name.

Plants and Herbicides

What Plant Is This?

You're helping load the trucks as the crew prepares for a day of spraying roadsides. One of the supervisors mentions something about "broadleaf control." When you arrive at the roadside, you notice the side of the road that was sprayed last week is grassy. The roadside the crew is setting up to spray has a lot of weeds mixed in with the grass — two of these weeds you recognize as wild carrot and ragweed.

Later during a break, you ask the crew leader if the spray will kill everything on the roadside. "That's not what we're trying to do," he says. "We want to have the grasses grow, but not all the other stuff."

He explains that grassy plants are encouraged along roadsides because they maintain a more uniform height and can be controlled more easily with mowers. Broadleaf plants, he says, sometimes grow more quickly and unevenly, creating more maintenance problems, and broadleaf plants are not as aesthetic as grasses. So the crew is spraying to control only broadleaf plants and allow the grasses to grow.

The supervisor also says that woody plants cannot be allowed to grow along roadsides because they obstruct the driver's view and shade the road. He says shaded roads take longer to dry after a rain and do not allow snow and ice to melt as quickly.

You walk away with one big question in your head — how can you tell the difference between all these plants?



Regnier

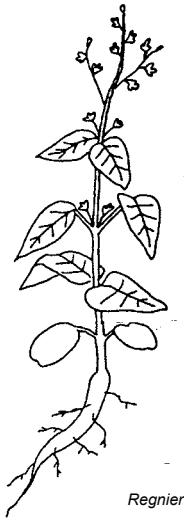
Grasses

Grasses have narrow leaves with parallel veins. Grasses have two types of leaves. One is called the sheath that wraps around the stem. The other is the true leaf that attaches to the sheath at an area called the collar. The seedlings emerge from the ground with only one leaf.

Grass species are usually encouraged to grow on roadsides and in rights of way. A healthy grass turf will discourage growth of unwanted vegetation such as tall weeds and brush. Grass remains relatively short while also providing habitat for wildlife.

Among grasses, some species are considered weeds, even in an area that will be kept grassy. Crabgrass and Johnsongrass are two examples. These are often considered weeds and may be selectively sprayed for in an area.

Broadleaf Species



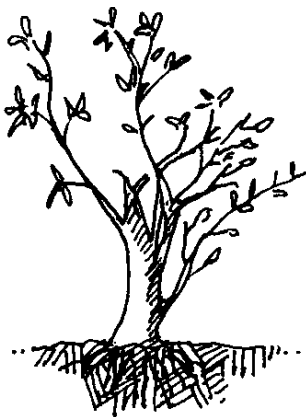
Just as the name implies, broadleaf species usually have broad leaves with a pattern of veins that look almost net-like. The leaves of most broadleaf species are attached to the node of the plant with a prominent structure.

The flowers of broadleaf species usually have colored petals. This is compared to grasses where the flowers have no petals. The broadleaf species emerge from the ground with two leaves, unlike the one-leafed grass. Broadleaf species are often targeted for control because they can grow very tall and are often considered unsightly.

However, in some areas, broadleaf species may be encouraged to grow. Many wildflowers are considered broadleaf species. These may be planted in roadside areas. Spraying in the area will be done selectively to protect the wildflowers while controlling invasive broadleaf weeds like wild carrot.

Woody Plants

Woody plants are those that form wood and live for more than two years. This includes brush, shrubs, and trees. Brush and shrubs are woody plants that have several stems and are less than 10-feet tall. Trees are woody plants which usually have a single stem (trunk) and are more than 10-feet tall.



Woody plants need to be removed from the right of way because their height could interfere with utility wires. Too many trees also reduce visibility for line people who are trying to locate downed wires. Dense brush also makes it difficult for crews and equipment to access utility wires. Woody plants are a nuisance near the edge of roads as they make it hard for drivers to see around curves and reduce the size of the safety recovery zone along the roadside.

Growth Stages

Plants have various stages of growth. Usually, weeds are easiest to control in the seedling, or young, stage of growth. At this time, the leaf surface is easy to penetrate. The surface hairs on the leaf are also fewer and smaller at this stage.

Other plants, such as Canada thistle, are easier to control when they are blooming and preparing to make seeds. During this time, the plant is storing sugars and food. A herbicide can be used to disrupt this process.

A weed is considered mature when it is fully grown and does not produce any more seeds. Spraying herbicides at this stage will not control a weed very well. The seeds have already been spread, or the roots have grown deeper and stored food for the plant.

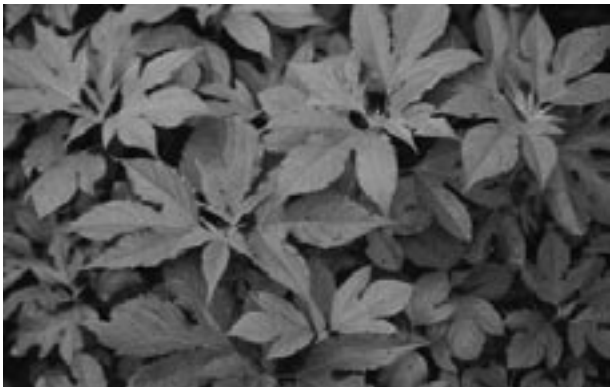
Plant Structure

Often herbicides are sprayed on the leaves of weeds for control. The leaf structure can affect how well the herbicide will enter the plant. Herbicides may have trouble penetrating leaves with thick, waxy surfaces. Spraying these type of plants when they are small and immature will increase herbicide control. Some plants have leaves with short or long hairs. The hairs can keep the herbicide from touching the green part of the leaf. These plants need to be sprayed when they are young. Sometimes additions can be made to the herbicide to help the spray stay on these leaves.

Herbicide Selection

Herbicides will be selected based on what weeds need to be controlled. Proper selection of herbicides will help control the intended weed. So, properly identifying the weed as a grass, broadleaf, or woody plant is important. The next step is to identify the life cycle of the plant. Generally, young tender weeds are easier to control. Within the categories of grasses and broadleaf species, there are different life cycles. Plants can be annuals, biennials, or perennials. Knowing the life cycle will help decide the time of year to spray.

Annuals complete their life cycle in one year. An annual plant grows from seed, flowers, produces new seed, and dies within one year. Some annual species germinate in the fall and flower in the early spring. These are called **winter annuals**. Other annual species germinate in the spring and flower during the summer. These are called **summer annuals**.



Giant ragweed — annual

Photo: Virginia Tech

It's important to know which annual weed you are trying to control. Winter annuals must be sprayed in the fall or early spring before the seeds are produced. Summer annuals must be sprayed in the later spring or summer before the seeds are made

in the fall. The goal is to eliminate the weed before it creates seeds. If the annual weed is not controlled before seeds are formed, you will be fighting the same plant again next year. Also, spraying when plants are young will increase control.

Annuals can be controlled with herbicides that are applied directly to the plant. If the plant dies before producing new seeds, you are able to control the population.

Biennials need two years to complete their life cycle. The first year, these weeds grow leaves and roots and store energy. Flowers and seeds are produced the second year, and then the plant dies. Biennials only reproduce by seeds.



Chicory — perennial

Photo: Virginia Tech

Like annuals, biennials can be controlled with herbicides that are applied directly to the plant. The plant needs to be sprayed before new seeds are produced. This prevents new weeds from developing.

Perennials persist year after year. There are two types of perennials. One is called woody because the stem is always visible. These perennials would be trees, shrubs, and brush.

The other type is called herbaceous which means the stems are killed by frost. This would include plants like Canada thistle, dandelions, and Johnsongrass. The plant then regrows from underground vegetative organs such as bulbs, stolons, tubers, rhizomes, or creeping roots.

Many woody perennials only reproduce by seeds, but some woody perennials and all herbaceous perennials reproduce by vegetative organs. Perennials that have stolons, rhizomes, or creeping roots can spread up to several feet.

Perennials need different control than annuals and biennials because the plants do not always grow from seed. Some plants have creeping roots or rhizomes that spread underground. The herbicide to control these must kill the plant above ground as well as the roots and other vegetative organs below ground.

Because of the life cycle of perennials, timing for spraying may be different than for other weeds. For example, annual weeds are most

vulnerable when they are young. However, Canada thistle, a perennial, is most susceptible during the bud to bloom stage. This is when the sugars and food produced by the plant are moving to the roots. So, the herbicide moves downward with the food to kill the rhizomes and not just the top of the plant.

Ohio Noxious Weeds*

Shatter cane
 Russian thistle
 Johnsongrass
 Wild parsnip
 Wild carrot
 Oxeye daisy
 Wild mustard
 Canada thistle
 Poison hemlock
 Cressleaf groundsel
 Musk thistle
 Purple loosestrife
 Mile-a-Minute Weed
 Grapevine (*groups of 100 and not cultivated for two years*)

* List as of 2005.

Grasses are either annual or perennial, while broadleaf species can have any of the three different life cycles. Herbicide selection and timing depends on the plant's growth cycle so the maximum amount of control will occur with the least amount of herbicide used. This not only saves money but also is environmentally friendly.

Noxious Weeds

Another reason to control some broadleaf species is to target noxious weeds. Noxious weeds are especially problematic weeds. They aggressively compete with other plants and destroy natural habitat. Some are toxic to livestock, and some are a threat to public health, safety, or navigation.

Ohio has several laws governing weed control. Prohibited noxious weeds may be regulated on private property, rights of way, and public roadsides. A list of Ohio prohibited noxious weeds (*see box at left*) and the noxious weed law are available in the Ohio Revised Code.

Study Questions

1. Which type of vegetation has narrow leaves, parallel veins, and flowers without petals?
 - a. Grasses
 - b. Broadleaf species
 - c. Dandelions
 - d. Thistles

2. What is one reason why woody plants are discouraged in utility rights of way?
 - a. Considered unsightly under wires.
 - b. Height interferes with wires.
 - c. Viewed as public relations risk.

3. Why is it important to understand the type of plant to be controlled?
 - a. To determine the size of the area.
 - b. To be able to select the correct herbicide to be used.

Explanations

1. a – Grasses. Grasses have narrow leaves, parallel veins, and flowers without petals. Dandelion and thistle are broadleaf plants.
2. b – Height interferes with wires. While woody plants may be considered unsightly and a public relations risk, the most important reason is that the height of trees interferes with the utility wires. The tall trees create a safety hazard.
3. b – To be able to select the correct herbicide to be used. Knowing the enemy — in this case, the weed or brush — helps applicators choose the correct herbicide and timing to control the vegetation.

Herbicide Label

A herbicide can be identified by reading the label. The **brand name** is usually located in a prominent place on the label. Each manufacturer has a brand name for each of its products. Different manufacturers may use different brand names for the same pesticide Active Ingredient.

The entire label must be read, instead of choosing a pesticide product by brand name alone. Many companies use a basic brand name with only minor variations to designate different pesticide formulations.

Brush Terminator S (*brand name*)

Brush Terminator S is a water-soluble liquid to be diluted with water and applied as a foliar spray for control and/or suppression of many woody species.

Brush Terminator S is recommended for use on non-cropland, including highway rights of way, industrial sites, railroad rights of way, storage areas, utility and pipeline rights of way.

Active Ingredient:

Ammonium salt of fosamine	41.5%
[ethyl hydrogen (aminocarbonyl) phosphonate]	
Inert Ingredients	58.5%
Total Ingredients	100.0%

The statement describing the type of herbicide usually can be found under the brand name, although it sometimes may be elsewhere on the label.

An example of a label is shown on page 17. *Brush Terminator S* is the brand name of the herbicide. Sometimes formulations are part of the trade name, but not always. This is especially true if multiple formulations are available. The "S" in *Brush Terminator S* refers to the formulation of water soluble liquid.

Your Records

During a break on the roadside, you are given the job of filling out the herbicide application record form. One of the blanks asks for the Active Ingredient. Looking at the label (see the sample on the previous page), you discover a string of extremely long scientific-looking words along with percentages. These words are the **chemical name** for the herbicide. Closer inspection shows the words *Active Ingredient* followed by the chemical name.

The Active Ingredient is an important part of the herbicide label. It's included on most herbicide application records. But the blank on your paper is not long enough for that big chemical name.

However, you can use the common name of the Active Ingredient. Looking back at your *Brush Terminator S* label, you'll see the Active Ingredient listed as ammonium salt of fosamine [ethyl hydrogen (aminocarbonyl) phosphonate]. **Ammonium salt of fosamine** is the **common name** of the chemical. Common names are shorter names used for the longer, complex chemical name. The common name is registered with the U.S. EPA. Common names are usually in front of the chemical name, separated by a colon, brackets, or something else. These can be written on the application record and used for any medical purposes. The common names are often easier to say and remember than the complicated chemical name.

The Active Ingredient is important in case of a pesticide poisoning emergency. The herbicide label should be taken with the patient to the hospital or the doctor's office to aid in diagnosis and treatment.

Study Questions

1. A herbicide can be chosen on brand name alone.
 - a. True
 - b. False

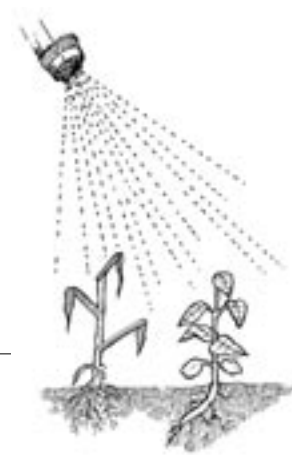
2. The label for *Brush Terminator* is on a previous page. Look at the label. What is the common name of the Active Ingredient?
 - a. Ethyl hydrogen
 - b. Ammonium salt of fosamine

Explanations

1. b – False. Always read the entire label. Brand names may be only slightly changed for a herbicide with a totally different Active Ingredient.
2. b – Ammonium salt of fosamine. On the sample label, the Active Ingredient is listed in the middle of the box. Look for the word(s) in front of the chemical name, in this case separated by brackets — [].

Chapter 3

Herbicide Characteristics



Objectives for This Chapter...

1. Compare selective and nonselective herbicides.
2. Compare preemergent and postemergent herbicides.
3. Compare contact and translocated herbicides.
4. Define residual and nonresidual herbicides.
5. Describe the following terms:

a. Drift	c. Runoff
b. Volatilization	d. Leaching

Key Terms to Know...

Selective herbicides — Herbicides that control **only certain** plant species while leaving other species alone.

Nonselective herbicides — Herbicides that control **most** plants and brush species.

Preemergent herbicides — Herbicides applied to an area **before** weeds are present.

Postemergent herbicides — Herbicides applied to an area **after** weeds are present.

Contact herbicides — Herbicides that control only the green part of the plant the herbicide touches.

Translocated herbicides — Systemic herbicides that move throughout the plant.

Residual herbicides — Herbicides that remain active for longer periods of time.

Nonresidual herbicides — Herbicides that break down quickly.

Drift — Pesticide droplets or dust that lands on nontarget areas or organisms.

Volatilization — The process by which a herbicide becomes a gas or a vapor because of high temperatures and low humidity.

Herbicide Characteristics

Selecting Herbicides for Controlling Vegetation

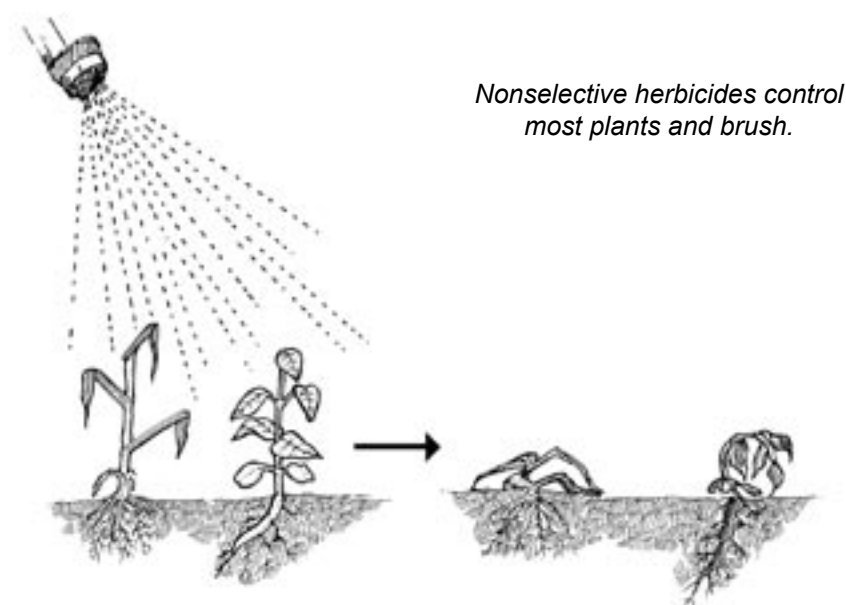
Your supervisor is sending you to a utility substation to control some vegetation. “Spray any plants inside the fence,” your supervisor tells you. “The utility company doesn’t want anything growing inside the fence for safety reasons.”

When you arrive at the substation, you notice some grasses and dandelions growing next to the building and over by the fence. You begin target spraying the weeds with a backpack sprayer. After going to the other side of the building, you see some small, five-inch-high maple seedlings. You guess they seeded from some nearby trees. Are you sure that the herbicide you are using will also control the maples?

Nonselective Herbicide

Your supervisor sent you with a **nonselective** herbicide. A nonselective herbicide controls most plants and brush species, including the maple seedlings. Nonselective herbicides are used in areas where all vegetation needs to be controlled, areas such as land around road signs, parking lots, and fencerows. These herbicides provide full vegetation control for an area and are routinely used in industrial vegetation management.

Most likely, you would not use a nonselective herbicide along a roadside in the middle of the growing season. If you spray a nonselective herbicide on an area with a lot of green growing plants, the plants (including trees) will all eventually turn brown. The public would view the area as an eyesore. The bare ground could also be vulnerable to erosion and washout.

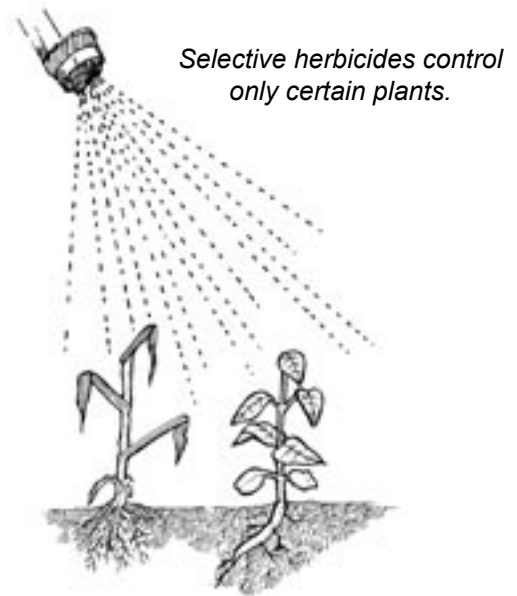


Selective Herbicide

There are times when you do not want complete vegetation control. The roadsides would look ugly without any grass, and rights of way are more appealing to wildlife with grassy cover instead of bare, brown soil. Selective herbicides are used in areas like roadsides and rights of way.

Selective herbicides will control only certain plants and leave the desired plants.

Selective herbicides are selected so vegetation can flourish to control erosion, be pleasing to look at, and provide wildlife habitat. On roadsides, grasses are allowed to flourish while broadleaves are controlled.



Plant Growth Regulators

Vegetation can also be controlled with plant growth regulators (PGR). The PGRs inhibit or limit cell division or cell elongation. The plant responds by slowing down new growth.

Tree growth regulators are used on trees to slow down the growth of branches. This is beneficial for roadsides and rights of way where trees and other plants need to be limited in size. Grass growth regulators are used on roadsides and in other areas to reduce growth and suppress seedhead formation of various turfgrass species. Growth regulators do not persist in the soil but can injure some off-target plant species.

Study Questions

1. Which type of herbicide is used to control all plants and brush in an area?
 - a. Selective
 - b. Nonselective
 - c. Growth regulator
 - d. Broadleaf

2. Why would an applicator choose a selective herbicide?
 - a. To buy the cheapest product.
 - b. To provide bare-ground control.
 - c. To control broadleaf species in a grassy area.
 - d. To keep the regulators satisfied.

3. What is the purpose of plant growth regulators?
 - a. To slow the growth of the plant.
 - b. To increase herbicide effectiveness.
 - c. To kill unwanted plants.

Explanations

1. b – Nonselective. Nonselective herbicides are used for total control of vegetation in an area. The herbicide can control grasses, broadleaves, and woody plants.

2. c – To control broadleaf species in a grassy area. Selective herbicides can be used to control only selected weeds.

3. a – To slow the growth of the plant. Plant growth regulators are used when the vegetation needs to be limited in growth but not completely controlled.

Herbicide Terms

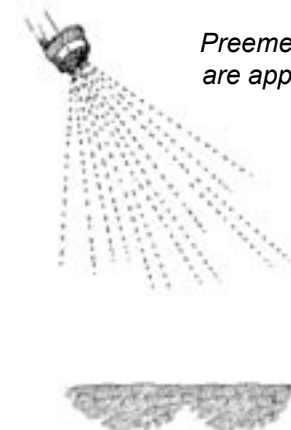
You are sitting in the break room waiting for everyone to return from lunch. You notice a pile of brochures left by the chemical representative. The brochures show a variety of new herbicides available for industrial vegetation. You look through the pile, wondering why there are so many herbicides just to control weeds.

You already know that herbicides can be either selective or nonselective. But herbicides have characteristics that affect the way they control plants.

Preemergence

Preemergence herbicides are applied to an area before the weeds are even seen. The herbicide forms a control barrier in the soil. As the weed starts germinating from seed, it cannot develop and dies before emerging.

These herbicides could be used in the early spring before plants have started to emerge. Preemergence herbicides

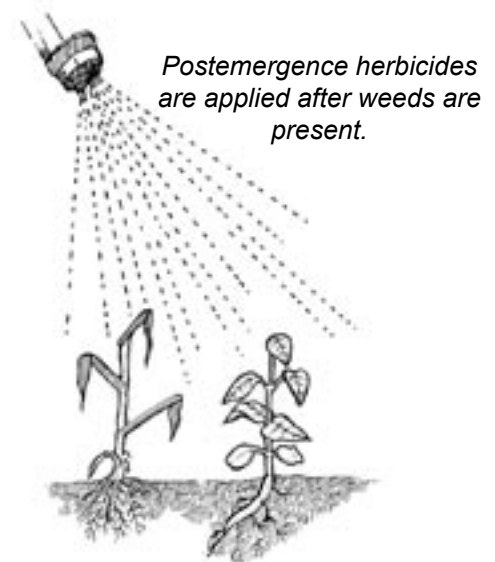


Preemergence herbicides are applied before weeds are seen.

could also be used where the ground has been tilled, before plants begin growing again.

Postemergence

Postemergence herbicides are applied after weeds are present. These herbicides can be either foliar active or soil active. The most common method is to apply a **foliar-active** herbicide that is absorbed by the plant leaves. The herbicide may then move to the buds of the plant and to the ground roots to stop plant growth. Root-absorbed herbicides are translocated to the shoots.



These herbicides could be used throughout the growing year. Postemergence herbicides can be used on plants, brush, and trees from spring to fall. Some of these herbicides can also be used on trees during the winter as a dormant, basal application. **Basal applications** consist of a concentrated herbicide applied to the base of a woody plant.

Plant Damage from Herbicides

You and your supervisor are driving past roadside sites that were sprayed last week. You notice the herbicide is starting to work. The leaves on the broadleaf weeds are starting to twist, cup, and curl, so you expect them to die soon. This will leave just grass in the areas that were sprayed. Your supervisor seems pleased with the control at the sites visited.

But he mentions the real reason for the drive is to respond to a complaint from a local farmer. The farmer says the herbicides applied to the roadside affected his soybean field. Your supervisor stops the truck in front of a soybean field, and you and your supervisor get out of the cab. You walk over to the fence and notice that the soybeans along the edge of the field look like the broadleaf weeds in the roadside ditch. The leaves are starting to twist, cup, and curl, showing signs of stress.

“Phenoxy damage,” sighs your supervisor. “What’s that?” you ask. Your supervisor explains that different herbicides affect plants in different ways. The phenoxy herbicides, such as 2-4,D and dicamba, disrupt the

cell growth of the plant. This causes the plant's leaves to curl, turn yellow, and eventually die. The soybeans in the field are showing these signs of stress.

“The herbicide drifted to the soybean field and caused this damage,” says your supervisor. “It's important that we know how a herbicide affects plants before applications. If we don't, we could use the wrong herbicide in the wrong location. Or, we could use the herbicide in the wrong weather conditions and cause damage to other plants.”

Not all herbicides affect plants the same way. Some herbicides will slow down photosynthesis, or the way a plant makes food. Other herbicides will affect the soil and prevent any plants from growing in an area. Knowing how the herbicide controls the plant is important in herbicide selection.

How the Herbicide Controls the Plant

The herbicide's active ingredient, formulation, and application will affect how it controls the target plant. Some herbicides only affect the plant, while others affect the plant and surrounding soil. Some herbicides have long-lasting effects (called residual) while others break down quickly (called nonresidual).

Knowing these characteristics is important for industrial vegetation applicators. Some areas, such as substations and guardrails, need long-lasting control. So a longer-lasting herbicide would be used. However, you must consider off-target plants when choosing a herbicide. For example, you may decide to use a long-lasting herbicide for controlling weeds in a parking lot. But you don't want the herbicide to have the same long-lasting effects on the landscaped pine trees planted next to the parking lot.

The active ingredients in the herbicide also affect the plant in different ways to control it. This is called **mode of action**. For example, some herbicides interfere with photosynthesis which is the way plants make their food supply from the sun. Some herbicides disrupt photosynthesis so the plant starves, causing it to turn yellow. If you apply a herbicide that affects photosynthesis on a cloudy day, the herbicide activity will be slowed, since the plant is not opening up for sunshine. While the herbicide will control the plant, the control will take longer than you originally planned.

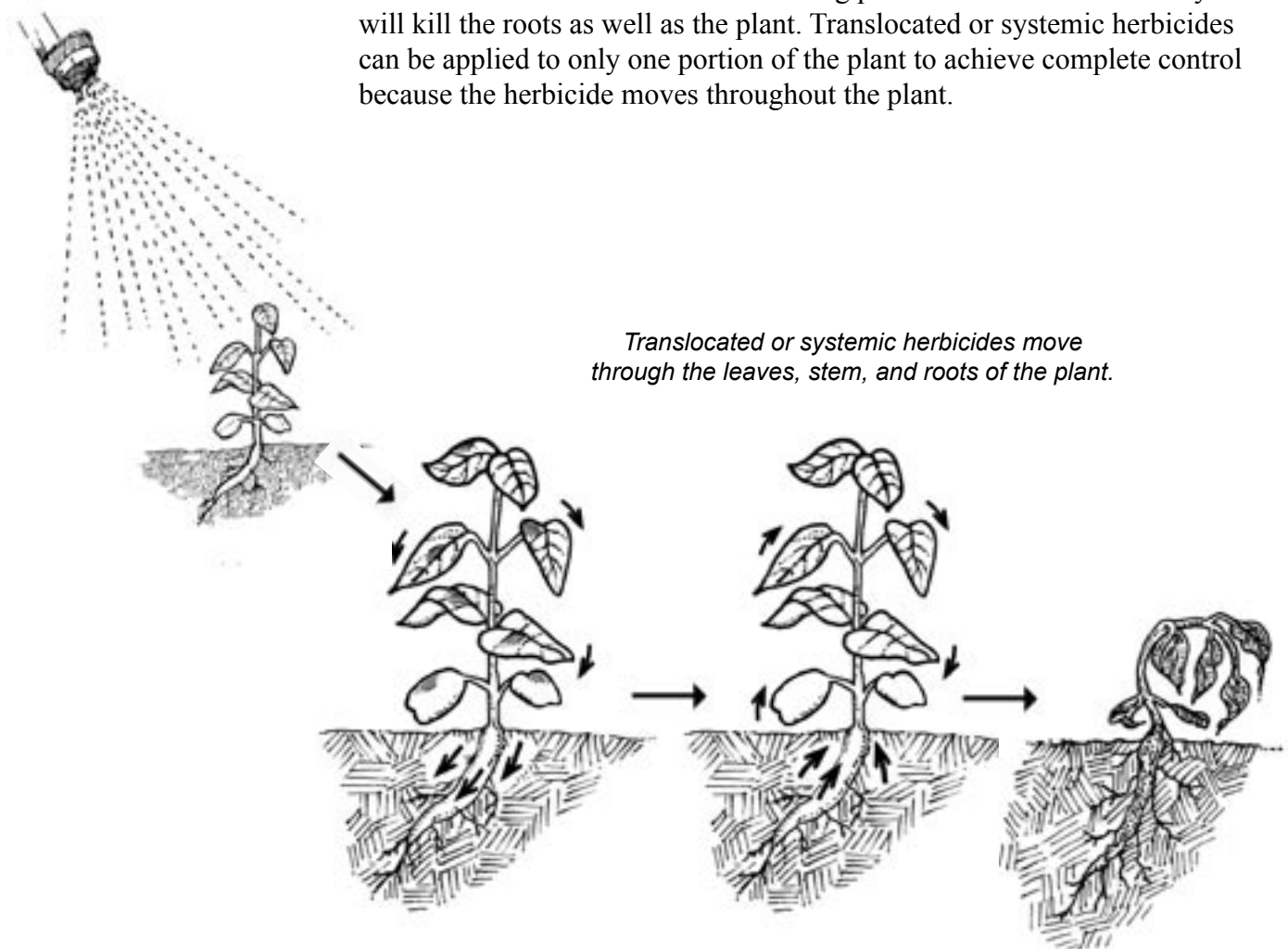
The example in the beginning of this section talked about herbicides that disrupt cell growth causing the leaves of the plant to twist, cup, and curl. Knowing how herbicides control plants, you will be able to identify plant damage from herbicides.

How a herbicide affects plants is important when you choose and apply the chemical. Choosing the wrong herbicide, or applying the herbicide incorrectly, could result in poor control or damage to plants you aren't intending to control. Several of the characteristics of herbicides are explained in the following section.

Translocated

Translocated or **systemic** herbicides move throughout the plant as illustrated in the figure shown here. Depending on the herbicide, the application can be made to the foliage, and the toxins move throughout the plant and to the roots. The plant is completely controlled. Other translocated or systemic herbicides can be applied to the soil, and the roots will take up the chemicals which travel into the plant leaves to control the plant.

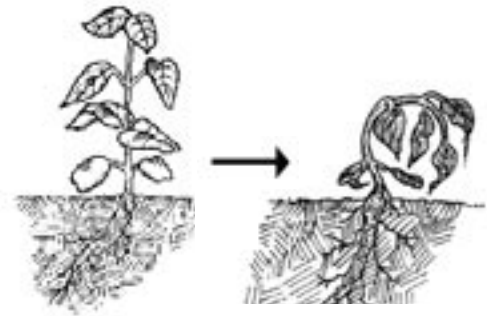
These herbicides are useful in controlling perennial weeds because they will kill the roots as well as the plant. Translocated or systemic herbicides can be applied to only one portion of the plant to achieve complete control because the herbicide moves throughout the plant.



Translocated or systemic herbicides move through the leaves, stem, and roots of the plant.

Contact

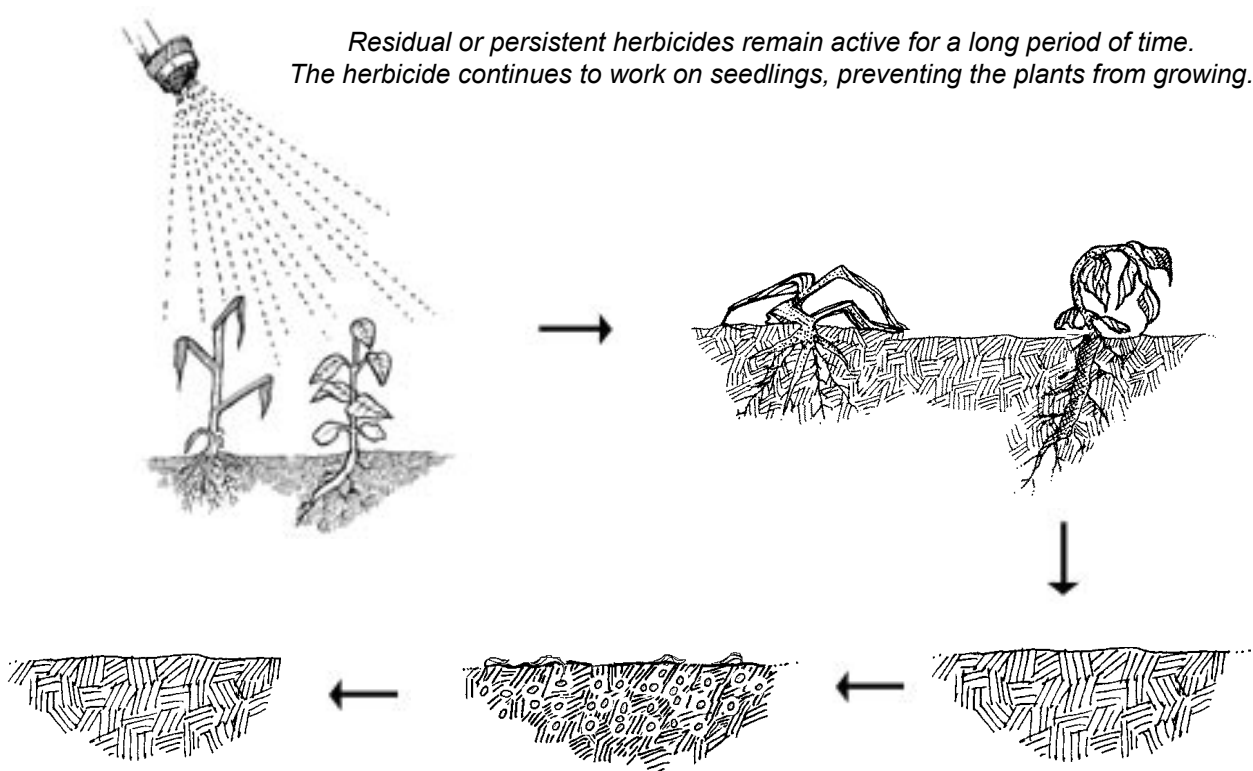
Contact herbicides kill only the green part of the plant that the herbicide contacts. So it's important that the applicator completely covers the plant. These herbicides are useful in controlling annual weeds, but they are not useful for long-term control of most perennial species.



*Contact herbicides kill only the **green** part of the plant the herbicide touches.*

Residual (Persistent)

Residual or persistent herbicides remain active for a long period of time as illustrated in the figure here. This means the herbicide will continue controlling weeds after the first set of weeds dies. These herbicides are used when long-term or residual weed control is needed. An example would be around guard rails on a roadside. However, if these herbicides are used in an area where some plant growth is encouraged, the effects could be too long lasting.



Residual or persistent herbicides remain active for a long period of time. The herbicide continues to work on seedlings, preventing the plants from growing.

The effects of residual, or persistent, herbicides can last for months, possibly even more than one growing season.

These herbicides can also be called *soil active* or *soil sterilant*. The herbicide can be applied to the soil to kill existing weeds then provide long-term control, thus remaining active to plants trying to grow in the soil.

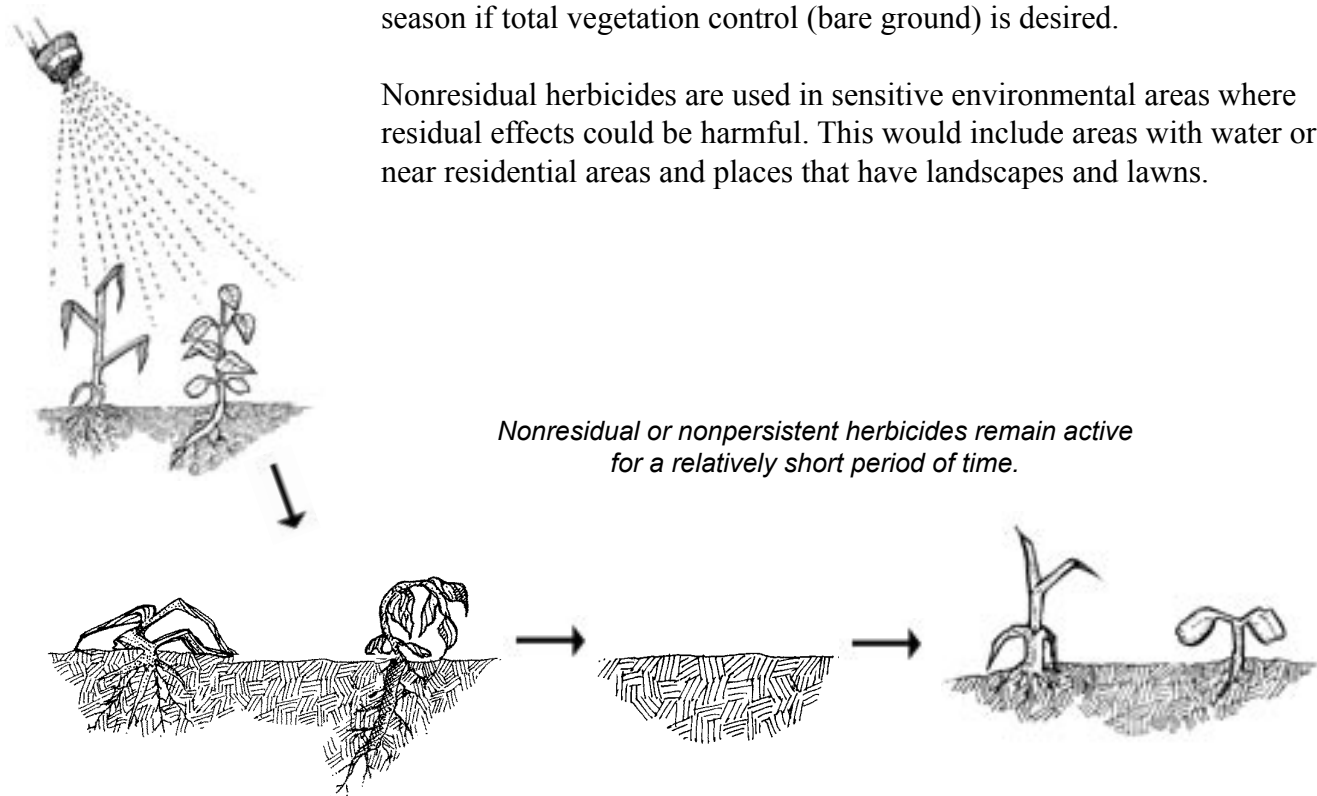
Residual herbicides are often used in industrial vegetation applications for substations, storage areas, and other areas that require total vegetation control. However, the pesticide applicator must be careful about where the pesticide may drift or runoff. Since the herbicide stays active in the soil, no plants will be able to grow in the area for long periods of time. If a nearby area is damaged from drift or runoff, no plants will grow there for a long time. The applicator needs to understand where and how the product is being used.

Nonresidual (Nonpersistent)

Nonresidual or *nonpersistent* herbicides are relatively short-lived as illustrated here. These herbicides are easily broken down by soil organisms or are not available for plant use.

These herbicides are also called non-soil-active herbicides. Once the initial plant is killed, the herbicide breaks down and is no longer effective in controlling plants. Multiple applications must be made during the growing season if total vegetation control (bare ground) is desired.

Nonresidual herbicides are used in sensitive environmental areas where residual effects could be harmful. This would include areas with water or near residential areas and places that have landscapes and lawns.



Nonresidual or nonpersistent herbicides remain active for a relatively short period of time.

Study Questions

1. What is the term used on the label to describe applying a pesticide after the weed has started to grow?
 - a. Postemergent
 - b. Preemergent
2. An applicator wants to kill some noxious perennial weeds by applying a herbicide that will kill the roots and the plant. What description would the applicator look for on the label?
 - a. Contact
 - b. Translocated
3. What is important when applying contact herbicides?
 - a. To completely cover the foliage to ensure control.
 - b. To completely cover the surrounding soil to ensure control.
4. An applicator sprays a roadside herbicide one summer. He returns the next summer to see that no plants are growing in the area. Most likely, what was on the herbicide's label?
 - a. Nonresidual, nonpersistent
 - b. Residual, persistent

Explanations

1. a – Postemergent. The prefix *post* means after, so the herbicide was applied after the weed started to grow.
2. b – Translocated. Translocated herbicides travel through the entire weed, killing foliage and roots. They are effective in controlling perennial weeds.
3. a – To completely cover the foliage to ensure control. Contact herbicides only affect what they contact. So the foliage of the weed must be sprayed to kill the weed. Spraying the soil is only a waste of pesticide and could be harmful to the environment.
4. b – Residual, persistent. Some herbicides remain active in the soil for a long period of time. These are called soil active, or persistent. Because the herbicide is still active, no plants will grow at the application site.

Herbicide Movement

Weather conditions, such as wind speed and temperature, can affect a herbicide application. The herbicide label contains information about ideal weather conditions and should be consulted by the applicator before applying any herbicides.

Drift

Acme Weed Control Co. was contacted to control weeds on and around a large commercial parking lot. The company sent out a crew with a nonselective herbicide to spray the border of the parking lot and any weeds growing in cracks on the edges of the parking lot. A strong breeze was blowing when the crew arrived at the site, but they sprayed the area anyway and returned to their office. A few days after the spraying, Acme received a call from the property owner about a large amount of brown grass in the adjoining lawn.



During application, the wind carried fine liquid droplets or particles of dust away from target surfaces. This is called **drift**. It is the most frequent cause of complaints from herbicide applications.

The herbicide Acme sprayed on the parking lot (the target surface) drifted over to the adjoining lawn and killed a large section of grass. The applicators could have avoided this by not spraying in windy conditions. The company could have rescheduled the application, but instead they have to settle a complaint.

You need to pay attention to wind direction and speed. There is a place to record this information on the herbicide application record sheet. If the material is moving away from the target weeds, stop the application!

Also, use extreme caution around ponds or other surface water. Most herbicides are not labeled to be used on water, so any drift could hurt fish and other organisms. This also includes small ornamental ponds in a landscaped area.

Volatilization

Under high temperatures and low humidity, some herbicides can become a gas or a vapor. This process is called **volatilization**. It can occur during or after an application. Air currents carry the gas to nearby plants — like the trees next to a parking lot — and cause injury. Some herbicides are more likely to be volatile than others. For example, products containing the active ingredient dicamba or 2,4-D are very susceptible to volatilization. Consult the label to see the ideal temperature for applying the herbicide.

Always read the label and consider the weather conditions before applying a herbicide. You might not see the gas when a herbicide vaporizes, but the results on a neighbor's property will be very noticeable.

Amine and Ester

Products with 2,4-D commonly come in an *ester* form or an *amine* form. These are two types of chemical forms. The amine form creates a clear solution when added to water. The ester form creates a milky-white solution when added to water.

The ester form tends to be more volatile than the amine form. The ester form is generally used when the temperatures are cooler, as in spring and fall. This is because the potential for volatilization is lower with cool temperatures. Also, non-target plants are less likely to be injured since they are not in leaf.

The amine form is considered less active, but it can still be volatile if the temperature is high enough. Before applying the herbicide, always read the label to see what the maximum outdoor temperature is for a successful application.

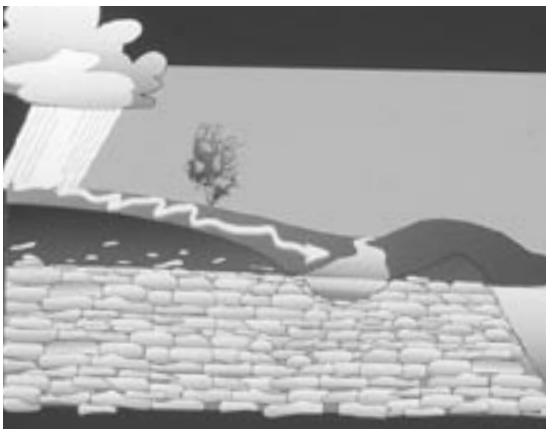
Adjuvants

Adjuvants are substances that can be added to a pesticide formulation to increase its effectiveness or safety. The applicator can purchase adjuvants separately to add to the tank mixture. Or, the pesticide manufacturer may have already added them to the pesticide formulation. There are different types of adjuvants. Some of the things adjuvants do are:

- Create a more uniform layer over the target plant.
- Help the pesticide stay on the target plant.
- Allow the pesticide to penetrate the leaf surface.
- Reduce the potential for drift.
- Increase droplet size to reduce drift.
- Help the pesticide mix more easily in the tank.

Runoff

Your supervisor has on your job list some weed control around an industrial site. Heavy thunderstorms are forecast for the early afternoon, so you hurry over to complete the application in the morning. You feel good about getting the work done, and as you are driving back to the garage, rain pours on the truck.



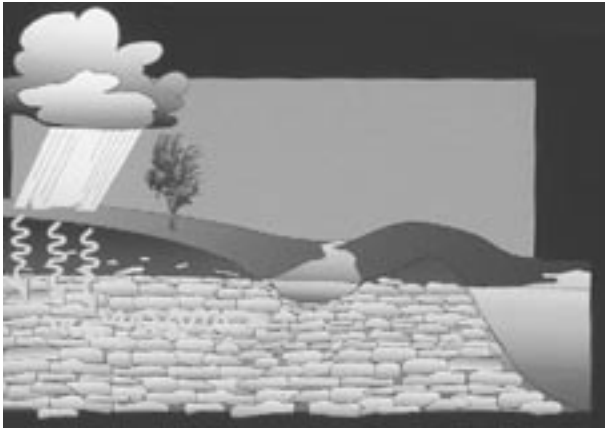
About a week later, your supervisor takes you back to the industrial site you sprayed. The weeds are controlled in the areas you sprayed. But there is a wide strip of brown grass from the application site down to a nearby stream.

This is an example of runoff. Surface runoff occurs when herbicides move across the ground with water,

away from the application site. Runoff is increased by heavy rains or irrigation. Some herbicides have chemical properties that allow them to run off more easily than other herbicides. The herbicide in surface runoff could move from the application site into a nearby pond, stream, or lake.

Leaching

Leaching is similar to runoff, except the herbicides and water move downward through the soil instead of across the ground. The herbicide leaches down into the soil where it could contaminate groundwater and even wells. Some herbicides leach more easily, due to their chemical nature. Other herbicides leach very little or not at all.



Because leaching happens in the soil, be sure to take note of soils in the region. Sand and other coarse soils are more likely to have leaching potential. In addition to groundwater concerns, leaching can also cause damage to non-target plants. A herbicide that moves through the soil to a tree root, killing the tree, is an example of leaching. Even though the tree was not part of the application site, it became an off-site target.

Study Questions

1. While Joe was spraying a utility right of way, he noticed the wind started blowing harder, but he continued spraying. About two weeks later, the company received a call from a landowner saying that his raspberry bushes were damaged. What caused the damage to the bushes?
 - a. Drift of the herbicide
 - b. Volatilization of the herbicide

2. On an extremely hot summer afternoon, a crew was spraying roadsides. There was very little wind, so the crew didn't pay attention to how close they were getting to some soybean fields. Two weeks later, their supervisor received a call from an irate farmer about some damaged soybean plants. How did the herbicide move off-target?
 - a. Drift
 - b. Volatilization

3. You are preparing to spray for broadleaf weeds in a roadside right of way with a product containing 2,4-D. The weather forecast is for a hot afternoon with temperatures in the low 80s. Which form should you choose?
 - a. Amine
 - b. Ester
4. What is the term used when herbicides move with water across the ground's surface?
 - a. Runoff
 - b. Leaching
5. What is the term used when herbicides move with water in the soil?
 - a. Runoff
 - b. Leaching

Explanations

1. a – Drift. When the wind exceeded the speed suggested on the label, the herbicide started to drift over to nontarget areas.
2. b – Volatilization. Extremely hot temperatures can cause some herbicides to vaporize and become a gas or vapor. This process is known as volatilization. Once the herbicide becomes a vapor, it can drift to off-target areas. Always consult the label to identify ideal weather conditions, including temperature, before applying the herbicide.
3. a – Amine. The amine form is less volatile and can be used in higher temperatures. However, if the temperatures are excessively hot, even the amine form may cause injury. Check the label for precautions.
4. a – Runoff. Rain helps move herbicides across the ground, away from the application site. This is called surface runoff and could contaminate rivers, streams, lakes, or ponds and damage off-target plants.
5. b – Leaching. Leaching occurs when herbicides move into the soil and affect other plants through their roots. Also, the herbicides could potentially contaminate groundwater or wells.

Herbicide Characteristics Table

On the following pages is a herbicide characteristics table. The table details the characteristics of herbicides commonly used in industrial vegetation management. The herbicides are grouped by their activity against weeds:

- Non-selective, not soil active
- Selective, not soil active
- Non-selective, soil active
- Selective, soil active

The table contains information on the active ingredient and some current trade names for the herbicides. The places where the herbicide is labeled for use are included. However, labels may change. Always check the label of your product for labelled uses and sites. A section providing plant injury information and special comments helps applicators determine if the herbicide may have an effect on nontarget plants and provides special information about use of the product.

Industrial Vegetation Herbicide Table Ohio State University Extension



Non-Selective Herbicides – Not Soil Active (Weeds are killed by foliar activity rather than root uptake.) No Soil Residue (Injury to non-target plants from soil uptake is not a problem.)

Active Ingredient	Trade Name(s)* Examples	Use	Activity in Plant	Plant Injury/Special Comments
glyphosate	Roundup Pro, Roundup Ultra Maxx, Prosecutor Credit, Accord Site Prep, Accord, Mirage, Rodeo, Glyphosate, Razor, Razor SPI, Honcho, Campaign, Campadre, Touchdown Pro, many others	landscape, noncrop	foliar systemic	<ul style="list-style-type: none"> Some products have an aquatic label and others do not. Check the label. Not recommended for use as an over-the-top broadcast spray in ornamentals and Christmas tree species.
diquat	Reward, Reward L&A	landscape noncrop	foliar contact	<ul style="list-style-type: none"> Labeled for aquatic use.
glufosinate-ammonium	Finale, Derringer	landscape noncrop	foliar contact	<ul style="list-style-type: none"> Complete coverage is necessary.

Selective Herbicides – Not Soil Active (Weeds are killed by foliar activity rather than root uptake.) No Soil Residue (Injury to non-target plants from soil uptake is not a problem.)

Active Ingredient	Trade Name(s)* Examples	Use	Activity in Plant	Plant Injury/Special Comments
2,4-D	2,4-D, Turf Weed & Brush Control, Salvo, Crossbow	turf noncrop	foliar systemic	<ul style="list-style-type: none"> Can mix with triclopyr or glyphosate for brush control
triclopyr	Garlon 3A, Garlon 4, Turflon Ester, PathFinder II	turf, noncrop, ind., wildlife openings	foliar systemic	<ul style="list-style-type: none"> Broadleaf weeds and woody brush, cut stump and basal bark treatments
clopyralid	Transline	non-crop, indust., wildlife openings	foliar systemic	<ul style="list-style-type: none"> Very effective on Canada thistle and vetch Can severely damage plants in pea family (e.g., redbud)
fosamine ammonium	Krenite S	industrial, noncrop	foliar, cut stump	<ul style="list-style-type: none"> Brush control - only portions sprayed are affected Sprayed branches fail to grow further.
MCPA	MCPA L.V. 4 Ester	noncrop	foliar, systemic	<ul style="list-style-type: none"> Broadleaf weed control

*Trade names may change. Always check the product label for active ingredient, registered sites, and uses.

**Non-Selective Herbicides – Soil Active (Weeds are killed by root uptake.)
Soil Residue (Injury to non-target plants from soil uptake could be a problem.)**

Many strictly industrial-vegetation control products have long residual activity and can severely affect desirable plants in the vicinity if not used with utmost care. Some of these chemicals are essentially soil-sterilants. Tank rinsate also must be carefully managed since even rinsates may injure non-target plants.

Active Ingredient	Trade Name(s) Examples	Use	Activity in Plant	Plant Injury/Special Comments
dichlobenil	Casoron, Barrier	landscape noncrop, ind. veg. control	root + seed	<ul style="list-style-type: none"> • Preemergence herbicide with some post activity on perennials • Labeled for use in late fall, winter, early spring
imazapyr	Arsenal, Sahara DG (imazapyr + diuron)	ind. veg. control	foliar, root absorbed	<ul style="list-style-type: none"> • Very long residual (<i>months to years</i>). • Industrial use chemical for bare-ground weed control
hexazinone	Velpar	ind. veg. control	foliar contact & root absorbed	<ul style="list-style-type: none"> • Pre and Post control of weeds and brush • Leaches readily
bromacil	Hyvar X, Hyvar X-L, Krovar, [Hyvar + diuron]	industrial vegetation control	primarily root absorbed	<ul style="list-style-type: none"> • Potent, long-residual bare-ground control of weeds and brush. • Leaches - don't use near desirable trees
diuron	Karmex	non-crop, industrial vegetation control	some foliar, mostly root absorbed	<ul style="list-style-type: none"> • Herbaceous weeds, not brush. • Leach resistant • Can be used in drainage ditches when empty • Problems occur if roots of desirable plants grow into treated soil.
prometon	Pramitol	industrial vegetation control	foliar and root absorbed	<ul style="list-style-type: none"> • Extremely long residual (<i>years</i>) for bare-ground weed control. • Don't use near desirable trees • Leaches readily
tebuthiuron	Spike 5G, Spike 80 DF	ind. veg. vegetation	primarily root absorbed	<ul style="list-style-type: none"> • Very long residual (<i>years</i>). • Controls weeds and woody brush • Don't use near desirable trees

*Trade names may change. Always check the product label for active ingredient, registered sites, and uses.

Selective Herbicides – Soil Active (Weeds are killed by root uptake.)
Soil Residue (Injury to non-target plants from soil uptake could be a problem.)

Active Ingredient	Trade Name(s)* Examples	Use	Activity in Plant	Plant Injury/Special Comments
dicamba	Banvel, many 3-way lawn products	turf, noncrop, industrial	foliar and root absorbed systemic	<ul style="list-style-type: none"> • Postemergence broadleaf herbicide. • Injury to nearby ornamentals by root uptake is possible.
picloram	Tordon 101, Tordon K, Tordon RTU, Tordon 22K [Tordon + triclopyr], Pathway [Tordon + 2,4-D]	industrial vegetation, noncrop, rangeland	foliar and root absorbed systemic	<ul style="list-style-type: none"> • Deep-rooted broadleaf weeds and woody brush controlled. • Limited mobility in soil; problem occurs if roots of desirable plants grow into treated soil.
imazapic	Plateau, Plateau DG	noncrop, parks, golf courses, turf	foliar, root absorbed	<ul style="list-style-type: none"> • Same chemistry as imazapyr, less persistent. • Is a “softer” alternative for bare-ground weed control. • Tank mix at higher rates with glyphosate for nonselective post + residual control. • Lower rates can be used selectively in turf, prairie grass, and wildflowers.
metsulfuron-methyl	Escort	industrial vegetation control	foliar and root absorbed — primarily root uptake	<ul style="list-style-type: none"> • Postemergence bare-ground control of weeds and brush, tolerant of grasses. • Controls autumn olive, multiflora rose. • Don't use near desirable trees.
sulfometuron	Oust	industrial vegetation control	foliar and root absorbed	<ul style="list-style-type: none"> • Post + preemergence control. • Can be used on unimproved turf (roadsides). • Leaches — don't use near desirable trees.
chlorsulfuron	Telar	industrial vegetation control	foliar and root absorbed	<ul style="list-style-type: none"> • Early post + preemergence bare-ground control. • Most effective on broadleaf plants. • Can be used on unimproved turf (roadsides). • Leaches — don't use near desirable trees.

*Trade names may change. Always check the product label for active ingredient, registered sites, and uses.

Table updated by Hannah Mathers, Ph.D., Extension Specialist, Landscape Horticulture, and Jenny Pope, Research Associate, Department of Horticulture and Crop Science, The Ohio State University. Adapted from table by Mary Ann Rose, Ph.D.

Chapter 4

Plant Control Methods



Objectives for This Chapter...

1. List the differences between broadcast and spot treatments.
2. Identify the difference between low-volume and high-volume applications.
3. Compare various methods of woody plant control.
4. Recognize uses for plant-growth regulators.

Key Terms to Know...

Broadcast Treatments — Applying the herbicide to an entire area.

Spot Treatments — Applying the herbicide directly to the target plant/weed.

Low-Volume Application — Higher concentration of herbicide in the mix solution. Often applied with small application equipment.

High-Volume Application — Lower concentration of herbicide in the mix solution. Most often applied with larger application equipment.

Cut-Stump Application — Herbicide is applied on a freshly cut tree stump.

Basal Application — Herbicide is applied on the lower two feet of a tree trunk.

Foliar Application — Herbicide is applied to foliage when trees and brush are in full leaf.

Side Trimming — Herbicide is applied to only one side of the target tree.

Plant Control Methods

Your crew is preparing to start work on an utility right of way. You go to the site to evaluate what needs to be done. What are some of the things you will be evaluating? As mentioned in the previous chapters, the type of vegetation to be controlled determines what herbicides may be used. But you will also need to select the correct application method to use.

First, determine if you are controlling grasses, broadleaves, or woody plants. For woody plants, you will need to figure how dense the vegetation is, that is how many plants or stems per acre. A general rule of thumb to determine density is:

Low density:	less than 1,000 stems per acre
Moderate density:	1,000 to 3,000 stems per acre
High density:	more than 3,000 stems per acre

Determining the density of the vegetation will determine what application method you will be using. The method could vary from a broadcast high-volume application to a spot treatment using a low-volume application.

Broadcast and Spot Treatments

Industrial vegetation herbicides are usually applied by broadcast or spot treatments. Applying the herbicide to an entire area is called a **broadcast treatment**. The herbicide could be selective or nonselective for controlling weeds or brush.



Broadcast applications are usually most efficient in moderate to dense brush areas, or other areas where a lot of vegetation needs to be controlled. These applications are used for rights of way, roadsides, and substations.

Applying the herbicide directly to small numbers of plants is called **spot treatment**. Again, either selective or nonselective herbicides are used for these treatments. Spot treatments allow for less herbicide use by treating only the necessary plants. However, spot treatments are more labor intensive.

Low- and High-Volume Applications

Different methods of application are used for vegetation control, depending on the application site, terrain, and target. Applications in highly visible areas, such as roadsides, may be different from applications used in more remote utility right-of-way locations.

Low-volume applications are used in virtually all areas of industrial vegetation control. Low-volume applications have a higher concentration of herbicide in the mixture.



Photo: Dow AgroSciences

These applications are typically done with a backpack sprayer or equipment that uses small tanks. Low-volume application is especially useful in highly visible areas. Two applicators walking through an area with backpack sprayers do not look as threatening to the public as a large truck with a large tank and booms. Low-volume application is also used in remote areas that are inaccessible to large equipment.

Low-volume applications work best for a translocating type of herbicide. These applications also work best for sites with low plant or stem densities.

Sometimes a low-volume application is made with large equipment. The high concentration of herbicides can also be used in large tank mixtures. This could mean that less carrier, such as water, needs to be added to the tank. As a result, the applicator can spray for longer periods of time before mixing new solution. Low volume relates most to the mixture having a higher concentration of herbicide.

High-volume applications are necessary for some areas. These applications have a lower concentration of herbicide in the solution.

The amount of solution used in a given area is higher. The equipment is typically larger to accommodate the larger tanks. High-volume applications are necessary for contact-type herbicides and sites with high plant or stem density.



High-volume applications are frequently used for treating roadsides and related areas, because the large equipment can access such areas easily. High-volume applications may also be used in areas that have not been maintained or in places that need broad coverage. While the industry may be moving toward low-volume applications, there are still places that need the high-volume application method.

Walk In, Spray Out

Walk In, Spray Out is an important safety factor for industrial-vegetation pesticide applicators. When making an application in a designated area, you should start at the farthest point and work your way back. For example, you should walk to the far side of a grove of trees and spray while walking back to the truck. This eliminates having to walk through an area that's already been sprayed.

This application method reduces unnecessary pesticide exposure. Wet herbicides on trees can saturate clothing when an applicator walks by. The *walk in, spray out* method helps eliminate this.

Study Questions

1. A small area needs to be treated, with just a few trees as the target plants. Which method would be most effective for this area?
 - a. Broadcast
 - b. Spot treatment
2. A crew of two people is sent with backpack sprayers to make applications on a utility right of way. The sprayer contains a higher concentration of herbicide with less water. Which method does this demonstrate?
 - a. High-volume application
 - b. Low-volume application
3. The boom sprayer truck is ready to go, with the tank filled. The tank contains a lower concentration of herbicide with more water. Which method does this demonstrate?
 - a. High-volume application
 - b. Low-volume application
4. Why is the *walk in, spray out* rule important for applications?
 - a. It reduces pesticide exposure for the applicator.
 - b. It changes the mode of action for the herbicide.

Explanations

1. b – Spot treatment. In a small area, with fewer target plants, spot treatments are very effective. Broadcast applications are used in large areas with a high number of target plants.
2. b – Low-volume application. The applicators are using backpacks, which have small tanks. The mixture has a higher concentration of herbicide.
3. a – High-volume application. High-volume applications contain a lower concentration of herbicide and typically have a larger tank.
4. a – *Walk in, spray out* reduces pesticide exposure for the applicator. By first walking into an area, then spraying on the way back out, the applicator doesn't have to walk through an area that has already been sprayed.

Woody Plant Control Methods



Photo: Dow AgroSciences

Cut-Stump Application

Cut-Stump Applications

Your company has just received the contract to maintain rights of way for the local electric company. You and your crew will be doing woody plant control to prevent trees and brush from growing into the power lines and to keep an area open for crews to access the power lines. You've done this work before, cutting down the small, unwanted trees with a chainsaw, while the crew behind you did **cut-stump** herbicide applications. These applications prevented the tree from resprouting and growing back.

For a cut-stump application, stumps should be cut as low to the ground as possible, without going below the soil surface. Often herbicide application needs to be done within an hour after the tree is cut. Read the label to see if there are any restrictions for the herbicide you'll be using.

The herbicide is sprayed on the cambium layer of the tree. The **cambium layer** is where the bark and the wood meet, the first ring inside of the tree. This layer is the area of active growth in a tree. So this layer needs to be completely covered to prevent any regrowth.



Photo: Dow AgroSciences

Colorant on the Cambium Layer

Colorants are often added to the herbicide so the applicator can make sure the cambium layer is completely covered. Treated stumps can be easily identified with the colorants. Most herbicides for this type of application are not diluted but used in concentrated form.

The equipment used for cut-stump application is either a pressurized hand applicator or a small backpack sprayer. Because of this, cut stump applications can be done in highly visible areas where large spray equipment would not be well received.

Cut-stump applications should not be made when the tree has heavy sap flow, known as bleeding. This could reduce the effectiveness of the herbicide. Otherwise, cut-stump applications can be done year round, including winter when the trees are dormant.



Photo: Dow AgroSciences
Basal Application

Basal Applications

In a **basal application**, herbicide is applied on the lower 24 inches of a tree trunk. The herbicide penetrates the bark layer and is absorbed into the cambium layer. The herbicide translocates to the roots and foliage for complete control. Basal treatments are more time efficient than cut stump, since you do not need to cut down trees or brush. However, basal applications can only be used on stems less than four inches in diameter.

These treatments can be made year-round, including winter. The only time basal applications cannot be made is when snow is covering the stem and ground line. Basal applications in the winter or early spring are preferred to prevent brownout. **Brownout** is the term used when the leaves of trees and brush turn from green to brown. With a basal application, the trees simply fail to leaf out in the spring, which keeps the public from seeing this brownout.

Basal applications are usually done as low-volume applications, with a backpack sprayer for equipment. The base of the stem needs to be completely covered by the spray, to the point of beginning to run off to the soil surface.

Foliar Application

Another method of woody plant control is **foliar application**. This method is used when the brush and the trees are bearing leaves. Herbicide is sprayed directly on the foliage. Spraying is done from the crown (or top) of the brush down. After spraying one side of the tree, move to the opposite side and spray again. You need uniform coverage of the foliage for the herbicide to be effective.



Foliar Application

Photo: Dow AgroSciences

After foliar application, the leaves of the trees and the brush turn brown. This brownout can be a problem if a large amount of brown foliage occurs in a highly visible place. Public attention would be drawn to the herbicide application.

Low or high volume is used for foliar applications, depending on the herbicide used and the plant or stem density. The applications can be done selectively to target unwanted brush and trees, or broadcast applications can be made.

Side trimming is a form of foliar application used on roadsides and utility areas. Herbicides are used on only one side of the tree. The buds are killed, so the branches begin to die back. This method is effective in clearing areas of visibility on curves and along roadways. Side trimming is used in utility

rights of way where only a portion of the tree needs to be removed, so the remaining portion can continue to grow. Only contact herbicides can be used for side trimming.

Soil Treatment

Herbicides can also be applied to the soil for vegetation control. Instead of spraying directly on the target plant, pellets or liquids are applied to the soil around the plant. Rain helps deliver the herbicide to the roots for complete control. Soil treatments use residual herbicides. Soil treatments can be done any time of the year, except when the soil is frozen. Only a few herbicides are effective with this type of application.

Study Questions

1. What layer of the tree do you spray for cut-stump application?
 - a. Bark
 - b. Cambium
 - c. Inner center ring
2. A crew will be controlling trees along a busy highway. The supervisor wants to choose a method that will not draw attention to the herbicide application site by causing brownout. Which method should be chosen?
 - a. Foliar application in the summer
 - b. Basal application in the winter
3. How much of the stem should be sprayed for a basal application?
 - a. 3 inches
 - b. 10 inches
 - c. 24 inches
4. Why is brownout a concern for foliar applications?
 - a. Brownout could arouse public concern in highly visible areas.
 - b. Brownout implies the wrong herbicide was selected.

Explanations

1. b – Cambium. The cambium layer is the outer ring where the bark and the wood meet. The cambium is the active growth layer in a tree. Complete coverage of this layer will prevent tree regrowth and new sprouts from the stump.
2. b – Basal application in the winter. The trees will simply not leaf out in the spring, bringing little notice. In contrast, the foliar application would result in a group of trees suddenly turning brown. Since the

trees are in a public place, they are highly visible. Some people become alarmed when they see pesticides used.

3. c – 24 inches. The lower two feet (24 inches) of the stem should be sprayed for best results.
4. a – Brownout could arouse public concern in highly visible areas. Brownout is the term used for the brown leaves of trees after foliage applications. In highly visible areas, this might create concern about herbicide use.

Tree and Plant Growth Regulators



Photo: Dow AgroSciences

Tree on left treated with a tree growth regulator.

A large, beautiful oak tree graces the side of a busy street in a large town. The tree is the pride of the neighborhood, along with other trees that grace the residential side of the street. However, the tree is starting to grow into the utility lines above it.

Usually, these trees are manually trimmed on a regular basis to keep branches out of the utility lines. Because this tree is on such a busy street, the tree trimmers will have to take extra precautions to avoid traffic while setting up their equipment. They may even need to hire a flagger to direct traffic around the trimming operation, adding to the expense of the operation.

In this case, **tree growth regulators** (TGRs) may be used on the tree. TGRs are used to slow the tree's growth. Trees treated with a growth regulator will have smaller crowns and show more dense and compact growth. Growth regulators cannot be used on conifers (such as pines or spruce), fruit or nut trees, and trees that will be tapped for sugar.

Use of growth regulators allows trees to remain in an area, such as a residential street, but controls growth before the trees reach powerlines. TGRs are more cost effective when used in areas such as the example cited previously where tree trimmers would have the extra expense of fighting traffic to trim just a few trees.

TGRs can be applied three different ways. A **basal drench** is similar to a basal application. The tree growth regulator is sprayed on the lower 24 inches of the tree. This method is effective for smaller stemmed trees.

Soil injection places the growth regulator near the roots of the tree. This method uses a special soil injector tool. This method has very low visibility and prevents runoff.

The limiting factor for soil injection is soil type. Soil injection works best in highly organic soils or coarse soils. Heavy, compacted soils may require a root drench, which is similar to soil injection. Root drenches are done by digging a trench around the base of the tree and applying the growth regulator for absorption to the roots.

The third method is **implants** into the bark of the tree. The implants are done with a regular drill. The hole is drilled near the base of the tree, and the implant is placed in the hole. The implant is absorbed through the tree to begin regulating growth.

TGRs can also be used on newly trimmed trees, to prolong the time period before returning to trim the tree again. **Plant growth regulators** (PGRs) can be used on grass for the same results as tree growth regulators. These PGRs slow the growth of grass on roadsides and other areas that need regular mowing.

Study Questions

1. What is the advantage of using tree growth regulators (TGRs)?
 - a. This can only be done as a high-volume application.
 - b. This is ideal for high-maintenance trees.
2. How do tree growth regulators affect the tree's growth?
 - a. Smaller crown
 - b. Less bark

Explanations

1. b – Ideal for high-maintenance trees. These trees need to be maintained, but because of their location, such as a busy street, tree growth regulators may be more cost effective.
2. a – Smaller crown. The crown is smaller on trees treated with a tree growth regulator. Although implants are placed in the bark, the product is translocated, and the bark is usually not affected.

Label Applications

The label contains information on what kind of control method should be used with the herbicide. Remember, **the label is the law**, and the product should be

used only as the label intends. The example at the left is an excerpt from the label for Controller Herbicide.

Controller

Specialty Herbicide

For controlling unwanted trees by using cut-surface treatments in forest and non-cropland areas such as fence rows, roadsides, and rights of way.

General Information

Controller herbicide is a ready-to-use product that is effective in cut-surface applications for killing unwanted trees and preventing undesirable sprouting of cut trees in forest and other non-crop areas such as fence rows, roadsides, and rights of way.

As the label indicates, this herbicide is to be used only for cut-stump treatments. Using the herbicide for basal drenching or foliar application would be against the law. Remember to always check the label, even if it is a product you have used the previous year. Sometimes the label will change in

accordance with EPA re-registration requirements, and you need to stay informed.

Application Equipment

We have talked about herbicide types, formulations, and application methods. The next step is identifying the correct equipment for the application. Equipment for industrial-vegetation applications varies from helicopters for aerial application, to boom sprayers for roadsides, to backpacks for spot treatments in rights of way. Because of these extremes, choosing the right piece of equipment for the job involves consideration of several factors, including:

- Land layout of the application site.
- Herbicide to be used.
- Size of crew.
- Acreage of the application site.
- Proximity to populated areas.

The charts on pages 50 and 51 give an overview of application equipment used in various industrial-vegetation situations.

Study Questions




1. Which sprayers are used for hard-to-access roadside areas because the equipment can remain on the road surface?
 - a. Boom sprayer
 - b. Boomless sprayer
 - c. Backpack sprayer




2. Which sprayer is ideal for high-profile public areas?
 - a. Boom sprayer
 - b. Boomless sprayer
 - c. Backpack sprayer

Explanations

1. c – Boomless sprayer. The boomless sprayer has the nozzles in a cluster, either attached on the side of the equipment or on an expandable arm, so the equipment can stay on the road surface while the spray is directed at the roadside.

2. c – Backpack sprayer. A backpack sprayer is ideal for high-profile places as there is only a single applicator on foot. This is in contrast to large equipment that draws more attention because it is loud and might have several people in the crew.

Equipment	Application Site	Application Type	Efficacy	Advantages	Disadvantages
<p>Hydraulic Units Unit has a pump, tank, engine, hose, and spray gun/wand.</p> 	<ul style="list-style-type: none"> • Rights of way • Roadsides 	<ul style="list-style-type: none"> • Broadcast • Foliar • Mainly high volume but can be used for low volume 	<ul style="list-style-type: none"> • Highly effective for foliar applications 	<ul style="list-style-type: none"> • Large tanks to work uninterrupted longer • Ability to travel longer distances 	<ul style="list-style-type: none"> • More moving parts makes for higher potential for break-down • Highly pressurized, increasing drift potential
<p>Boom Sprayers Several nozzles are arranged on a horizontal boom mounted on or behind the equipment.</p> 	<ul style="list-style-type: none"> • Rights of way • Roadsides • Guardrails • Parking lots • Storage areas • Industrial 	<ul style="list-style-type: none"> • Broadcast • Weed control and small brush control • Mainly high volume but can be used for low volume 	<ul style="list-style-type: none"> • Effective for selective and nonselective applications 	<ul style="list-style-type: none"> • Direct applications • Full coverage • Similar to farm sprayers so replacement parts are easier to find 	<ul style="list-style-type: none"> • High potential for drift • Not useful for foliar applications.
<p>Boomless Sprayers Several nozzles arranged in a cluster are located on the side of the equipment or on expandable arms.</p> 	<ul style="list-style-type: none"> • Roadsides • Guardrails 	<ul style="list-style-type: none"> • Broadcast • Foliar • Side trimming 	<ul style="list-style-type: none"> • Effective for selective and nonselective applications 	<ul style="list-style-type: none"> • Able to stay on the road while spraying • Can access steep roadside slopes 	<ul style="list-style-type: none"> • High potential for drift • Most nozzles have a straight stream, so vibrating or oscillating action is added to break spray into droplets

Equipment	Application Site	Application Types	Efficacy	Advantages	Disadvantages
<p>Backpack Sprayers <i>Backpacks are usually piston or diaphragm. Used by solo applicator.</i></p>  <p><small>Photo: Dow AgroSciences</small></p>	<ul style="list-style-type: none"> • Rights of way • Roadsides • Industrial sites • Substations • Fences • Parking lots • Driveways 	<ul style="list-style-type: none"> • Selective spraying • Basal drenching • Growth regulators • Mainly low volume • Cut stump 	<ul style="list-style-type: none"> • Effective for foliar, basal, and other applications • Selective applications 	<ul style="list-style-type: none"> • Lower profile • Lower initial costs • Lower drift potential 	<ul style="list-style-type: none"> • Usually greater amount of active ingredient • Must pump to keep pressurized
<p>Hand Cans <i>Sprayer bottles, usually with pre-mixed solutions.</i></p> 	<ul style="list-style-type: none"> • Rights of way • Roadsides • Substations • Driveways • Parking lots • Fences 	<ul style="list-style-type: none"> • Cut stump • Selective spraying 	<ul style="list-style-type: none"> • Effective for target applications • Selective applications 	<ul style="list-style-type: none"> • Lower profile • Easily carried • Lower drift potential 	<ul style="list-style-type: none"> • Small quantities • Often greater amount of active ingredient • Not efficient for broadcast
<p>Hand Guns or Wands <i>Used in combination with other sprayers.</i></p> 	<ul style="list-style-type: none"> • Rights of way • Roadsides • Substations • Driveways • Parking lots • Fences • Property lines 	<ul style="list-style-type: none"> • Used in combination with other sprayers such as a hydraulic unit or a backpack 	<ul style="list-style-type: none"> • Effective for broadcast applications • Effective for foliar, basal, selective, and nonselective applications 	<ul style="list-style-type: none"> • Adaptable to different spraying applications • Nozzles can be easily changed to decrease drift potential 	<ul style="list-style-type: none"> • Increased potential for applicator exposure

Chapter 5

Accurate Applications



Photo: USDA

Objectives for This Chapter...

1. Describe steps involved in calibrating equipment.
2. Recognize factors that will influence the application rate.
 - Speed
 - Flow rate
 - Pressure or spin rate
 - Concentration of spray solution or granule size
3. Calculate the correct amount of product to use for a spray tank or for a given area.
4. Explain possible causes for application failure.
5. Recognize potential problems in applications.
6. List steps involved in equipment cleaning.

Key Terms to Know...

Spray Volume — Amount of solution your sprayer applies over a given area.

Calibration — Process of measuring and adjusting the amount of chemical your sprayer will apply to a target area.

Colorants — Color added to herbicides to ensure the applicator that the target plant is being completely covered.

Surfactants — Surface-active substances (like detergent) that are added to help herbicides spread uniformly on the leaves of the target plants. Stickers help herbicides remain on the leaf.

Cross-contamination — Occurs when spray tanks are not well cleaned and herbicides become mixed improperly; could contaminate a site.

Application Equipment

You and your family are headed to the state park for a day on the lake. Of course, you know the short cut along some backroads to avoid the traffic and get there before the crowd. In fact, you're travelling along a road your crew had treated about a month earlier. The crew did broadleaf control on the noxious weeds growing along the road. But that work was done a month ago and instead of seeing control, you notice the thistles and the ragweed increased in size. What happened?

Under- and Over-Application



The crew had under-applied the selective herbicide on the roadside. The crew was not using the proper rate for the roadside, and so the road did not receive complete control. Under-application will cost the company money as another crew will have to be dispatched to make another application to the roadside. This costs the company a wasted day and more expenses in labor and herbicide costs. It may even be too late to easily control the larger weeds now.

“More isn't always better” is also true for pesticide applications. Over-applying herbicides is harmful to the environment and increases herbicide costs. Neighbors will certainly notice an over-applied roadside area and might start complaining. There could even be environmental damage that might result in fines to the applicator and the company.

This chapter will explore calibration, delivery rates, and calculations for product amounts. These concepts are important for pesticide applicators. In addition to information here in Chapter 5, additional calculations and information are in the Appendix.

Calibrating Your Equipment

Calibration is the process of measuring and adjusting the amount of chemical your sprayer will apply to the target area. A calibration check is making a trial run on some known area and measuring the amount applied with your equipment. Then adjustments can be made so the herbicide is properly applied.

Calibration is important because too little herbicide can result in poor control of weeds. An additional application will need to be made, which costs money for the company. Too much herbicide could injure non-target plants, and it costs too much money. Also, using pesticide rates that are higher than the rates on the label is illegal.

Four Basic Steps of Calibration

Application equipment may be different, depending on where you are spraying. However, there are four basic steps for calibration of any equipment. These four basic steps are:

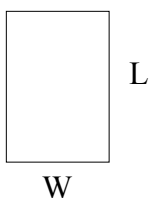
1. Size of the area to be treated (*number of acres or square feet*).
2. Application rate of the sprayer (*gallons/acre*).
3. Number of acres the sprayer tank will treat (*acres/tank*).
4. Amount of product to put in the sprayer tank (*product/tank*).

Complete calibration steps for all types of equipment are not included in this manual. You should refer to manufacturer equipment instructions or Ohio State University bulletins or fact sheets for more complete directions. Remember, the four basic steps listed previously are needed for proper calibration. Some additional examples of calculations and formulas used for calibration are in the Appendix of this book.

Size of the Area for Treatment

Most herbicide labels give the rate of product to apply as per acre or per 1,000 square feet. This rate of application applies to boom, boomless, invert applications, and some hand-gun uses.

You need to figure the size of the area that is going to be sprayed. Most roadside or right-of-way sites can be shown as long, narrow rectangles. So you can determine the area of a rectangle and apply it to the site. The area of a rectangle is found by multiplying the width by the length



Width x Length =
Area of Rectangle

To convert to acres, keep in mind that 43,560 square feet = 1 acre.

Application Rate of the Sprayer

It's important to have the sprayer in working order and applying the herbicide at the rate you want. To set the equipment properly to deliver the right rate, you must determine and adjust such things as travel speed, pressure, nozzle size, and other settings.

Once you have calibrated your sprayer for a particular **speed**, you need to maintain that speed. Driving slower will cause over application and moving too fast will cause under application of the herbicide. Rough terrain will slow your normal walking speed. If you are using a computer-controlled sprayer, the computer will adjust for changes in your speed. However, you still need to be aware of the ideal speed for you to use while spraying.



Pressure and nozzles also affect the application rate of the sprayer. Make sure to follow the manufacturer's instructions for the sprayer and nozzles when setting the pressure. Make sure there are no clogged nozzles. On boom sprayers, make sure the nozzles are properly aligned, and the boom is set at the correct height.

Watch That Speed!

Speed is an important part of the proper application. How fast you are driving or walking will affect the rate your sprayer applies the herbicide. Wheel slippage and a broken speedometer may cause the ground speed to differ from speedometer readings. Rough terrain will slow your normal walking speed.

To measure speed, mark off a measured distance of a few hundred feet of the application area. Then drive the equipment over this distance at the operating speed, carefully marking the throttle setting or speedometer reading, and record the travel time, usually in seconds. Be sure the equipment has reached full operating speed before you reach the starting point.

If you are making the application on foot, such as with a hand gun, walk over the distance with the equipment in hand just as you will in the actual application. Record the time it takes to cover the distance, usually in seconds.

When you calibrate a sprayer while it is not moving, you have to assume a speed and know that your sprayer is traveling at that speed. Remember, if you are using a computer-controlled sprayer, the computer will adjust for changes in your speed. However, you still need to be aware of the ideal speed for you to use while spraying. More detailed calculations for determining speed for calibrating sprayers can be found in OSU bulletins and fact sheets.

Number of Acres the Sprayer Tank Will Treat

When you are spraying herbicides at a given rate (ounces, pounds, pints, quarts, or gallons), you must know how many gallons your sprayer is applying per acre, known as the **spray volume**. Determining the spray volume is important in the calibration process.

Dividing Reminders

When dividing fractions, remember to change the function to multiplication. Then invert the number to the right of the multiplication sign and solve. For example:

$$\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c}$$

The same concept applies to numbers that include units such as gallons/acre. For example, the problem would begin like this:

$$\frac{5 \text{ gallons}}{\text{tank}} \div \frac{6 \text{ gallons}}{\text{acre}}$$

Then change to multiplication and invert the second number.

$$\frac{5 \text{ gallons}}{\text{tank}} \times \frac{\text{acre}}{6 \text{ gallons}}$$

One way to figure the spray volume is to spray an acre at the desired speed with a tank full of water. Then you measure the amount of water needed to refill the tank. If it takes 20 gallons to refill the tank after spraying one acre, you are spraying at the rate of 20 gallons per acre. This is the application rate or spray volume per acre. (See the Appendix for calculating spray volume for hand-gun sprayers.)

How many acres will your tank spray? First, you figure how many gallons per acre your sprayer applies (which was explained earlier). Then you measure or check the markings on your spray tank to see how many gallons it will hold. Divide the gallons the tank will hold by the spray volume (which is shown by gallons/acre). Then you will have the number of acres you can spray with a full tank.

$$\frac{\text{gallons}}{\text{tank}} \div \frac{\text{gallons}}{\text{acre}} = \frac{\text{acres}}{\text{tank}}$$

Convert to multiplication

$$\frac{\text{gallons}}{\text{tank}} \times \frac{\text{acre}}{\text{gallons}} = \frac{\text{acres}}{\text{tank}}$$

Amount of Product to Put in the Sprayer Tank

You have adjusted your sprayer and know how many gallons of solution your equipment will apply per acre. You also know how many acres your tank will treat. Now, you must decide how much herbicide to put in the tank. You need to follow the directions on the herbicide label.

On the herbicide label, the rate will be expressed in the amount of formulated product to use, or the rate may be given by active ingredient (a.i.). The amount of herbicide needed for each application will be different from one product to another product, so you must read the label first. See the Appendix for calculating the amount of product for filling partial or multiple spray tanks.

Calculate the Amount of Product per Tank

1. Determine the sprayer's delivery rate in gallons per acre.

2. Divide the gallons in the tank by the calibrated rate of the sprayer.

(Remember to convert to multiplication and invert the second number.)

$$\frac{\text{gallons}}{\text{tank}} \div \frac{\text{gallons}}{\text{acre}}$$

$$\frac{\text{gallons}}{\text{tank}} \times \frac{\text{acre}}{\text{gallons}} = \frac{\text{number of acres}}{\text{tank}}$$

3. Convert the recommended amount of product on the herbicide label to gallons.

Some helpful conversions

$$8 \text{ pints} = 1 \text{ gallon}$$

$$4 \text{ quarts} = 1 \text{ gallon}$$

4. Determine how much product to add to your tank to have the proper amount for application (remember: the recommended rate is in gallons/acre):

$$\frac{\text{gallons}}{\text{acre}} \times \frac{\text{acres}}{\text{tank}} = \frac{\text{gallons of product}}{\text{tank}}$$

Example of Calculating Amount of Product per Tank

Your sprayer holds 300 gallons of solution, and the recommended rate for the herbicide is 2 pints per acre. Your sprayer was calibrated and has a delivery rate of 40 gallons/acre. How much of the herbicide product will you use in a full tank?

1. You need to determine how many acres one full tank on the sprayer will cover at the sprayer's delivery rate. Then divide the amount of solution in the sprayer tank by the delivery rate.

$$\frac{300 \text{ gallons}}{\text{tank}} \div \frac{40 \text{ gallons}}{\text{acre}}$$

$$\frac{300 \text{ gallons}}{\text{tank}} \times \frac{\text{acres}}{40 \text{ gallons}} = \frac{7.5 \text{ acres}}{\text{tank}}$$

Your sprayer will cover 7.5 acres with a full tank.

2. The recommended rate of 2 pints per acre needs to be converted to gallons.

$$\frac{2 \text{ pints}}{1} \times \frac{1 \text{ gallon}}{8 \text{ pints}} = 0.25 \text{ gallon}$$

- Multiply the recommended rate by the number of acres with a full tank to determine the number of gallons of product for a full tank.

$$\frac{0.25 \text{ gallons}}{\text{acres}} \times \frac{7.5 \text{ acres}}{\text{tank}} = \frac{1.88 \text{ gallons of product}}{\text{tank}}$$

You will need 1.88 gallons of product for a full tank mix.

Converting Active Ingredient to Product

The herbicide label directions for mixing the product may be written as active ingredient per acre. So you need to convert the active ingredient to product. Also, the amount is usually written as a percentage. So you'll have to convert the percentage to a decimal number by multiplying by 0.01. Let's briefly review the decimal equivalent of these percents by looking at the following chart.

Percent	Decimal Equivalent
50%	0.50
30%	0.30
20%	0.20
10%	0.10
3%	0.03
2%	0.02
1%	0.01
1/2 (0.5%)	0.005
1/4 (0.25%)	0.0025

- For liquid or dry formulations, you may need to figure the amount of active ingredient (a.i.) needed. We will use a.i. to indicate active ingredient. Often a.i. in the formulation is expressed as a percentage. You will need to convert the percentage to a decimal.

$$\begin{array}{r} \% \text{ a.i.} \\ \times 0.01 \\ \hline \text{decimal amount of a.i.} \end{array}$$

- Divide the pounds of a.i. needed by the percentage of a.i. in the formulation.

$$\frac{\text{pounds a.i.}}{\text{acre}} \div \frac{\text{decimal a.i.}}{1} = \frac{\text{pounds product}}{\text{acre}}$$

- Convert to multiplication and cancel like units.

$$\frac{\text{pounds a.i.}}{\text{acre}} \times \frac{1}{\text{decimal a.i.}} = \frac{\text{pounds product}}{\text{acre}}$$

Example of Converting Active Ingredient to Product

The formulation of a herbicide is an 80% wettable powder, and you want to apply 4 pounds of active ingredient (a.i.) per acre. How many pounds of product must be applied per acre?

- Change the percentage to a decimal.

$$\begin{array}{r} 80\% \\ \times 0.01 \\ \hline 0.80 \end{array}$$

- Determine the amount per acre.

$$\frac{4 \text{ pounds a.i.}}{\text{acre}} \div \frac{0.80 \text{ a.i.}}{1} = \frac{\text{pounds product}}{\text{acre}}$$

- Convert to multiplication and cancel like units.

$$\frac{4 \text{ pounds a.i.}}{\text{acre}} \times \frac{1}{0.80 \text{ a.i.}} = \frac{5 \text{ pounds product}}{\text{acre}}$$

Percentage of Product per Tank

Some pesticide labels will identify the percentage of the product to be used in the spray solution. This is often used in the products designed for backpacks and hand cans. Usually the mixture is sprayed-to-wet. Mixing percent solutions is also done for wiping applicators, and some surfactants are added as a percent of volume.

The percentages for herbicides may be numbers like 1, 2, 3, 10, 20, 30 or 50%. For surfactants, the numbers are usually 1/4 or 1/2%. You convert percentages to decimals by multiplying by 0.01. See the decimal conversion chart in the a.i. example given on the previous page.

Calculating Percentage of Product per Tank

- Convert the percentage to a decimal by multiplying by 0.01.

$$\begin{array}{r} \text{Percentage (\%)} \\ \times 0.01 \\ \hline \text{decimal amount} \end{array}$$

2. Multiply the decimal amount of product by the total volume of the solution in the tank.

$$\begin{array}{r} \text{decimal amount} \\ \times \text{tank volume} \\ \hline \text{amount of product needed} \end{array}$$

Example of Calculating Percentage per Tank

1. The recommended rate on the label for the product is 1%. So you convert to a decimal:

$$\begin{array}{r} 1\% \\ \times 0.01 \\ \hline 0.01 \end{array}$$

2. Your tank holds 50 gallons. So, filling in the numbers:

$$\begin{array}{r} 0.01 \\ \times 50 \text{ gallons} \\ \hline 0.5 \text{ gallons} \end{array}$$

You will need 0.5 gallon (or 1/2 gallon) of the product.

Granule and Pellet Applications

The examples in this chapter have shown calibration and calculations for liquid applications. You may be using a granule or pellet application for the herbicide. When using the calculations for dry formulations, remember this conversion: **16 oz. = 1 pound**

When calibrating equipment for granule or pellet applications, there are some important considerations. In all types of granular equipment, the amount of granules applied per acre or per 1,000 square feet depends on several factors. These factors include:

- Size of the adjustable opening.
- Speed of equipment when applying herbicide.
- Speed of the spinning disc.
- Surface roughness of the application site.
- Granular formulation chosen (granular size, weight, shape, and texture).
- Temperature and humidity.

Because there are so many variables that can affect delivery rate, you must calibrate application equipment for each granular product. You must also calibrate for each person if the equipment is hand operated.

Consult the equipment manual for the manufacturer's recommendations for approximate settings for the granules being applied. If the equipment is motorized, select the speed by using the manufacturer's suggestions. Also consider the condition of the application site. Soft, muddy, or uneven surfaces and small areas with many obstacles mean slower speeds.

Study Questions

- Your tank holds 1,200 gallons of spray solution, and your sprayer is applying 30 gallons of solution per acre. The label says to use 2 quarts of product per acre. How much of the product should you put in the tank?
 - 20 gallons
 - 35 gallons
 - 40 gallons
- The label says to use the product at 1/2% by volume. How much should be added to a 500-gallon tank?
 - 1.5 gallons
 - 2.0 gallons
 - 2.5 gallons

Explanations

- a – 20 gallons. The amount of acreage covered by a full sprayer tank is 40 acres. The formulation would look like:

$$\frac{1,200 \text{ gallons}}{\text{tank}} \times \frac{\text{acres}}{30 \text{ gallons}} = \frac{40 \text{ acres}}{\text{tank}}$$

Convert the amount of product needed, 2 quarts, to gallons:

$$\frac{2 \text{ quarts}}{\text{acre}} \times \frac{1 \text{ gallon}}{4 \text{ quarts}} = \frac{0.5 \text{ gallons}}{\text{acre}}$$

Then take the 0.5 gallons and determine the amount of product needed for the spray tank:

$$\frac{0.5 \text{ gallons}}{\text{acres}} \times \frac{40 \text{ acres}}{\text{tank}} = \frac{20 \text{ gallons}}{\text{tank}}$$

- b – 2.5 gallons/tank. Using the formula for Calculation for Percent of Tank, first determine the decimal amount for 0.5%.

$$\begin{array}{r} 0.5\% \\ \times \underline{0.01} \\ \hline .005 \end{array}$$

Then, multiply the decimal amount by the gallons in the tank.

$$\begin{array}{r} .005 \\ \times \underline{500 \text{ gallons}} \\ \hline 2.5 \text{ gallons} \end{array}$$

Preparing for the Application

Under and over application are examples of not preparing correctly for the pesticide application. Much of spraying herbicides is getting everything ready before actually making the application. This includes items discussed in earlier chapters, such as selecting the correct herbicide, calibrating the equipment, and applying the correct amount of product.

Once you are at the site and ready to make the application, you need to be aware of the surroundings, your equipment, and the weather conditions during the application. Something simple like the weather not cooperating could make your herbicide ineffective — and create bigger problems.

Possible Causes of Application Failure

As in the example of under and over application, herbicide application failure can be costly to a company — and possibly dangerous. Applicators need to focus on proper pesticide application during the whole process to avoid herbicide failure.

What are some other causes of application failure?

- Not completely mixing the pesticide solution.
- Not properly calibrating the equipment.
- Not completely covering the target plant.
- Equipment not working correctly.
- Plugged nozzles.

Complete Coverage

Complete coverage is essential in pesticide applications. In foliar applications, you need to make sure all the leaves are sprayed, which includes both sides of a tree. Otherwise, the area will be under-applied. The same is true for other applications, also.



Photo: Dow AgroSciences

Colorants can be added to herbicides to ensure complete applications. With the herbicide colored, it's easier for the applicator to make sure he or she is completely covering each bush and tree.

Additives like **surfactants** can also be used, especially in foliar applications. Surfactants are surface-active substances that can be used to help the herbicide spread more uniformly over the leaf surface. (Stickers help herbicides remain on the leaves of the target plants.)

Complete coverage is also important to soil applications and any other type of industrial vegetation control. It is extra expense and trouble to have to go back to an application site because large areas were missed, or the applicator skipped places that needed to be treated.

If you take a break or leave the area to refill the tanks, leave a flag or ribbon where you stopped. This way, you'll be able to start in the right place instead of trying to guess where the dried spray begins and ends.

Who Put That Cow There?

You are doing basal drenching to woody plants along a utility right-of-way that goes across several cattle pastures. In the third pasture, you see a dead cow on the other side of the fence. You ignore the cow, spray some trees, and move onto the next site.

The next day, your supervisor receives an angry phone call from the landowner that pesticides killed one of his cows, and he's concerned that the rest were poisoned. The supervisor looks over your records from the day before, but he does not see anything out of the ordinary. Unfortunately, he cannot talk to you, because you're out working on a different utility right-of-way.



As a member of an applicator crew, you have the responsibility to notice things that are out of place or that might be potential problems for the application. These items need to be noted in the records for the day. By noting the cow lying dead before your crew even arrived, you could have saved the company a lot of headaches and directed the landowner to look for a different cause of death.

In addition to noting dead livestock in your records, other items to document might include:

- Ponds with dead fish floating.
- Large areas of vegetation already dead.

- Streams with strong smells or off-colored water.
- Any dead or sick wildlife such as deer, birds-of-prey, etc.
- Non-target vegetation showing stress.

Concentration Is Important

Because of breakdowns in your equipment, your crew is behind on its application schedule. You decide to start earlier to help the crew catch up on the work. You arrive at the utility line early, and the crew begins work, doing low-volume foliar applications with backpacks. The morning dew is especially heavy and as the crew members emerge from a grove of trees, you notice that their clothes are dripping wet from the dew. This could be a safety issue as the crew's clothes are wet and could be vulnerable to absorbing pesticides. Also, are the wet leaves able to absorb the pesticide to make the herbicide application successful?

The person making the pesticide application is responsible for the spraying. As the applicator, you know firsthand what the conditions are at the site. It's important that you are aware of the weather, spray area, and any unusual events. The supervisors back in the office are relying on your good judgment for the application to be done correctly and safely.

Weather plays an important role in pesticide applications. Hot, humid days can have damaging effects on non-target plants just like strong, windy days. Be aware of any label directions on special weather considerations.



Photo: USDA

Clean That Sprayer!

Today, you are planning to do selective, broadleaf-weed control along a roadside. You are using a sprayer that was used the day before at an utility substation project. One week later, your supervisor comes back to the shop very upset. A large area of the roadside you sprayed is completely brown, including a wide stretch of grass leading down a hill into the creek. What happened?

The crew spraying the substation had used a persistent, nonselective herbicide to ensure long-term vegetation control. The spray tank was not completely cleaned out. The residual herbicide mixed with the herbicide you were using and produced a nonselective herbicide. This is called **cross-contamination**. Unfortunately, the mistake will still show as the persistent herbicide will not allow vegetation to grow for quite a while.

Completely cleaning pesticide tanks is essential. As described earlier, the results of herbicide residue can be damaging to the environment and the company. Sprayers should be cleaned immediately after each use. First, flush and rinse, inside and out, with water. In addition to the first rinse with water, the sprayer may need to be flushed with a cleaning agent, because some herbicide residues can cling to plastic tanks. Some companies even have defined which sprayer tanks can be used with which herbicides to reduce cross-contamination from residues. Keeping the tanks designated for use with certain herbicides can help control potential plant damage.

Always clean the equipment on a pad or impermeable surface so the rinse water, called rinsate, can be recovered. The rinsate legally can be used in another tank mix if it is labeled for the intended application crop and the amount in the final mix doesn't exceed label rates for that acreage.

If sprayers are cleaned in rights of way or in a field, select a spot where there is little threat of runoff entering a waterway, well, or surface water. Avoid cleaning sprayers in the same location multiple times. Over time, the surrounding area could become contaminated with pesticides.

Study Questions

1. Why are colorants added to herbicides?
 - a. To ensure complete coverage by the applicator.
 - b. To increase efficacy of the active ingredient.
2. Why are surfactants used in foliar applications?
 - a. The bright color helps the applicator ensure complete coverage.
 - b. The surface-active substance helps the herbicide remain on the leaves.
3. What is rinsate?
 - a. The carrier added to the herbicide.
 - b. The rinse water after cleaning the sprayer.
4. Where is the best place to clean a sprayer?
 - a. In a field.
 - b. On a driveway.
 - c. On a rinse pad.

Explanations

1. a – To ensure complete coverage by the applicator. The color helps the applicator make sure all the leaves, bark, or weeds have been covered by the herbicide.

2. b – The surface-active substance (stickers) helps the herbicide remain on the leaves. Rather than dripping off the leaves during a foliar application, other surfactants (spreaders) act like a detergent that helps the herbicide spread more uniformly on the leaf.
3. b – The rinse water after cleaning the sprayer. The rinsate needs to be collected and can be reused, according to the label directions of the pesticide.
4. c – On a rinse pad. A rinse pad collects the rinsate so it will not become run-off and possibly cause environmental harm. The field is *not* the best place.

Chapter 6 Pesticides in the Environment



Photo: Ohio State University Extension

Objectives for This Chapter...

1. Recognize potential sources of contamination from pesticides.
2. Recognize non-target challenges.
3. Identify how herbicides could contaminate water sources.
4. List appropriate actions to prevent environmental problems.

Key Terms to Know...

Sensitive areas — Sites or living things that are easily injured by a pesticide.

Soluble — Dissolves easily in water.

Adsorption — Becomes tightly attached to soil particles and organic matter.

Persistent — Breaks down slowly.

Degradation — Rate at which herbicides break down in the soil.

Soil texture — Relative proportions of sand, silt, and clay in the soil.

Soil permeability — Measure of how quickly water moves downward in a particular soil.

Soil organic matter — Dead and decaying plant material and other organisms that add nutrients to the soil. Organic matter also allows for greater holding capacity for water and herbicides.

Pesticides in the Environment

The label is the law. This concept is very important to remember, especially when it comes to the environment. Each label has a statement about environmental hazards. This statement alerts you to sensitive areas with this pesticide. These are areas you should avoid when making an application.

DeadWeed DG

Provides weed control and/or turf-height suppression on non-cropland areas such as railroad, utility, pipeline, and highway rights of way, utility-plant sites, non-agricultural fence rows, non-irrigation ditch banks, Conservation Reserve Program (CRP) land, prairie sites, airports, industrial turf, recreational and non-residential turf, and other similar areas.

Environmental Hazards

For terrestrial use only. DO NOT apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high-water mark.

DO NOT contaminate water when disposing of equipment wash water or rinsate.

This chemical demonstrates the properties and characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground-water contamination.

For example, DeadWeed DG is a herbicide used for utility rights of way. DeadWeed is a selective herbicide for controlling woody plants and broadleaf weeds. The environmental hazards section of the label looks like the example at the left.

The label specifies that you need to avoid surface water. Make sure the sprayer avoids streams and other water when you spray the rights of way, otherwise you would be applying the herbicide illegally.

Looking at the label, you can see that DeadWeed DG can be used for selective weed control on non-irrigation ditchbanks. Even though the application site is a ditchbank, the applicator must be careful not to spray the herbicide on the water, or allow the herbicide to drift over the water.

Sensitive Areas

Sensitive areas are sites or living things that are easily injured by a pesticide. Because industrial vegetation covers such a large assortment of sites, there are often several sensitive areas where you are spraying.

Usually, the sensitive areas are listed on the herbicide label. Sensitive areas can also include places with environmental concerns. This could be surface water, ground water, or wildlife areas. Sensitive areas can also include crops, such as grapes, that are very susceptible to herbicide damage.

You need to make sure you avoid sensitive areas during applications. This may mean leaving an untreated buffer zone, or a no-spray area, near the

sensitive area. For example, if the herbicide cannot be sprayed on surface water, leave a buffer zone near surface water to help prevent an off-target application.

Some sensitive areas are not listed on the label but need to be considered whenever making herbicide applications. These areas include (but are not limited) to:

- Field crops.
- Organic farms.
- Home gardens and lawns.

Endangered Species

Applicators need to ensure the protection of endangered species, especially when controlling industrial vegetation. The herbicide label will indicate if any special steps are needed to protect endangered species. This applies if your application site is designated as the current habitat of an endangered species. You will need to follow the special steps, or consider another herbicide that is labeled for use in that habitat.

Off-Target Applications

You are doing herbicide applications around a large factory to control vegetation in their storage area. You do this project every year, so you are very familiar with the factory site. You come across a fence that is badly corroded. Last year, you remember the fence being a shiny, new galvanized fence. What happened?

Off-target applications refer to objects, sites, plants, or animals that are not part of the application site but are sprayed. Some herbicides can cause corrosion and damage objects, such as a fence. You need to avoid needlessly spraying things that could be damaged.



Photo: Ohio Department of Agriculture

Plants treated with the wrong product could also be a kind of off-target application. Nontarget plants could also absorb the product through their roots from the targeted plants. Off-target applications can result in complaints or damage to the surrounding environment.

Herbicide Movement in Soil

Several factors affect how herbicides move through the soil. These factors determine if the herbicide could possibly be a threat to groundwater. Leaching can happen when herbicides move through the soil.

Solubility describes herbicides that dissolve easily in water and are more likely to move into water systems. When using herbicides near surface water sources such as ponds and streams, you should avoid highly soluble herbicides. Highly soluble herbicides should also be used carefully when near groundwater sources such as wells.

Adsorption refers to the ability of herbicides to attach themselves chemically to a soil particle. Some herbicides become tightly attached (strongly adsorbed) to soil particles and organic matter and are not likely to move out of the soil and into water systems. Clay soils or soils with high organic matter readily adsorb some pesticides.

Persistence or degradation refers to how long it takes herbicides to break down in the soil. Some herbicides degrade (break down) slowly and remain in the environment for a long time. Others degrade quickly in the soil. Natural processes also affect degradation, or breakdown, of the herbicides. The natural processes are sunlight, moisture, chemical reactions, and microorganisms.

Soil Properties

Soil texture is the relative proportion of sand, silt, and clay in the soil. Coarse, sandy soils generally allow water to carry the pesticides rapidly downward. Finer textured soils, like silt and clay, generally allow water to move at much slower rates. High clay-content soils will allow more herbicide adsorption to occur. This can reduce leaching and allow for longer herbicide persistence.

Soil Properties		
Texture <i>Affects movement of water particles</i>	Permeability <i>Measures speed of water's downward movement</i>	Organic Content <i>Affects volume of water and soil's ability to adsorb pesticides</i>
Coarse <i>(Sand)</i>	High permeability <i>(fast flow)</i>	Low organic content = faster water flow and little adsorption of pesticides
Smooth <i>(Clay, Silt)</i>	Low permeability <i>(slow flow)</i>	High organic content = higher water retention and greater adsorption of pesticides

Soil permeability is a general measure of how fast water can move downward in a particular soil. The more permeable soils must be managed carefully to keep pesticides from reaching ground water.

Soil organic matter influences the water-holding capacity of the soil particles. Soil containing organic matter has a greater ability to adsorb herbicides.

Study Questions

1. The label is a source of information for what areas?
 - a. Equipment maintenance.
 - b. Record-keeping procedures.
 - c. Sensitive areas.
2. A herbicide label says: “Do not apply directly to water.” What should you do when approaching a stream?
 - a. Drive quickly.
 - b. Avoid spraying the stream.
 - c. Call your supervisor.

Explanations

1. c – Sensitive areas. The label will have information on sensitive areas that need to be avoided with the herbicide product.
2. b – Avoid spraying the stream. You need to avoid spraying on the water or allowing the herbicide to drift onto the surface water.

Protecting Water Sources During Rinsing

As with the example of the herbicide label, DeadWeed, water resources are a sensitive area during pesticide applications. Surface water includes streams, rivers, ponds, and lakes. Sources of surface water can also include culverts, drains, waterways, and anywhere water runs over the ground. Groundwater could be accessed through wellheads and sinkholes. Applicators should practice caution when applying herbicides near surface water, wellheads, or other sources of water.

Look back at the DeadWeed label on page 70. Notice the sentence: “Do not contaminate water when disposing of equipment wash water.” This means that you need to contain the rinse water when cleaning the application equipment. Water sources, especially surface water, are still at risk when the equipment is being cleaned. The rinse water could contain enough herbicide to do damage.

Loading and Mixing Concerns

Another source of potential water contamination occurs during loading and mixing of herbicides. Industrial-vegetation applicators often use water from creeks and streams to avoid hauling water. The rights of ways and roadsides being treated are often long distances from headquarters. Applicators need to be careful of **back siphoning**. Back siphoning occurs when water flows from the spray equipment back into the water source while the tank is filling. The herbicide in the tank then contaminates the water source.

An air gap or backflow prevention device between the water source and the spray tank can help avoid back siphoning. Another idea is to use a nurse tank, which is used only for water and never filled with herbicide.

Never mix the tanks by a water source. Move to an area where any potential spills will not run into the water. *Always* give your job full concentration, whether loading, mixing, or applying.

Handling Spills

Herbicide spills can happen to anyone — even the most experienced, well-trained applicator. Spills or accidents can happen when:

- A hose breaks while you are spraying.
- You are involved in a motor vehicle accident in which the truck overturns and the tank ruptures.
- Someone accidentally opens a valve, releasing the tank mix.
- Herbicide containers fall off the truck.

Being prepared for spills and accidents is very important. Carry the following items whenever you are transporting herbicides:

- Spill kits.
- Absorbent material (like cat-box litter).
- Shovel or spade.
- Labels, Material Safety Data Sheets (MSDS).
 - Personal protective equipment.
 - Emergency phone numbers.
 - Container for cleanup.



You need to take immediate action in a spill situation. Your goal is to control and contain the flow of herbicide. Here are some guidelines:

1. Shut off running equipment or stop the leak if possible.
2. Contain the spill with a dam of dirt. Small spills can be absorbed with cat-box litter, sawdust, or other absorbent material.

3. Direct the spill away from ditches, streams, or any water source.
4. Never flush the area with water for cleanup.
5. Isolate the area and keep people away.
6. Stay at the scene. Do not leave the vehicle or the spill unattended.
7. Take time to use proper protective equipment. Do not expose yourself to the pesticide unnecessarily.
8. Clean up the spill and the contaminated area.

Large herbicide spills that cause environmental contamination should be reported. The emergency contacts include:

- Your supervisor.
- Local fire fighters.
- Ohio EPA at 1-800-282-0378 (24 hours a day, 7 days a week).
- Ohio Department of Agriculture at 1-614-728-6987 (8 a.m. to 4:30 p.m., Monday through Friday).
- National Response Center at 1-800-424-8802 if the herbicide enters any body of water.

Information that needs to be reported when a spill occurs:

1. Name.
2. Phone number.
3. Date of spill.
4. Time the spill occurred or was discovered.
5. Location.
6. Probable source of the spill.
7. Substance spilled.
8. Quantity spilled and duration of the spill.
9. Present and expected movement.
10. Weather conditions.
11. Company or emergency personnel on the scene.
12. Potential health risks.
13. What you are doing to contain the spill.

Study Questions

1. What is back siphoning?
 - a. Using water to rinse out the tank.
 - b. Allowing water to flow back into the water source.
2. What is one of the first steps when you discover a spill?
 - a. Contain the spill.
 - b. Flush the area with water.

Explanations

1. b – Allowing water to flow back into the water source. This usually happens when filling the tank. Maintaining an air space or installing a backflow prevention device (anti-siphoning device) between the water source and the tank will help eliminate this problem.

2. a – Contain the spill. You can build a small dam of dirt with a shovel or spade, or use absorbent material for small spills. Never flush the area with water.

Chapter 7

Problem Solving and Crisis Management



Photo: Ohio Department of Agriculture

Objectives for This Chapter...

1. Identify problem-solving skills.
2. Recognize plans for crisis management.
3. Describe how to respond to complaints.

Key Terms to Know...

Crisis Management — Response to a disruption in usual routines.

Problem Solving and Crisis Management

On-Site Public Relations

You are supervising a crew spraying roadsides in a rural county. A car passes the crew, then turns around and pulls up alongside you. The driver gets out and starts asking questions about roadside spraying. First, you ask him to step away from the equipment so you can hear him better. Of course, it also puts a safe distance between him and the equipment in case anything malfunctions.



The driver, who identifies himself as Mr. Jones, wants to know why you are spraying deadly pesticides along the roadsides in his neighborhood. You tell Mr. Jones that the crew is using a federally registered herbicide that is labeled for this application site. Mr. Jones hotly replies that the herbicide will just turn everything brown. You explain that the crew is using a selective herbicide, so only the undesired plants will be affected. The rest of the vegetation will be allowed to flourish.

You tell Mr. Jones that controlling roadside vegetation makes it safer for drivers on the road by increasing visibility. Also, roads with less shade dry faster after rain and snow to eliminate slippery spots.

Mr. Jones' face brightens. "Wow, you guys have done your homework," he says. "By the way, since that stuff you're spraying will knock out ugly ragweed, how about giving me some to use along my fencerows?"

Mr. Jones goes to his car and starts rummaging through the trunk for a container to hold the pesticide. Should you give him some pesticide, trying to be a good neighbor and help community relations?

Use Common Sense and Stay Out of Trouble

Although it sounds like good public relations to give a passer-by a little bit of herbicide to use, it is illegal. **Pesticides cannot be distributed unless they are in the original container with a label.** Also, are you using a restricted-use pesticide that he is not licensed to use?

So use your common sense. You are not guaranteed that Mr. Jones will use the pesticide according to the label, and you do not want to be liable for giving away pesticides. Even if the herbicide is labeled for general use, **you are not licensed to distribute the pesticide**, only to spray it for your company.

Even though you know Mr. Jones won't like your answer, you tell him he cannot have any of the herbicide the crew is using. "Mr. Jones," you say, "my

first responsibility is to make sure these pesticides are used correctly, according to the label. That's why I'm here to supervise the crew, and why I spend time training them in our off-season. If you have a weed problem, visit your county office of Ohio State University Extension or your local pesticide retailer and ask about the best herbicide to use."

Problem-Solving Skills

Industrial vegetation management focuses on controlling weeds and brush. But you'll still have people like Mr. Jones asking questions. You will also encounter complaints. When working with complaints, keep in mind some basic problem-solving skills:

- Get the facts.
- Research the problem.
- Determine the solution.
- Take action.
- Evaluate.

Wildflowers That Die and You Are Blamed...

It's a rainy day in late August, and you're in the office trying to catch up on some paperwork. The phone rings and a very angry voice says, "I'm Mrs. Smith. Your company sprayed the roadside and killed my new planting of wildflowers — even though I posted signs saying that no spraying was allowed!" What do you do? Evidently, this is a very upset homeowner who is convinced that your company destroyed her wildflowers. How should you handle the call?

Get the Facts

Obviously, Mrs. Smith is very upset. You need to reassure her that the company will look into her complaint. While she is on the phone, you need to get some information from her, such as:

- Where are her wildflowers located?
- What kind of wildflowers does she have planted?
- What kind of symptoms are her wildflowers showing?
- When did she first notice the damage to the wildflowers?
- Where is the damage on the wildflowers (the whole patch, one part of the patch)?
- Who else has been doing work, such as road work or spraying, in the area?
- How have the weather conditions been at her house (drought, lots of rain, cool, or extremely hot)?

Research the Problem

After talking with Mrs. Smith, you decide that you need to determine if the damage to the wildflowers was from spray or another factor. The first place to start is with the records from the crew who was spraying the roadside near Mrs. Smith's house.



Photo: Ohio State University Extension

After looking at the records, you see the crew was spraying in the area at the end of June. The crew leader had made a special note in the book about a patch of wildflowers with signs posted. The crew had shut off the nozzles and not sprayed in that area. According to the records, your crew sprayed the roadside two months before Mrs. Smith's flowers died.

The next step is to talk with someone who is knowledgeable about the situation. In this case, you need to talk with someone with information on the wildflowers Mrs. Smith has planted. There may be someone within your company who is knowledgeable. Another source is your county office of Ohio State University Extension.

Determine the Solution

After talking with the horticulture agent in your county Ohio State University Extension office, you find Mrs. Smith planted a mixture of springtime wildflowers, which would start dying naturally in August. Because your crew kept such accurate records about the spraying, you know it is not your company's fault that Mrs. Smith's wildflowers are dead.

Take Action

You call Mrs. Smith to talk with her on the telephone, and she rather sheepishly agrees with your solution. After talking with you, she had consulted the Internet and realized that it was a natural thing for her wildflowers to be dying now.

Evaluate

You are glad your crew kept such good records. The records, in addition to a good understanding of the situation, helped make your company's position secure. Luckily, Mrs. Smith also saw the error and was willing to accept the solution.

Crisis Management

Crisis management is the response to a disruption in the usual routine. Crises come in different shapes and sizes. A crisis could be a complaint like the one from Mrs. Smith. Or a crisis could be a truck overturning, spilling herbicide

over a roadway, and threatening a stream. The steps used for the problem-solving process are also used for crisis management.

Get the Facts — After the spill has been cleaned up, find out how the spill happened, how much pesticide was spilled, and whether any environmental damage occurred.

Research the Problem — With something as public as a spill, you might have reporters or neighbors calling the company. Give phone calls to someone who is knowledgeable about the situation and trained to handle the media and the public. Make sure your crews know when questions need to be referred to management. Also look at the crew's records to determine what happened.



Determine the Solution — The solution may be as simple as knowing how to respond to questions from the media and the public. Also make sure the spill is completely cleaned-up, and the proper authorities are contacted.

Take Action — The worst answer to any question during a crisis is: “No comment.” The public might think the company is trying to hide something. Answering questions accurately and being open about what happened is good policy.

Evaluate — After the dust has settled, you can evaluate if your team answered questions correctly and in a timely manner. This is also a good time to evaluate how the spill happened and put a policy in place to prevent future spills.

Records, Records, and More Records

Record-keeping is an essential part of every pesticide applicator's job. Well-kept records can save a company time and money. Records need to reflect the herbicide used, amount used, area covered, weather conditions, and anything worth noting that happened during the application. Records are especially important if a crisis would ever strike.

Pesticide Security and Vandalism

You've had a hard day trying to finish the right of way under some utility lines. The day seemed filled with obstacles, and tomorrow you'd like to get started right away so that you can get back on schedule. “If I fill up the sprayer tonight, it will be one less thing to do tomorrow morning,” you think to yourself. But is this a good idea?

Filled sprayers left in parking lots or fields are an open target to vandals and could pose a security threat. A filled sprayer could be stolen and used to damage areas by vandals or others. Likewise, even an empty sprayer on the back of the truck left in an open, unsecured area could mean trouble.

The best policy is to keep sprayers and trucks as secure as possible. Never leave keys in the ignition and never leave the sprayer unsecured. Full tanks of herbicides could accidentally, or intentionally, be spilled in an area.

Study Questions

1. What is a proper first step when someone registers a complaint?
 - a. Start defending the company.
 - b. Call an expert for help.
 - c. Get the facts about the complaint.

2. Why are records important?
 - a. Records can save the company time and money.
 - b. Records keep applicators busy.

3. How can you prevent pesticide vandalism?
 - a. Post signs noting toxicity of the pesticides.
 - b. Never leave a full sprayer unattended.

Explanations

1. c – Get the facts about the complaint. The facts are a very important part of problem solving. Knowing as much as you can about the problem will direct you to the correct solution.

2. a – Records can save the company time and money. Record-keeping is required by state and federal pesticide laws. Also, keeping good records can benefit the company if there is ever a complaint.

3. b – Never leave a full sprayer unattended. Leaving sprayers that are full of pesticides unattended, such as overnight in a field, creates an opportunity for vandals. Pesticide-spraying equipment should be kept secure. If the equipment must remain somewhere unattended, it should be completely empty to avoid potential problems.

Chapter 8 Applicator Safety



Objectives for This Chapter...

1. Explain terms associated with applicator risk.
2. List common routes of exposure.
3. Compare levels of exposure.
4. Describe various types of Personal Protective Equipment (PPE).
5. List personal hygiene habits to minimize pesticide exposure.
6. Identify symptoms of acute pesticide poisonings.
7. Describe basic first-aid procedures.

Key Terms to Know...

Personal Protective Equipment (PPE) — Required safety clothing to reduce applicator exposure to pesticides.

Walk In, Spray Out — Start spraying at the furthest point so you spray back to the beginning to avoid walking in sprayed areas.

Applicator Safety

You and your crew are preparing to leave for a day of spraying along ditch banks. The sprayer is ready to go, the extra herbicide and water are loaded, equipment is in the toolbox, and you are supplied with maps, a spill kit, and miscellaneous supplies.

Did you remember the Personal Protective Equipment (PPE)?

You and your crew are the most at risk for pesticide contamination and exposure. Only you and your crew have direct control over your short-term and long-term exposure risks.

Hazard = Toxicity x Exposure

How hazardous are the pesticides you are using? Well, it depends. The formula shown here gives a clue:

$$\text{Hazard} = \text{Toxicity} \times \text{Exposure}$$

Toxicity refers to the pesticide that is being used. Some pesticides have a higher toxicity than others. The exposure refers to how long you will be using the pesticide, or if you are using the correct PPE.

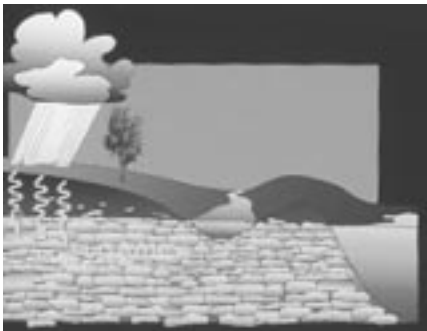


Photo: USDA

For example: If you use a highly toxic pesticide only once, then the toxicity would be high and the exposure would be low. To illustrate, we'll assign some numbers to the equation given earlier:

Toxicity = 10 (the high toxicity of the chemical)

Exposure = 1 (using the pesticide only once for a short period)

So, the equation would look like:

$$\text{Hazard} = 10 (\text{toxicity}) \times 1 (\text{exposure})$$

$$\text{Hazard} = 10$$

For example: If you use a pesticide with low toxicity and use it often, then the toxicity would be low and the exposure would be high. To illustrate, we'll assign numbers to the equation:

Toxicity = 1 (for the low toxicity of the chemical)

Exposure = 10 (for using the pesticide many times)

The equation would look like:

$$\text{Hazard} = 1 (\text{toxicity}) \times 10 (\text{exposure})$$

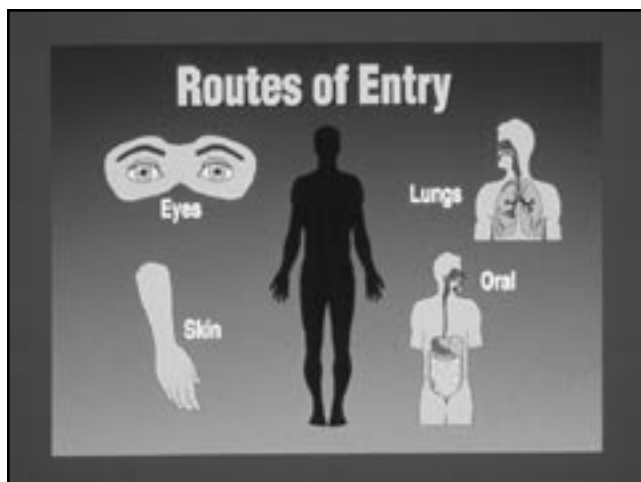
$$\text{Hazard} = 10$$

Both instances have the same hazard to you as an applicator, even though the pesticides were different in their toxicity level. You can lower exposure risk by

using the proper PPE. Personal protection is important whether the pesticide is a general-use pesticide or a restricted-use pesticide. For more information, consult Ohio State University Bulletin 825, *Applying Pesticides Correctly*.

Common Routes of Exposure

The pesticide label is your No. 1 source of information for reducing exposure risk. The label will specify the Personal Protective Equipment (PPE) that needs to be worn when loading, mixing, and applying the pesticide.



Pesticides can enter your body in four ways. PPE is designed to reduce the risk of pesticides being absorbed into your body through one of these pathways. The four major entry points are skin, eyes, mouth, and nose.

1. Skin Absorption

Splashes or spills may bring pesticides in contact with your skin. Exposure can occur during mixing or loading and when applying the pesticide. Equipment or hoses may have pesticide residues on them. The outside of pesticide containers can also be contaminated. Be sure to protect your hands. In the field, it is also possible to

contaminate yourself with a hand wand or when you are working on the sprayer.

Skin is the primary route of exposure because skin is so easily exposed. Also there is such a large area for potential contact. Gloves, long-sleeved shirts, long pants, shoes, and socks are needed for standard pesticide applications to guard against skin absorption.

2. Eye Exposure

While mixing and loading, clouds of dust or liquid splashes can contaminate your eyes. During applications, the wind could also blow pesticide spray into your eyes. Goggles are used to reduce exposure to pesticides for the eyes.

3. Mouth (Oral) Exposure

Pesticides can be unintentionally swallowed. This can happen through accidental splashing or sloppy work practices such as blowing through nozzles to unplug them or smoking and eating before washing your hands. While making pesticide applications, refrain from touching your mouth, nose, or eyes. Always wash your hands before eating, drinking, smoking, or going to the bathroom.

4. Nose (Respiratory) Inhalation

You may be breathing in pesticides without realizing it. Pesticides can be inhaled through both your nose or mouth. This can happen while mixing or loading dusts. Sometimes vapors can be a problem, too. The label may indicate that respirators are necessary when working with certain pesticides in order to reduce nose or respiratory inhalation.

Signal Words

Signal words appear in large letters on the front panel of the pesticide label. The signal word — DANGER, WARNING, or CAUTION — indicates how acutely toxic the product is to humans.

The signal word is immediately below the statement, “Keep out of reach of children,” which must also appear on every label.



Danger — The pesticide is highly toxic. The product is very likely to cause acute illness from oral, dermal, or inhalation exposure or to cause severe eye or skin irritation. It may also have the skull and crossbones symbol with the word *poison* on the label. If the skull and crossbones symbol is not on the label with the word *danger*, the product causes acute illness through skin and eye irritation.

Warning — The pesticide is moderately toxic and moderately likely to cause acute illness from oral, dermal, or inhalation exposure or the product is likely to cause moderate skin or eye irritation.

Caution — The pesticide is slightly toxic or relatively nontoxic. The product has only slight potential to cause acute illness from oral, dermal, or inhalation exposure. The skin or eye irritation it would cause, if any, is likely to be slight.

Study Questions

1. How can you reduce your exposure to a pesticide?
 - a. Do all work very quickly.
 - b. Wear Personal Protective Equipment (PPE).
 - c. Rely on your good genetics to avoid sickness.
2. What is the best way to prevent mouth (oral) exposure?
 - a. Wash hands before eating or using tobacco products.
 - b. Always keep your mouth shut.

Explanations

1. b – Wear Personal Protective Equipment. PPE is the best way to reduce exposure. Doing work very quickly might increase exposure as you become sloppy in your haste. Good genetics are great to have, but they are not as dependable as Personal Protective Equipment.
2. a – Wash hands before eating or using tobacco products. This removes any pesticide residues that may still be on your hands and keeps them out of your body.

Controller

Specialty Herbicide

For controlling unwanted trees by cut-surface treatments in forests and non-cropland areas such as fence rows, roadsides, and rights of way.

Applicators and other handlers, including persons repairing or cleaning equipment, must wear:

- Long-sleeved shirt and long pants.
- Chemical-resistant gloves such as Barrier Laminate, Butyl Rubber, Nitrile Rubber, Neoprene Rubber, Polyvinyl Chloride (PVC), or Viton.
- Shoes and socks.
- Protective eye wear.
- **For containers over 1 gallon but less than 5 gallons:** Mixers and loaders who do not use a mechanical system (such as probe and pump or spigot) to transfer the contents of this container must wear coveralls or a chemical-resistant apron in addition to other required PPE.
- Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product’s concentrate. Do not reuse them. Follow manufacturer’s instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry. After each day of use, clothing or PPE must not be reused until it has been cleaned.

Personal Protective Equipment (PPE)

When you and your crew prepare for a day of spraying, what PPE should you use? The best place to look is on the pesticide label. Here is part of a label from a herbicide used for cut-stump treatment. The PPE is listed right on the label. You and your crew should be wearing the listed PPE when you are doing cut-stump applications and working with this herbicide.

A similar list will appear on every pesticide label. Different herbicides have different routes of entry into your body. The PPE is chosen for each individual pesticide to reduce your exposure.

Mixing and Loading

Notice that there is separate Personal Protective Equipment listed for mixing and loading the herbicide. Because there is greater risk of splashing during the mixing and loading process, most pesticides will recommend

coveralls or a chemical-resistant apron in addition to the other required Personal Protective Equipment.

During the mixing and loading process, you may be dealing with concentrated pesticides that are generally more toxic than diluted mixtures. As you mix pesticides and load them into application equipment, you are more likely to come in direct contact with these concentrates.

Study Questions

1. How can you reduce skin exposure to pesticides?
 - a. Wear short sleeves so pesticides can be easily washed off.
 - b. Wear long sleeves to prevent absorption by the skin.

2. Respirators help reduce exposure to which body part?
 - a. Eyes.
 - b. Ears.
 - c. Nose.

Explanations

1. b – Wear long sleeves to prevent absorption by the skin. When wearing short sleeves, by the time you wash your arm, your body has already absorbed the pesticide through the skin.

2. c – Nose. Respirators cover the nose and the mouth to protect you from breathing in the pesticide. Respirators also help protect you from being overcome by noxious fumes.

Consult the Label

“I don’t want to walk onto a public site wearing a huge breathing apparatus and a moon suit! The public will think I’m spraying nuclear waste!”



The label lists the required Personal Protective Equipment for that pesticide. If you will be spraying a visible public area, you might decide to use a herbicide that requires less PPE. The applicator **must** have adequate protection against exposure.

Reducing Application Exposure

Applying pesticides is generally less hazardous than mixing and loading them. When mixing and loading, the pesticides are more concentrated. During an application, you are usually using diluted materials compared to mixing and loading. However, you are exposed to the pesticides for longer periods of time during applications than with mixing and loading — which goes back to our equation:

$$\text{Hazard} = \text{Toxicity} \times \text{Exposure}$$

Increased exposure means you still are at risk when applying pesticides. Always read the label to determine the proper PPE. There are some steps to remember when applying pesticides in industrial vegetation circumstances: walk-in, spray out; spray direction; and heavy dew situations.

Walk In, Spray Out

You are preparing to spray the foliage on some brush along a utility right of way. The brush is together in a tight clump. To make sure all the brush is sprayed, you have to walk into the middle of the clump to begin spraying.

You climb down from the back of the truck with the hose and wand and walk toward the brush. You're about to begin spraying the bush nearest you, when you realize you would have to walk past that bush to spray the others.



Walk In, Spray Out is the concept described earlier in this manual. It involves starting to spray at the point furthest from your equipment, so you spray on your way back. This way, you do not walk past trees or other plants that are already sprayed. By reducing this exposure, you can help limit your risk.

Spray Direction

Foliar spraying often means spraying objects that are taller than you. Always spray from one side and upwind from your target. Never spray directly underneath the target where the spray could come back down on you. If you stand underneath a tree and spray directly up to make contact with leaves above you, gravity will bring the spray back down into your face. This will increase your exposure risk. By standing on a truck or some other elevated place, you can spray a tree without allowing gravity to bring the pesticide back onto you. Or you can spray from the side and upwind from the target so the spray is directed away from you.

Heavy Dew Situations

Often, spraying is done in the early morning, when winds are calm, to reduce drift. Early mornings also mean the dew has not dried, and sometimes applicators can get wet just walking through tall grass and brush.

This can be a source of pesticide exposure as the skin can absorb the chemicals through the wet shirt and pants. When applying pesticides in early mornings with heavy dew, plan to spray the drier areas first. This may be an area with short grass and brush, or a hillside with an eastern exposure.

Don't Take It Home

The last thing you want is to contaminate and expose your family to pesticides. Yet, what is on your clothes and body when you go home could contaminate your family.

Pesticide residues can stay on your clothes, your shoes, and any unwashed portion of your body. So, if you climb into your car after spraying pesticides without taking a shower first and changing your clothes, your car interior will be contaminated. If you walk through your house with shoes that you wore while spraying pesticides, you could be spreading pesticides on your carpets.



Hugging your children or kissing your spouse without taking a shower first (or while wearing pesticide-contaminated clothes) could unnecessarily expose them. ALWAYS shower and change clothes at the end of the work day, either at work or immediately upon arriving home.

Laundering and Maintaining PPE

Some PPE is disposable and should be discarded immediately after being used. Other PPE is designed for frequent use. ALWAYS clean or launder such PPE after each pesticide application. There are important steps to be followed in laundering your pesticide-contaminated clothes.

1. Put PPE in a plastic bag until it can be laundered.
2. Keep the PPE bag away from children, pets, and the family wash.
3. NEVER wash PPE in the same load with family laundry.
4. Clean out the washer after washing pesticide-contaminated clothing by running an empty load with detergent.

Routinely check PPE for tears or holes. Discard any items that are damaged in any way. Your safety is important, and small holes or tears could result in unnecessary exposure.

Study Questions

1. Which selection would be a good rule to follow when applying pesticides?
 - a. Consult the label to determine adequate PPE.
 - b. Gloves are all you need when working with pesticides.
2. How should you handle the clothes you wore while applying pesticides?
 - a. Keep contaminated clothes separate from the family wash.
 - b. Wash with the usual family loads.

Explanations

1. a – Consult the label to determine adequate PPE. The label specifies the vulnerable routes of exposure for the pesticide. Gloves are a good idea, because they'll lower the risk of skin absorption, but some pesticides require more PPE.
2. a – Keep contaminated clothes separate from the family wash. The clothes you wore while applying pesticides are contaminated. Mixing them in with the usual family wash would expose your spouse and children to pesticides needlessly.

Pesticides and Beverages Don't Mix

Joe had just finished his lunch and was eager to get back to work. The sprayer had broken down, and he wanted to get it fixed before the crew returned from town. He still had some soda pop left in his can, so he took it out to the sprayer with him. He set the pop up on the boom and began working on the nozzles. Joe would stop every few minutes, take a drink from his can, and start working again.



Suddenly, Joe began to feel very dizzy. He tried to keep working, but finally decided he better go sit down in the shade. He started walking toward the trees, but the last thing he remembered was seeing the crew drive in and get out of the truck.

Joe was lucky. The crew saw him fall, began first aid, and immediately took him to the local hospital. Fortunately, the crew had been trained in handling possible pesticide poisonings and remembered to bring along the pesticide label so the emergency room doctor could treat Joe.

Joe had contaminated himself with his can of pop. While working on the nozzles, he had put his contaminated hands on the pop can. He also had not noticed that some of the pesticide had drifted over to the can when he had done test sprays while repairing the equipment.

Personal Habits That Can Reduce Exposure

1. Never eat or drink while applying pesticides or working on equipment.
2. Always wash hands before going to the bathroom, eating, or smoking.
3. Always shower at the end of the workday and put on clean clothes.

Joe learned the hard way that pesticide exposure can be hard to detect until it's too late. Other bad habits such as cleaning plugged nozzles by blowing them out with your mouth could result in pesticide poisoning. It's important

for people working around pesticides to be trained in pesticide safety and the signs of pesticide poisoning.

Signs of Pesticide Poisoning

Pesticide poisoning signs will be different, depending on whether the person experienced skin, eye, respiratory, or oral contamination. The general signs of pesticide poisoning when working with herbicides are:

- Skin irritation.
- Eye irritation.
- Irritation of mouth and throat.
- Abdominal pain and vomiting.
- Diarrhea.
- Dizziness or faintness.
- Chest pain.
- Muscle twitching and weakness.
- Burning of the throat, stomach irritation, vomiting, and bloody diarrhea caused by ingestion of the pesticide.

These signs are a general description of common symptoms of poisoning. People will react differently to chemical exposure. Also, the symptoms here refer mainly to acute or immediate effects. Results from long-term exposure, or chronic or delayed effects, are less well-known.

First Aid for Pesticide Poisoning

If overexposure from a pesticide occurs, immediately call for help. Follow these general first-aid procedures while awaiting help:

Pesticide on the skin:

- Remove contaminated clothing.
- Wash thoroughly with large amounts of water.

Pesticide in the eyes:

- Flush eyes with large volumes of water for 15 minutes.

Pesticide in the mouth or swallowed:

- Consult the label for instructions regarding vomiting. Depending on the pesticide, vomiting could make things worse.
- Medical-grade activated charcoal is sometimes used to absorb pesticides in the stomach.
- Never induce vomiting if the person is unconscious.

ALWAYS notify a physician in cases of pesticide poisoning.

- Provide the name of the pesticide.
- Be prepared to supply pesticide labels and Material Safety Data Sheets (MSDS).*

***Material Safety Data Sheets**

Material Safety Data Sheets (MSDS) contain additional information on the physical and chemical hazards of pesticides and other chemicals. Chemical manufacturers and distributors should provide them when pesticides are purchased.

Post Emergency Numbers

It's important to always have emergency numbers in easy-to-find places. This includes near telephones in shops and storage areas or in truck cabs for spraying done in remote areas. Make these emergency numbers available:

- Local poison control numbers.
- National poison control toll-free number.
- Manufacturer's hot-line phone number.

Study Questions

1. Is it safe to eat or drink around pesticide products?
 - a. Yes
 - b. No
2. Where should emergency numbers be kept?
 - a. In the boss' rotary file of telephone numbers.
 - b. By the telephone.

Explanations

1. b – No. To lower your risk of exposure, you should always eat or drink away from pesticide products. If you are out in the field, you should eat away from the equipment in an area that has not been sprayed.
2. b – By the telephone. In an emergency, the boss' telephone file might be too hard to find. Keeping the emergency number in an easy-to-see location near the phone will save precious time during a pesticide poisoning emergency.

Chapter 9

Laws and Regulations



Photo: DuPont

Objectives for This Chapter...

1. Explain the importance of keeping accurate records.
2. Summarize the information required for applicator records.
3. Describe Ohio's notification requirements for cases of personal illness or property damage.
4. Identify the laws and regulations with which you must comply when engaged in specific pesticide activities.
5. Recognize practices and situations that are violations of state and/or federal pesticide laws.

Key Terms to Know...

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) — The federal law that regulates the registration, manufacture, transport, and use of pesticides.

Ohio Pesticide Law — State laws and regulations that govern all pesticide activities in Ohio and the licensing of pesticide applicators and businesses. These laws are usually stricter than federal law.

Laws and Regulations

One beautiful morning you are in the office enjoying the sunshine. “Life doesn’t get any better than this,” you think to yourself. You smile as someone walks in the door. Your smile fades as the person introduces himself as an inspector from the Ohio Department of Agriculture (ODA) and states that he is here to look at your pesticide application records.

“What records?” You don’t know what records should be given to this inspector. Suddenly, you feel yourself getting very hot and uncomfortable. Should it be like this? **No.** Ohio Pesticide Law spells out the information you need to keep for accurate and legal record-keeping. Don’t let yourself get caught with your file drawer empty. Make sure you and your crews keep accurate records of all pesticide usage and applications.

Compliance with Pesticide Law

A basic understanding of pesticide laws is needed to help *protect you, your customers, the community, and the environment*. Compliance with laws will also help you avoid costly fines and litigation. Pesticide products may be cancelled if companies do not make responsible applications. EPA will allow the continued use of some pesticides based on the idea that trained, certified applicators are working to properly apply the pesticide products.

Federal, state, and local laws govern the use, handling, application, storage, and transport of pesticides. Much of this information is covered in Ohio State University Extension Bulletin 825, *Applying Pesticides Correctly*. In this chapter, we will highlight regulations of particular concern to industrial vegetation managers.

Ohio Pesticide Law — Record-Keeping

When the inspector from the Ohio Department of Agriculture stopped by your office, he or she asked for your pesticide application records. What records? What information needs to be in those records? The answer is written in the Ohio Pesticide Law:

Regulation 901:5-11-07, Applicator Records

Records of all applications of pesticides made by commercial applicators shall be held for a **period of three years** from the date of application and be made available to the Director of Agriculture or his/her agent upon request. The *following information shall be recorded on the day of application* except as exempted by the following sections of the rule:

1. Name and business address of responsible certified applicator and name of trained servicepersons applying pesticides at the application site.



*Photo: Dr. Harvey Holt,
Department of Forestry, Purdue University*

2. Name and address of person contracting for service.
3. Date of application and re-entry date when applicable.
4. Type of plants, crop, or animals to be treated.
5. Principal pests to be controlled.
6. Acreage or number of plants or animals treated.
7. Location or field identification number of treatment area.
8. Trade name (brand name) and EPA registration number of pesticides used.
9. Total amount of each pesticide product used.
10. Rate of application and concentration of pesticide formulation applied.
11. Type of equipment used.
12. Time of day of the application, including the time of starting the actual application and the time of completion of application or, if uncompleted, the time when operations ceased for the day.
13. Wind direction and velocity, air temperature, and other weather conditions when applicable.
14. Any other pertinent information as required by the pesticide label.

Study Questions

1. How long should you keep pesticide application records?
 - a. Two years.
 - b. Three years.
 - c. Five years.
2. Which of the following is required by law to be on the pesticide application record?
 - a. Formulation.
 - b. Unusual obstacles.
 - c. Weather conditions.

Explanations

1. b – Three years. According to law, pesticide application records must be kept for three years.

2. c – Weather conditions. Weather conditions are required by law to be on the pesticide application records. The other required items are in the list of 13 items on pages 84 and 85. Other items may be needed by the company for its records.

Ohio Pesticide Law — Personal Illness/Property Damage

Mr. Brown, who is obviously frantic, calls your office one morning. His wife is not feeling well and is planning to go to the doctor this morning. Also, his four-year-old son has developed a rash. Yesterday, your crew was spraying roadsides on the county road on which Mr. Brown lives. He is convinced that your company poisoned his family. What are your legal obligations in the case of Mr. Brown? The answer is written in the Ohio Pesticide Law:



Regulation 905:5-11-02, Personal Illness/Property Damage

A commercial applicator shall report to the Director of Agriculture:

1. By telephone, within 48 hours of his/her knowledge of any human illness requiring medical attention, resulting from or allegedly resulting from, a pesticide used by him/her followed by a written report within seven (7) days.
2. By written report, within ten (10) days of his/her knowledge of any property damage, in excess of \$500, allegedly resulting from his/her pesticide handling activity.

So you need to call the Ohio Department of Agriculture about Mr. Brown's situation. This does not assign the blame to your company about illnesses in the Brown family. This does allow the Ohio Department of Agriculture to conduct a comprehensive investigation of the incident. You are required by law to report Mr. Brown's complaint.

In another case, Mrs. James called saying that roadside spray had drifted into her yard and killed a row of mature trees. Do you need to report this complaint to the Ohio Department of Agriculture? Yes. The law requires that if damage exceeds \$500 you must report it. Most likely her trees are worth at least that much. Again, like the case mentioned earlier, this does not assign blame to your company, but does help ODA start the investigation.

Ohio Pesticide Law — Drift/Nontarget Application

We've talked about drift in previous chapters. For industrial vegetation, controlling drift is very important. The Ohio pesticide law states:

Regulation 905:5-11-02, Drift/Nontarget Application

F. No person shall apply a pesticide to an area or a crop in such a manner

or at such a time that he/she will contaminate adjacent crops, pasture land, or other areas or water.

- G. No person shall apply a pesticide at such time or under such conditions that the wind velocity will cause the pesticide to drift and cause damage.

Preventing drift is very important to your company, both from a public viewpoint and the Ohio Pesticide Law. This is where good records come into play. By keeping records of weather conditions and locations of sensitive areas, you can help yourself prevent drift. You also have records to show in case your spraying is challenged by a neighboring landowner.

FIFRA — Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended, is a federal law that regulates the registration, manufacture, transport, and use of pesticides. The law affects you in many ways. Most important, it provides that:

- All pesticides must be used only as directed on the label.
- All pesticide uses must be classified as *restricted* or *general*.
- Persons who buy or use restricted-use pesticides must be certified as competent pesticide applicators or must be directly supervised by a certified applicator.*
- Persons who do not obey the law will be subject to penalties (fines and jail terms).

* Remember, Ohio law goes beyond FIFRA and requires commercial applicators to be certified or be directly supervised by a certified applicator even when using general use products.

Use Inconsistent with the Label

An applicator may not use any pesticide in a manner not permitted on the label. You must use the pesticide only on the plants, animals, or sites specified in the directions for use. You may not use higher dosages, higher concentrations, or more frequent applications. You must follow directions for use, safety, mixing, diluting, storage, and disposal as well as restrictions on re-entry and days to harvest, slaughter, and graze.

You must wear the specified Personal Protective Equipment even though you may be risking only your own safety by not wearing it. The use directions are not advisory — they are requirements.



The law does allow you to:

- Apply a pesticide at any dosage, concentration, or frequency that is less than that listed on the label.
- Apply a pesticide against any target pest not listed on the label if the application is to a crop, animal, or site that is listed.
- Use any equipment or method of application that is not prohibited by the labeling.
- Mix a pesticide or pesticides with a fertilizer if the mixture is not prohibited by the labeling.
- Mix two or more pesticides, if all the dosages are at or below the labeled rate.

Study Questions

1. When must you call the Ohio Department of Agriculture about a drift complaint you receive?
 - a. Every call should be reported to the Ohio Department of Agriculture.
 - b. When the value of the damage exceeds \$100.
 - c. When the value of the damage exceeds \$500.

2. What should you always do first, before applying pesticides?
 - a. Read the label.
 - b. Call the Ohio Department of Agriculture.

Explanations

1. c – When the value of the damage exceeds \$500. This is the only time you need to involve the Ohio Department of Agriculture in the drift complaint.

2. a – Read the label. **The label is the law.** Any information you need to know about applying the pesticide is on the label, including proper PPE, application sites, buffer strips needed, and sensitive areas and crops.

Appendix



For More Information

This appendix provides some calculations for partial and multiple spray tanks. Also included are spray volume calculations for hand-gun sprayers and calibration for boom sprayers.

This is not a complete listing of all calculations necessary for your pesticide application and calibrations. For more information, consult your county office of Ohio State University Extension and OSU Extension bulletins and fact sheets available at <http://ohioline.osu.edu> or the manufacturer of your equipment.

Calculating for Partial Spray Tanks

You are planning to use a boom sprayer to spray a gravel parking lot. The lot is 2 acres in size, but the 300-gallon tank on your sprayer covers 7.5 acres with a delivery rate of 40 gallons/acre. You are using a herbicide with the recommended rate of 2 pints per acre that will be mixed with water. How much product and water should you put in your tank?

1. Convert the recommended rate of herbicide from pints to gallons.

$$\frac{2 \text{ pints}}{\text{acre}} \times \frac{1 \text{ gallon}}{8 \text{ pints}} = \frac{0.25 \text{ gallons}}{\text{acre}}$$

2. Determine how much herbicide product you will need for the parking lot.

$$\frac{0.25 \text{ gallons}}{\text{acre}} \times \frac{2 \text{ acres}}{1} = 0.5 \text{ gallons of herbicide product}$$

3. Now, determine how much total solution to put in your sprayer tank. Take the delivery rate of your sprayer and multiply it by the size of the area to be sprayed.

$$\frac{40 \text{ gallons}}{\text{acre}} \times \frac{2 \text{ acres}}{1} = 80 \text{ gallons}$$

4. Subtract the amount of herbicide product from the amount of total solution.

$$\begin{array}{r} 80.0 \text{ gallons (total solution)} \\ - 0.5 \text{ gallons (herbicide amount)} \\ \hline 79.5 \text{ gallons (water or other carrier)} \end{array}$$

Calculating for Multiple Spray Tanks

You are preparing for a full day of spraying along some utility rights of way. Your tank holds 300 gallons of spray solution, and your sprayer is applying 40 gallons of solution per acre. The label says to use 2 quarts of product per acre. You figure that you will be spraying about 225 acres today. How much product will you need to take for the day's work?

1. Determine how many acres a full tank on your sprayer will spray.

$$\frac{300 \text{ gallons}}{\text{tank}} \div \frac{40 \text{ gallons}}{\text{acre}}$$

Convert to multiplication

$$\frac{300 \text{ gallons}}{\text{tank}} \times \frac{1 \text{ acre}}{40 \text{ gallons}} = \frac{7.5 \text{ acres}}{\text{tank}}$$

2. Convert the recommended rate per acre to gallons per acre.

$$\frac{2 \text{ quarts}}{\text{acre}} \times \frac{1 \text{ gallon}}{4 \text{ quarts}} = \frac{0.5 \text{ gallons}}{\text{acre}}$$

3. Determine the amount of product per tank.

$$\frac{0.5 \text{ gallons}}{\text{acre}} \times \frac{7.5 \text{ acres}}{\text{tank}} = \frac{3.75 \text{ gallons}}{\text{tank}}$$

4. Determine the number of tanks needed to cover 225 acres.

$$\frac{225 \text{ acres}}{1} \div \frac{3.75 \text{ gallons}}{\text{tank}}$$

Convert to multiplication

$$\frac{225 \text{ acres}}{1} \times \frac{\text{tank}}{7.5 \text{ acres}} = 30 \text{ tanks}$$

5. Determine amount of herbicide needed for the day.

$$\frac{3.75 \text{ gallons}}{\text{tank}} \times \frac{30 \text{ tanks}}{1} = 112.5 \text{ gallons of herbicide product}$$

Spray Volume for Handgun Sprayers

1. Measure and mark an area that is 10 feet by 100 feet (this equals 1,000 square feet). Fill the sprayer with water.
2. Spray the 10-foot by 100-foot area and time yourself.
3. Spray water into a bucket for the same amount of time it took you to spray the 10-foot by 100-foot area.
4. Convert the quantity of water in the bucket into gallons. (128 ounces equals 1 gallon.)
5. Multiply the gallons of water that were sprayed into the bucket times 43.65 (conversion from 1,000 square feet to acres) and this equals gallons per acre.

Example of Spray Volume for Hand-Gun Sprayers

(Follows the steps outlined previously.)

1. Measure and mark an area that is 10 feet by 100 feet (1,000 square feet) and spray the area.
2. After spraying the area, you see it took you 5 minutes to spray the 1,000 square feet.
3. Spray water into a measured bucket for 5 minutes. You measure 295 ounces of water sprayed into the bucket.
4. Convert the quantity of water in the bucket into gallons.

$$\frac{295 \text{ ounces}}{1} \div \frac{128 \text{ ounces}}{\text{gallons}}$$

Convert to multiplication

$$\frac{295 \text{ ounces}}{1} \times \frac{\text{gallons}}{128 \text{ ounces}} = 2.3 \text{ gallons to cover 1,000 sq. ft.}$$

5. Now you can convert into gallons per acre:

$$2.3 \text{ gallons} \times 43.56 \text{ acres} = 100.188 \text{ gallons/acre}$$

You can round to 100, which means your sprayer uses 100 gallons per acre.

Calibration for Boom Sprayers (Delivery Rate)
(sprayers with multiple nozzles spread along a boom)

1. Inspect the sprayer to make sure there are no plugged nozzles or leaks.
2. Calibrate speed by measuring out an 88-foot tract. Record the amount of time (in seconds) it takes the equipment to travel that tract (at normal spraying speed). The miles per hour (mph) is determined by the distance multiplied by 60, divided by the product of time multiplied by 88.

$$\frac{\text{distance (feet)} \times 60}{\text{time (seconds)} \times 88}$$

3. Determine the nozzle flow rate. With the sprayer parked, run the sprayer at the same pressure level and catch the output from each nozzle in a measuring jar for one minute. The combined total will be the ounces per minute.*

Then divide the ounces per minute by 128 ounces to arrive at the final amount of gallons per minute.

$$\frac{\text{ounces per minute}}{128 \text{ ounces}}$$

* *You can check for plugged or worn nozzles while determining the nozzle flow rate. If a nozzle has a significantly lower output than neighboring nozzles, it could be plugged or may need to be replaced.*