Texas Agricultural Extension Service
The Texas A&M University System

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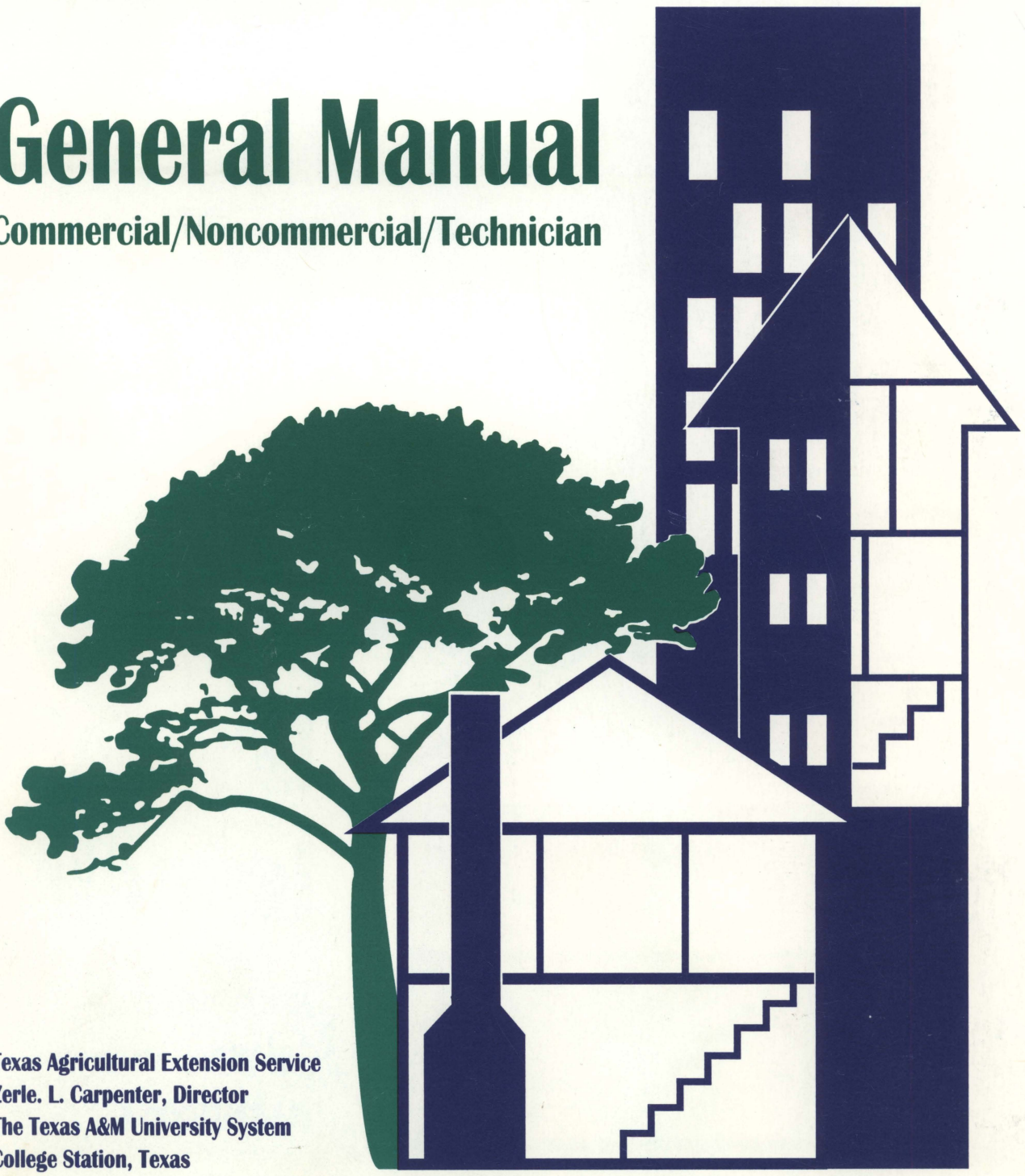
Structural Pesticide Applicator Training

General Manual

Commercial/Noncommercial/Technician



Texas Agricultural Extension Service
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Structural Pesticide Applicator Training

General Manual

Commercial
Noncommercial
Technician

This manual is intended for Texas pesticide applicators. It may be used as a study guide for certification tests conducted by both the Texas Department of Agriculture and the Texas Structural Pest Control Board.

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Acknowledgment

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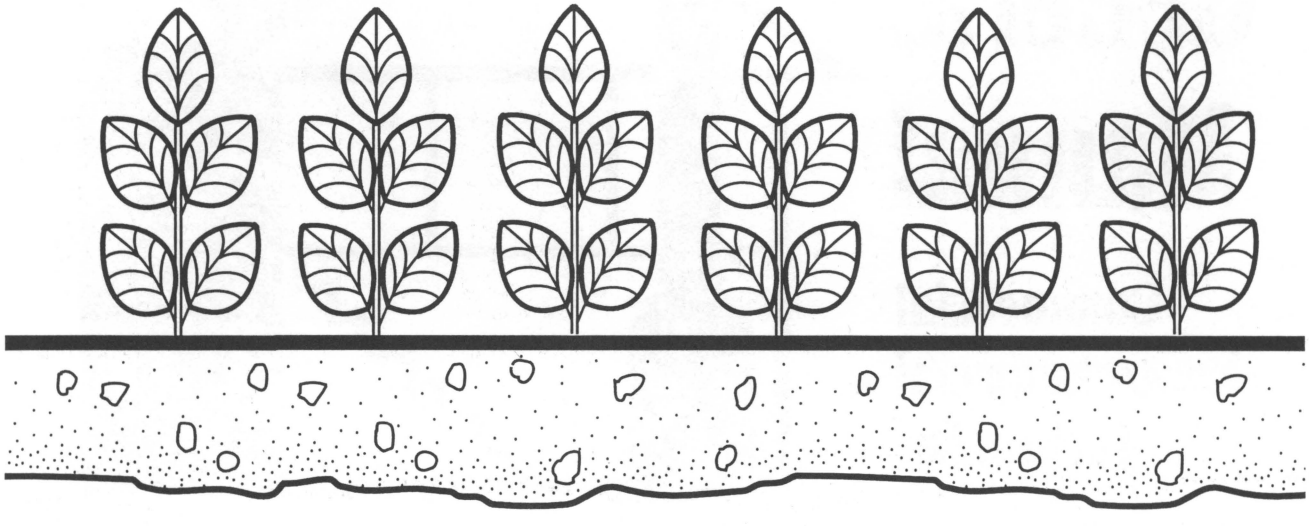
In addition, some excerpts and illustrations are adapted from a 1991 publication from the United States Environmental Protection Agency: *Applying Pesticides Correctly: A Guide for Private and Commercial Applicators.*



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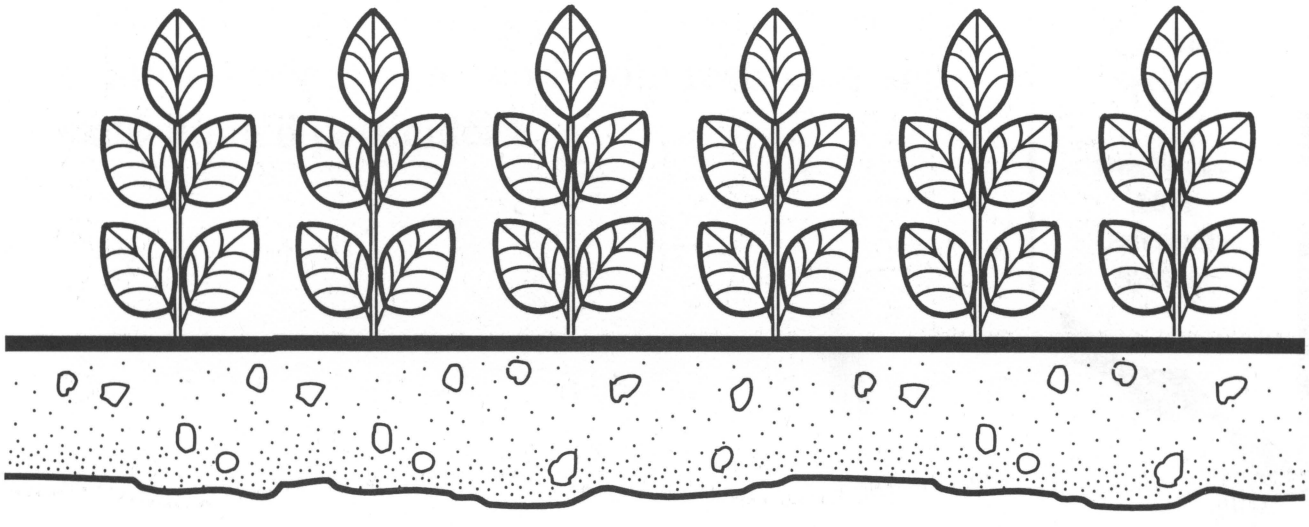

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Applicator Certification & Licensing

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Pesticide application is very complex. In fact, it requires more knowledge about safety and proper use than ever before. To make sure you learn all that you should, the government requires you to undergo training and testing. This is called certification. You will be certified as a pesticide applicator only after you complete your training and testing.

Certification is one of the steps to obtaining a Texas pesticide applicator license. You must have a license to legally perform structural pest control services or to work with restricted and state-limited pesticides.

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Learning Objectives

- Know who needs to be licensed.
- Know the difference between a private applicator, commercial applicator and noncommercial applicator.
- Be familiar with the categories of commercial and noncommercial application.

Licensing in Texas

Four state agencies share responsibility for pesticide applicator training, certification and licensing:

The **Texas Department of Agriculture (TDA)** tests and licenses people who want to use restricted and state-limited pesticides to produce a food or feed commodity.

The **Texas Structural Pest Control Board (SPCB)** tests and licenses people who want to perform structural pest control, as either a contractor or employee. Structural refers to space in or next to a residence, business, industrial plant, institution, park or street.

The **Texas Department of Health (TDH)** certifies applicators for vector control (control of health-related pests) and licenses only government employees.

The **Texas Agricultural Extension Service (TAEX)** develops applicator training and study materials. Training is available through Extension Service county offices and certain providers approved by the TDA and SPCB. Both the TDA and SPCB require continuing education courses for recertification and license renewal.

Who Must Comply

- **SPCB requirements**
- **TDA requirements**

SPCB requirements

The Structural Pest Control Board requires licensing of all structural service providers, whether they use pesticides classified as restricted, state-limited or general use. The SPCB issues six types of licenses: commercial, business, technician-apprentice, technician, noncommercial and noncommercial apprentice.

1. *Commercial license:* for persons who provide structural pest control services for hire. Pest control services include inspections and the recommendation and application of any pesticide.

2. *Business license:* required of commercial pest control businesses for each of their locations, including branch offices. These licensees also must have their own licensed commercial applicator, one who does not work for any other pest control business.
3. *Technician-apprentice license:* for temporary workers and technicians-in-training who assist commercial applicators. These persons must work under the direct supervision of a commercial applicator. The license is valid for only six months within a 12-month period.
4. *Technician license:* for technician-apprentices who complete their apprenticeship and want to continue working in pest control. They still must be supervised directly by a commercial applicator. They also must be licensed for every pest control business where they work.
5. *Noncommercial license:* for persons who perform pest control as an employee at an apartment building, day-care center, hospital, nursing home, hotel, motel, lodge, warehouse, food processing business, school or education institution.
6. *Noncommercial apprentice license:* for temporary workers or those training to become a certified noncommercial applicator. They must work under direct, on-site supervision by a noncommercial applicator and may not apply restricted or state-limited pesticides. This license is not renewable. It is valid for only six months within a 12-month period.

TDA requirements

The Texas Department of Agriculture administers licensing for all other applicators (except those under TDH). TDA issues three types of licenses: commercial, noncommercial and private.

1. A *commercial* license is required to use or supervise the use of restricted or state-limited pesticides on the land of another person for hire or compensation.
2. Applicators employed by government agencies must have a *noncommercial* license. It also applies to someone who uses pesticides on their employer's property but does not qualify as a private applicator.
3. The *private* license is required for a person who uses or supervises the use of restricted use or state-limited pesticides to produce agricultural commodities.

Agricultural commodity is defined as any plant or plant part, and any animal or animal product produced for sale, feed, food or other use by humans or animals. For example: nursery stock, sod, Christmas trees, apples, cotton, corn, carrots, potatoes, cattle, milk and eggs.

Examples of private applicators include farmers, ranchers, vineyardists, plant propagators, Christmas tree growers, aquaculturists, floriculturists, orchardists, nurserymen, sod growers and other similar occupations.

Anyone who works with "restricted use" or "state-limited use" pesticides must be licensed or directly supervised by someone who is licensed. For commercial applicators, the supervisor must be on-site during the entire application. For noncommercial and private applicators, "direct supervision" means that the licensed person is available, not necessarily present, to give directions or advice.

Certification Categories

- **Federal categories**
- **TDA categories**
- **SPCB categories**

Federal standards designate 10 different groups or categories of commercial and noncommercial applicators. States can divide the categories further or omit those that don't apply to their state. Both commercial and noncommercial applicators may apply for certification in any category.

All applicators must be certified in each category in which they practice. With both the TDA and SPCB, this requires passing one general exam and a separate test for each category.

Federal categories

1. **Agricultural pest control** — *Subcategory Plant:* on agricultural crops, including grasslands and noncrop agricultural land. *Subcategory Animal:* on animals and their pens, corrals, barnyards and other areas where animals are confined.
2. **Forest pest control:** on forests, forest nurseries and forest seed producing areas.
3. **Ornamental and turf pest control:** on ornamental trees, shrubs, flowers and turf. *Subcategories:* ornamentals and shade trees (including turf) or turf only.
4. **Seed treatment:** commercial seed treatments.
5. **Aquatic pest control:** on standing or running water. *Subcategories:* aquatic vegetation control, aquatic insect control and undesirable fish control.
6. **Right-of-way pest control:** on roadsides, railway right-of-ways, electric power lines, pipelines and other similar areas. *Subcategories:* highway right-of-way, railroad right-of-way and utility and pipelines right-of-way.
7. **Industrial, institutional, structural and health-related pest control:** in, on or around food handling establishments, homes, schools, hospitals, other public institutions, warehouses, grain elevators and other industrial buildings; areas near these buildings and around stored, processed or manufactured products.

Subcategories: structural and rodent, fumigation, termite, lumber and wood products, construction, food processing, cooling towers and other.

8. **Public health pest control:** public health programs carried out by state, federal or other government employees.
9. **Regulatory pest control:** control of regulated pests by state, federal or other government employees.
10. **Demonstration and research pest control:** includes those who use or demonstrate the use of restricted-use pesticides for research, demonstration or instructional purposes.

TDA categories

1. Agricultural pest control
   - A. Field crop pest control
   - B. Fruit & vegetable pest control
   - C. Weed & brush pest control
   - D. Predatory animal pest control
   - E. Farm storage pest control
   - F. Fumigation
   - G. Animal pest control
     1. Tick, louse & mite control
     2. Fly control
   - H. Citrus pest control
   - I. Livestock protection collar applicator
2. Forest pest control
   - A. Insect & disease control
   - B. Weed & brush control
3. Ornamental & turf pest control
   - A. Plant pest control*
   - B. Greenhouse pest control
   - C. Weed control*
4. Seed treatment
5. Right-of-way pest control
6. Aquatic pest control
   - A. Aquatic plant pest control
   - B. Aquatic animal pest control
   - C. Antifouling paint
7. Demonstration & research
8. Regulatory pest control
9. Aerial application
10. Chemigation

M-44 sodium cyanide applicator certification also is available to specially trained applicators who meet additional requirements.

* For private, noncommercial and commercial applicators who are nurserymen or who confine applications to production sites.

SPCB categories

1. Termite control
2. Pest control
3. Lawn and ornamental
4. Structural fumigation
5. Commodity fumigation
6. Weed control
7. Wood preservation

Pesticides are not for amateurs. To protect people and the environment, pesticide applicators must be professionals!

Study Questions

1. If unsupervised, you must have a license to legally work with restricted pesticides, but not to work with state-limited pesticides.
   True False
2. To legally perform structural pest control, you must have a license, regardless of the kind of pesticides you use.
   True False
3. Which is *not* an agency that shares responsibility for pesticide applicator training, certification and licensing?
   a. Texas Department of Agriculture (TDA)
   b. Texas Structural Pest Control Board (SPCB)
   c. Texas Department of Health (TDH)
   d. Texas Agricultural Experiment Station (TAES)
4. Which license must be obtained by a person who wants to perform pest control as an employee at an apartment building or hospital?
   a. A business license from the SPCB
   b. A noncommercial license from the SPCB
   c. A private license from either the TDA or the SPCB
5. To work for hire, using restricted pesticides on another person's land, you must have:
   a. A business license from the TDA
   b. A commercial license from the TDA
   c. A private license from the TDA
6. All licensed applicators must be certified in each application category in which they practice.
   True False
7. Which of the following is *not* among the TDA application categories?
   a. Right-of-way
   b. Predatory animal
   c. Wood preservation
   d. Fumigation
8. Which of the following is *not* among the SPCB application categories?
   a. Termite
   b. Seed treatment
   c. Wood preservation
   d. Commodity fumigation

1. false
2. true
3. d
4. b
5. b
6. true
7. c
8. b

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State Laws and Regulations

Each state has its own laws about the use of pesticides. These laws may deal with problems that occur only in that state. Or the laws may add to federal law with more restrictions on certain chemicals.

State pesticide rules may be stricter but not less strict than federal standards. Both federal and state laws apply to each person who uses pesticides within the state.

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Learning Objectives

- Know which agencies govern pesticide use in Texas.
- Know the state laws that rule pesticide application.
- Learn your duties under these laws.

Regulatory Agencies

A major agency in this state for pesticide regulation is the Texas Department of Agriculture (TDA). The Texas Pesticide Law gives the TDA power to oversee registration, distribution and use of pesticides in Texas. Three other state agencies also oversee pesticide use. They are the Texas Structural Pest Control Board, the Texas Water Commission and the Texas Department of Health. The TDA works cooperatively with these agencies and also enforces federal pesticide laws in cooperation with the United States Environmental Protection Agency.

The Texas Pesticide Law

The general provisions of this law authorize the TDA to restrict pesticide use, provide laboratory analysis of pesticides, and enter cooperative agreements with other government agencies. Other sections of the Texas Pesticide Law pertain to:

1. *Labeling.* The TDA may require certain label information on pesticides before they can be used in Texas.
2. *Registration.* Every pesticide must be registered with the TDA before it can be used in Texas.
3. *Licensing of dealers.* You may not distribute a restricted or state-limited pesticide without a dealer's license from the TDA.
4. *Use and application.* This section authorizes the TDA to regulate pesticide use and application, and coordinate the pesticide activities of other state agencies. This section also sets licensing requirements for certified applicators.
5. *Storage and disposal.* The TDA may make rules governing the storage and disposal of pesticides and pesticide containers.
6. *Enforcement.* The TDA can enter public or private property to inspect, examine or sample pesticides.
7. *Penalties.* This section defines offenses of the law and their penalties. It also describes defenses allowed by the law.
8. *Remedies.* This section tells how to appeal rulings by the TDA.

Pesticide Regulations

Texas Pesticide Regulations are rules set by the TDA to enforce the Texas Pesticide Law. The Texas Pesticide Regulations also define the following terms:

1. *State limited-use pesticides:* pesticides identified by the TDA that can harm nontarget vegetation, animals, public health or the environment.
2. *Pesticide application standards:* application guidelines to reduce health risks and protect workers and others in the production of agricultural field crops.
3. *Prior notification:* the responsibility of farm personnel to notify adjacent landowners and others prior to pesticide application.
4. *Reentry requirements and intervals:* the responsibility of the farm operator to insure that workers do not enter a field treated with a pesticide until the reentry interval has expired, unless the workers wear suitable protective clothing.
5. *Livestock protection collar requirements:* regulate the sales and use of the active ingredient sodium fluoroacetate and devices for livestock predation control.
6. *M-44 sodium cyanide requirements:* regulate the sales and use of the active ingredient sodium cyanide and devices for livestock predation control.

Herbicide Laws and Regulations

The Texas Herbicide Law and Regulations pertain to herbicides that contain these active ingredients:

- 2,4-D
- 2,4,5-T
- MCPA
- Silvex
- Polychlorinated Benzoic acids (dicamba)
- Derivatives and other formulations of these substances

County commissioners courts may set additional rules on the use of these herbicides. However, the law allows the courts to propose rules and conduct a public hearing only from October through December. New rules may become effective the following January 1.

A county may prohibit use of a regulated herbicide in all or part of the county. In some counties, you must either file a notice of intent or obtain a permit to spray regulated herbicide. This can be done at a TDA regional office. You need the notice of intent for jobs up to 10 acres, and the permit for jobs over 10 acres. In some counties, these spray notices and permits are required only during certain months.

Under the Texas Herbicide Law, you must have a herbicide dealers license to sell regulated herbicides. As a dealer, you must submit to the TDA a monthly record of all the regulated herbicide that you sell. You must keep these sales records in your own files for two years.

Commercial applicators must obtain an individual spray permit or a blanket spray permit before using regulated herbicides. With a blanket spray permit, you must submit a special report to the TDA within seven days of application.

The TDA may enter and inspect any target site and the surrounding area before granting a spray permit. The TDA also may amend, revoke or refuse to grant a permit.

People who apply these herbicides in regulated counties must have their equipment inspected. Ground application equipment must be inspected once each year, and aerial equipment must be inspected every 30 days during use.

Texas Structural Pest Control Act

The 1971 Texas Structural Pest Control Act is enforced by the Texas Structural Pest Control Board (SPCB). As amended, this law authorizes the SPCB to certify and license persons engaged in structural pest control. The law also directs the SPCB to set rules on structural pest control methods that affect public health and welfare.

Other provisions of the law pertain to record-keeping and public notices. Business licensees and certified noncommercial applicators must keep a two-year record of their work, including all uses of pesticides and pest control devices.

The law also requires you to inform the public of your work. The rules include handing out SPCB consumer information sheets before indoor or outdoor pesticide applications (at least 48 hours before indoor treatments).

Penalties under the Texas Structural Pest Control Act include the loss or suspension of your license, or conviction of a Class C or Class B misdemeanor. You also may receive a civil penalty from $50 to $1,000 for each violation and for each day of violation.

Texas Solid Waste Disposal Act

Certain waste pesticides are considered "hazardous waste." Their disposal is regulated under the Federal Resource Conservation and Recovery Act (RCRA) and the Texas Solid Waste Disposal Act. The Texas Water Commission administers the Texas Solid Waste Disposal Act.

This chapter is a brief overview of Texas laws and regulations that pertain to pesticides. It does *not* adequately prepare you for TDA or SPCB test questions over these laws. The TDA and SPCB can provide copies of the laws that apply to you. You should obtain these to study from and to follow in your daily work.

Remember, you must know the law in order to comply with it.

Study Questions

1. Which of the following state agencies is *not* involved in pesticide regulation?
   a. Texas Department of Agriculture
   b. Texas Agricultural Extension Service
   c. Texas Water Commission
   d. Texas Department of Health
2. Under the Texas Pesticide Law, pesticides used in this state must be registered with the Texas Department of Agriculture, even if they are already registered with the U.S. Environmental Protection Agency.
   True False
3. _____ _____ is your responsibility to inform nearby residents or adjacent landowners before you apply pesticides.
4. What law regulates the use of products containing such active ingredients as 2,4,5-T and Silvex?
5. In addition to state government, even county commissioners courts may set rules on the use of certain pesticides.
   True False
6. Even with a commercial applicator license, you must still obtain a state permit before using regulated herbicides.
   True False
7. In some Texas counties, ground application equipment must be inspected _____ per year to legally apply regulated herbicides.
8. The Texas Structural Pest Control Act requires you to give public notice at least ____ hours before applying indoor pesticide treatments.
9. By which agency is the Texas Solid Waste Disposal Act administered?
   a. Texas Department of Agriculture
   b. Texas Water Commission
   c. Texas Structural Pest Control Board
   d. Texas Hazardous Waste Commission

1. b
2. true
3. Prior notification
4. Texas Herbicide Law
5. true
6. true
7. once
8. 48
9. b

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Federal Pesticide Laws

The United States government sets rules for pesticide handling and use. These rules pertain to record keeping, storage and disposal, transportation, reentry intervals, filling and mixing methods, and more.

Some safety practices that were only suggested in the past are now required by law. Many applicators already follow these laws. Other applicators must make some changes. All the new laws help make pesticide use safer for both people and the environment.

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Learning Objectives

- Become familiar with the names and acronyms (initials) of the laws and government agencies involved with pesticides.
- Understand the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA).
- Understand the other laws and regulations (in addition to FIFRA) listed in this chapter.

Federal laws and regulations set standards for pesticide use. States may set even stricter standards. You are responsible for complying with federal law and the rules of each state where you work.

The United States Congress established the Environmental Protection Agency (EPA) in 1970. The agency regulates pesticides through its Office of Pesticide Programs (OPP), with authority from the Federal Insecticide, Fungicide and Rodenticide Act.

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)

FIFRA was enacted in 1947 and has been changed (amended) several times since then. The most important amendment to FIFRA is the 1972 Federal Environmental Pesticide Control Act (FEPCA). It deals with protection of both public health and the environment.

FIFRA governs the licensing (registration) of pesticides. It gives the EPA the power to approve pesticides before they can be sold in the U.S. Each use for a pesticide must receive EPA approval. The pesticide also must receive an EPA registration number. These rules enable EPA to make sure the pesticide will not cause "unreasonable human health or environmental effects."

FIFRA Provisions

In summary, the Federal Insecticide, Fungicide and Rodenticide Act:

- Requires EPA to register all pesticides as well as each pesticide use, and approve product labels.
- Requires classification of registered pesticides as either "general use" pesticides, which can be used by anyone, or "restricted use" pesticides.
- Requires that users of restricted pesticides must be certified as either "private" or "commercial" applicators, or work under the direct supervision of a private or commercial applicator. Certification is carried

out by the states (except in Colorado and Nebraska, which have federal programs).
- Sets tolerances for residues on raw agricultural products or in processed food.
- Sets penalties for use "inconsistent with the label" of a pesticide.
- Makes it illegal to store or dispose of pesticides and containers in a way that violates regulations, and sets penalties for illegal container handling.
- Authorizes civil penalties against people who unknowingly violate a regulation. The law allows fines up to $1,000 for private applicators, and as much as $5,000 for each offense by commercial applicators. Before EPA can fine you, you have a right to ask for a hearing in your own city or county.
- Authorizes criminal penalties against people who knowingly violate the law. The maximum penalty for private applicators is $1,000 and 30 days in jail. Commercial applicators may be fined up to $25,000 and one year in jail.
- Permits states to establish stricter standards, but not more permissive standards.

FIFRA and the EPA

- **Reentry standards**
- **Worker protection**
- **Consumer protection**
- **Pesticide registration**

FIFRA gives EPA the authority to register pesticides and to develop regulations. *Regulations* are interpretations of the law (in this case FIFRA) and have the force of law. Current EPA regulations (published in the Code of Federal Regulations, Title 40) include:

- reentry standards for treated areas,
- standards for worker protection, and
- consumer protection measures.

Reentry standards

EPA defines *reentry time* as the time just after pesticide application when unprotected workers may not enter the treated area. The regulations state that:

- No unprotected person may be in the treated area during pesticide application.
- No pesticide application is permitted that will expose any person to pesticides, either directly or through drift (except workers involved in the application).
- If labeling for reentry is stricter than general standards, then you must follow label restrictions.
- When no reentry time is specified, treated areas may be reentered without protective clothing after the spray has dried or the dust has settled. (EPA exempts some pesticides from reentry

requirements. However, Texas sets a minimum reentry time for all pesticides, with no exemptions.)
- Appropriate and timely warnings of pesticide applications must be given to workers, either verbally or in writing, or both. Warnings must be in a language understood by the workers.

Worker protection

EPA has many options for regulating pesticides. If the risk is to people who mix, load and apply the pesticide, EPA can require:

- personal protective clothing such as gloves, hats, respirators and chemical-resistant suits;
- use restrictions or use only by certified pesticide applicators;
- prohibition of certain formulations such as dusts, granules, ultra-low volume concentrates or sprays;
- engineering controls such as enclosed cabs or closed mixing/loading systems;
- label warnings about health risks, such as cancer and birth defects, to encourage better compliance with handling instructions;
- restrictions on rate and frequency of applications;
- prohibition of certain application methods such as aerial applications or backpack sprayers; and
- other pest control practices such as removal of crop residue or spraying only at infestation sites.

If the risk is to farmworkers who reenter treated fields, EPA can require:

- reentry intervals to keep farmworkers from entering a treated field for a certain time, unless they are wearing specified protective clothing;
- restrictions on formulation or application rates; and
- verbal notice or posting of signs to warn farmworkers that treatment has occurred.

Consumer protection

If the risk is to consumers of crops that have been treated with pesticides, EPA can require:

- longer preharvest intervals so residues have more time to dissipate;
- changes in the manufacturing process of pesticides to reduce levels of contaminants or impurities; and
- restrictions on rate and frequency of applications.

EPA also can cancel or deny registration for high-risk uses of a pesticide. Or EPA may phase out a pesticide to spur development of alternative chemicals or technologies.

EPA can suspend use of a pesticide at any time. This prohibits the product until EPA decides whether to cancel the pesticide's registration.

Pesticide registration

Under FIFRA, EPA has registered about 25,000 pesticide products. How the EPA handles an application depends on whether the product is new or already has one or more registered uses.

New pesticides and new formulations (since 1972). The law requires EPA to consider economic, social and environmental costs and benefits in making decisions. EPA bases decisions on its own evaluation of test data provided by the manufacturer. The manufacturer must conduct tests to see if a pesticide might hurt humans, fish, wildlife or endangered species. Potential human risks include acute reactions or eye irritation, and long-term effects like cancer, birth defects and reproductive system disorders. Data on "environmental fate" (how a pesticide behaves in the environment) also are required. This enables EPA to find, among other things, whether a pesticide poses a threat to ground or surface water.

Old Pesticides. Pesticides registered and used before today's standards also must be evaluated by the "no unreasonable adverse effect" rule. To do this, EPA has established "registration standards" and requires reregistration of registered pesticides.

Food, Drug and Cosmetic Act (FDCA)

The Food, Drug and Cosmetic Act of 1938 and its amendments are enforced by the Food and Drug Administration (FDA) of the Department of Health and Human Welfare.

The FDCA addresses pesticide residue levels in food and feed crops sold in the U.S. It requires the EPA to set tolerances (maximum legal limits) for these residues. This ensures that U.S. consumers are not exposed to unsafe pesticide residue levels. The FDA enforces tolerance levels set by EPA.

The FDCA also requires:

- monitoring and enforcement of food additive tolerances; and
- monitoring of pesticide residues in animals by the Meat Inspection Division of the U.S. Department of Agriculture.

Occupational Safety and Health Act (OSHA)

The Occupational Safety and Health Act of 1970 is administered by the Occupational Safety and Health Administration of the Department of Labor. This law:

- Requires employers with 11 or more employees to keep records of all work-related deaths, injuries and illness, and to make periodic reports. Minor injuries needing only first aid treatment need not be reported. Records must be made if the injury involves medical treatment, loss of consciousness, restriction of work or motion, or transfer to another job.
- Requires investigation of employee complaints related to pesticide use, reentry or accidents.

Hazard Communication Standard (HCS)

This is a rule written and enforced by OSHA. It protects employees who may be exposed to hazardous chemicals, including pesticides, under normal operating conditions or in foreseeable emergencies. The terms *exposure* and *exposed* refer to the contact of an employee with a hazardous chemical in the course ofemployment. This includes contact through any route of entry (inhalation, ingestion or absorption) and also includes potential (accidental) exposure.

This law requires employers to:

- read and understand their responsibilities;
- make a list of hazardous chemicals in the work place;
- obtain material safety data sheets (MSDS) for all hazardous substances on their list;
- label all containers;
- develop and implement a written communication program;
- conduct employee training based on the chemical list, MSDS and labeling information; and
- create a hazard communication file, and make it available to any employee upon request in a reasonable period of time.

Resource Conservation and Recovery Act (RCRA)

The federal Resource Conservation and Recovery Act of 1976 directs the Environmental Protection Agency to manage all hazardous wastes. Under this law:

- Private applicators (farmers) who properly dispose of pesticide waste and containers are generally exempt. State requirements often are more strict.
- Others are regulated if they accumulate per month 2.2 pounds or more of waste containing acute hazardous chemical, or 2,200 pounds of waste containing a hazardous chemical. These applicators must register as a generator of hazardous waste and obtain an ID number from EPA.

• Triple-rinsed used containers can be disposed of in EPA-approved landfills without an ID number or further regulation. Regulated waste includes unrinsed containers, excess pesticide, pesticide dilutions and rinsewater, etc. that contain a listed chemical and cannot be used properly.

Any flammable, corrosive, reactive or toxic waste is considered hazardous even if not on the list. In general, you probably should treat pesticides as hazardous. Also remember to follow state hazardous waste rules.

Transportation Safety Act

The Transportation Safety Act of 1974 authorized the U.S. Department of Transportation (DOT) to regulate all transportation of hazardous materials. These regulations are contained in Title 49 of the Code of Federal Regulations (49 CFR). They cover every safety aspect of transporting hazardous materials, including the packing, repacking, handling, describing, labeling, marking, placarding and routing of such materials. Many states also have adopted these rules.

Materials under this law include explosives, compressed gases, flammable liquids and solids, poisons and several other types of chemicals. Most DOT hazard classes include some pesticides.

A shipper who transports or transfers material in commerce must describe the hazardous material on a shipping paper. An applicator or carrier may not transport the material unless it is accompanied by a shipping paper. However, most pesticides do not need shipping papers unless the quantity of the material in one package equals or exceeds the "reportable quantity" (RQ) defined by law.

A pesticide is considered a hazardous substance if its active ingredient is equal to or greater than the reportable quantity (RQ) per package. When transporting hazardous materials, the shipping paper must be within reach of the driver while in the seat belt. When a driver is away from the vehicle, the shipping paper must be on the driver's seat or in the pouch of the vehicle door.

Superfund Amendments and Reauthorization Act (SARA Title III)

SARA Title III is a federal right-to-know law that affects those who produce or store hazardous chemicals. This includes pesticide producers, distributors, retailers and some applicators. The law is designed to inform communities about hazardous chemicals located nearby and to address the need for community emergency response plans.

Title III has many sections. However, only four sections have rules that may affect you:

Section 302 - Emergency planning and notification. EPA has assigned a Threshold Planning Quantity (TPQ) for each active pesticide ingredient (not total weight of formulated product). When you store that amount or more, you must notify the State Emergency Response Commission (SERC) in writing. You must also name a coordinator to work with the Local Emergency Planning Committee (LEPC). The state will notify the LEPC that your operation is covered under SARA. This is a one-time notification.

Section 304 - Emergency release reporting. This tells how and when to report an accidental release (such as a spill) of any extremely hazardous substance. Under certain circumstances, you must notify the SERC, LEPC and the National Response Center (1-800-424-8802).

Section 311 - Reporting of material safety data sheets. Employers must obtain and keep material safety data sheets (MSDS) and submit copies of each sheet (or a listing) to their local fire department, the LEPC and the SERC. There is one exclusion to this rule: *if a chemical is used solely for household, consumer or agricultural purposes, then notification is not required.*

Section 312 - Reporting of annual chemical inventory. Storage facilities must submit an annual chemical inventory to their local fire department, LEPC and SERC. The inventory must include all hazardous chemicals stored at or above 100,000 pounds, and any extremely hazardous chemicals stored at or above 500 pounds (or 55 gallons) or above the TPQ, whichever is less. *Agricultural producers are exempt from this section.*

The Endangered Species Act (ESA)

The Endangered Species Act of 1973 protects endangered species. It is administered by the Fish and Wildlife Service (FWS), of the Department of the Interior. The ESA makes it illegal to kill, harm or collect endangered wildlife or fish, or to remove endangered plants from areas under federal control. It also requires other federal agencies to ensure that their actions are not likely to harm an endangered species, or to damage its main habitat.

The FWS determines if a species is endangered. An endangered species is a plant or animal in danger of extinction throughout all or much of its range. A threatened species is likely to become endangered in the foreseeable future.

The reasons a species becomes endangered or threatened are complex and difficult to correct. Habitat destruction is a major reason for the decline of some species. This destruction usually results from industrial, agricultural, residential or recreational development.

Within the United States about 275 animals and 190 plants are endangered or threatened. Once a species becomes endangered, its main habitat may be protected by the FWS from change of any kind.

EPA must help ensure that registered pesticides do not jeopardize endangered species. Jeopardize means to reduce the likelihood that the species will survive. First, EPA estimates the maximum environmental concentration of each pesticide. If this estimated concentration might affect an endangered species, the pesticide is referred to FWS. If FWS confirms a hazard, the agency may restrict use of the pesticide. If the pesticide produces only minor effects, FWS may enforce less restrictive conservation measures.

EPA responds to FWS jeopardy opinions by making changes to the pesticide label. The new label may contain specific restrictions or it may tell you to read an Endangered Species Bulletin. The bulletin will contain directions for pesticide use where endangered species may be affected.

In the end, protection of endangered species from pesticides falls to you. Preserving the biological diversity of our planet contributes to the overall quality of life. Each plant or animal is part of a complex food chain. If you break one of the links, others are hurt. The decline of one plant can endanger up to 30 other species that depend on it, including insects, higher animals and other plants.

Other Regulations

Regulations governing agricultural aircraft are administered by the Federal Aviation Administration in the U.S. Department of Transportation. It issues commercial and private aircraft operator certificates under Title 14, Code of Federal Regulations, Part 137.

Pesticide regulation merges science, public policy and law. Since scientific knowledge constantly changes, as do the needs of society, the regulatory process never stops. EPA continuously updates pesticide decisions as knowledge increases.

Study Questions

1. What is the full name and acronym of the federal agency that regulates pesticides?
   a. U.S. Department of Agriculture (USDA)
   b. Office of Pesticide Programs (OPP)
   c. Federal Insecticide, Fungicide and Rodenticide Agency (FIFRA)
   d. Environmental Protection Agency (EPA)
2. What is the full name and acronym of the law EPA uses to manage pesticides?
   a. Federal Insecticide Act (FIA)
   b. Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)
   c. Federal Environmental Pesticide Control Act (FEPCA)
3. Which of the things below is *not* something the EPA must do before a pesticide may be marketed in the U.S.?
   a. Approve each use.
   b. Assign a product registration number.
   c. Consult the Office of Pesticide Programs.
4. Which *two* answers are penalties defined by FIFRA for applicators who violate the law?
   a. Civil penalties when the violation is unintentional.
   b. Criminal penalties when the violation is unintentional.
   c. Criminal penalties when the law is knowingly violated.
   d. Civil penalties when the law is knowingly violated.
5. Does FIFRA allow prison terms for criminal (intentional) violators?
   a. Yes, up to one year for private and commercial applicators.
   b. No, FIFRA sets fines only.
   c. Yes, up to 30 days for private applicators and up to one year for commercial applicators.
   d. Not for private applicators but up to one year for commercial applicators.
6. What are regulations?
   a. Interpretations of the law that have the force of law.
   b. Interpretations of the law intended only as a guide.
   c. Exceptions to the law.
7. What is meant by the term "reentry time"?
   a. The time *right after* pesticide application when *protected* workers may not enter the treated area.
   b. The time *during* pesticide application when *unprotected* workers may not stay in the treated area.
   c. The time *right after* pesticide application when *unprotected* workers may not enter the treated area.

1. d
2. b
3. c
4. a and c
5. c
6. a
7. c

8. Of the following statements about EPA rules on warnings to workers, which is *not* true?
   a. Warnings of pesticide application must be timely and appropriate.
   b. Warnings of pesticide application must be in the language understood by the workers.
   c. Warnings of pesticide application must be given in writing.
   d. Warnings of pesticide application may be given verbally or in writing.
9. What is EPA's pesticide registration decision based on?
   a. EPA evaluation of test data provided by the manufacturer.
   b. The manufacturer's evaluation of test data.
   c. EPA evaluation of test data provided by certified applicators.
10. If EPA decides that a pesticide poses a risk to workers, what can the EPA do?
    a. Set reentry intervals to restrict workers from entering a treated field.
    b. Set restrictions on formulation or application rates.
    c. Require verbal or written warnings to workers.
    d. All of the above.
11. If EPA decides that a pesticide poses a risk to consumers, what can the EPA do?
    a. Require longer preharvest intervals so residues will break down.
    b. Set restrictions on the frequency of application and rates.
    c. Cancel or suspend use of the pesticide.
    d. All of the above.
12. Which federal agency *sets* food tolerances for pesticides?
13. Which federal agency *enforces* food tolerances for pesticides?
14. What is the purpose of the tolerance program?
    a. To ensure that U.S. consumers are not exposed to *any* pesticide residues in food.
    b. To ensure that U.S. consumers are not exposed to *unsafe* pesticide residues levels in food.
    c. To ensure that U.S. consumers can tolerate pesticide residues in food.
15. Which act is administered by EPA to manage all hazardous waste?
    a. Occupational Safety and Health Act
    b. Federal Insecticide, Fungicide and Rodenticide Act
    c. Resource Conservation and Recovery Act
    d. Transportation Safety Act
16. How can triple-rinsed, used pesticide containers be disposed of?
    a. In any sanitary landfill
    b. In an EPA-approved sanitary landfill
    c. In a private landfill
17. What kind of pesticide standards does FIFRA allow states to establish?
    a. Less strict than federal standards
    b. Stricter than federal standards
    c. Only the same standards as FIFRA

8. c
9. a
10. d
11. d
12. EPA
13. FDA
14. b
15. c
16. b
17. b

18. Which agency administers the Hazard Communication Standard?
    a. Environmental Protection Agency (EPA)
    b. Food and Drug Administration (FDA)
    c. Federal Food Drug and Cosmetic Board (FFDCB)
    d. Occupational Safety and Health Administration (OSHA)
19. Pesticide applicators generate waste during normal work operations. Which of the items below is not "regulated waste" under the Federal Resource Conservation and Recovery Act (RCRA)?
    a. Triple-rinsed used containers
    b. Excess pesticide and pesticide dilution
    c. Rinsewater which contains a listed chemical and cannot be properly used
20. Regulations interpreting the Transportation Safety Act are contained in 49 CFR. What do these regulations cover?
    a. Some safety aspects of transporting hazardous materials, such as packing, labeling, marking and placarding of such materials.
    b. Most safety aspects of transporting hazardous materials.
    c. All safety aspects of transporting hazardous materials.
21. What is the act SARA III designed to do?
    a. Inform communities of hazardous chemicals in the area and provide for community emergency response plans in the event of an accident.
    b. Protect endangered species from pesticides.
    c. Require employers to keep material safety data sheets and submit copies to their local fire department.
22. What is an endangered species?
    a. A plant or animal that may not be harvested or hunted, except as allowed by law.
    b. A plant or animal that is in danger of extinction throughout all or much of its range.
    c. An animal whose habitat has been severely damaged.
23. Which federal agency determines what species are endangered?
    a. The U.S. Department of Agriculture
    b. Office of Pesticide Programs (OPP) of the EPA
    c. Fish and Wildlife Service (FWS) of the Department of the Interior
24. Who ultimately bears the responsibility of protecting endangered species from pesticides?
    a. The federal government
    b. The state government
    c. Conservationists
    d. You, the applicator

18. d
19. a
20. c
21. a
22. b
23. c
24. d

Toxicity of Pesticides

4

A pesticide is any substance used to control pests. Most people control pests with poison. While some products are harmless to humans, others are poisonous (toxic) enough to injure or even kill humans. If not handled properly, pesticides can irritate the skin, eyes, nose and mouth. Always use caution when you work with any pesticide!

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Understand what toxicity is and how it affects humans.
- Learn the three routes of entry (how pesticides enter the body) and the importance of each.
- Understand how toxicity is measured and what is meant by label warning statements.

Toxicity: What is it?

The *toxicity* of a substance is its capacity to injure a living system. A living system can be many things, for example: a human body or a forest and creatures that live there. A substance that is toxic is poisonous. If you know the toxicity of a pesticide, you know how poisonous it is.

Dose-Time Relationship

The effect of a pesticide on your health depends on several factors. The most important factor is called the *dose-time relationship.* Look at the meaning of the terms below.

Dose: the amount of a substance to which something or someone is exposed.
Time: rate of exposure; in other words, how often and how long exposure occurs.
Exposure: any kind of contact with a pesticide.

Thus, the dose-time relationship is the amount and rate of exposure to a substance. This relationship gives rise to two types of toxicity that you should know and understand. They are acute and chronic toxicity.

Types of Toxicity Acute vs. Chronic

Acute toxicity refers to how poisonous a pesticide is after *one* short-term exposure. Acute toxic effects appear promptly, or within 24 hours of exposure. A pesticide that is acutely toxic is deadly in a very small amount and in a very short time, usually a few minutes.

Warning statements on pesticide labels are based on acute toxicity. It may be measured as acute oral toxicity, acute dermal toxicity and acute inhalation toxicity.

Chronic toxicity is a delayed poisonous effect from exposure to a substance. It is measured in experimental conditions after either continuous or occasional exposure. Chronic toxicity of pesticides concerns the public, as well as pesticide handlers, because of potential exposure to pesticides through food, water and air.

A material with high acute toxicity may not have high chronic toxicity. Nor does a chemical with low acute toxicity necessarily have low chronic toxicity. For many pesticides, the toxic effects of one acute exposure are quite different from the effects of chronic exposure. For example, rats suffer little effect when they eat a large one-time amount of the pesticide cryolite. It quickly passes through the intestinal tract without harm. However, if rats are fed a small amount of cryolite every day, they will become ill and die.

Cryolite is very insoluble, meaning it does not readily dissolve. The small amount of chemical absorbed at one time is not enough to cause illness; but absorption of a small amount every day, day after day, can cause chronic illness and death. The effects of both acute toxicity and chronic toxicity are dose-related; the greater the dose, the greater the effect.

Types of Exposure Acute vs. Chronic

You cannot change the toxicity of a pesticide. You can lessen the risk of being poisoned by preventing or limiting exposure. Remember, pesticide exposure is defined as coming in contact with a pesticide. Two types of exposure may occur: acute and chronic.

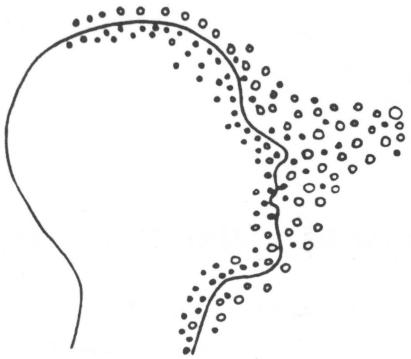
Acute exposure is a one-time or short-term contact with pesticide. In animal experiments, acute exposure is defined as contact for 24 hours or less. Acute effects can be detected and studied more easily than chronic effects. Pesticides that the body absorbs rapidly are most likely to produce immediate toxic effects.

Chronic exposure is long-term repeated contact with pesticides. It is studied by repeatedly exposing test animals for more than three months. Chronic exposure to pesticides may cause both immediate effects after each exposure and long-term low level effects. In other words, frequent exposure to a chemical can produce both acute and chronic symptoms. The potential for a chronic effect is related to the level, duration and frequency of exposure.

Routes of Entry

- **Dermal route**
- **Inhalation route**
- **Oral route**

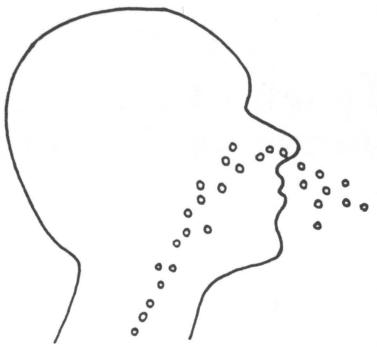
Three routes by which pesticides can enter your body are described below. Few chemicals are equally poisonous by all routes. However, some chemicals are poisonous by any route. Sometimes you can be poisoned without knowing it, especially if pesticide enters through your skin or lungs. This is often the case with chronic toxicity.



Dermal route

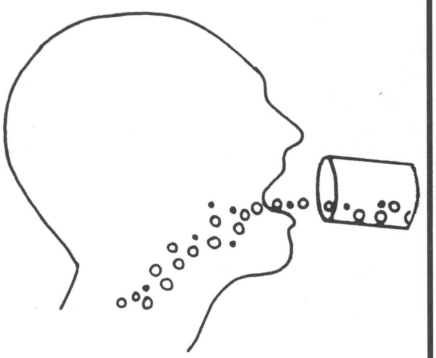
Wet, dry or gaseous pesticides can pass through your skin. Passage through the skin (dermis) is called the dermal route. This may occur if pesticides get on your skin while you mix or apply them, or if you wear pesticide contaminated clothing. Oil-based pesticides and liquid pesticides containing solvents are absorbed more quickly than dry or water-based pesticides. Some pesticides soak through quickly and can be as dangerous as if they were swallowed.

Skin varies in its capacity to block pesticides. The eyes, ear drums, scalp and genitals absorb pesticides more quickly than other body parts. Chapped, cut or scraped skin is penetrated more readily than healthy skin. Once pesticides pass through your skin, they enter the blood stream and flow throughout your body.



Inhalation route

As you breathe, you might draw pesticide dusts, spray mist and fumes into your lungs. This could happen while you mix wettable powders, dusts or granules, or if you fumigate or spray without a self-contained breathing apparatus or a proper respirator. Large particles that are inhaled tend to stay on the surface of the throat and nasal passages, and do not enter the lungs. Smaller particles go directly into the lungs. The risk of poisoning depends on the number of inhaled particles and the concentration of chemical in the particles. Even dilute pesticides can cause poisoning. Once chemicals pass through your lungs, they enter the blood stream and travel to the rest of your body.



Oral route

Pesticides can enter the body through the mouth. This could occur if you fail to wash your hands properly before eating or smoking. Accidental ingestion could occur if, against proper practice, pesticides are stored in food containers. Or you might unknowingly drink contaminated water. Swallowed chemicals can be absorbed anywhere along your intestinal tract. The major absorption site is the small intestine. Once absorbed, the chemicals eventually enter the blood stream and circulate in your body.

Qualities of the Exposed Person

The toxicity of a pesticide varies among different people. Your own characteristics affect how you respond to a pesticide if exposed. These qualities include:

- Health conditions: heredity, pregnancy and disease may cause different responses.
- Age: the youngest and oldest individuals tend to be most sensitive.
- Sex: males and females may respond very differently.
- Environment: exposure to other toxic substances in food, air, water, etc.
- Health behaviors: smoking, dietary practices, drug use, personal hygiene, exercise, etc.
- Body size: toxic effects are related closely to body weight. The heavier the person, the more poison needed to cause an effect.

Effects of Toxicity

- **Local or systemic**
- **Immediate or delayed**
- **Reversible or irreversible**
- **Additive, antagonistic or synergistic**

Besides being acute or chronic, toxic effects can be any of the following:

Local or systemic (Some pesticides produce both.)

Local effects occur at the site of contact with a pesticide. Examples include: skin inflammation on your hand after touching a pesticide; irritation of the mucous membrane lining your lungs after breathing toxic fumes.

Systemic effects are quite different because they occur away from the point of contact. They develop when pesticides are carried throughout your body or "system." An example of a systemic effect is the blocking of an essential enzyme in your nervous system, called cholinesterase, after exposure to some pesticides.

Immediate or delayed (Some pesticides produce both.)

Immediate toxic effects happen upon or shortly after exposure, for example: a sneezing attack after inhaling pesticides during mixing.

Delayed effects develop after some time has passed. Examples include neurotoxicity, long-term reproductive damage and some tumors. Delayed effects can result from a single or chronic exposure.

Reversible or irreversible

Reversible effects are not permanent and can be changed or remedied. Skin rash, nausea, eye irritation and dizziness are reversible toxic effects. Injury to the liver is usually reversible because this organ can heal itself.

Irreversible effects are permanent and cannot be changed. Injury to the nervous system is usually irreversible because nerve cells cannot be replaced. Irreversible effects include birth defects, mutations and cancer.

Additive, antagonistic or synergistic

An *additive* effect is one in which the combined effect of two pesticides equals the sum of effects from each (that is, 2 + 2 = 4).

An *antagonistic* effect occurs when the toxic effect of a combination of pesticides is less than the toxicity of each pesticide alone. The pesticides in this combination counteract each other to some degree. Antagonism is like adding 2 + 2 and getting 3.

A *synergistic* effect occurs when the combined effect of two pesticides is much more than the sum of their individual effects. Synergism is like adding 2 + 2 and getting 5.

Additional effects of toxicity

Exposure to pesticides also may cause the following:

Reproductive effects: effects on the reproductive system or on the ability to produce healthy offspring.
Teratogenic effects: effects on unborn offspring.
Carcinogenic effects: cancer-causing effects.
Oncogenic effects: tumor-forming effects (not necessarily cancerous).
Mutagenic effects: permanent effects on genetic material that can be inherited.
Neurotoxicity: poisoning of the nervous system, including the brain.
Immunosuppression: blocking of the immune system's ability to protect the body.

Measuring Toxicity

It is very hard to measure the exact toxicity of a pesticide to humans. Animal testing is the main way to measure toxicity. Many kinds of animals, including rats, rabbits, mice, guinea pigs and dogs, are used to test pesticide toxicity. However, because our bodies and animal bodies work differently, results of animal tests do not always apply directly to humans.

Toxicity studies are just guidelines for estimating toxic effects of pesticides. We can only talk about what we see or observe. The term "No Observable Effect Level," or NOEL, means the stated dose caused no observable effects in test animals.

Acute Toxicity Measures

To find out how acutely toxic a pesticide is, scientists expose test animals to short-term doses of the pesticide. The animals are then observed carefully for a response to exposure.

LD50

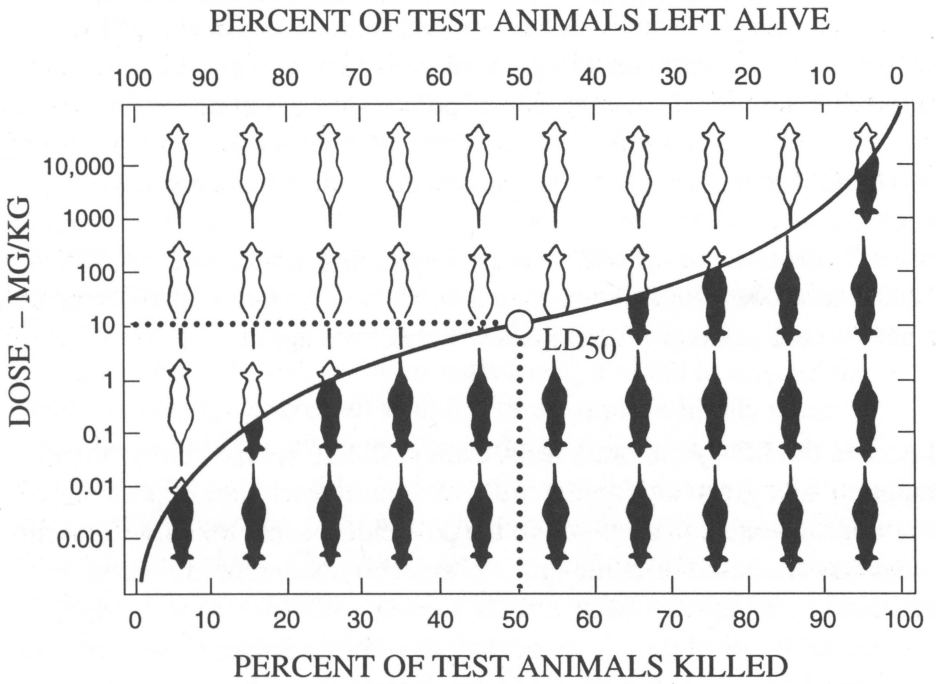
Lethal Dose Fifty (LD50) is a rating of chemical toxicity. It is the amount of pesticide that kills half the animals in a laboratory test. Tests are conducted to find the LD50 for both dermal and oral routes of exposure. For example, an oral LD50 is the amount of pesticide eaten by test animals that causes half the test group to die.

The smaller the LD50 value, the less chemical required to be fatal, so the more poisonous the pesticide. A pesticide with a dermal LD50 of 25 is much more poisonous than a pesticide with a dermal LD50 of 2000.

This rating does not tell us how a chemical acts. It does not tell us how sensitive different organs within an animal or human might be. This rating only tells us how much chemical it takes to kill half the test animals. The LD50 of different chemicals can be compared only if the same kind of test animal was used.

Milligrams per kilogram (mg/kg)

Pesticide LD50 values are measured in units of weight called *milligrams per kilogram* (mg/kg). There are 28,375 milligrams in an ounce. A kilogram contains 1,000,000 milligrams and equals about 2.2 pounds. The LD50 value refers to the milligrams of pesticide needed for each kilogram of animal body weight to kill half the test animals. For example, an oral LD50 of 10 mg/kg means a chemical is toxic when 10 mg of the chemical are given orally for every kilogram (or 2.2 pounds) of an animal's weight.



The amount of pesticide that will kill half of a group of test animals is known as the LD50. The smaller the LD50 the more toxic the pesticide. In this figure the LD50 is 10mg of pesticide per kg of body weight of test animal.

- **Lethal dose fifty**
- **Milligrams per kilogram**
- **Parts per million**
- **Lethal concentration fifty**

Parts per million (ppm)

Another way of measuring pesticide is referred to as *parts per million*, abbreviated "ppm." This means that for every million parts of a solution or mixture, there is one part of pesticide. The measures mg/kg and ppm are the same. Other measures of pesticide include: "parts per billion" (ppb) and "parts per trillion" (ppt). The following list may help you see how small these are:

- parts per million (ppm) = 1 milligram (mg)/kilogram (kg)
  1 inch in 16 miles
  1 minute in 2 years
- parts per billion (ppb) = 1 inch in 16,000 miles
  1 second in 32 years
- parts per trillion (ppt) = 1 inch in 16,000,000 miles
  1 second in 32,000 years

LC_{50}

To find the *acute inhalation toxicity* of a pesticide, scientists give test animals a known amount of pesticide to breathe. The amount that kills 50 percent of the animals is the *Lethal Concentration Fifty* (LC_{50}). The lower the LC50 value, the more poisonous the pesticide. Lethal Concentration Fifty is measured in milligrams per liter (mg/l) and sometimes in milligrams per cubic meter (mg/m^3).

Chronic Toxicity Measures

There is no standard measure for chronic toxicity studies. Often, such studies simply state the length of the experiment and the amount of each dose. For example, a study of chronic oral toxicity might state: "Eight milligrams of pesticide per kilogram of body weight were fed to rats daily for two years. No symptoms of poisoning appeared."

Two classes of pesticides, organophosphates and carbamates, have chronic effects. These chemicals slowly attack an essential body enzyme called cholinesterase. Blood tests can reveal any changes in cholinesterase levels. In humans, a drop in cholinesterase is a sure sign to avoid these pesticides until the level is normal again.

Acute Toxicity Label Warning Statements

Based on the LD_{50} and other tests, each pesticide is placed in a "toxicity category" and given a "signal word". A signal word must appear on every product label to alert you to the pesticide's acute toxicity. Toxicity categories are based on acute oral, dermal and inhalation toxicities, as well as eye and skin irritation effects of each pesticide. A pesticide is categorized by its highest level of toxicity. For example, if the acute oral and dermal toxicities of a pesticide are slightly toxic, but the acute

Table 1. The four categories of acute pesticide toxicity.

Category	*Signal Word Required on Label*	*Approximate Oral Dose That Can Kill an Average Person*
I Highly Toxic	DANGER (POISON! Skull & Crossbones)*	A few drops to 1 teaspoonful (or a few drops on the skin)
II Moderately Toxic	WARNING!	Over 1 teaspoonful to 3 teaspoonfuls
III Slightly Toxic	CAUTION!	Over 1 ounce to 1 pint or 1 pound
IV Relatively Nontoxic	CAUTION!	Over 1 pint or 1 pound

* Not used for skin and eye irritation.

inhalation toxicity is highly toxic, then the pesticide label will have the signal words for a highly toxic pesticide. See Table 1.

Hazard Factors

Hazard is a measure of risk. It is the chance that pesticide use will harm you, bystanders, livestock, wildlife, crops, consumers, water and more. The hazard of a toxic chemical is based on two things: the chemical's ability to harm (its toxicity or corrosiveness) and the likelihood that people may come in contact with it. For example, a highly toxic pesticide usually is considered "hazardous" (high risk) because of potential harm to the public and environment. However, proper handling can greatly reduce the risk. *Many factors besides toxicity may make a pesticide hazardous. These include: your skill, pest habitat, the type of pesticide, the formulation chosen, other chemicals in the formulation, and the concentration and dosage used.*

Usually, the more concentrated a formulation, the more hazard it poses. Dilute the concentration and you reduce the hazard. For example, one ounce of pesticide A contains a lethal oral dose. If you dilute that ounce in 10 gallons of water, each ounce of the mixture contains only .0008 ounces of pesticide A. The dilute mixture is much less hazardous to people than the concentrate, yet still effective on pests because of their small body size. Follow the label when figuring out the concentration and dosage of a pesticide. Try to use the lowest concentration and dosage necessary to control the target pest.

A skilled, experienced applicator is less a hazard to himself and others. A certified applicator should have the skill and knowledge to handle pesticides safely.

The site of application is called the *target.* It may include plants, soil, insects, animals and structures. The use of pesticide on a target is meant to control specific target pests. An ideal pesticide controls the target pest with little or no hazard to other species.

Another hazard factor is the kind of formulation a pesticide is made into. Formulations that are easily absorbed or inhaled pose more hazard than those less easily absorbed or inhaled. In general, the formulations of a specific pesticide pose a hazard in the following order:

1. emulsified concentrate — most hazardous
2. wettable powder/ flowable (in suspension)
3. granular — least hazardous

Choose the safest formulation available to do the job. (See Chapter 14 for a more detailed explanation of formulations.)

All pesticides are hazardous if misused. Use caution whenever you handle them!

Study Questions

1. _____ is the capacity of a substance to injure or poison a living system, such as a human being, an animal, a lake or a forest.
2. What is pesticide exposure?
   a. Pesticide exposure is defined as coming in contact with a pesticide.
   b. Pesticide exposure is defined as being poisoned by a pesticide.
   c. Neither of the above.
   d. Both of the above.
3. _____ _____ refers to how poisonous a pesticide is after one short-term exposure.
4. _____ _____ is a one-time or short-term contact with pesticide.
5. _____ _____ is a delayed poisonous effect from exposure to a substance.
6. _____ _____ is long-term repeated contact with pesticides.
7. The effects of which type of exposure — acute or chronic — can be more easily detected and studied?
8. A pesticide dose is the _____ of pesticide to which a surface, plant or animal is exposed.
9. Name the three routes by which pesticide can enter your body.
10. Some pesticides are poisonous no matter how they enter the body.
    True False
11. Which pesticide solution is most likely to be absorbed through the skin?
    a. Oil-based
    b. Water-based
    c. Dry
12. Which areas of the body absorb pesticides quickly?
    a. Feet, hands, head and groin
    b. Scalp, nose, hands and arms
    c. Face, hands, torso and scalp
    d. Eyes, ears, scalp and genitals
13. Which two routes of entry are likely to be the most important to you?
    a. Dermal and oral
    b. Dermal and inhalation
    c. Inhalation and oral
14. Which factor affects the toxicity of a pesticide?
    a. Route of entry
    b. Frequency and duration (rate) exposure
    c. Dose received
    d. All of the above

1. Toxicity
2. a
3. Acute toxicity
4. Acute exposure
5. Chronic toxicity
6. Chronic exposure
7. acute
8. amount
9. dermal, oral and inhalation
10. true
11. a
12. d
13. b
14. d

15. An example of a chronic effect is the drop in _____, an essential body enzyme, caused by organophosphates and carbamates.
16. _____ effects occur at the site of contact with a pesticide while _____ effects occur away from the point of contact.
17. Skin rash, nausea, eye irritation and dizziness are examples of _____ toxic effects.
18. LD_{50} means "Lethal Dose Fifty." It refers to the amount of a chemical that kills _____ the animals exposed to it in a laboratory test.
19. The smaller the LD_{50} value, the less chemical required to be fatal, so the more poisonous the pesticide.
    True False
20. Acute oral toxicity and acute dermal toxicity are measured in LD_{50}s. The higher the LD_{50} the _____ (more or less) toxic the pesticide.
21. How is LD_{50} used?
    a. LD_{50} is used with other tests to place pesticides in a "toxicity category" and give them a "signal word."
    b. LD_{50} is used to compare the toxicity of different chemicals.
    c. LD_{50} is used to tell how a chemical acts and how sensitive different organs within an animal or human might be.
22. LC_{50} means "Lethal _____ Fifty." It refers to the amount of chemical in the air that causes half of the test animals to die when they inhale it.
23. Six milligrams per kilogram (mg/kg) is equal to _____ parts per million.
24. What signal word must be on the label for pesticides classified as "Relatively non-toxic"
    a. CAUTION! b. DANGER! c. WARNING!
25. What signal word must be on the label for pesticides classified as "Highly toxic"
    a. CAUTION! b. DANGER! c. WARNING!
26. What signal word must be on the label for pesticides classified as "Slightly toxic"
    a. CAUTION! b. DANGER! c. WARNING!
27. What signal word must be on the label for pesticides classified as "Moderately toxic"
    a. CAUTION! b. DANGER! c. WARNING!
28. The toxicity of a substance is its ability to cause injury, while _____ is the risk or chance that harm will come from using the pesticide.
29. Is a highly toxic material always very hazardous?
    a. No, if a highly toxic material is handled properly it could actually pose a low risk or hazard.
    b. Yes, no matter how it is handled a highly toxic material is always hazardous.

15. cholinesterase
16. local, systemic
17. reversible
18. half (50%)
19. true
20. less
21. a
22. Concentration
23. six
24. a
25. b
26. a
27. c
28. hazard
29. a

Residue, Tolerance & Registration

5

The use of pesticides is strictly controlled in the United States. Every chemical that has possible use as a pesticide is tested and reviewed carefully before it is marketed. Laws controlling pesticide use on food and feed crops are especially strict. The amount of pesticide remaining on a crop at harvest also is regulated closely.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Know the difference between deposits and residues.
- Understand the positive and negative features of long-lasting residues.
- Define tolerance and explain how one is set.
- Understand the importance of "Days to Slaughter" and "Days to Harvest."
- Learn what information is important in registering a pesticide.

Residues

Pesticide found on leaves, skin and other surfaces right after application is called a *deposit.* Sometimes the deposit can be seen easily, as with many dusts or wettable powders. At other times it cannot be seen.

After application, the pesticide deposit that remains is called a *residue.* Heat, light, moisture, soil organisms and other chemical reactions in the environment quickly break down most pesticides. Other pesticides can leave a residue for weeks, months or years. How long a residue lasts varies with each pesticide, depending on its chemical nature and how the pesticide is used. That is one reason each possible use of a pesticide is studied and regulated closely. Unfortunately, a legal application may leave an illegal residue if drift contacts a nontarget crop or surface.

A long-lasting residue may have benefits. For example, if the pesticide remains effective, you may not need to apply it as often. However, long-lasting residues are not always desirable. A chemical that remains on food or feed may make them hazardous to eat. Some residues may remain in the soil and interfere with new crops. Or residues may injure people who reenter the treated area.

Clearly it is important to know what residue, if any, remains after a period of time. In fact, there may be no residue at all. Some sites or crops may never have been treated, or were treated with a minimum dose that degraded.

However, residues sometimes remain on treated crops at harvest time. Since some crops are to be eaten, safe amounts of residues must be established. The maximum amount of residue allowed on a harvested crop is called a *tolerance.*

Tolerances

- **How tolerances are set**
- **Negligible residue tolerances**
- **Finite tolerances**

Federal law requires the EPA to set a tolerance for every pesticide used on food or feed. Tolerances vary from crop to crop, depending on many safety factors. If a residue exceeds the set tolerance, the crop cannot be sold.

How tolerances are set

Industry researchers gather and submit much information to the EPA for analysis. They must:

- test lab animals to determine the acute and chronic toxicity of a chemical;
- determine toxicity to fish, birds and mammals;
- measure the length of time pesticide remains in the environment; and
- study possible long-term effects such as buildup of the chemical in animals or in the environment.

EPA considers this information and more before setting a tolerance.

EPA usually sets the tolerance at least 100 times smaller than the highest dose that is safe for test animals. For example, 200 parts per million (ppm) of pesticide A have no effect on test animals. Then the tolerance for pesticide A on any food or feed crop may be no higher than 2 ppm. The "safety factor" is 100 times.

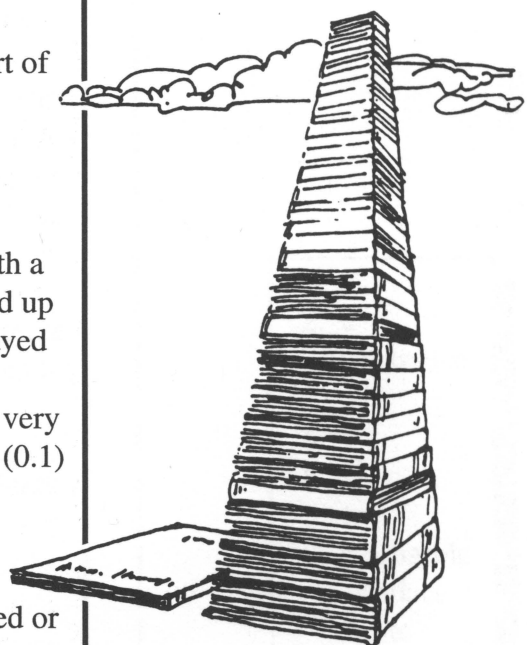
In the same example, suppose field tests achieve pest control using doses and methods that leave less residue than 2 ppm. In that case, the EPA would set the tolerance for pesticide A at the lower residue level. Tolerances are stated in parts per million by weight. That is, one part of pesticide to one million parts of crop or meat.

Negligible residue tolerances

A residue may be found on a crop even though the crop was never treated with pesticide. Such residue results from indirect contact with a chemical. For example, a herbicide residue in the soil may be picked up later by a crop. Or, a residue may be found in livestock that eat sprayed forage or grass. In either case, the harvested crop and meat cannot contain more than a *negligible residue tolerance*. Negligible means very small or minor. EPA usually sets the negligible residue at one-tenth (0.1) of a part per million or less. It is far below any known toxic level.

Finite Tolerances

EPA sets a *finite tolerance* for pesticides applied directly to food, feed or animals. A finite tolerance (often called just "tolerance") is usually larger than a negligible residue. However, it is still well below possible toxic levels.



A book 1/16" thick is 1ppm of a stack 1 mile high!

Days to Harvest

Most pesticides break down in the environment. The amount that remains at harvest depends on how long before harvest you apply the pesticide. "Days to Harvest" is the number of days between the last pesticide application and harvest day. "Days to Slaughter" is used with livestock. Instructions about both are listed on the pesticide label. For example, when pesticide A is applied on the day of harvest, it leaves a residue of 10 ppm. However, when applied seven days before harvest, it leaves a residue of only 2 ppm. If this provides acceptable pest control, EPA likely will set the tolerance at 2 ppm and the "Days to Harvest" at seven days. When you follow label instructions, residues should fall below the set tolerance.

Registration

Each pesticide and every use for it must be registered by the Environmental Protection Agency. The EPA reviews all required data, including toxicity studies, wildlife and environmental studies, breakdown and residue studies, and chemical studies. EPA grants registration only if the proposed use controls the target pest without harming public health and the environment. EPA also reviews and registers all statements that appear on the pesticide label. (See Chapter 13, *The Label*.) No pesticide may be bought, sold or used in the United States until it has federal registration for the product, the use and the label.

It is up to you to help make sure all food is safe to eat. Carelessness could lead to illegal residues and condemnation of crops and other food products. Always follow label directions carefully.

Study Questions

1. Which of the statements below is *not* true about a pesticide *deposit*?
   a. A deposit is pesticide that remains on treated surfaces right after application.
   b. Pesticide deposits may or may not be seen easily.
   c. Most deposits remain on surfaces for a very long time.
2. Which of the statements below is *not* true about a pesticide *residue*?
   a. Some residues may remain for months or years.
   b. Residue information is required for each crop you apply pesticide to.
   c. Residues are found only on target crops and surfaces.
3. _____ is the maximum amount of pesticide residue allowed on a harvested crop, as set by the EPA.
4. Can a harvested crop contain more than the set tolerance of a pesticide and still be legally sold?
   a. No, it cannot be legally sold.
   b. Yes, it may be sold if it is not condemned or seized by federal or state regulatory agencies.
   c. Yes, it may be sold if it is identified as contaminated.
5. What margin of safety ("safety factor") does the EPA use to set tolerances?
   a. 10 times
   b. 100 times
   c. 1000 times
6. Food may have no residues at all because the residues may have degraded or the crop may have been treated with a minimum dose of a pesticide.
   True False
7. Food crops and animals may contain pesticide residue even when they are not directly sprayed with the pesticide.
   True False
8. EPA sets two kinds of tolerances: _____ _____ tolerances for pesticides that indirectly contact food and _____ tolerances for pesticides applied directly to food.
9. "Days to Slaughter" or "Days to Harvest" refers to the _____ (least/most) number of days allowed between the last pesticide application and the slaughter or harvest day.
10. No pesticide may be bought, sold or used in the United States until it has federal registration for the product, the use and the label.
    True False

1. c
2. c
3. Tolerance
4. a
5. b
6. true
7. true
8. negligible residue, finite
9. least
10. true

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6

Ecology and Environmental Protection

Often we hear the words "environment" and "ecology" because of news about something harmful to the earth. Everyday we learn more about how human activities affect the earth. For instance, we know that pesticide drift can affect air quality; pesticide residue in the food chain can threaten wildlife; pesticide buildup in soil can limit crop production; and pesticide leaching can contaminate groundwater.

As a result, pesticide practices have become a public concern. It is important to do your job right by controlling pests and protecting the environment at the same time.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Understand the dangers of pesticide in the environment.
- Know how certain pesticides may pollute groundwater and what steps can prevent this.
- Understand how pesticides persist in the environment.

Pesticides in the Environment

We all need air, water, food and an environment that will not threaten our health and safety. We each have a duty to protect the earth's resources for other people and other living creatures.

Unfortunately, pollution worsens as our human population grows. It is important that awareness of this problem also grows. Larger populations require more food, fiber and building materials, which increases demand on the earth's finite resources. This also prompts more public action and government regulation to protect the environment.

Pesticides enhance public health and the environment when used properly and wisely. For example, in addition to protecting crops, pesticides can protect people by controlling pests that spread disease. These pests include rats that carry plague and mosquitos that carry malaria. Control of such pests is essential, especially in crowded places.

However, misused pesticides can harm public health and the environment. Any pesticide that is off-target is a pollutant.

Pesticides and Air

- **Vapor drift**
- **Particle drift**

Air can move particles for long distances. Unfortunately for you, this creates the problem of drift. Drift is the movement of spray particles or droplets away from the spray site, before they reach the target or ground. Pesticides in the air are not controllable. They may settle into waterways, homes, lawns, wooded areas and other off-target places. You *must* avoid drift.

Controlling drift is important for both commercial and private applicators. To be effective, a pesticide must be applied precisely on target at the correct rate, volume and pressure. Drift from the target site may injure people, pets, wildlife and plants. Poorly timed applications can kill bees and other pollinators working in the area. Beneficial parasites and predators that help control pests also may be killed.

In addition, drift can be a problem indoors. Forced air heating systems and air conditioners can circulate poorly applied pesticides.

Vapor drift

A pesticide that vaporizes (evaporates) can be carried from the treated area by air currents. Such movement is called vapor drift. While drift of sprays and dusts sometimes can be seen, vapor drift is not visible. Vapor, unlike spray or dust, is related to the chemical properties of the pesticide. A pesticide that vaporizes easily is called *volatile*.

Certain herbicides are volatile. Any drift of such herbicides reduces control of target weeds and increases the chance of injury to nontarget plants. Pesticide vapors inside a home also can cause injury, particularly if the occupants are sensitive to chemicals.

Vapor leakage can lead to vapor drift. Like air in a balloon, fumigants and other volatile materials exert pressure trying to escape. To prevent vapor leakage from containers, keep the containers closed or sealed. Fumigation sites also must be sealed properly to avoid leakage. Apply fumigants with vapor tight equipment.

Avoid using a volatile pesticide when conditions, such as low humidity and high temperature, favor vapor formation. Be alert to label warnings about vapors. The following warnings are examples:

- At high air or ground surface temperatures, vapors from this product may injure susceptible plants.
- Under very high temperatures, vapors from this product may injure susceptible plants in the immediate vicinity.
- Off-site movement of spray drift or vapors of this product can cause foliar whitening or yellowing of some plants.

Particle drift

Many factors influence particle drift. Particle size, nozzle design and orientation, pressure, height of release, air movement and other weather conditions are among several important factors.

Particle and droplet size. The smaller the particle size, the greater the potential for drift. Dust formulations are made of small particles that are more likely to drift than granular formulations. Small liquid droplets, especially those under 100 microns, tend to drift more than large droplets. Whenever practical, use the largest effective droplet size.

Nozzle type and orientation. For liquid drift control, nozzle choice is important. Different nozzles produce different droplet sizes. Avoid

nozzles that produce small (fine) droplets. How you position the nozzle, especially on airblast and aerial application equipment, also affects droplet size. Nozzles pointed across the air flow produce smaller droplets. This is caused by wind shear.

Pressure. Pressure also affects droplet size. The higher the pressure, the smaller the droplet. Smaller droplets may give better coverage, resulting in higher chemical performance but less drift control. You may be able to correct drift by reducing pressure. This produces larger droplets, which are heavier and less likely to move off target.

Height of release. Nozzles positioned too high disperse spray over a wider area. This increases the likelihood of drift. You can achieve the desired swath width by striking a balance between nozzle spray angle, pressure and height above the target. For example, if you increase the application pressure and rate, but maintain swath width, you should lower the nozzle to adjust for the increased pressure. Lowering the nozzle may require switching to a nozzle with a wider spray angle.

Air movement and other weather factors. Both horizontal and vertical air movement cause drift. Unless the weather is calm, most pesticide applications are subject to constant air movement. Even indoors, heaters and air conditioners cause air currents that can move pesticides. Outside, unpredictable changes in wind can cause spray drift at any time. Thus, wind direction and speed directly affect the direction, amount and distance of drift.

Another kind of drift is the release of pesticide from evaporated droplets. A droplet that evaporates before reaching the target does not control pests. Evaporation is worsened by high temperatures and low humidity.

How to Avoid Drift

- Choose nonvolatile pesticide formulations (those that do not vaporize easily).
- Apply the largest effective droplet size.
- Use the lowest practical pressure.
- Choose nozzles that produce large numbers of large particles.
- Place nozzles with the air stream and not across it.
- Apply as close as practical to the target.
- Use a drift control additive.
- Do not apply when wind, temperature or humidity are unfavorable.

Even when you follow common sense and good application methods, drift can be a problem. So follow label instructions and pay strict attention to drift control.

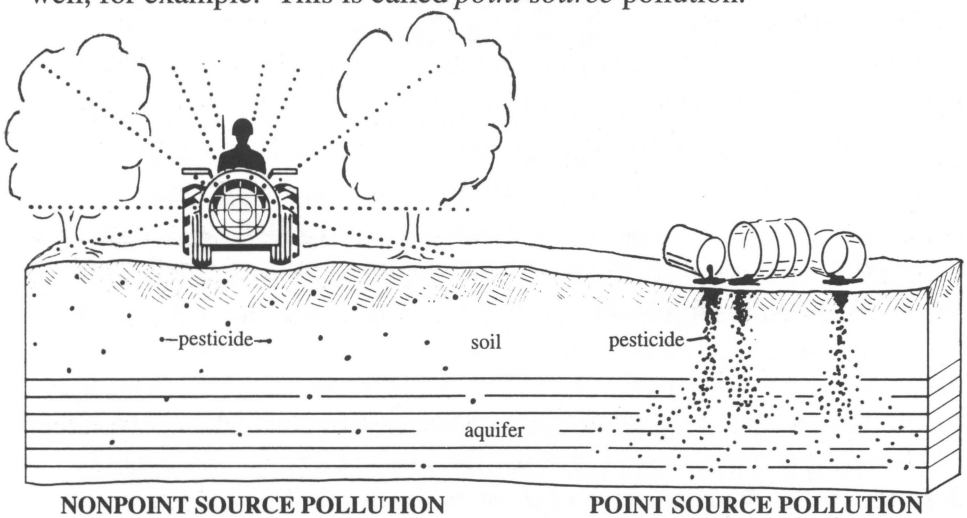
Pesticides and Water

Water is one of our greatest and most essential resources. People need clean water for drinking, cooking and bathing. Farmers need clean water to feed livestock and irrigate crops. Half the U.S. population and 90 percent of rural residents rely on groundwater for their drinking water. Once considered safe from pollution, groundwater is now a threatened natural resource.

Groundwater is stored mainly in aquifers: geologic formations of permeable rock, sand and gravel that contain enough water to supply wells and springs. Groundwater may come to the surface naturally at a spring or it may be drawn to the surface from a well.

How pesticides pollute groundwater

Under certain conditions, chemicals may make their way to groundwater. Even some correctly applied pesticides may move downward with rain or irrigation water, reaching the water table below. This kind of pollution is said to come from a *nonpoint source.* Pesticides also may enter groundwater directly, through spillage or back-siphonage into a well, for example. This is called *point source* pollution.



Point sources of pollution are specific places where pollutants are released into the environment, such as from spills, discharge pipes or dump sites. Nonpoint sources of pollution come from normal use of a substance over a large area.

Because groundwater moves slowly, pollutants do not spread quickly. Pesticides that reach groundwater may continue to break down, but at a much slower rate than above ground. When finally detected, pollution is often widespread. Even if the pollution stops, an aquifer may take years to purify itself through natural processes. Man-made cleaning processes are difficult and expensive. The water may be unusable for years. *The best protection against groundwater pollution is prevention.*

The Fate of Pesticides in Water

Two basic processes exist among factors that affect pesticides after their release. First are processes that degrade or break down chemicals. These are: microbial, chemical and photodegradation (sunlight). They will be discussed later in this chapter. Second are processes that transfer chemicals or influence their movement: adsorption, volatilization, runoff, leaching and removal of treated crops or animals from an area. This second group is discussed further below.

Transfer processes

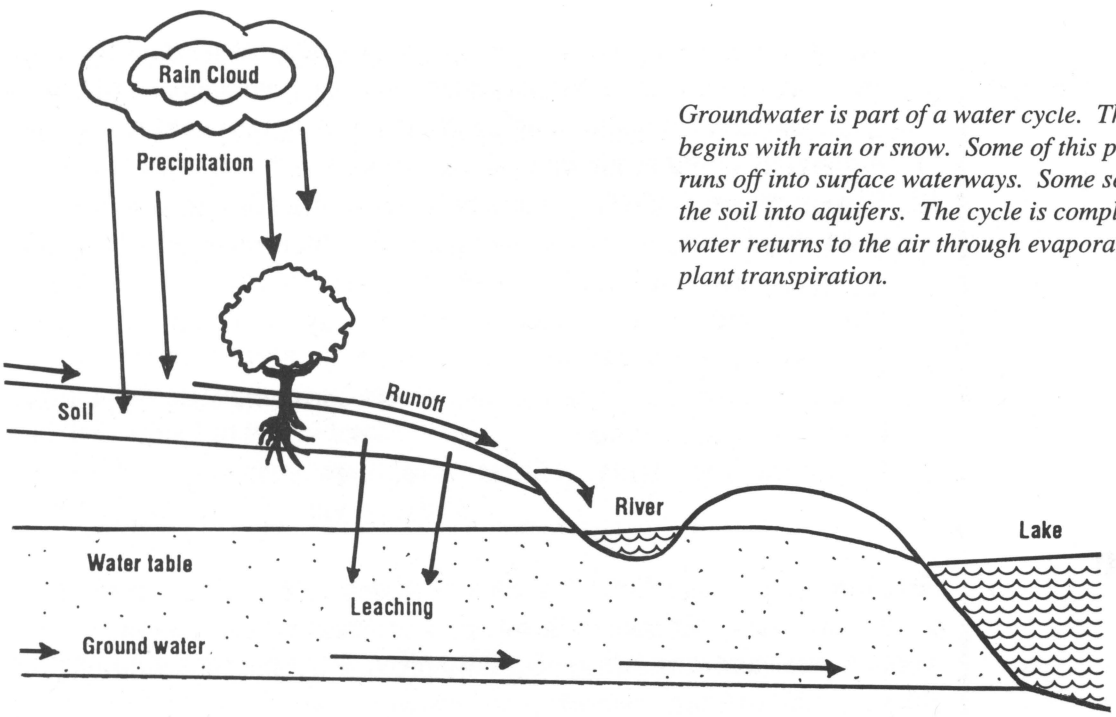
Adsorption. Adsorption is the binding of chemicals to other particles. Pesticide adsorption in soil depends on the pesticide properties, soil moisture content, soil pH (acidity) and soil texture. Soils high in organic matter or clay are the most adsorptive. Coarse, sandy soils that lack organic matter or clay are much less adsorptive.

A soil-adsorbed pesticide is less likely to vaporize, leach or degrade. However, pesticides that bind tightly to soil are less easily taken in by plants and microorganisms. Soil-adsorbed pesticides also can be lost by erosion. If you understand adsorption, you can prevent damage to sensitive plants, leaching to groundwater and illegal residues.

Volatilization. Volatilization is like evaporation. A solid or liquid can change into a gas or vapor. For example, water left in an open pan volatilizes (evaporates) into water vapor and disappears. Some pesticides are very volatile – they turn into vapor easily. Higher air temperature and air movement, low relative humidity and small droplet size all speed up volatization.

Runoff. Rain washes pesticides off plants and onto the soil. Pesticide runoff occurs when rain or irrigation water carries pesticides away, either mixed in the water or bound to soil. The amount of pesticide runoff depends on the grade or slope of an area, the erodibility and texture of the soil, the soil moisture content, the amount and timing of irrigation or rainfall, and the properties of the pesticide.

Leaching. Some pesticides leach through the soil into groundwater. Several factors influence this. A pesticide that dissolves easily flows with water through the soil. Sandy and gravel soils allow water and pesticides to leach through quickly. A heavy clay soil does not allow rapid leaching. Pesticides that are strongly adsorbed to soil particles leach less. Leaching of pesticides from treatment, mixing and rinsing sites and waste disposal areas is a major groundwater concern.



Groundwater is part of a water cycle. The cycle begins with rain or snow. Some of this precipitation runs off into surface waterways. Some seeps through the soil into aquifers. The cycle is completed when water returns to the air through evaporation and plant transpiration.

Groundwater Protection

To minimize pesticide pollution of groundwater, follow these steps:

1. Read the label for warnings. Follow label directions.
2. Evaluate the need, method and frequency of pesticide use.
3. Use alternative pest control methods when possible.
4. Learn about the leaching potential of the soil and the pesticide.
5. Consider the treatment site in relation to groundwater and surface water. Know the water table depth and the permeability of the ground above. Be cautious around sinkholes and old wells. They provide a path for leaks into groundwater.
6. Avoid pesticide use and handling close to water wells. Pollutants can enter a well directly from the surface, through openings in or beneath a pump base, or through soil around the well. Wells should be constructed far from pollution sources. Be very careful to prevent spills near wells.
7. Choose pesticides with the least potential for leaching into groundwater. Such pesticides are insoluble, relatively stable and readily adsorbed to soil.
8. Apply pesticides at the appropriate time.
9. Measure pesticide properly and carefully. Calibrate equipment accurately and often. During calibration, check equipment for leaks and malfunctions.
10. Avoid spills and back-siphoning. Hold the end of the fill hose above the water level in the spray tank to prevent chemicals from back-siphoning into the water supply. Use an anti-backflow device (an air

gap or check valve) when siphoning or pumping water directly from a well, pond or stream. Some states require a mechanical anti-backflow device on all filling equipment.

11. Accurately apply pesticide to the target site.
12. Dispose of pesticide containers properly and according to local, state and federal laws. Triple-rinse containers. Pour rinsewater back into the spray tank to treat labeled sites or crops.
13. Store pesticides safely. Keep in a place away from wells, cisterns, springs and other water sources.
14. Maintain records of pesticide use. Check local and state regulations for record requirements.
15. Comply with pesticide certification requirements.

Wildlife

Fish, birds and mammals are assets to man and an essential part of the ecosystem. Parks, farmland, lawns, golf courses and surrounding wooded areas and waterways generally provide habitat for wildlife. Take care to protect these areas.

Endangered Species

Certain plants and animals are endangered or threatened species. An *endangered* species is one on the brink of extinction throughout all or much of its range. A *threatened* species is likely to become endangered.

A major problem for most wildlife is destruction of their habitat, usually by industrial, agricultural, residential or recreational development. Pesticide damage to wildlife habitat is potentially harmful to wildlife. For example, the reproduction of fish and animals can be affected by low doses of pesticides in their diets.

All living things are part of a complex, delicately balanced network. The removal of a single species can set off a harmful chain reaction affecting many others. It is estimated that a disappearing plant can affect up to 30 other species, including insects, higher animals and other plants. Recovery is difficult or perhaps even impossible.

The U.S. Fish and Wildlife Service estimates that some 900 U.S. counties contain endangered species. You must make every effort to avoid harming these important species.

Honeybees

Honeybees help pollinate commercial crops and home gardens. Because honeybees are insects, they can be killed with insecticides. Careful selection of insecticide and application methods can reduce the risk of bee kills. Do not apply any pesticide on or allow it to drift onto crops in

bloom. Do not spray shade trees and weeds during bloom. Mow cover crops and weeds to remove blooms before spraying. Plants in bloom may attract bees to the area, increasing the chance of bee kills. Ideally, apply insecticides when there is no wind and bees are not "working" plants in the area. To minimize damage, make late afternoon applications with a spray that breaks down within hours. In general, evening applications are least harmful to bees.

Do not treat near hives. Bees may need to be moved or covered before you apply insecticide near their colonies. Do not let spray drip form puddles or pool in wheel tracks. An area-wide application may be harmful to bees because they cannot avoid contact with the spray. Thus, the total wild bee loss may be sizable.

Check product labels for specific bee hazards. Select an insecticide and a formulation that will be least harmful to foraging bees. Dusts present more of a hazard than sprays. Wettable powders are usually more hazardous than emulsifiable concentrates or water soluble mixtures. Microencapsulated insecticides are the most harmful. These are tiny capsules that bees can carry back to the hive just like pollen. The bees pass the capsules throughout the hive, poisoning much of the colony.

Ultra-low volume applications of some materials are sometimes more toxic than regular sprays. Granular formulations are generally the safest for bees. Some states have bee protection regulations.

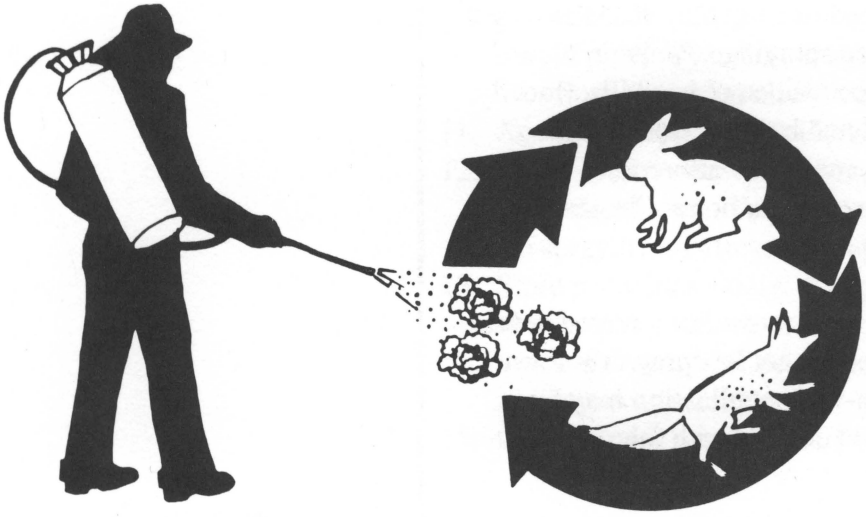
Food and Pesticides

- **The food chain**
- **Accumulative pesticides**
- **Nonaccumulative pesticides**

With the help of pesticides, farmers can produce more food per acre. Control of plant pests leads to higher yields and better crop quality. However, overdoses of pesticide can ruin the land. Pesticide may kill all or most plant life and make land useless for farm or recreational use. Too much pesticide may lead to illegal pesticide residue in crops and food, and unacceptable health risk to the public. Finally, applying pesticides at higher than labeled rates is against state and federal law.

The food chain

All animals depend on each other for food. This dependence is described as a food chain that links all plant-eaters and meat-eaters to each other. Pesticide pollution that kills a plant or animal food source affects the food chain. Wildlife affected by the loss may create new competition for food and space with other animals. A predatory animal lacking prey may shift to a valued game species or even domestic livestock. Fish and wildlife can ingest pesticide by eating other animals or plants that carry pesticide. Pesticide transfer also could occur with birds feeding on insects and earthworms, etc.



Accumulative pesticides

Some types of pesticides can build up in the bodies of animals and humans. Predators get pesticides in their bodies by eating a diet of plants or animals that carry pesticides. This is how certain pesticides slowly build up in the food chain. Humans are at the top of the food chain. We eat enough meat that we are potentially exposed to higher levels of pesticide than other animals.

Nonaccumulative pesticides

Pesticides that do not build up in the bodies of animals or in the food chain are nonaccumulative. These pesticides break down rapidly into relatively harmless materials. For example, organophosphate pesticides have high toxicity at first. But they do not accumulate in most creatures, so they are generally not as dangerous to the environment as other chemicals. Usually pesticides that degrade quickly are less harmful to the environment.

Pesticide Persistence

Persistent pesticides remain in the environment without breaking down. They are useful for long-term pest control.

Persistent pesticides do not always build up in animal bodies or in the food chain, but they could injure or kill nearby plants. Some pesticides persist in the soil but do not affect animals. An example is atrazine, a popular field herbicide. The persistence of some pesticides is an advantage. For example, termiticides protect wood buildings from termite attack. The chemicals are both expensive and difficult to apply. So it is desirable for the termiticide to protect a building for a long time after only one application.

Degradation processes

Microbial degradation. Most pesticides are destroyed in soils by fungi and bacteria (microbes). This is called microbial degradation. Microbial degradation can be fast and thorough under certain soil conditions. Such conditions include adequate soil moisture, aeration and fertility; warm temperature and favorable pH levels. Adsorption also is a factor. Soil-adsorbed pesticides are less exposed to microorganisms and so degrade more slowly.

Some pesticides require higher application rates to account for microbial degradation. In an extreme case, a pesticide that normally works for weeks suddenly becomes ineffective in days. In such a case, one application may speed the growth of microbes that in turn quickly break down new applications.

Chemical degradation. Chemical breakdown does not involve living organisms but does involve pesticide adsorption to soil and the pH, temperature and moisture of soil. These factors affect the rate and type of chemical degradation. Many pesticides, especially organophosphate insecticides, break down faster by hydrolysis in high pH soils and spray mixes. The products of chemical degradation are usually nontoxic or nonpesticidal, so the amount and strength of pesticide is reduced.

Photodegradation. Photodegradation is the breakdown of pesticides by sunlight. Pesticides vary widely in their stability when exposed to sunlight. Like the other processes, photodegradation reduces the amount of chemical present and lowers the level of pest control. Mixing or soaking pesticide into the soil can reduce pesticide exposure to sunlight.

Do your part to aid the environment. Protect your surroundings by practicing proper pesticide use.

Study Questions

1. Sometimes even small environmental changes can greatly reduce the chances of survival for fish and wildlife.
   True False
2. When a pesticide evaporates and moves off target, this is called _____ _____.
3. Which of these factors does *not* influence drift?
   a. Particle size
   b. Pollution
   c. Nozzle design and orientation
   d. Temperature
4. Which of these additional factors does *not* influence drift?
   a. Humidity
   b. Height of release
   c. Wind speed and direction
   d. Reentry interval
5. Why should honeybees be protected?
   a. Because they are the most important beneficial insect.
   b. Because poisoned bees are more dangerous to people and animals.
   c. Because their work as pollinators is necessary for crop production.
6. Pesticide residues can build up in the bodies of animals, including man.
   True False
7. Only pesticides that are applied incorrectly are likely to move downward with rain or irrigation water into the water table below.
   True False
8. A pesticide becomes a pollutant and potentially dangerous when it is applied over the dose recommended on the label or when it drifts off target.
   True False
9. How should you change pressure to reduce liquid droplet drift?
   a. Reduce pressure to increase droplet size.
   b. Increase pressure to increase droplet size.
   c. Reduce pressure to reduce droplet size.
   d. Increase pressure to reduce droplet size.
10. What are the possible consequences of pesticide drift onto forage and pastureland or into drinking water?
    a. People, pets and livestock can be injured by pesticide exposure.
    b. Pasture grasses could be destroyed.
    c. Milk or meat could have illegal residues if cattle eat contaminated forage.
    d. Water may become too contaminated to drink.
    e. All of the above.

1. true
2. vapor drift
3. b
4. d
5. c
6. true
7. false
8. true
9. a
10. e

11. Pesticide pollution can help a pest you are trying to destroy by killing predators and parasites of the pest.
    True False
12. An _____ is a geologic formation of permeable rock, sand or gravel that stores large amounts of water.
13. Why are aquifers important?
    a. Because they are the main water supply for manufacturing industries.
    b. Because so many people use water from aquifers for drinking.
    c. Because building and maintaining them provides jobs.
14. What is the name given to the complex prey/predator cycle in which all animals (including man) take part?
    a. Food chain
    b. Habitat
    c. Ecosystem
15. The best protection against groundwater pollution is _____.
    a. Preventing contamination
    b. Stopping irrigation
    c. Cleaning groundwater after contamination
16. At what level is man in the food chain?
    a. Near the bottom
    b. Near the middle
    c. Near the top
17. An _____ pesticide is one that builds up in animal and plant tissues.
18. A _____ pesticide is one that remains in the environment without breaking down.
19. Even though persistent pesticides remain in the environment, they do not always accumulate in animals or plants.
    True False
20. An _____ _____ is a plant or animal that is near extinction throughout all or most of its range.
21. Which of the following is not a process that causes pesticides to break down after application?
    a. Photodegredation
    b. Microbial degradation
    c. Chemical degradation
    d. Atmospheric degradation
22. Pesticides that degrade _____ in the environment are the least hazardous.
    a. Slowly
    b. Quickly
    c. At a moderate rate

11. true
12. aquifer
13. b
14. a
15. a
16. c
17. accumulative
18. persistent
19. true
20. endangered species
21. d
22. b

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7

General Safety Precautions

As an applicator working with toxic materials, you are interested in protecting your health. You also want to protect other people and the environment from pesticide injury. Most pesticide accidents result from carelessness or ignorance. Learn safe procedures; it's for your own good!

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Learn proper safety precautions for before, during and after pesticide application.
- Understand the importance of cleanup measures.
- Understand the need for personal protective equipment.

Before Application

- **Plan ahead**
- **Move pesticides safely**
- **Select personal protective equipment**
- **Select application equipment**
- **Give prior notification**

Before you apply pesticides, always be sure all factors are favorable for protecting you, others and the environment. Do not apply pesticides if any of the factors described in this chapter are not as they should be.

Many safety precautions should be taken before you apply pesticides. Too many applicators are exposed dangerously and unnecessarily to pesticides while preparing to spray.

All pesticide users should keep thorough records for personal, crop and economic protection. Records can be very helpful. For example, information on previous applications helps you prevent damage to sensitive crops and buildup of illegal residues. Consistent yearly records can help you with pest control practices now and in the future.

Plan ahead

Always read the pesticide labeling first. Make sure you understand everything about the pesticide ahead of time so you will be a responsible user. Carefully follow all directions and precautionary statements on the label. Consult with experts when you do not understand something.

Be prepared for emergencies. Know first aid procedures for the pesticides you use and always post emergency phone numbers. If you or other workers feel sick, do not try to finish the job. Leave the treated area and seek help immediately.

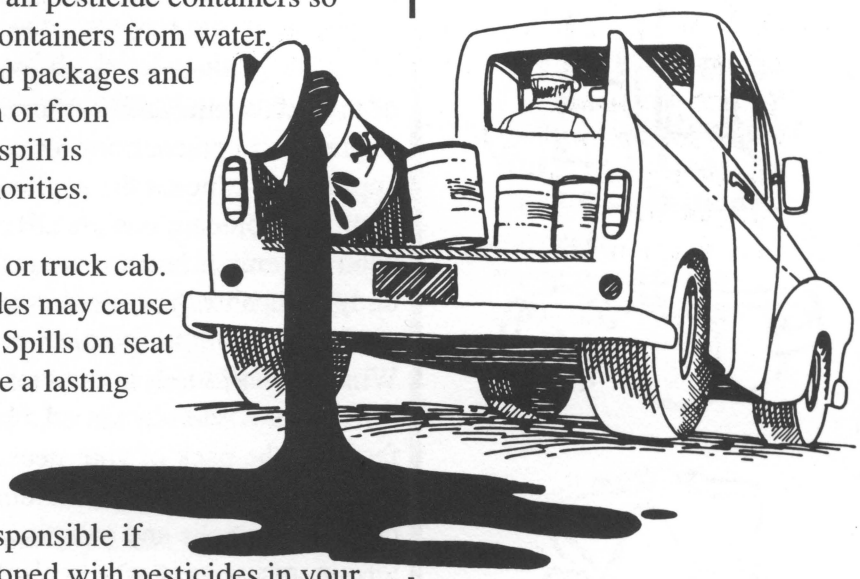
To prepare for accidents, have available some absorbent material such as kitty litter, clay, activated charcoal or sawdust to soak up spills and leaks. Keep hydrated lime available to decontaminate spill surfaces. Also keep plenty of soap, detergent and water — or anything else suggested on the label for emergencies or cleanup. Have extra clothes or protective suits on hand in case you need a change of clothing.

Finally, understand your legal responsibilities when you or your workers handle pesticides. Do not guess about this or anything else in your work. If you have questions, ask a recognized authority before using pesticides.

Move pesticides safely

Careless transport of pesticides can lead to broken containers, spills and contamination. Once you have the pesticides, you are responsible for safely transporting them. Accidents can occur even over short distances. Always work to prevent transport problems, but be prepared for emergencies.

The safest way to move pesticides is in the back of a truck. Flatbed trucks should have side and tail racks. Steel beds are best because they are easier to clean if a spill occurs. Secure all pesticide containers so they cannot shift, roll or bounce. Protect containers from water. Moisture can soak into paper and cardboard packages and rust metal. Immediately clean any spills in or from the vehicle, using correct procedures. If a spill is more than 5 gallons, notify regulatory authorities.



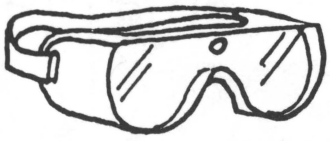
Never carry pesticides inside your car, van or truck cab. Skin contact or fumes from spilled pesticides may cause injury or death to you or your passengers. Spills on seat covers are very hard to remove, and may be a lasting source of exposure if not cleaned properly.

Never leave your vehicle unattended when transporting pesticides. You are legally responsible if curious children or careless adults are poisoned with pesticides in your care. Also, never allow children to ride on or near pesticides and never transport groceries or livestock feed near pesticides.

Some pesticides are designated "hazardous substances" by the Department of Transportation (DOT). Certain guidelines apply to transportation of these pesticides. For example, shipping papers must be carried in the truck cab when these pesticides are moved on the highway. A sign (placard) may be required stating that the truck contains hazardous substances. Contact the state DOT office for rules about pesticides on the hazardous substance list.

Select personal protective equipment

The need for personal protective equipment depends mainly on the pesticides with which you work. Protection requirements are printed on the pesticide label.



You may wear ordinary work clothes (long-sleeve shirt and pants) while using pesticides of low toxicity (category III or lower). It is a good idea to save one set of work clothes just for this purpose.

More toxic chemicals (categories I and II) require chemical-resistant suits or coveralls worn over another layer of clothes. You also need chemical-resistant gloves and chemical-resistant footwear. Material that is "chemical-resistant" permits no measurable movement of pesticide through it.

If the pesticide is an eye irritant, wear goggles, shielded safety glasses or a face shield. If coveralls will wet through, use a chemical-resistant suit or apron. Synthetic rubber boots protect against liquid and dry formulations. Natural rubber boots work only for dry formulations.

The activity, the environment and the handler also influence the choice of protective equipment. For example, mixing/loading activities often require extra precautions for concentrated pesticides. Airblast application exposes the applicator more than other methods, so additional precautions are advisable. Activities that risk exposure to the head or genitals require protective head- or body-gear because these body parts absorb pesticide very quickly

Wind increases risk in outdoor pesticide application. When exposed to drift, wear a wide-brimmed, chemical-resistant hat that protects your face and the back of your neck. Consider wearing a face mask, shielded safety glasses or goggles. Remember, extreme heat and humidity can cause heat stroke and exhaustion. Other environmental factors are terrain, nearness to public places and open versus closed spaces.

You make the final decisions in selection, use and care of your personal protective equipment. No one garment offers total protection. Carefully read label requirements for protective equipment. Then take extra precautions warranted by the activity, environment and your own needs.

Select application equipment

Carefully choose the most suitable equipment for applying a pesticide. Always use equipment correctly and take good care of it. Before operating equipment, check it thoroughly. Be positive everything works properly.

Calibrate your equipment to apply just the right amount of pesticide. Be sure there are no leaks in hoses, pumps or tanks. Check for loose connections and worn spots that could leak or burst. One way to find loose connections is to operate equipment at normal pressure with clean

water before filling with spray mix. Put safety guards over any exposed belts, pulleys or drive chains. Make sure the spray tank has a tight lid to prevent splashing and leaking.

Give prior notification

Before application, clear the treatment area of all unprotected people. Many states, including Texas, require that all persons in the treatment area and adjacent areas be informed about pesticide applications in advance. This warning is called *prior notification*. Prior notification is intended to protect others from exposure to pesticides. Check with the Texas Department of Agriculture or your county extension agent for the notification procedures required in this state.

While Mixing and Filling

- **Wear protective gear**
- **Work in safe area**
- **Measure pesticides correctly**
- **Pour pesticides carefully**

Read and carefully follow label directions each time you mix pesticides. Even if you have used a pesticide before, read the label again. Labels frequently change. Each new container may have important new information.

Wear protective gear

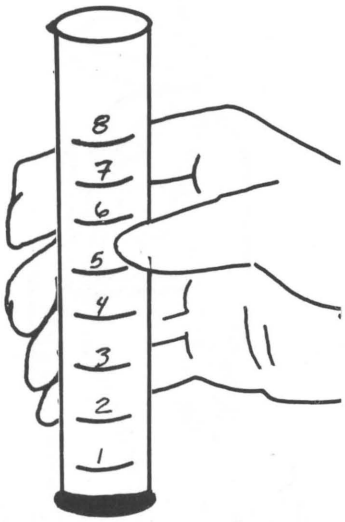
Protective gear is especially important when you mix and load pesticides. You are at greater risk of accidental poisoning when handling pesticide concentrates. Pouring concentrates from one container to another is a very hazardous activity. That is why you should put on protective clothing and equipment before you handle pesticides.

Work in safe area

Carefully choose the pesticide mixing and loading area. It should be outside or in a well-ventilated place away from people, livestock, pets and food or feed. It is best to mix and load pesticides on a concrete pad where spills are cleaned easily. Do not mix pesticides where a spill or overflow could reach a water supply. If your handling area is near a pond or stream bank, grade the ground to slope away from the water. If you or your workers must work indoors, or at night, work in a well-ventilated area with good lighting. If possible, do not work alone, especially when using highly toxic pesticides. It is a good idea when handling very poisonous materials to talk or make eye contact with another person every two hours.

Measure pesticides correctly

Measure pesticides carefully, making sure to mix them in correct proportions. Do not mix different pesticides unless a combination is called for on a label or you have consulted an authority. Remember, keep pesticides in their original containers so the label directions and



precautions are always with them. Mark all items used with pesticides (measuring utensils, protective equipment, etc.). Do not use these items for other purposes.

Plan your application so that you *mix and use only what is needed.* Do not use any more than the rate listed on the label. Using more product than the label recommends is illegal. It will *not* do a better job of controlling pests. The overuse of pesticides may:

- raise the cost of pest control,
- increase the chance of illegal pesticide residues in food,
- increase the possibility of groundwater pollution, and
- lead to pesticide resistance.

Open containers carefully to prevent accidental splashes, spills or drift. Do not tear paper containers open; use scissors to be safe and spill-free. Clean tools with which you open containers; use those tools only for pesticide-related work.

Pour pesticides carefully

When pouring pesticides, always wear a face shield. Stand with your head well above the container and the filling hole of the spray tank, so you and your clothing do not get splashed. Never use your mouth to siphon a pesticide. Never work so that a breeze blows toxic pesticide toward you. Do not use pesticides when there is a strong wind.

Never leave a spray tank unattended while filling it – it may overflow. Install antisiphon devices on filler pipes and maintain an air gap between the filler pipe and the tank. Close containers after each use to pevent spills. If a pesticide spills on the floor or ground, clean it immediately.

During Application

- **Avoid exposure**
- **Avoid sensitive areas**
- **Avoid drift, runoff and spills**
- **Avoid equipment accidents**

There are many safety precautions to follow while you apply pesticides. You are responsible for protecting yourself, other people, domestic animals and the environment. You cannot afford to be careless!

Avoid exposure

Even moderately toxic chemicals can poison you when you use them day after day. Pesticide that gets on your clothing may soak through to your skin. Do not work in drift, spray or runoff unless you are properly protected. If pesticide spills on your gloves, be careful not to wipe your gloves on your clothing. Work in pairs when using hazardous pesticides. Handlers of highly toxic pesticides should try to make visual or voice contact with another person every two hours. Carefully supervise employees to make sure they follow all safety precautions.

Never blow out clogged hoses or nozzels with your mouth. Use a nylon brush to clean such parts. Save the brush for only this purpose.

Wash your hands and face thoroughly after using pesticides and before doing anything else. Never eat, drink or smoke when handling pesticides. You may transfer chemicals from your hands to your mouth, particularly while smoking. Getting burned is another danger when smoking with pesticide-soiled hands, if you used flammable chemicals. Do not smoke in recently treated areas.

Not all labels state it, but pesticide applicators are required by law to prevent direct or indirect exposure of workers and other persons. Keep unauthorized persons out of the target area and at a safe distance from sprayers, dusters, filler tanks, storage areas and pesticide containers.

Avoid sensitive areas

Avoid spraying near houses, schools, playgrounds, hospitals, bee hives (apiaries), lakes, streams, pastures and sensitive crops. If you must spray near sensitive areas, do so on calm days. Even with low winds, always apply downwind from sensitive areas. Plan applications for times when people, animals and nontarget insects (such as honeybees) will not be exposed. Notify residents and beekeepers when you will spray in their areas and urge them to take precautions. But first, ask authorities about required spraying permits and procedures.

Completely cover or remove toys and pet dishes, and close all windows. Keep children and pets away from the application area. Avoid sensitive indoor sites such as infants' rooms, kitchens and food pantries, heating and air conditioning systems, and pet and fish tank locations.

Avoid drift, runoff and spills

Pesticides that fall outside the target area can injure people, crops and the environment. Choose weather conditions, pesticides, application equipment, pressure, droplet size, formulations and adjuvants that minimize drift and runoff hazards. Avoid spills by taking precautions.

Avoid equipment accidents

Properly maintained and carefully used equipment contributes to safe pesticide application. Poor maintenance and careless use of equipment add to the hazard posed by pesticides.

- Be sure to turn off machinery before adjusting or repairing it. Warn mechanics to protect themselves before they work on equipment that has not been cleaned.

- Do not allow children, pets or unauthorized people near pesticide equipment. If you must work away from your equipment or at the end of a long spray hose, have someone keep watch near the machinery.
- Between jobs, pressurized tanks and sprayers should be depressurized. Turn off the main pressure valve on bulk containers and release the pressure remaining in your application wand.
- Once the tank is empty, release the pressure from your application equipment. Be sure to close the outlet valves. Always return equipment to appropriate areas for cleaning and storage after you complete pesticide applications.

Safety and caution do not end with application of the chemical. You also must clean up properly and safely. Complete one job entirely before going on to the next.

Storage and Disposal

Try to use all the pesticide in your tank. If you have some left, use it on other target locations at the recommended dosage. Clean equipment and put it away immediately to prevent accidents.

Do not leave pesticides or pesticide containers in the field or at the application site. Be sure to account for every container used. Safely dispose of empty containers. Do not reuse them for any purpose. NEVER give them to children. Tightly store unused pesticides in their original containers and place in a locked building. Keep children and uninformed people away from the storage area. (See Chapter 20 — *Disposal* and Chapter 21 — *Storage*.)

Cleanup

Clean mixing, loading and application equipment as soon as you finish using them. Clean them in a special area that has a wash rack or concrete apron with a sump for catching contaminated washwater. The best way to dispose of washwater containing a registered pesticide is to use it as directed on the label. Collect the contaminated water and use it to dilute the pesticide or a compatible pesticide if possible. *Waste from equipment cleanup must be kept out of water supplies and streams.*

It is very important to clean pesticide equipment between applications. Accidental injury or death of sensitive plants and animals may occur from applications that are made with slight residues of old pesticides.

Always clean the inside and outside of the equipment, including nozzles. Only trained persons wearing proper personal protective equipment should do this job. Washing the outside of equipment insures that people touching it will not be exposed to pesticides. Cleaning the inside insures that dangerous chemical mixing will not occur.

At the end of each day take a shower. Wash your body and scalp thoroughly with soap and water. Remember to scrub your nails. Place used protective gear in a special place away from people, pets and the family laundry. Separately launder washable clothing every day — this applies to regular work clothes worn under protective coveralls, and to garments directly exposed to pesticides. Do not reuse disposable or limited-use garments. Discard according to federal, state and local regulations. Ask the Texas Water Commission for disposal recommendations.

Wash pesticide-soiled clothing

Change and wash your spray clothing daily. Any pesticide on your clothes could harm other people who touch them. Keep contaminated clothing away from the family laundry and warn anyone who washes your clothes of possible dangers. Whoever does the laundry should wear chemical-resistant gloves. Do not allow children to play in or near your work clothes. Do not dry-clean contaminated clothing. To clean contaminated clothing for reuse, follow these procedures:

1. *Air:* hang garments outdoors to air. Sunshine and ventilation help break down certain pesticides. Do not hang contaminated garments with other clothing. Do not hang contaminated garments close to homes or near people and pets.
2. *Prerinse:* use one of three methods: a) hose off garments outdoors in an area away from people and pets, b) rinse in separate tub or pail kept for that purpose, or c) agitate in an automatic washer.
3. *Pretreat:* rub a heavy-duty liquid detergent into heavily soiled areas of the contaminated garment.
4. *Washer load:* always wash work garments separately from regular laundry. Pesticides can move from contaminated clothes to other clothing, to equipment and to the hands of whoever does the laundry. Wash garments soiled with the same pesticide together.
5. *Load size:* wash only a few garments at a time.
6. *Water level:* use full water level.
7. *Water temperature:* use hot water, 140°F or higher.
8. *Wash cycle:* use a normal 12-minute wash cycle.
9. *Laundry detergent:* use a built, heavy-duty laundry detergent. Built detergents contain extra cleaning agents. These agents control water hardness, adjust alkalinity of washwater, react with oily soils and suspend particulate soil. Built detergents are needed for contaminated clothing because the pesticide often is mixed with other soils. Polyphosphates are the best builder because they clean well without leaving a residue on the clothing. Where phosphates

are prohibited, as in New York, use sodium carbonate, sodium aluminosilicate or sodium nitrilotriacetate as builders. Use the amount recommended on the package; use more for heavily soiled garments or hard water. Dissolve powdered detergent before adding clothes to the washing machine.

10. *Rinse:* use two complete warm rinses.
11. *Rewash:* wash contaminated garments two or three times for more complete pesticide removal.
12. *Air dry:* hang outdoors to avoid contaminating your dryer and to encourage further dissipation of the chemical.
13. *Clean washer:* run a complete, but empty cycle. Use hot water and detergent.

Reentry

Unprotected people should wait until it is safe to enter a treated site. A reentry interval is the time you must wait between treatment and returning to the treatment area. Reentry intervals may be listed on some pesticide labels. Do not allow workers, children or others to reenter the sprayed area until this time has passed. When no reentry times are stated on the label, use good judgement in allowing people to return to treated sites. Always wait at least until sprays dry, dusts settle and vapors disperse. In Texas this is the minimum reentry interval. If you must reenter an area soon after spraying:

- Wear all personal protective equipment required on the label.
- Do not touch treated surfaces.
- Have decontamination water nearby and know how to use it.

Some highly toxic pesticides (organophosphates and carbamates) have reentry intervals set by federal law. These time periods are listed on the labels. Some states set even longer reentry times because of certain hazards and climatic conditions that exist in some places.

Carelessness causes injury and death. Protect yourself, others and the environment by using care and common sense. Learn safe procedures, it's for your own good!

Study Questions

1. Which is *not* a reason why pesticide accidents occur?
   a. Lack of up-to-date knowledge
   b. Unsafe handling practices
   c. Reading and understanding pesticide labels
2. If you or your partner feels sick on the job, should you leave the work undone or try to finish it?
   a. Always try to finish the job unless there is an emergency or you are working alone and feel as though you might faint.
   b. If you or any other worker feels sick, do not try to finish the job. Get out of the area immediately and get help.
3. How should you clean your washing machine after laundering pesticide-soiled clothing?
   a. Run a complete, but empty cycle using hot water and detergent.
   b. Clean the inside of the machine by hand.
   c. Run a rinse cycle only.
4. The safest way to move pesticides is in the back of a truck that has a steel bed with enclosed sides and a tail gate.
   True False
5. You should wear a wide-brimmed, chemical-resistant waterproof hat (not a cap) when you are exposed to pesticide drift.
   True False
6. You should store all clean protective equipment and clothing separately from stored pesticides.
   True False
7. When you plan to work with pesticides, where should you look for information about the protective clothing you need?
   a. In the American Chemical Users Handbook
   b. On the pesticide label
   c. In your pesticide applicator training manuals
8. During pesticide handling, you should wear both gloves and boots made of chemical-resistant material.
   True False
9. You should wear protective clothing when you are exposed to pesticide drift, but hardly ever when you are mixing and filling pesticides.
   True False
10. When filling a spray tank you should always stand with your head above the container and the filling hole of the spray tank.
    True False

1. c
2. b
3. a
4. true
5. true
6. true
7. b
8. true
9. false
10. true

11. How should you prepare for an accidental spill of a pesticide?
    a. Have some kind of absorptive material available.
    b. Have bleach or hydrated lime for decontamination.
    c. Keep soap, detergent and water close at hand.
    d. Have a change of clothes available.
    e. All of the above.
12. If a nozzle clogs up while you are spraying pesticides, the best way to clear it is to blow the nozzle out with your mouth.
    True False
13. If the pesticide is not too toxic, is it OK to let children and pets play in the area while you are spraying there?
    a. Yes, if the pesticide is not too toxic, children and pets may play in the area.
    b. Pets may be allowed to play in the area, but not children.
    c. Never let children or pets play in a treatment area during spraying.
14. When you are spraying near bee colonies, it is up to the owners alone to keep the bees out of your way or to remove the bees.
    True False
15. How can you prevent accidents commonly caused by equipment?
    a. Choose the safest equipment for your pesticide application needs.
    b. Do not allow children or unauthorized people near pesticide equipment.
    c. Operate equipment correctly.
    d. Maintain equipment well.
    e. All of the above
16. The length of time that should pass between treatment and returning to a treated area is called the _____ _____.
17. Regardless of the reentry interval stated on the label, you may reenter a treated site after sprays dry, dusts settle and vapors disperse.
    True False

11. e
12. false
13. c
14. false
15. e
16. reentry interval
17. false

Protective Equipment & Personal Safety

8

Pesticides can enter your body through your skin, eyes, mouth and lungs. Pesticide poisoning occurs most commonly through skin contact. Some pesticides can soak through skin quite easily. Concentrates are especially dangerous. Also, two areas of your body — your head and genitals — absorb pesticide very fast and need extra protection.

If pesticide spills on you, your skin will absorb most of it within minutes. Wash off the pesticide immediately. Avoid direct contact with pesticides by wearing protective clothing. The pesticide label will tell you what protective equipment is necessary.

Texas Agricultural Extension Service

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Learning Objectives

- Understand the importance of personal protective equipment.
- Understand why different fabrics and materials are used to protect you and how they differ.
- Learn the importance of and method for layering protective clothing.
- Learn the basics of respirators and their use.

Gloves

When handling pesticides, except relatively nontoxic products, always wear unlined, elbow-length chemical-resistant gloves. Elbow-length gloves protect your hands, wrists and upper arms. Never use fingerless gloves.

Glove materials include nitrile, butyl, neoprene, natural rubber (latex), polyethylene and polyvinylchloride (PVC). Nitrile, butyl and neoprene offer good protection for both dry and liquid pesticides. Do *not* wear gloves when using certain fumigants. Natural rubber is effective only for dry formulations. Leather or cotton gloves can be more hazardous than no protection at all because they absorb and hold pesticide close to your skin. You may wear cotton gloves under chemical-resistant gloves to improve comfort, but wash the cotton pair after each use.

Remember, proper use is as important as selection. Check gloves closely for holes by filling with clean water and gently squeezing. Discard the gloves if a leak appears. For overhead work, turn glove cuffs up to trap any liquid that runs down your arm. When you finish spraying, wash your gloves with detergent and water **before** removing them. Then you will not contaminate yourself or the inside of the gloves as you take them off. Promptly wash your hands with lots of soap and water.

Always wash gloves after use and buy new gloves regularly. Slash discarded gloves so they cannot be used by someone else. Wrap them in a plastic bag and put with an empty pesticide container for proper disposal.

Body Covering

Regular work attire of long pants, a long-sleeve shirt, shoes and socks are acceptable for slightly toxic (category III) and relatively nontoxic (category IV) pesticides. Many applicators prefer work uniforms and cotton coveralls that fit this description and provide equal protection. Reserve one set of clothing for pesticide use only. Launder and store them separately from all other clothing.

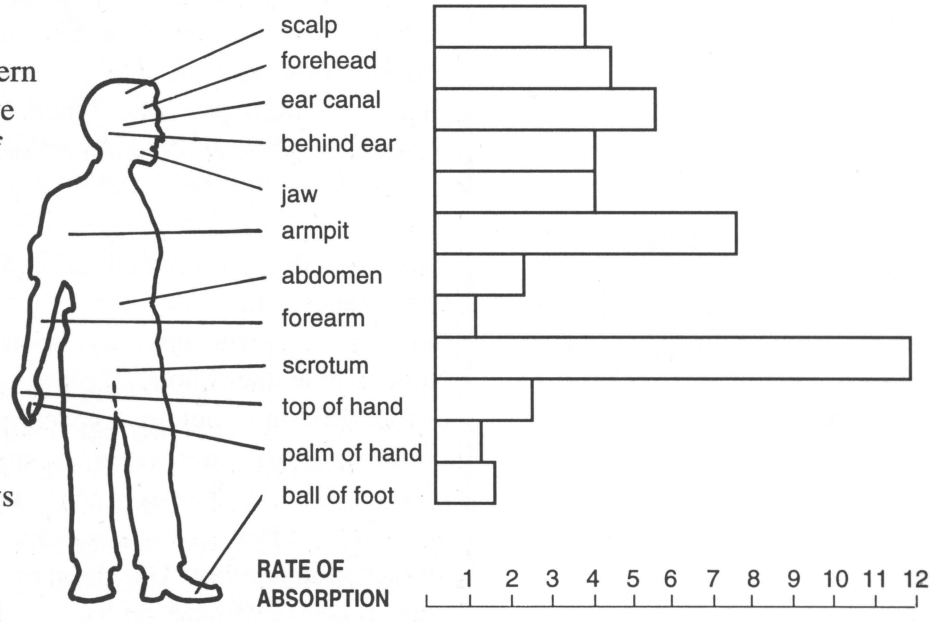
To apply moderately toxic (category II) or highly toxic (category I) chemicals, wear a clean, dry protective suit that covers your entire body from wrists to ankles. Protective suits are one- or two-piece garments that you should wear over regular work clothes and underwear. The sleeves must be long enough to overlap with gloves. The fewer pockets and openings there are in the suit, the better.

Protective suits may be disposable or reusable. They are available in woven, nonwoven, coated and laminated fabrics. The degree of protection increases from woven to nonwoven to coated to laminated. Read the manufacturer's label for information about care and intended use. Good quality construction and proper fit are also important.

Among woven fabrics, tightly woven, cotton twill offers better pesticide protection. Cotton coveralls are a sensible choice for general use. They reduce the risk of dermal exposure to pesticides in dust, granule or powder form. However, cotton coveralls do not protect you against spills, fumigants or mists.

Nonwoven fabrics have a random pattern of fibers that is slightly more protective than woven fabrics. However, suits of nonwoven fabric are hotter to wear. Take precautions to avoid heat stress. Most nonwoven suits are disposable; discard them after eight hours of use.

Uncoated nonwoven fabrics are convenient for use with pesticides in dust, granule or powder form. They do not protect you against spills, sprays or mists from liquid pesticides.



Different places on your body absorb pesticides at different rates. The rates shown above are based on studies using the insecticide parathion. Never handle pesticides without adequate protective clothing.

Protective suits of coated or laminated fabrics are a must when you are in a mist or spray that can wet your clothing. However, not all these fabrics qualify as chemical-resistant. Chemical-resistant suits are best when handling highly toxic (category I) pesticides. Coated and laminated fabrics used for protective suits are listed below:

1. *Tyvek QC*: a DuPont product of 100 percent spunbonded polyethylene fabric coated with a polyethylene film. Protects against dry and liquid drift or splashes. Does not protect against chlorinated hydrocarbons or organophosphorus compounds. Not chemical-resistant. Uncomfortable in hot weather. Disposable.

2. *Tyvek QC+*: DuPont Tyvek that is laminated with Saranex-23P, a saran film made by Dow Chemical. Provides more breakthrough protection from dry and certain liquid pesticides at the category I and category II toxicity levels. Does not protect against chlorinated hydrocarbons. Uncomfortable in hot weather. Disposable.
3. *Waterproof rainwear*: Fabrics with PVC, butyl and neoprene coatings that protect against liquid and toxic pesticides. Butyl and neoprene appear more resistant than PVC. Wearers complain that these suits are cumbersome and uncomfortable in hot weather. Reusable if properly maintained, but longevity is still being tested.
4. *Goretex*: a microporous film laminate produced by W.L. Gore and Associates, Inc. Chemically resistant and comfortable to wear. Not yet practical because of its expense and some maintenance problems.

Apron

Wear a chemical-resistant apron when repairing or cleaning spray equipment and when mixing or loading. This is a good practice with all pesticides. It is essential for pesticides of category I and II toxicity. Aprons offer excellent protection against spills and splashes of liquid formulations. Aprons also are useful when handling dry formulations such as wettable powders. Nitrile, butyl and neoprene offer the best protection. PVC and natural rubber also are available.

Boots

When handling moderately or highly toxic pesticides, wear unlined chemical-resistant boots that cover your ankles. Purchase boots with thick soles. Nitrile and butyl boots appear to give the best protection. Never use leather boots. If chemical-resistant boots are too hot to wear or too difficult to put on, try wearing chemical-resistant overboots with washable shoes (such as canvas sneakers or layered socks.) Put your pant legs outside the boots so pesticide cannot drain into your boot. Wash boots after each use and dry thoroughly inside and out to remove all pesticide residue. Use them only for pesticide applications. It is wise to keep two pairs on hand in case of accidental contamination. Wash socks and canvas sneakers worn under chemical-resistant boots, according to laundry instructions in Chapter 7.

Goggles or Face Shield

Wear snug-fitting, non-fogging goggles or a full face shield whenever a chemical could contact your eyes. Always protect your face when you are pouring or mixing concentrates or working in highly toxic spray or dust. Clean head gear after each use. Be careful of the headband; it may be made of material that absorbs and holds chemicals. Have several spare bands and change them often or use a chemical-resistant strap. If possible, wear the strap under your head covering.

Head and Neck Coverings

The hair and skin on your neck and head must be protected too. This is most important when exposure from overhead dusts or sprays is possible, as with airblast spraying or flagging. Chemical-resistant rain hats, wide-brimmed hats and washable hard hats (with no absorbing liner) are good. In cool weather, chemical-resistant parkas with attached hoods are a good choice. Do not use cotton or felt hats; they absorb pesticides.

Respirators

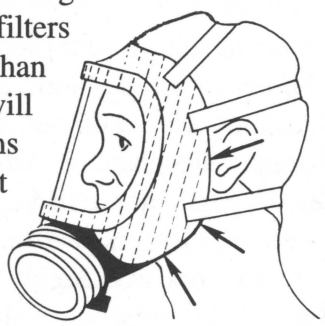
Respirators protect you from breathing toxic chemicals. Pesticide labels tell you if you need a respirator. Respirators are necessary when you handle highly toxic, concentrated pesticides. Also wear one if you will be exposed constantly to small amounts of moderately toxic pesticide for one or more days.

Cartridge Respirators

The cartridge respirator is a mask that usually covers only your nose and mouth. It contains one or two "cartridges" that absorb toxic fumes and filter the air you breathe. These respirators are useful for a short exposure period to concentrated chemicals or for a long exposure to low concentrations of toxic chemicals. Wear goggles in addition to the respirator. The main limitation of this type of respirator is the leakage that can occur around the face shield. Make sure to use the correct replacement cartridge.

Gas Masks

Gas mask respirators cover your entire face, protecting your eyes, nose and mouth. They contain better filters (and more absorbent material) to cleanse the air than cartridge respirators. Use gas masks when you will be exposed to toxic fumes in heavy concentrations or for long periods. Some gas masks can connect to an oxygen supply so you don't have to use contaminated outside air. These are best when you are exposed to unknown vapors as a result of accident, fire or reentering fumigated areas.



Correct Use of Respirators

Wear your respirator tightly enough to form a seal all around your face. Respirators come in different sizes. To select the best size, test the fit. If you have a beard, groom it to allow a proper seal between your face and the respirator. You may have to remove a beard or long sideburns altogether.

Respirator manufacturers make a variety of cartridges and each cartridge has its own intended use. Be sure to select a cartridge that absorbs pesticides. The wrong cartridge may allow toxic levels of pesticides to pass through. Check the filter (the cloth-like outer layer) of your respirator often. Replace it when it looks dirty or if breathing becomes difficult. Change cartridges after every eight hours of use. If you notice a pesticide odor, first check the seal of the respirator on your face. If the odor persists, change the cartridge right away.

After each use, wash the face piece with detergent and warm water. Rinse thoroughly and wipe dry with a clean cloth. Store the respirator, filters and cartridges in a clean, dry place away from pesticides. A tightly closed plastic bag works well for storage.

Common Sense

Always work in pairs when handling highly toxic chemicals. Watch your co-worker carefully for unusual behavior or actions. Remind him (and yourself) to wash his face and hands before eating, drinking or smoking. Never use the toilet without washing your hands first. It is important to avoid getting pesticide on any part of your body. At the end of the day remove your contaminated clothing carefully and put it in a plastic bag, well away from regular laundry. Shower and clean yourself thoroughly from head to toe. Pay close attention to fingernails and hair where pesticide could remain.

Cholinesterase

Consider getting your blood tested to find your normal (base) level of a natural enzyme called cholinesterase. This enzyme is necessary for your nervous system. Both carbamate and organophosphate pesticides attack this enzyme in your blood. After your base level of cholinesterase is known, a simple blood test will show if you still have the normal amount. If you do not, you have been overexposed to an organophosphate or carbamate pesticide. Avoid further contact with these pesticides until your cholinesterase level returns to normal. In severe cases, antidotes must be given. Follow your doctor's directions. If you work with highly toxic chemicals, have your cholinesterase level tested at regular intervals throughout the spray season. (Cholinesterase tests are not useful for n-methyl carbamate pesticides.)

Reentry Requirements

Reentry intervals protect workers from exposure to dangerous levels of pesticide in newly treated areas. The minimum reentry interval is the time it takes sprays to dry, dusts to settle or vapors to disperse. Stricter reentry intervals are based on the pesticide's acute dermal toxicity, eye irritation effects or skin irritation effects. For example, a 48-hour

reentry interval might be set for any organophosphate pesticide in toxicity category I. Product labels and Texas pesticide regulations state the reentry interval. They also state that early reentry (before the reentry interval is over) can be done only by workers wearing specific protective clothing.

Safe Transport

Whenever you handle a pesticide, you are responsible for transporting it safely. Do all you can to prevent problems and be prepared in case of emergency. Carry pesticides in the back of a truck, not in the cab. Flatbed trucks should have racks. Steel beds are best since you can clean them more easily if a spill occurs. Never carry pesticides near passengers, pets, fertilizers, seed, food or feed. This avoids the risk of contamination should a spill occur.

Make sure all containers are closed tightly and have legible labels. Secure containers so they will not roll or slide. Protect all containers from moisture and temperature extremes. Do not leave your vehicle with pesticides in an unlocked truck bed or compartment. The legal responsibility for injury of curious children or careless adults is yours.

A Checklist for Accident Prevention

Everyone can improve their methods for safe handling of pesticides. However, experienced pesticide applicators may become so familiar with their equipment and materials that they get careless or take shortcuts. An accident is waiting to happen.

The checklist on the next page is based on common causes of pesticide accidents. Check it against your handling practices and see how many accidents are waiting to happen to you. Just one "No" may be the one that gets you into trouble!

Never take chances with highly toxic chemicals.
Don't gamble with your life and others.

A Checklist for Accident Prevention

Store your pesticides safely.

Yes	No	
[ ]	[ ]	Do you have a separate space to store pesticides?
[ ]	[ ]	Do you keep the space locked? Are the windows locked, barred or boarded over?
[ ]	[ ]	Do you keep all your pesticides in this storage rather than in the garage, feed room, basement, porch, kitchen or refrigerator?
[ ]	[ ]	Do you store herbicides separately from other pesticides?
[ ]	[ ]	Are there signs on your storage to warn fire fighters and others?
[ ]	[ ]	Do you check periodically for leaking containers?

Keep the original container so the label is there!

Yes	No	
[ ]	[ ]	Do you always keep pesticides in the original container, not in old bottles, milk cartons or other food containers?
[ ]	[ ]	When people ask you for a little spray mix out of your tank do you refuse?
[ ]	[ ]	Do you always mark what you put in an unlabeled container?
[ ]	[ ]	If using an unlabeled container, do you always attach the safety precautions, antidotes and directions for use?
[ ]	[ ]	Do you safely dispose of unlabeled pesticides, rather than take a chance with your memory?

Use recommended clothing and protective equipment.

Yes	No	
[ ]	[ ]	Do you read the label to see what protective clothing to wear?
[ ]	[ ]	Do you start each spraying day with clean spray clothing?
[ ]	[ ]	Do you check the signal words and precautions on the label to see what protective equipment is necessary?
[ ]	[ ]	Do you wear the protective equipment recommended on the label?
[ ]	[ ]	Do you clean and maintain your protective equipment regularly and often?
[ ]	[ ]	Do you throw away rubber gloves that have tiny holes in them?

Spills and splashes of concentrates can be very hazardous!

Yes	No	
[ ]	[ ]	Do you know what to do if you spill a pesticide on yourself while mixing?
[ ]	[ ]	Do you wear adequate footgear, with your pant cuffs on the outside, so pesticides won't run into your footgear?
[ ]	[ ]	Do you have sawdust, vermiculite, kitty litter or some other absorbent on hand to soak up spills?
[ ]	[ ]	Do you always watch your sprayer tank when filling so it won't run over and spill on the ground?
[ ]	[ ]	Do you have a check valve or other device on your equipment to prevent back-siphoning into the water supply?

[ ] [ ] Is your application equipment maintained well so it doesn't leak and leave toxic puddles or piles of pesticide on the ground?

[ ] [ ] Do you avoid draining leftover spray mix on the ground?

[ ] [ ] Do you discard old high-pressure hose instead of patching it and hoping no one will be nearby when it bursts?

[ ] [ ] Do you clean nozzles with a brush, or by rinsing, instead of blowing them out with your mouth?

Poor container disposal may cause bad accidents!

Yes No

[ ] [ ] Do you rinse each "empty" liquid container at least three times and dump the rinsewater into the tank?

[ ] [ ] Do you keep used containers in your storage area until disposal?

[ ] [ ] Do you collect containers for disposal before leaving a job, instead of leaving them in the field or at your tank filling station?

[ ] [ ] Do you puncture, break or crush nonburnable containers so they can't be reused?

[ ] [ ] Do you keep or return to the manufacturer 30 and 55 gallon pesticide drums, rather than giving them away for floats, trash barrels, etc.?

Attractive nuisances can result in lawsuits!

Yes No

[ ] [ ] Do you keep spray equipment where children cannot play on it?

[ ] [ ] Do you keep spray equipment clean so anyone who touches it will not be contaminated?

[ ] [ ] Do you always release pressure on your equipment so spray guns won't be accidentally triggered?

Care in application prevents accidents.

Yes No

[ ] [ ] Do you check the wind direction and the area downwind before applying pesticides?

[ ] [ ] Do you consider substituting a safer chemical if you are spraying near a sensitive area?

[ ] [ ] Do you check for the possibility of rain showers and damaging runoff before applying pesticides?

[ ] [ ] Do you plan your pesticide application so it will have little or no effect on bees, birds, fish or other wildlife?

[ ] [ ] Do you remove, turn over or cover up pet dishes, sand boxes, plastic pools, etc., before spraying a private property?

[ ] [ ] Do you make sure that children and pets are out of the area and stay out until the spray dries?

Study Questions

1. What is the most common cause of pesticide poisoning for applicators?
   a. Inhalation
   b. Skin contact
   c. Swallowing
2. When should you wear elbow-length chemical-resistant gloves?
   a. When handling any pesticide.
   b. When handling any pesticide, except certain fumigants and relatively nontoxic products.
   c. Only when working overhead.
3. Why not use cotton or leather gloves when handling highly toxic pesticides?
   a. Because you might stain them.
   b. Because they absorb pesticide and hold it close to your skin.
   c. Because they reduce your dexterity, thus increasing the chance of accident.
4. You must always wear a chemical-resistant suit when handling highly toxic pesticides.
   True False
5. How often should you wash your contaminated overalls?
   a. Weekly
   b. Daily
   c. Never. Throw them away after they become contaminated.
6. Should you ever wash the inside of your boots?
   a. Yes, after each use.
   b. Yes, at least weekly.
   c. No, you might spread pesticide from the outside to the inside of the boot.
7. When is it necessary to wear goggles or a full face shield?
   a. Whenever pesticide could contact your eyes.
   b. When you pour or mix concentrates.
   c. When you work with a highly toxic spray or dust.
   d. All of the above
8. Which type of hat is useful to protect your head and neck from highly toxic pesticides?
   a. Chemical-resistant rainhat
   b. Washable hard hat with no liner
   c. Certain wide-brimmed hats
   d. All of the above
9. Are cotton or felt hats adequate head protection against highly toxic pesticides?
   Yes No

1. b
2. b
3. b
4. true
5. b
6. a
7. d
8. d
9. no

10. How do you know if a respirator is necessary?
    a. If there is a strong odor.
    b. If you feel lightheaded.
    c. If the pesticide label says so.
11. When must you always wear a respirator?
    a. Anytime you apply pesticides indoors.
    b. Whenever mixing or filling highly toxic pesticides.
    c. Only when you choose to.
12. Applicators who will be constantly exposed to small amounts of toxic pesticides for a day or several days should wear a respirator.
    True False
13. When are cartridge respirators often used?
    a. For a relatively short exposure period to concentrated chemicals.
    b. For a long exposure period to low concentrations of toxic chemicals.
    c. Both A and B
    d. Neither A nor B
14. What is the main drawback of cartridge respirators?
    a. Leakage around the face shield
    b. Discomfort
    c. The expense of the cartridges
15. Gas masks are used when the applicator will be exposed to toxic fumes in heavy concentrations or for long time periods.
    True False
16. When should gas masks be used with an independent oxygen supply?
    a. When you are exposed to unknown vapors.
    b. When you reenter a fumigated area.
    c. Both A and B
    d. Neither A nor B
17. Should you try to fit the respirator so that some air can leak in around your face?
    Yes No
18. When should you replace the filter on your respirator?
    a. After each use
    b. Weekly
    c. When it becomes dirty or breathing becomes difficult
19. How often should you change the cartridges on your respirator?
    a. Every 8 hours
    b. Every 24 hours
    c. Every 48 hours
20. To safely clean and store a respirator: Wash the face piece with detergent and warm water. Rinse. Wipe dry with clean cloth. Store in a tightly closed plastic bag.
    True False

10. c
11. b
12. true
13. c
14. a
15. true
16. c
17. no
18. c
19. a
20. true

21. When handling highly toxic pesticides. . .
    a. you can work safely alone for up to 4 hours.
    b. you should always work in pairs.
    c. you should always work in teams of at least three.
22. If you wash your face and hands first, it is all right to have a snack or a chew of tobacco while you are on the job.
    True False
23. You may wear pesticide-soaked clothing again, without laundering, as soon as the clothing dries.
    True False
24. Cholinesterase tests show whether you have been overexposed to _____or _____ pesticides.
25. You should wash your gloved hands before removing the gloves.
    True False
26. Natural rubber protects against _____.
    a. Liquid formulations
    b. Dry formulations
    c. Both liquid and dry formulations

21. b
22. true
23. false
24. carbamate, organophosphate
25. true
26. b

Pesticide Poisoning & First Aid

9

You should know the early signs of poisoning. You also should know first aid to help someone who shows these signs. If someone suffers pesticide poisoning, take the person away from the source of exposure quickly. Remove contaminated clothing and wash off any chemical that soaked through. You may save a life.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Recognize the signs of pesticide poisoning.
- Know basic first aid for pesticide poisoning.
- Know the importance of a first aid kit and what it should contain.
- Understand the importance of poison control centers.

Pesticide Poisoning or Not?

Pesticide poisoning has symptoms similar to some diseases and conditions, as well as other types of poisoning. Heat exhaustion, food poisoning, hangovers, asthma and other illnesses sometimes are confused with pesticide poisoning. Just because a person becomes ill after using or being around pesticides is not proof of poisoning.

This chapter describes symptoms that may occur in a person who is exposed suddenly to a large amount of toxic chemical. The symptoms also may occur in a person who is exposed continuously to small amounts of toxic chemical over a long time. If the symptoms appear, call and tell your doctor what chemical was involved.

Warn Medical Doctors in Advance

Many medical doctors are not familiar with pesticide poisoning because they treat so few cases. Doctors may be confused by symptoms that are the same as those of other illnesses and poisonings. Tell your doctor that you work with chemicals and which chemicals you use. Then your doctor can review the symptoms and treatment, and obtain antidotes to keep on hand.

Poison Control Centers

Poison control centers have information on all types of poisonings, including pesticide poisoning. Post the telephone number of the nearest poison control center near your phone. Also give the number to your doctor.

Acute vs. Chronic Poisoning

Acute poisoning is severe poisoning that occurs immediately upon exposure to a toxic pesticide. Symptoms may be sudden and dramatic or they may be delayed. *Chronic* poisoning occurs as a result of repeated small, nonlethal doses over a long time. Many symptoms may appear, such as nervousness, slowed reflexes, irritability or a general decline in health.

General Symptoms

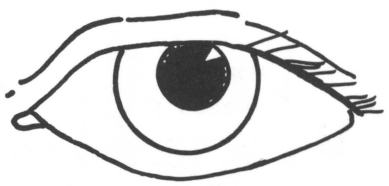
Unfortunately, all pesticide poisoning symptoms are not the same. Each chemical family — organophosphates, carbamates and chlorinated hydrocarbons — can attack the human body in a different way. However, beware of the following general symptoms. Usually, a poisoned person exhibits more than one of them.

Mild poisoning or early symptoms of acute poisoning: headache, fatigue, weakness, dizziness, restlessness, nervousness, perspiration, nausea, diarrhea, loss of appetite, loss of weight, thirst, moodiness, soreness in joints, skin irritation, eye irritation, irritation of the nose and throat.

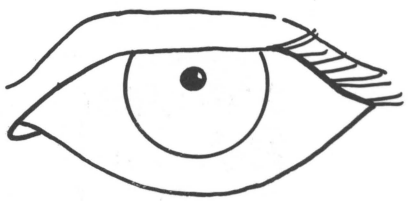
Moderate poisoning or early symptoms of acute poisoning: nausea, diarrhea, excessive saliva, stomach cramps, excessive perspiration, trembling, no muscle coordination, twitches, extreme weakness, mental confusion, blurred vision, difficulty in breathing, cough, rapid pulse, flushed or yellow skin, weeping.

Severe or acute poisoning: fever, intense thirst, increased rate of breathing, vomiting, uncontrollable muscle twitches, pinpoint pupils, convulsions, inability to breathe and unconsciousness, as well as the symptoms of mild and moderate poisoning.

If you are unsure that poisoning has occurred, let your doctor decide!



Normal pupil



Pinpoint pupil, a symptom of poisoning

Call a Doctor

First Aid is the initial effort to help a victim while medical help is on the way. Step one in a poisoning emergency is to call an ambulance or doctor. The only exception is when you are alone with the victim. Then you must see that the victim is breathing and is not further exposed before you leave to call. Always save the pesticide and label for the doctor. Never give mouth-to-mouth resuscitation to someone with pesticide on or in the mouth.

Many communities have rescue units with ambulances and emergency medical technicians who can begin treatment enroute. If a rescue unit is not available, you will have to transport the patient. Call the hospital emergency room for instructions and to alert them to prepare for the victim's arrival.

Do NOT use atropine tablets in a poisoning emergency. Atropine can hide or delay early symptoms of poisoning. The victim may think he is okay and may even go back to work. It is possible a doctor may not detect a problem because the symptoms are hidden by the atropine.

WARNING: Atropine can be poisonous if misused. Never use it to prevent poisoning. Do not carry atropine for first aid. Use it only under a doctor's directions. Doctors should not administer atropine unless they are sure what pesticide caused the poisoning.

What to Do for:

- **Poison on the skin**
- **Poison in the eye**
- **Inhaled poisons**
- **Swallowed poisons**

Poison on the skin

Quickly wash the poison off the patient. This will reduce further injury. However, take care not to get pesticide on yourself while helping the victim. Follow these steps:

1. Drench skin with water (from a shower, hose, faucet, pond, etc.).
2. Remove contaminated clothing.
3. Cleanse skin and hair thoroughly with soap and water. Detergents and commercial cleansers are better than soap.
4. Dry and wrap the patient in a blanket.

Poison in the eye

Wash the eye out as quickly and gently as possible, following these steps:

1. Hold eyelids open and wash eye gently with clean running water.
2. Continue washing for 15 minutes or more. It is important to use a large volume of water. If possible, use at least 5 gallons.
3. Do not use chemicals or drugs in the wash water. They may worsen the injury.
4. Cover the eye with a clean piece of cloth and seek medical help immediately.

Inhaled poisons (dusts, vapors, gases)

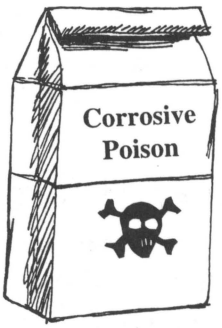
1. If the victim is in an enclosed space, do not go in after him unless you are wearing an air-supplied respirator.
2. Carry patient (do not let him walk) to fresh air immediately.
3. Loosen all tight clothing.
4. Use artificial respiration if the patient's breathing stops or is irregular.
5. Keep victim as quiet as possible.
6. If victim is convulsing, watch his breathing and protect him from falling and striking his head. Keep his chin up so his air passage will remain open for breathing.
7. Prevent chilling. Wrap patient in blankets but don't overheat him.

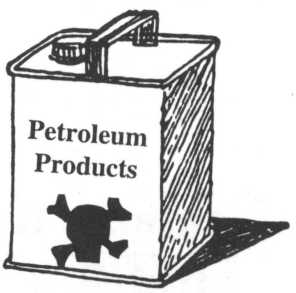
Swallowed poisons

The main decision to make when aiding a person who has swallowed pesticide is whether to make him vomit. You must decide quickly and accurately; the victim's life may depend on it. Usually it is best to get rid of swallowed poison fast, but:

- Never induce vomiting if the victim is unconscious or has convulsions. The victim could choke to death on the vomitus.
- Never induce vomiting if the victim swallowed a corrosive poison. A corrosive poison is a strong acid or alkali. The victim will complain of severe pain and burning in the mouth and throat. Dilute the poison as quickly as possible. For acids or alkalis, use milk or water. For patients one-year to five-years-old, use 1 to 2 cups; for patients five years and older, use up to 1 quart. For acids, milk of magnesia also may be used (2 tablespoons in 1 cup of water).
- Never induce vomiting if the person swallowed petroleum products such as kerosene, gasoline, oil or lighter fluid. Most pesticides that come in liquid formulations are dissolved in petroleum products. The words "emulsifiable concentrate" or "solution" on the pesticide label are signals NOT to induce vomiting if the poison victim swallowed concentrates. Concentrated petroleum products (like corrosive poisons) cause severe burns. They will burn as severely when vomited up. However, if a dilute form of these formulations was swallowed, force the victim to vomit immediately.

If a doctor or poison control center agrees, use activated charcoal as a "sponge" to absorb excess poisons after following the instructions for corrosive or noncorrosive poisons. Activated charcoal quickly absorbs many poisons and is available from a drug store. Mix the activated charcoal with water into a thick syrup for the victim to drink.





Do NOT induce vomiting

How to Induce Vomiting

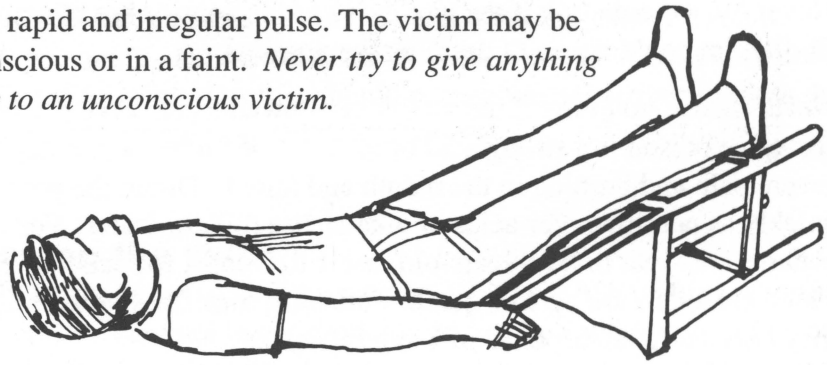
1. Give the patient large doses of milk or water: 1 to 2 cups for victims up to five years old; up to a quart for victims five years and older.
2. If the victim is alert and breathing normally, give syrup of ipecac followed by 1 to 2 glasses of water to induce vomiting. Adults (12 years and over): 30ml (2 tablespoons); children under 12 years: 15 ml (1 tablespoon). Activity hastens the effect of the syrup of ipecac.
3. Make sure the victim is lying face down or kneeling while vomiting. Do not let him lie on his back, because vomitus could enter the lungs. Collect some vomitus to take to the doctor. It may be needed for chemical testing.

The best first aid is to dilute the poison quickly with milk or preferably with water. Then get the victim to the hospital without delay.

How to Treat Shock

Sometimes poisoning victims go into shock. If untreated or ignored, the victim can die from shock even if the poisoning injuries are not fatal. Shock symptoms include: pale, cold and clammy skin; vacant and lackluster eyes with dilated pupils; shallow and irregular breathing; very

weak, rapid and irregular pulse. The victim may be unconscious or in a faint. *Never try to give anything orally to an unconscious victim.*

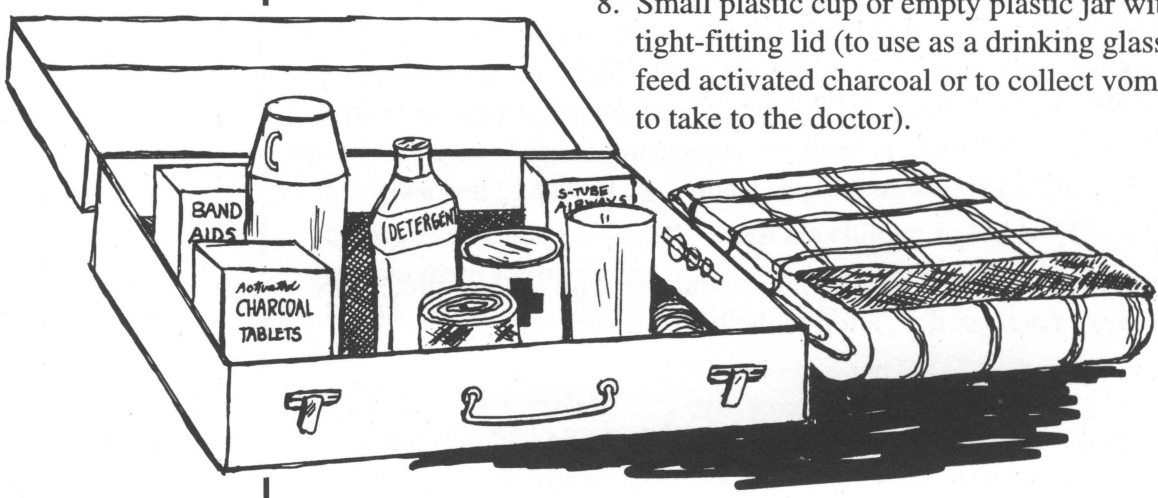


1. Unless he is vomiting, keep the victim flat on his back with his legs up 1 to 1 1/2 feet above his head.
2. Keep the victim warm enough to prevent shivering. Do not overheat.
3. Keep the victim quiet and reassure him often.

Contents for a First Aid Kit

Always keep a well-equipped first aid kit nearby. You can pack your own first aid kit in a lunch pail, tool box or sturdy wooden box. It should have a tight-fitting cover with latch so it won't fall open or allow pesticides to leak inside. Label it clearly with paint or a waterproof marker. Pack the kit with these items:

1. Small bottle of a common detergent for washing pesticides off skin.
2. Small package or bag of activated charcoal. When mixed with water and swallowed, this product absorbs pesticides.
3. Small plastic airway for mouth-to-mouth resuscitation.
4. Thermos or large plastic bottle (at least one quart) of clean water.
5. Simple band-aids, bandages and tape.
6. Blanket.
7. Coins for an emergency phone call.
8. Small plastic cup or empty plastic jar with a tight-fitting lid (to use as a drinking glass, to feed activated charcoal or to collect vomitus to take to the doctor).



Study Questions

1. The symptoms of pesticide poisoning are very different from all other types of poisoning.
   True False
2. A person exposed often to small amounts of toxic material over a long time usually shows the same poisoning symptoms as a person exposed suddenly to a large amount of toxic material.
   True False
3. Because each chemical family can attack the body in a different way, the symptoms of all pesticide poisoning are *not* the same.
   True False
4. What are some of the symptoms of mild poisoning?
   a. Headache, fatigue, sore throat
   b. Vomiting
   c. Fainting, dizziness
5. The symptoms of mild poisoning are similar to the early symptoms of acute poisoning.
   True False
6. What are some signs of severe or acute poisoning?
   a. Fever, intense thirst, vomiting
   b. Muscle twitches, pinpoint pupils
   c. Unconsciousness
   d. All of the above
7. What are the three major chemical families?
   a. Insecticides, fungicides and rodenticides
   b. Organophosphates, carbamates and chlorinated hydrocarbons
   c. Broad spectrum, narrow spectrum and systemics
8. What is the very first thing to do when someone has been poisoned?
   a. If you are alone with the victim, make sure he is breathing and not further exposed to poison.
   b. Call an ambulance or doctor.
   c. Call a poison control center.
   d. A and B
9. Your doctor should know which pesticides you normally use so he can obtain the _____ and keep it on hand.
10. If poison is on the victim's skin or in his eyes, it is most important to wash the victim with large amounts of running water.
    True False

1. false
2. true
3. true
4. a
5. true
6. d
7. b
8. d
9. antidote
10. true

11. When someone inhales poison, wear an air-supplied respirator if necessary to protect yourself and immediately carry the victim to fresh air.
    True False
12. If a person has swallowed a poison, you should make him vomit, except when . . .
    a. the victim is unconscious or in convulsions.
    b. the victim has swallowed corrosive poison.
    c. the victim has swallowed a petroleum product.
    d. All of the above.
13. In many cases, swallowed poisons can be absorbed by _____ _____, which is mixed with water into a thick syrup for the victim to drink.
14. Atropine tablets can be poisonous if misused. You should never use them to prevent poisoning.
    True False
15. Which of the following is *not* a sign of shock?
    a. Skin that is pale, cold and clammy
    b. Vacant eyes with dilated pupils
    c. Irregular breathing and pulse
    d. Delirium
16. Which of the following is *not* a treatment for shock?
    a. Keeping the victim flat on his back, with legs raised.
    b. Gently shaking the victim to keep him conscious.
    c. Keeping the victim warm enough to prevent shivering.
17. What is the best source for important information on all types of poisonings and their treatment?
    a. Pesticide manufacturers
    b. The Red Cross
    c. Poison Control Centers
    d. The Department of Human Health

11. true
12. d
13. activated charcoal
14. true
15. d
16. b
17. c

10

Integrated Pest Management

Integrated Pest Management (IPM) is a balanced, tactical approach to pest control. It involves taking action to anticipate pest outbreaks and prevent potential damage. IPM often combines several control tactics, including biological control, pest-resistant plants, cultural practices, mechanical controls, monitoring of pest population and damage, and careful use of chemical and biological pesticides. The goal of IPM is to achieve economical and effective pest control with the least risk to the environment.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Learn the definition of IPM.
- Understand the main tactics used in IPM.
- Learn what is meant by economic thresholds.

IPM Defined

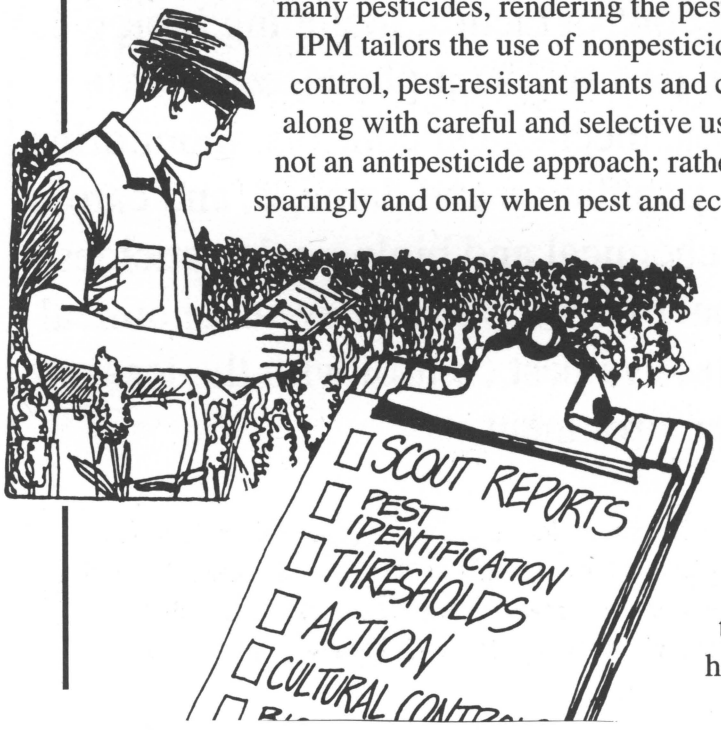
Integrated Pest Management (IPM): a strategy to anticipate and prevent pests from reaching damaging numbers by using all suitable tactics, such as natural enemies, pest-resistant plants, cultural and mechanical controls, and the wise use of pesticides.

Pests: unwanted organisms that can cause economic or physical harm to humans, domestic animals, wildlife, plants, structures and possessions.

Management: in this case, the process of planning and taking steps to keep pests from reaching intolerable or damaging levels.

Why Practice IPM?

By balancing the use of pesticides with other control tactics, IPM programs reduce reliance on pesticides. Over-reliance on pesticides can bring about adverse health and environmental effects. Pests, including insects, plant pathogens and weeds, develop resistance or tolerance to many pesticides, rendering the pesticides ineffective. IPM tailors the use of nonpesticide tactics (biological control, pest-resistant plants and cultural management) along with careful and selective use of pesticides. IPM is not an antipesticide approach; rather IPM uses pesticides sparingly and only when pest and economic conditions require it.



IPM can play a major role in reducing pesticide hazards to people, wildlife and the environment — all while providing economic advantages to farmers, ranchers and home owners.

The Basic Steps of IPM

- **Preventive measures**
- **Monitoring**
- **Assessment**
- **Action**

An IPM approach can be broken into four major steps:

1. Taking action to prevent pest buildup
2. Monitoring
3. Assessing the pest situation
4. Determining the best action to take

Preventive measures

Many IPM tactics prevent or stall buildup of pests:

Cultural controls. These are practices that disrupt the environment of the pest. Plowing, crop rotation, removal of infected plant material, sanitation of greenhouse equipment and proper manure processing are all cultural practices that deprive pests of a place to live and grow. Urban pest control improves with sanitation programs to clean out pest havens and increase garbage pickup.

Structural modifications. Avoid damage from wood-destroying pests by keeping support timbers off the soil. Wood absorbs moisture and is more susceptible to attack by carpenter ants and termites when in direct contact with the soil.

Construction site sanitation. Remove tree stumps and lumber scraps from construction sites. They are prime food sources for subterranean termites, which can cause problems in the future.

Biological controls. Natural enemies (biological control agents) help keep pests in check. Examples of biological control agents are beneficial mites that feed on mite pests in orchards; the milky spore disease that kills harmful soil grubs; and a wasp parasite of the greenhouse whitefly. Many biological control agents are commercially available.

Physical barriers. Materials such as netting over small fruits and screening in greenhouses keep pests out. Physical barriers are important in termite, house fly and rodent control.

Use of pheromones. Use of these natural insect scents has become common in pest management. Sometimes a manufactured "copy" of a female insect's pheromone can be used to confuse males and prevent mating. This works with the grape berry moth.

Pest-resistant varieties. These are less susceptible than other varieties to certain insects and diseases. Growers who use resistant varieties often do not need to apply as many pesticides. Potato growers control the golden nematode by planting resistant cultivars. Tomato growers can

avoid using soil nematicides by planting varities resistant to root knot nematodes. Farmers growing alfalfa and wheat keep several pests at bay by planting resistant varieties.

Monitoring (scouting)

After taking precautions to prevent pest infestations, it is still important to watch out for pests. This is called monitoring or scouting. It functions like an early warning system, helping to prevent a pest problem. Regularly check buildings and outdoor areas to detect pests early. Monitoring also involves proper pest identification and identification of effects from biological control agents.

Proper pest identification is very important. For example, brown-banded and German cockroaches can be confused easily. Also, some pests cause similar damage. Without correct identification you may target the wrong pest. Or you may use a management practice that controls only one species and not another. Identification enables you to cure the pest problem and avoid injury to nontarget organisms, particularly if you:

- use a pesticide that is specific to the pest,
- control the pest during the most susceptible stage of its life, and
- consider the use of a nonchemical control.

Identifying the effects of biological control means learning the impact of beneficial organisms on pests. Sometimes beneficials keep pest populations in check. This is called biological control. Counting beneficials helps you judge how much they're helping to control pests.

Assessment

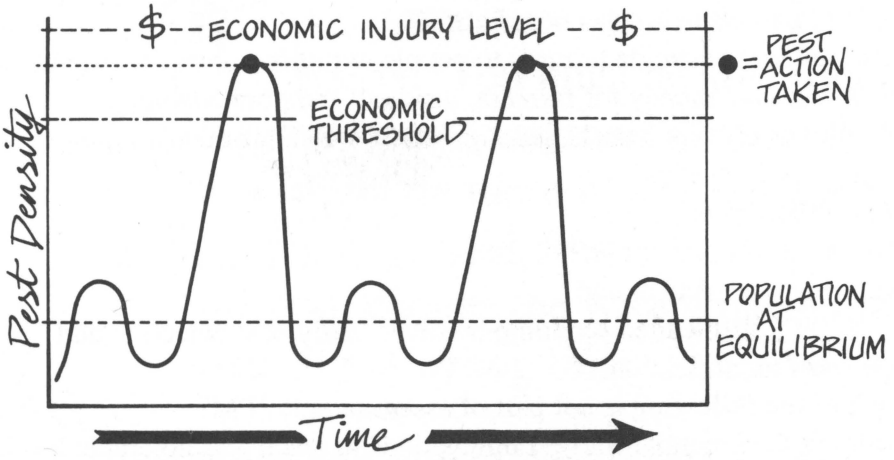
Judging the potential for pest populations to reach an economic threshold or an intolerable level is called *assessment*. Is a grower likely to suffer financially? Assessment helps answer this question. There are important differences between assessment of crop pests and urban pests.

Forecasting helps determine if weather conditions favor disease and insect pest development. For example, factors such as the number of rainy days and the temperatures for those days can help growers predict outbreaks. With forecasting, growers can spray only when conditions warrant.

Growers who keep good records of pest problems are better able to predict when weeds, insects and diseases will recur. Then the growers can prepare for early control of the problem.

Economic threshold and economic injury level represent the most damage a pest population can do without causing economic loss. Beyond these thresholds, the damage causes a grower to lose money. At that level, the cost of control equals the loss of yield or quality that would occur if no action were taken.

Thresholds for many pests and crops have been determined scientifically. If a pest has not reached threshold, there is no economic loss. So there is no need to apply a pesticide. Once pest damage reaches threshold, action is needed. Control costs will be less than or equal to the estimated loss the pests would cause if left uncontrolled.



Urban pest thresholds often are related to aesthetics rather than economics. Where health concerns exist, the tolerable level of the pest may be zero. A zero threshold forces action, even if only one pest has been detected. Zero thresholds exist in hospitals, food production, warehousing and retail facilities.

Action (control measures)

Once a pest reaches the economic threshold, action should be taken. Cultural controls alone may solve some situations. For example, early harvesting can avoid some pest problems. This prevents crop loss and may be more economical than a pesticide application. In urban settings, action is taken when pest numbers become intolerable.

Use chemical pesticides as a control measure only when no other strategy will bring the pest population under threshold. In fact, the success of waiting until a pest reaches threshold usually depends on availability of a fast-acting pesticide.

IPM uses many tactics to prevent pest buildups, monitor pest populations, assess damage and make informed decisions. These tactics include pesticide use in a judicious manner.

Study Questions

1. Which of the following does *not* describe integrated pest management?
   a. IPM combines several pest control tactics.
   b. IPM is an antipesticide approach to pest control.
   c. IPM is a way to anticipate and prevent pests from reaching damaging numbers.
   d. IPM achieves pest control with the least risk to the environment.
2. Which of the following is a benefit of IPM?
   a. IPM reduces pesticide hazards to people, wildlife and the environment.
   b. IPM can save money for farmers, ranchers and home owners.
   c. IPM helps prevent insects, pathogens and weeds from developing resistance to pesticides.
   d. All of the above.
3. The four basic steps or parts of IPM are _____ _____, monitoring, assessment and _____.
4. _____, also called scouting, involves early pest detection and proper pest identification.
5. Which of the following is *not* part of assessment in IPM?
   a. Judging the potential for pest populations to reach an intolerable level.
   b. Forecasting weather conditions that favor disease and insect pests.
   c. Carrying out control measures to manage pests.
6. Why is proper identification of pests so important?
   a. Because it enables you to treat the real source of a problem and not just the symptoms.
   b. Because it enables you to avoid injury to nontarget organisms.
   c. Because it helps you select the right pesticide for the job.
   d. All of the above.
7. In IPM, economic thresholds represent . . .
   a. the most money you can afford to spend to control a pest population.
   b. the most damage a pest population can do without causing economic loss.
   c. the difference between the cost of pest control and the cost of pest damage.
8. Which of the following are types of controls used in IPM?
   a. Biological, chemical and cultural controls
   b. Sanitation, structural modification and physical barriers
   c. Preventive measures, monitoring and assessment
   d. A and B

1. b
2. d
3. preventive measures, action
4. monitoring
5. c
6. d
7. b
8. d

Pests

11

Every structure, crop and animal has pests. You must be able to identify common pests and their hosts. Otherwise, you might do more harm than good. For example, you might use the wrong control method, choose the wrong pesticide or treat at the wrong time.

Knowing how a pest grows and how it does damage will help you to:

- choose the best time to control the pest;
- use less pesticide, or use other control methods;
- avoid injury to the host; and
- avoid injury to nontarget areas.

Never guess at your pest problems.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Recognize pests by their physical differences and the damage they do.
- Understand how different pests reproduce and develop.
- Be familiar with how diseases affect plants.

Throughout history, humans have competed with insects, rodents, diseases and weeds for survival. There are many historical records of plagues, famine and pestilence. With modern science, people have created pesticides and other tools to combat these pests.

To select the right tools, you must properly identify the pest problem. Recognizing a problem is the first step to effective control.

What Is a Pest?

A pest is considered anything that:

- injures humans, animals, crops, structures or possessions;
- competes with humans, domestic animals or crops for food, feed or water; or
- spreads disease to humans, domestic animals or crops.

As a certified applicator, you must know the pests you encounter. Doing a good job requires that you know about: common pest features, characteristics of pest damage, and pest biology and development.

Pests can be placed into four main categories:

- Insects and closely related animals
- Plant diseases
- Weeds
- Vertebrates

Insects

- **Harmless insects**
- **Beneficial insects**
- **Pest insects**

Insects outnumber all other living animals. Insects are found everywhere: in or on snow, water, air, soil, hot springs, plants and animals. Insects compete with humans and animals for food but also serve as food for many animals. Despite the damage done by some pests, we could not survive without insects. They are very important in the earth's ecosystem. Insects can be divided into three groups by their importance to people:

Harmless insects

About 99 percent of all insect species are not pests. They pollinate plants and are food for birds, fish, mammals, reptiles and other insects. Some insects are also pretty and pleasant to see.

Beneficial insects

This important group includes predators and parasites that feed on pest insects, mites and weeds. Good examples are ladybird beetles (lady bugs) and praying mantids. Pollinating insects, such as honeybees, bumblebees, moths, butterflies and beetles, are also very important. Honeybees make food for humans and animals. Other benefits derived from insects include silk made from silkworm cocoons and dyes made from insect secretions.

Pest insects

This group includes the fewest species. These insects feed on, transmit disease to or injure humans, animals, plants, food, fiber and structures. Pest insects include mosquitoes, fleas, termites, beetles and aphids.

Insect Body Characteristics

- **Head**
- **Thorax**
- **Abdomen**

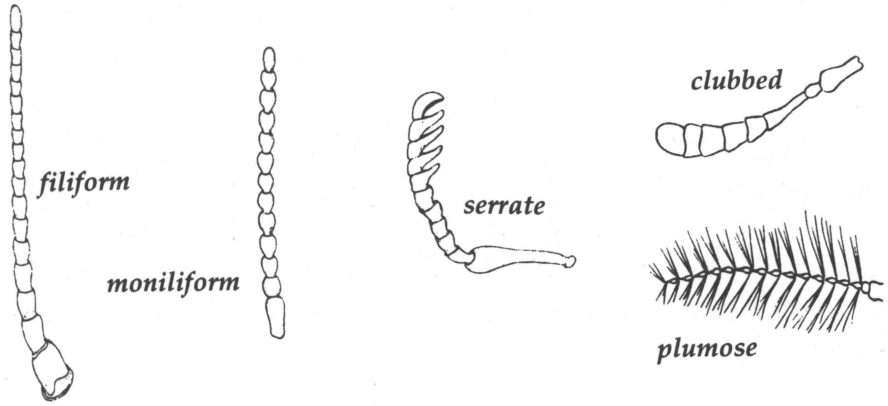
All adult insects have two characteristics in common: three pairs of jointed legs and three body regions. These regions are the head, thorax and abdomen.

Head

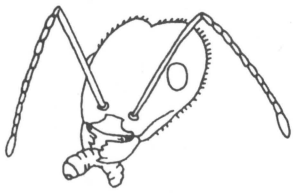
Attached to the insect head are the antennae, eyes and mouthparts. Differences in the size and shape of these parts can help you identify some insect pests.

Antennae are paired appendages usually located between, above or below the eyes. Common antennae types include:

- Filiform — threadlike (ground beetle, cockroach)
- Moniliform — look like a string of beads (termites)
- Serrate — sawlike (click beetle)



- Clubbed — segments increase in diameter away from the head (Japanese beetle)
- Plumose — feathery (male mosquito)

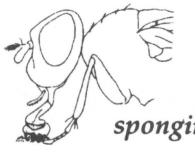


chewing

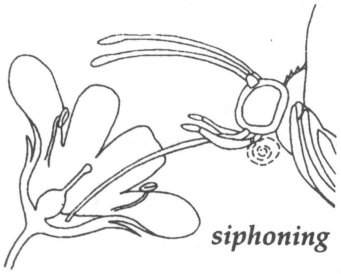
Mouthparts are different in various insect groups. An insect's mouth determines how the insect feeds and what sort of damage it does. You should know about these types of insect mouthparts:

- Chewing mouthparts — toothed jaws that bite and tear the food (beetles, cockroaches, ants, caterpillars and grasshoppers)
- Piercing-sucking mouthparts — long slender tubes that pierce plant or animal tissue to suck out fluids or blood (mosquitoes, aphids)
- Sponging mouthparts — tongue-like parts with spongy tips that suck up liquids or food that is liquified by the insect's vomit (house flies, blow flies)
- Siphoning mouthparts — long tubes used for sucking nectar (butterflies, moths)

piercing



sponging



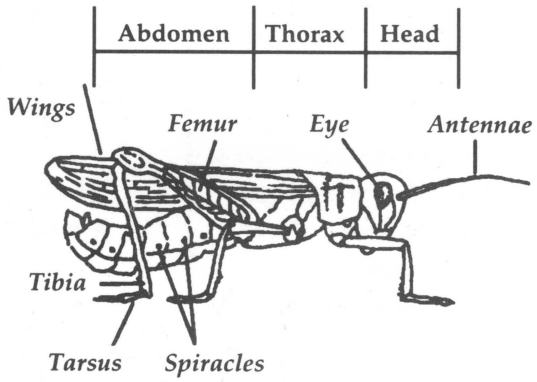
siphoning

Thorax

The thorax, or middle body segment, has three pairs of legs and sometimes one or two pairs of wings (forewings and hindwings).

Because legs come in many sizes and shapes, they are helpful in identifying insects. Used for walking, running, jumping and climbing, legs are very specialized in some insects, like the grasshopper's large jumping leg. Crickets and long-horned grasshoppers have an eardrum at the base of one of their leg segments.

Wings also vary in size, shape and texture. The pattern of veins on the wings often is used to identify insects. Forewings on some insects are hard and shell-like, as on beetles. Grasshoppers have forewings that are leathery. The forewings of flies are thin, almost clear membranes. Moths, butterflies and mosquitoes have membranous wings covered with scales.



Abdomen

An insect's abdomen is built of segments. Along the segments are openings, called spiracles, that the insect uses to breathe. The abdomen contains digestive and reproductive organs. Parts of the abdomen used in identification include: the ovipositor, male genitalia and cerci.

Insect Reproduction

In most insects, reproduction starts when males fertilize females. The females then lay eggs. This is the pattern of life for most insects, but there are a few interesting variations. For example, some parasitic wasps produce eggs without ever mating. In some of these species, males are unknown. A few insects give birth to live young, without the egg stage.

Egg hatching is affected by temperature, humidity and light. There are several egg sizes and shapes (round, oval, flat and elongate). Eggs may be laid one at a time, in groups or in floating rafts. Some insects produce capsules containing several eggs and carry the capsules until hatching (German cockroach). Other insects lay eggs inside animals, trees and plants. You can use eggs to identify the adult of some species. For example, certain species of cockroaches have unique egg capsules.

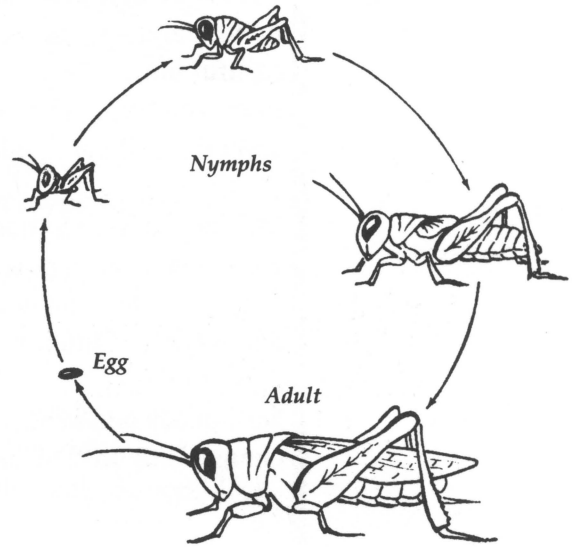
Insect Metamorphosis

Insects go through a series of changes as they develop from the egg to adulthood. This growth process is called *metamorphosis.*

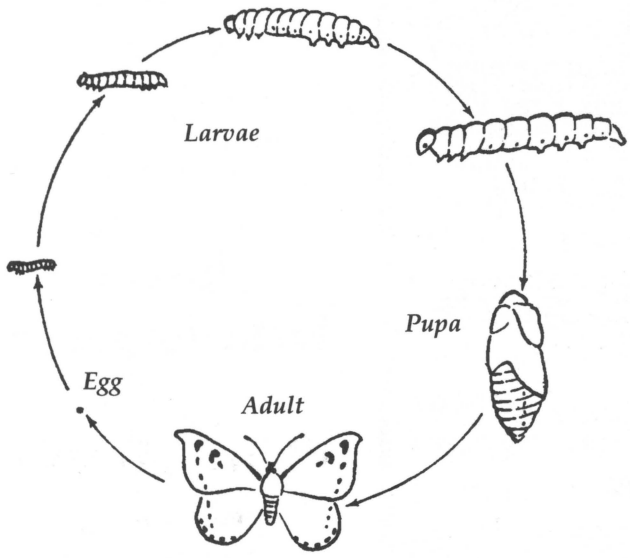
After hatching from an egg, the young insect is called either a larva, nymph or naiad. The young feed for a while and grow. When their skin cannot stretch further, young insects molt and form a new skin. These stages of growth and skin shedding (called instars) differ among insects and may vary with temperature, humidity and food supply. Generally, the heaviest feeding occurs in the last two instars. There are four types of metamorphosis:

No metamorphosis. Some insects change very little as they grow, except in size. The insect grows larger with each instar until it reaches maturity. The food and habitats of the nymphs are similar to those of the adult. The adults and nymphs are both wingless. Examples: springtails, firebrats and silverfish.

Simple or gradual metamorphosis. Insects in this group mature through three distinct stages of development: egg, nymph and adult. The nymphs resemble adults in both form and feeding behavior, and live in the same environment. If the adult has compound eyes, the nymph will have compound eyes. However, nymphs cannot reproduce. The body matures gradually, with wings and reproductive organs developing fully only in the adult stage. Examples: cockroaches, lice, termites, scales and aphids.



Incomplete metamorphosis. Insects with incomplete metamorphosis also pass through three stages of development: egg, naiad and adult. Some similarities exist between adult and naiad, but so do some striking differences. Naiads live in the water (aquatic) and breathe through gills. Adults have wings and live near water, but do not have gills. Examples: stoneflies, mayflies and dragonflies.



Complete metamorphosis. This development process consists of four stages called egg, larva (caterpillars, maggots and grubs), pupa and adult. Larvae differ entirely from adults and usually live in different habitats and eat different food. For example, caterpillars may live on a plant and eat leaves, while the adult butterfly flies freely, sipping nectar.

Larvae hatch from an egg and go through growth stages called instars. Larvae occur in many forms and sizes. For example, caterpillars have many legs while maggots have no legs. In the pupal stage, the larvae change into adults with legs, wings, antennae and a fully functional reproductive system.

Insect-Like Pests

- **Centipedes and millipedes**
- **Crustaceans**
- **Arachnids**

Spiders, ticks, mites, sowbugs, millipedes and centipedes resemble insects in habit, appearance, life cycle and size. Although they are not insects, they often are mistaken for insects. However, none have six legs. You should be familiar with these pests when evaluating a problem.

Centipedes and millipedes

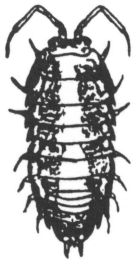
Centipedes are flat, long, wormlike animals. They have chewing mouthparts and many body segments and legs. Some centipedes give painful bites. Centipedes are found in protected places under tree bark or in rotting logs. They capture and feed on insects, spiders and other small animals. All centipedes have poisonous jaws.

Millipedes have a more tubelike shape, as well as many body segments. However, each segment has two pairs of legs. The mouthparts are adapted to feed on decaying organic material. Thus millipedes live in decaying leaf litter, rotting logs and damp debris near foundations.

Millipedes and centipedes have no metamorphosis. After hatching, they change only in size as they grow to adulthood.

Crustaceans

Animals in this class (for example, lobsters and shrimp) nearly all live in water. However, some live on land and often are mistaken for insects. Sowbugs (also called pillbugs) are black, gray or brown and can roll up into a ball. They live in damp decaying wood and under objects such as stones, boards and blocks. Sowbugs are plant pests in some areas, but usually are more a bother in damp basements and garages.



Sowbug

Arachnids

This group consists of spiders, mites, ticks and scorpions. All have eight legs and only two body regions. Arachnids also are wingless and lack antennae. They mature through gradual metamorphosis that includes both larval and nymphal stages. Eggs hatch into larvae (six legs), which molt into nymphs (eight legs) and then into adults. Spiders and scorpions have chewing mouthparts. Ticks and mites have a type of piercing-sucking mouthparts. Ticks are a concern because they can transmit Lyme disease and Rocky Mountain spotted fever to humans.

Plant Disease

- **Bacteria**
- **Fungi**
- **Viruses**
- **Nematodes**

A plant disease is any harmful condition that alters a plant's growth, appearance or function. Pesticides can cure some plant diseases and prevent others from starting.

Diseases are caused by biological agents called pathogens. Pathogens include bacteria, fungi, viruses and nematodes. They are spread by wind, rain, insects, birds, snails, slugs and earthworms. In addition, pathogens can be carried on soil, nursery grafts, plant cuttings, equipment, tools, seed, pollen, dust storms, irrigation water and people.

Plant pathogens are parasites that live and feed on a host plant. The pathogen's growth depends on weakness in the host and a favorable environment. Temperature and moisture are especially important.

Plants have three main responses to disease:

- Overdevelopment of tissue — galls, swellings and leaf curls
- Underdevelopment of tissue — stunting, lack of chlorophyll and incomplete development of organs
- Death of tissue — blights, leaf spots, wilting and cankers

Bacteria

Bacteria can be seen only with a microscope. They are one-celled organisms that reproduce quickly under warm, humid conditions. Bacteria may attack any plant part, above or below the soil. Several leaf spot and rot diseases are caused by bacteria.

Fungi

These are plants that lack chlorophyll and cannot make their own food. They are the most common plant pathogens. Fungi feed off other living organisms and decaying organic matter. Most fungi are beneficial because they help release nutrients from dead plants and animals, adding fertility to the soil. Fungi reproduce with spores, which function like seeds but usually are microscopic. Most spores die because they do not find a host to feed on, though some survive months without a host. High humidity (above 90 percent) is essential for spore germination and growth. Mildew and smut are good examples of fungal diseases.

Viruses

Viruses are smaller than bacteria and cannot be seen with an ordinary microscope. Viruses usually are recognized from the symptoms they cause. They need other living organisms for food and cannot live long on their own. Viruses invade healthy plants through wounds or during pollination. Insects with piercing-sucking mouthparts (aphids, whiteflies, leafhoppers), as well as chewing insects (beetles), can transmit viruses while feeding. Viruses also can be spread by nematodes. Almost all plants can be infected by viruses.

Mycoplasmas are the smallest known independent organisms. Unlike viruses, they can exist apart from their host. Mycoplasmas feed on plants. Yellows disease and some stunts are caused by mycoplasmas.

Nematodes

Nematodes are tiny (microscopic) eel or wormlike organisms. Many feed on root systems, which weakens the plant by reducing its uptake of water and minerals. Common symptoms are wilting, stunting and lack of vigorous growth under good growing conditions. Nematodes also may spread other diseases.

Not all nematodes feed on roots. Some foliar feeding nematodes attack chrysanthemums, producing triangles of brown, dried tissue on the leaves late in the season. Some nematodes are parasitic to insects.

Weeds

Any plant is considered a weed when it grows where it is not wanted. This is a broad definition, but consider the problems that weeds cause.

Weeds can harm man by:

- causing skin irritation (poison ivy),
- causing hay fever (ragweed), and
- harboring pests such as rodents, ticks and insects.

Weeds can harm desirable plants by:
- releasing toxins in the soil that inhibit plant growth;
- contaminating produce at harvest;
- competing for water, nutrients, light and space; and
- harboring pest insects, mites, vertebrates and pathogens.

Weeds can harm grazing animals by:
- poisoning, and
- causing an "off-flavor" in milk and meat.

Weeds may become pests in water by:
- hindering fish growth and reproduction;
- increasing mosquito reproduction;
- hindering boating, fishing and swimming; and
- clogging irrigation ditches, drainage ditches and channels.

Weeds are dangerous and undesirable on rights-of-way because:
- they block vision, road signs and crossroads; and
- increase road maintenance costs.

Plant Growth Stages

After a plant seed germinates, it goes through four growth stages:

- Seedling — very small, very vulnerable plantlets.
- Vegetative — rapid growth. Root stems and foliage are produced. Nutrients and water move rapidly through the plant.
- Seed production — Water and nutrient uptake are slow and directed to flower, fruit and seed production.
- Maturity — Movement of water and nutrients slows down; energy production is slow.

Duration of the Weed

- **Annuals**
- **Biennials**
- **Perennials**

Annuals

Plants that sprout, mature and produce seed in one year or less are called annuals. This group has many grasslike weeds (crabgrass) and broadleaved (pigweed) members. There are two types of annuals:

Summer annuals grow from seeds that sprout in the spring. They mature, produce seed and die before winter. Examples of weeds: foxtail, pigweed, lambsquarters and crabgrass.

Winter annuals grow from seeds that sprout in the fall. They mature, produce seed and die before the next summer. Examples of weeds: henbit, common chickweed and annual bluegrass.

Biennials

These plants have a two-year life cycle. In the first year, they sprout and develop a heavy root and a compact cluster of leaves (called a rosette). During the second year, they mature, produce seed and die. Examples of weeds: bull thistle and burdock.

Perennials

Plants that live more than two years are called perennial. Perennials may mature and reproduce in the first year, but they repeat the cycle for many years. Some perennials die back each winter. Others, such as trees, lose their leaves but do not die back. Most perennials grow from seed but many produce tubers, bulbs, rhizomes (below-ground root-like stems) or stolons (above-ground stems that grow roots).

Simple perennials usually reproduce with seeds. They also may reproduce when root pieces are cut by cultivation. The pieces then grow into new plants. Examples: trees, shrubs, plantain and dandelions.

Bulbous perennials may reproduce by seed bulblets or bulbs. An example is wild garlic, which produces seed, as well as above and below ground bulblets.

Creeping perennials produce seed, rhizomes or stolons. Examples: Johnsongrass, field bindweed and Bermudagrass.

Weed Identification

- **Arrangement of leaves**
- **Leaf structure**
- **Leaf shape**
- **Arrangement of flowers**
- **Flower parts**

Arrangement of leaves

- Alternate — one leaf found at each level on the stem.
- Opposite — two leaves opposite each other or paired.
- Whorled — three or more leaves at each level on the stem.

Leaf structure

- Simple — the leaf blade is a single piece and not divided into separate leaflets.
- Compound — the leaf blade is divided into several leaf-like parts called leaflets.

Leaf shape

- Ovate — egg-shaped, elliptical, broadest at the base.
- Lanceolate — lance-shape, are longer than ovate and usually pointed at the tip.
- Linear — long and narrow with parallel sides (grasses).

Arrangement of the flowers

- Inflorescence — in a definite cluster, usually at the top of the plant.
- Axillary — along the stem of the plant in the joints (leaf axils) with foliage and twigs.

Flower parts

- Petals — the expanded and usually colorful parts of the flower.
- Sepals — the greenish hull surrounding the flower when it is budding.

Major Classes of Weeds

- **Grasses**
- **Sedges**
- **Broadleaves**

Grasses

Grass leaves are narrow, stand upright and have parallel veins. Seedlings sprout with only one leaf. Grasses grow from a point (growing point) sheltered below the soil surface. That's why you can mow grass without killing it. Most grasses have fibrous root systems. There are both annual and perennial species.

Sedges

These are similar to grasses, but they have triangular stems and three rows of leaves. They sometimes are listed under grasses on pesticide labels. These plants are principal pests in fertile, well-drained soils. Yellow and purple nutsedge are perennial weeds that produce rhizomes and tubers.

Broadleaves

Seedlings of broadleaves have two leaves that emerge from the seed. The leaf veins are netlike. Broadleaves usually have a taproot and a relatively coarse root system. All broadleaf plants have exposed growing points at the end of each stem and in each leaf axil. Perennials also may have growing points elsewhere on the stem and on the roots. Broadleaf species may have annual, biennial or perennial life cycles.

Vertebrate Pests

Vertebrate animals all have a jointed backbone. Humans are vertebrates, as are mammals, birds, reptiles, amphibians and fish. Like insects, most vertebrate animals are not pests. They are an enjoyable part of our environment.

Situations can occur in which vertebrates are pests. Sometimes birds, rodents, raccoons and deer damage crops and ornamentals. Birds and rodents eat the same food as humans and often ruin more food than they eat. Mammal and bird predators of livestock and poultry cause financial losses to farmers and ranchers. Great flocks of roosting birds can soil buildings.

Some in the vertebrate group (particularly rodents) are a hazard to public health when they invade homes, restaurants, offices or warehouses. Rodents, other mammals and some birds carry serious diseases of humans and domestic animals, including rabies, plague and tularemia.

Study Questions

1. A pest is considered anything that . . .
   a. injures humans, animals, crops, structures or possessions.
   b. competes with humans, domestic animals or crops for food or water.
   c. spreads disease to humans, domestic animals or crops.
   d. All of the above.
2. _____ percent of all insects are considered pests.
3. Name the three main body parts of an insect.
   a. Head, thorax, abdomen
   b. Head, body, legs
   c. Head, abdomen, wings
4. Which of the following is an insect?
   a. Centipede
   b. Sowbug
   c. Mite
   d. None of the above
5. Diseases are caused by biological agents called _____.
6. Which of the following organisms are associated with plant disease?
   a. Bacteria and viruses
   b. Amoebas and algae
   c. Fungi and nematodes
   d. All of the above
   e. A and C
7. Some weeds can be pests by . . .
   a. causing hay fever in people.
   b. poisoning animals that eat them.
   c. hindering fish growth and reproduction.
   d. All of the above
8. Which of the following types of plants lives *more* than two years?
   a. Annual
   b. Perennial
   c. Biennial
9. What does the term vertebrate mean?
   a. Animals with wings.
   b. Animals with a jointed backbone.
   c. Animals that walk upright (vertically).
10. Which is an example of a vertebrate pest?
    a. Rodents
    b. Flies
    c. Arachnids

1. d
2. One
3. a
4. d
5. pathogens
6. e
7. d
8. b
9. b
10. a

Types of Pesticides

12

A pesticide is any chemical used to control pests. The pests may be insects, fungi, weeds, nematodes or slugs, for example. Therefore, insecticides, fungicides, herbicides and similar chemicals are all types of pesticides.

Some pesticides must only contact the pest to be deadly. Other chemicals must be eaten. The way each pesticide attacks a pest suggests the best way to apply it. For example, a pesticide may be more effective and less costly as a bait rather than a surface spray.

Texas Agricultural Extension Service

The Texas A&M University System

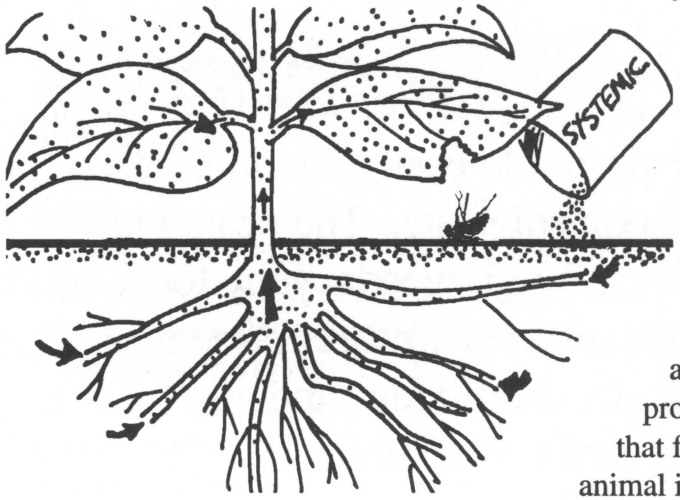
Learning Objectives

- Learn the different types of labeled pesticides.
- Be able to choose the type of pesticide to use for different pests.
- Understand how different pesticides attack pests.

Insecticides

- **Broad spectrum**
- **Narrow spectrum**
- **Short-term vs. residual**

Insecticides are chemicals that kill insects. People sometimes confuse "insecticide" with "pesticide." However, insecticide is only one of many types of pesticide.



Most insecticides work when the insect either touches or swallows the chemical. Some insecticides called *systemics* may be used on the plant or animal to be protected. An insect that feeds on this plant or animal ingests the systemic chemical and dies.

Broad spectrum

Some insecticides kill only a few kinds of insects. You can choose these insecticides when you wish to kill only one insect pest and not other beneficial insects. On the other hand, many insecticides are general purpose killers. These "broad spectrum" pesticides are used when several kinds of insects are a problem.

Narrow spectrum

Broad spectrum insecticides kill a wide variety of insects, usually by attacking a system common to all, such as the nervous system. Narrow spectrum insecticides are much more selective. For example, chitin inhibitors affect insects only at certain stages in the development of their exoskeleton. Growth regulators are even more specific. They affect only insects that have particular hormones.

Chitin synthesis inhibitors interfere with the growth and molting of immature insects. Chitin is the primary structural chemical in an insect's body wall. An immature insect treated with a chitin inhibitor dies the next time it tries to molt.

Insect growth regulators or IGRs mimic an insect's natural juvenile hormone. They interfere with certain normal processes and prevent immature insects from becoming reproductive adults. Growth regulators act slowly. Their effects include abnormal molting, twisted wings, loss of mating behavior and sometimes death to embryos in eggs. Because IGRs attack a growth process found only in insects, there is a great margin of safety for humans and other vertebrates.

Short-term vs. residual

Insecticides also vary in how long they last. Some break down quickly into nontoxic by-products. These short-term chemicals are best when the insects will not return and when long-term exposure could injure nontarget plants or animals. For example, short-term insecticides often are used in homes and dwellings where people and domestic animals might be exposed.

Other insecticides remain active killers for a long time. These *residual* pesticides are very useful for a persistant insect problem, if used where they will not become an environmental or health hazard. For example, residuals often are used for fly control in livestock buildings and for termite control in wooden structures.

Pheromones

Pheromones are natural chemicals produced by animals to signal each other. There are three basic types of pheromones. Aggregation pheromones attract many individuals together; for example, at a site where food is plentiful. Sex pheromones attract one sex of a species to the other sex. Trail pheromones are deposited by walking insects, such as ants, so others can follow. Synthetic pheromones mimic these natural chemicals. They are used to attract pests into traps, disrupt mating and monitor pest populations. Because they do not kill insects, pheromones are not true pesticides.

Miticides and Acaricides

Miticides or acaricides are chemicals that control mites (tiny spider-like animals) and ticks. The chemicals usually must contact the mites or ticks to work. These animals are so numerous and small that you must take great care to completely cover the area where they live. Miticides and insecticides are similar. Often the same pesticide kills both insects and mites. The terms "broad spectrum," "short-term" and "residual" also describe miticides.

Fungicides

- **Protectants**
- **Eradicants**

Fungicides control the fungi that cause molds, rots and plant diseases. All fungicides work on contact. Most are sprayed over a large surface area to hit every fungus directly. Some fungicides are systemic. You feed or inject them into the plant to be protected. The chemical then moves throughout the plant, killing the fungi.

Protectants

There are two basic types of fungicide. One prevents plant diseases and the other cures them. Fungicides used as *protectants* are similar in purpose to vaccinations for humans. You apply them *before* disease starts. This is very useful when a particular disease or group of diseases is likely to occur year after year. For example, protectants often are used as a routine precaution on fruit and vegetable crops.

Most protectant fungicides are fungistatic. This means they prevent or inhibit fungal growth. Once the fungistatic action stops, the target fungus may grow again or produce spores. You may have to apply fungicide regularly to maintain disease protection

Eradicants

Another type of fungicide kills disease *after* the plant is infected. These fungicides, called *eradicants,* are like penicillin and other antibiotics that cure human diseases. Eradicants are less common than protectants because fungus is hard to destroy after it infects a plant. Eradicants often are used when protectants are unavailable, too expensive or applied too late, or when a disease appears unexpectedly. For example, orchardists use eradicants to combat diseases such as pecan scab.

Herbicides

- **Types of herbicides**
- **Timing of application**

Herbicides are chemicals that kill unwanted plants. Many of these chemicals act by interfering with plant growth.

Types of Herbicides

Nonselective herbicides are toxic to all plants. Nonselective herbicides could be used for clearing under guardrails or for total control of weeds in industrial areas.

Selective herbicides kill some plants but cause little or no injury to other plants. Usually, selective types kill either broadleaf plants or grassy plants. Such herbicides are useful for lawns, golf courses or areas with desirable trees. Some very selective herbicides kill only certain plants in a group; for example, crabgrass killers on lawns.

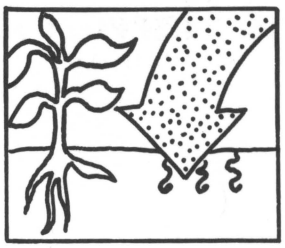
Timing of application

The timing of a herbicide application is important. The label directions tell you when to apply the herbicide for best results. *Preplanting* treatments are made before a crop is planted. These chemicals may be used in seed beds or mixed into the soil before planting.

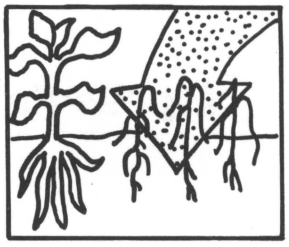
Any treatment made before a plant sprouts is called *preemergence*. Application may be timed before the crop emerges, before weeds emerge or before either emerge. The label directions will state "preemergence to the crop," "preemergence to the weeds," or "preemergence to both crop and weeds."

Herbicide treatments made after the crop or weeds appear are called *postemergence*. Postemergence applications must be very selective. They must control weeds but leave crops unharmed. Often, herbicides are applied postemergent to the crop but preemergent to weeds.

Preemergence



Postemergence



Other Pesticides

- **Rodenticides**
- **Avicides**
- **Nematicides**
- **Molluscicides**

Rodenticides

Rodenticides kill rats, mice and other rodents. Most rodenticides are stomach poisons prepared as baits. However, some products act on contact. Do not apply rodenticides over a large area where they pose a hazard to nontarget animals. Apply only in limited areas such as runways and known feeding places.

Avicides

Avicides are chemicals used to control pest species of birds. Some avicide baits cause birds to have distress reactions that frighten the rest of the flock away. Other avicides cause death, narcosis or sterility.

Nematicides

Nematicides are chemicals that kill nematodes. Nematodes are tiny hair-like worms, most of which live in the soil and feed on plant roots. Soil fumigants can control nematodes in the soil. However, a few contact insecticides and fungicides also work well against these tiny worms.

Molluscicides

Molluscicides control snails and slugs. Usually the chemicals must be eaten by the pest to work. Baits often are used to attract and kill snails or slugs in a target area.

Growth Regulators and Harvest Aids

A *plant growth regulator* (or plant regulator) changes the normal growth or reproduction of a plant. Growth regulators do not include fertilizers and other nutrients. Some growth regulators are used to move up or back the normal harvest date of a crop. Others improve crop quality and yield. Electric power utilities sometimes use growth regulators to slow tree growth near power lines.

Defoliants and desiccants generally are referred to as *harvest aids*. A *defoliant* causes the leaves of a plant to drop off early, but does not kill the plant. A *desiccant* kills the plant by drawing moisture from it.

Repellents

A repellent is a pesticide that makes a site or food unattractive to a target pest. Repellents are registered like other pesticides and must be used according to their label. Insect repellents come as aerosols and lotions and can be applied to skin, clothing or plants, usually to repel biting insects. Vertebrate repellents are sold as concentrates to mix with water, powders and granules. They can be sprayed or painted on nursery crops, ornamental plants, orchards, vineyards, vegetables and seeds.

If pesticide is needed, be sure to know which type to use, as well as how and when to apply it effectively.

Study Questions

1. A _____ is any chemical used to control pests.
2. Insecticide is just another word for pesticide.
   True False
3. How does a systemic insecticide act on the pest?
   a. A systemic flows inside a treated plant and kills the pest when the pest eats the plant.
   b. A systemic enters the pest and attacks only a particular body system, such as the pest's nervous system.
   c. A systemic kills insect pests on contact.
4. The effect on beneficial insects is a primary concern when choosing a broad spectrum insecticide.
   True False

1. pesticide
2. false
3. a
4. true

5. Short-term insecticides offer safety advantages in homes while residual insecticides are useful when the insects are a constant problem.
   True False
6. Miticides are very similar in action and application to_____.
   a. Fungicides
   b. Herbicides
   c. Insecticides
7. Of the two types of fungicides, _____ prevent plant diseases and _____ cure plant diseases.
8. Eradicants often are used . . .
   a. when protectants are too expensive or not available.
   b. when protectants have not been applied on time.
   c. when a disease breaks out unexpectedly.
   d. All of the above.
9. Would you choose a selective or nonselective herbicide for weed control in a park?
   a. Selective
   b. Nonselective
10. With herbicide applications, preplant means before the crop is planted. _____ means before the weeds appear and_____means after both the crop and weed appear.
11. What kind of chemicals are used to alter or change the crop itself?
    a. Synthetic hormones
    b. Growth regulators
    c. Organocides
12. Nematodes are . . .
    a. fungal growths on roots.
    b. tiny hair-like worms.
    c. small frogs that secrete a toxic chemical.
13. A _____ inhibitor kills immature insects by interfering with their growth and molting.
14. Insect growth regulators attack a growth process found only in insects so these chemicals are generally harmless to humans and other vertebrates.
    True False
15. Although repellants should be used according to their label, they are not registered like other pesticides with the EPA.
    True False

5. true
6. c
7. protectants, eradicants
8. d
9. a
10. preemergence, postemergence
11. b
12. b
13. chitin
14. true
15. false

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The Label

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The pesticide label is very important. It tells you how to use the pesticide safely and correctly.

Information on the label comes from years of careful tests and studies. When properly followed, label directions protect you, other people and the environment.

Each time you plan to use a pesticide, read the label completely. Don't rely on your memory.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Explain the terms "label" and "labeling."
- Define the term "Restricted Use" and know where to look for it on pesticide labeling.
- Know the difference between the terms "common name," "chemical name" and "brand name."
- Understand the signal words and symbols on pesticide labeling.
- Understand the hazard precaution statements on pesticide labeling.
- Understand the statement, "It is a violation of federal law to use this product in a manner inconsistent with its labeling."
- Explain your responsibilities for finding and following all instructions and rules on the use of pesticides.

Labeling

Labeling is all information the manufacturer provides about a product, including: the label on the product container and package, brochures, leaflets and any separate information available from your pesticide dealer or a recognized authority. It is your responsibility to comply with all available information.

The Label

The label is information printed on or provided with a pesticide container. The label serves many purposes:

- To the state and federal government, the label is a way to control distribution, storage, sale, use and disposal of pesticides.
- To the buyer or user, the label is a source of facts on how to use pesticides correctly, safely and legally.
- To physicians, the label is a source of information on proper treatment for poisoning cases.

Labels are NOT all the same. Remember to read the label of each product, each time you plan to use it.

The Law

The law requires you to use a pesticide according to label instructions. This is pointed out on the label with a statement that reads, "It is a violation of federal law to use this product in a manner inconsistent with its labeling." It is also illegal for anyone to recommend that you use a pesticide improperly.

Each statement on the label meets government rules. The label itself, not just the pesticide, must be registered by the U.S. Environmental Protection Agency (EPA). The EPA registers pesticides only after they pass strict government tests. These tests confirm that a pesticide used according to its label is safe for people and the environment.

Information on the label generally pertains to either product identification or proper product use. From this information, you can learn important facts about:

Facts to Learn from the Label

- Chemical hazards
- Registered uses
- Recommended rates
- Compatibility
- Phytotoxicity

Chemical hazards

The label tells you which chemicals are in the container. The contents are listed in a standard form so you know exactly what you are working with. Signal words — DANGER, WARNING or CAUTION — are used on most labels to let you know how hazardous the contents are. The label also lists the personal gear you need to protect yourself from poisoning.

Registered uses

The label lists uses that are EPA-approved. If your intended use is not on the label, do not use the product until you check for additional labeling and references. You are legally responsible for any accident or crop loss caused by an unapproved use. Generally, any nonlabeled use is illegal.

Recommended rates

Recommended rates and application directions also appear on every label. These are helpful because they state the maximum rate allowed by law. However, local conditions may not require maximum rates to achieve good pest control. Use no more pesticide than needed.

Compatibility

The label usually states if you may mix other chemicals with the pesticide. Often, fertilizers and pesticides can be combined for one application. However, such mixing destroys the effectiveness of some products. Check compatibility before you mix. If there is doubt, don't mix.

Phytotoxicity

The label also tells if the pesticide is phytotoxic (poisonous to plants). Some plants are more sensitive than others to pesticides. Injury can range from slight burning or complete loss of leaves to death of the plant. To be safe, treat only plants listed on the label.

Parts of the Label: Product Identity

- **Brand name**
- **Classification**
- **Net contents and ingredient statement**
- **Type of pesticide and formulation**
- **Registration and establishment numbers**

This section describes parts of the label that pertain to product identity.

Brand name

Manufacturers usually give unique brand names to their products. That's why products with the same active ingredient have different names. The brand or trade name shows up plainly on front of the label. It also is the name used by company salespeople and in advertisements.

Avoid choosing a pesticide by brand name alone. Many companies use one name with only minor changes for several different chemicals. For example:

Tersan LSR	= zinc and maneb
Tersan SP	= chloroneb
Tersan 1991	= benomyl
Tersan	= thiram

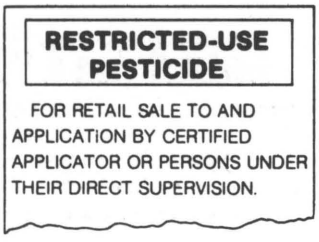
Always read the ingredient statement to learn what chemicals a product contains.

Classification

The EPA classifies every use of every pesticide as either "general" or "restricted." Only a certified applicator may use or supervise the use of restricted products. The label of restricted products must clearly show a statement such as:

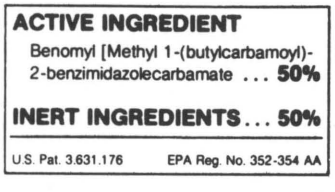
"RESTRICTED USE PESTICIDE. For retail sale and use only by certified applicators or persons under their direct supervision and only for those uses covered by the certified applicator's certification."

Each state government has authority to restrict a product. However, state restrictions do not appear on product labels. Contact the Texas Department of Agriculture for a list of "state-limited use" products.



Net contents and ingredient statement

The front of the label tells you the net contents — that is, *how much* product is in the container. Each label also must list *what* is in the product. The list shows active and inert ingredients and the amount of each. *Active ingredients* are the chemicals that control the target pest. They must be identified by their chemical name or official common name. Most products also have *inert (inactive) ingredients*. These are used to dilute the pesticide or to make it more effective. Inert ingredients need not be named on the label.



A *chemical name* is the complex name that identifies a pesticide's chemical makeup. For example, the chemical name of the active ingredient in Sevin 50% WP is 1-naphthyl N-methylcarbamate. The ingredient statement almost always lists chemical names.

Many chemical names are called by a shorter *common name.* Common names may be used in the ingredient statement only if they are accepted by the EPA. The ingredient statement usually lists a common name followed by the chemical name. A label with the trade name Sevin 50% WP would read:

Active ingredient:
carbaryl (1-naphthyl N-methylcarbamate). 50%
Inert ingredients 50%

Type of pesticide and formulation

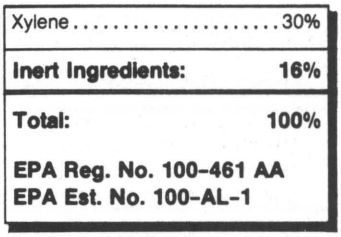
The type of pesticide usually is listed on front of the label. This short statement tells what kind of pests the product controls. Examples:

- Insecticide for control of certain insects on fruits, nuts and ornamentals
- Soil fungicide
- Herbicide for the control of trees, brush and weeds
- Algicide

A single pesticide often is sold in different *formulations* or mixtures, such as liquid, aerosol or granular. The label may name the formulation, or may show only an abbreviation, such as WP for wettable powder and D for dust.

Registration and establishment numbers

You need these numbers in case of accidental poisoning, claims of misuse, or faulty product or liability claims.



An EPA *registration number* appears on all pesticide labels. Most products contain only two sets of numbers — for example, EPA REG. no. 3120-280. The first set of digits, 3120, identifies the manufacturer. The second set, 280, identifies the product. Additional letters and numbers may be required by some states or used by the distributor.

In some cases, a state may approve pesticide for a *special local need* (SLN). These registrations are listed, for example, as EPA SLN No. TX-770009. TX stands for Texas, where the product is registered. SLN numbers may appear on labeling separate from the package.

The *establishment number* (for example, EPA Est. No. 5840-AZ-1) appears on either the label or container. This number identifies the facility that produced the product.

The law also requires the name and address of the manufacturer on the label. The maker or distributor of a product must list its full company name and address.

Parts of the Label: Product Use

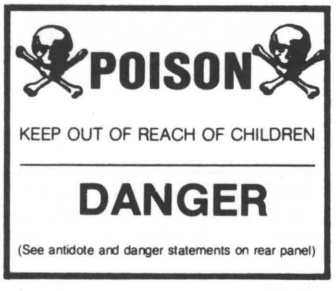
The remaining parts of the label will be reviewed in more detail. They pertain to proper product use rather than product identification. These important parts include:

- Signal words and symbols
- Precautionary statements, such as the reentry statement
- Storage and disposal instructions
- Directions for use

Signal Words and Symbols

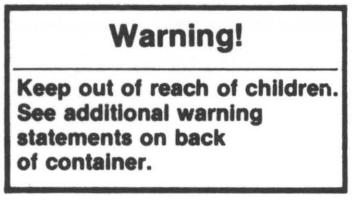
Every label has a *signal word* required by the EPA— "DANGER," "WARNING" or "CAUTION." This word gives you a signal of how dangerous the product is to humans. This knowledge helps you choose proper precautions for yourself, your workers and other people (and animals) who may be exposed. The signal word does not tell the risk of delayed effects or allergic effects.

The signal word appears in large letters on front of the label — usually next to the statement, "Keep Out of Reach of Children," which is required on every product.



DANGER. This word signals you that the pesticide is highly toxic, or could cause severe eye or skin burning. Highly toxic pesticides also carry the skull and crossbones symbol and the word POISON printed in red. Very small amounts, even just a drop, could kill an average-sized adult. Exposure through skin contact, breathing or swallowing could cause acute illness.

A pesticide that can badly damage the skin or eyes may have the signal word DANGER without the word POISON.



WARNING. Any product that is moderately toxic or causes moderate eye and skin irritation is labeled WARNING. A teaspoonful to a tablespoonful taken by mouth could kill an average-sized adult.

CAUTION. Any product that is slightly toxic or causes slight eye and skin irritation is labeled CAUTION. An ounce to more than a pint taken by mouth could kill the average-sized adult.

Precautionary Statements

- **Route of entry**
- **Specific actions**
- **Protective clothing and equipment**
- **Other precautions**
- **First aid or statement of practical treatment**
- **Hazards to wildlife and the environment**
- **General environmental statements**
- **Physical or chemical hazards**
- **Reentry statement**

All pesticide labels contain additional statements to help you take proper precautions to protect yourself and other people, animals and the environment. Part or all of the label may be written in another language; the same label requirements apply regardless of the language.

NOTE: Precautionary statements are not located in the same place on all pesticide labels. The statements also may have different headings, such as "Hazards," "Note," "Important" or "General Instructions." *Search the label for statements to help you apply the pesticide safely and wisely.*

Route of entry

This notice follows the signal word and tells which route of entry (mouth, skin, eyes, lungs) needs special protection. Many pesticides are hazardous in more than one way so study these statements carefully. "Danger" followed by "may be fatal if swallowed or inhaled" gives you a far different warning than "Danger: Corrosive — causes eye damage and severe skin burns."

Typical DANGER statements include:
- Fatal if swallowed.
- Poisonous if inhaled.
- Extremely hazardous by skin contact — rapidly absorbed through skin.
- Corrosive — causes eye damage and severe skin burns.

You may find many variations of these statements. More than one or all of them may be stated on the same label.

Specific actions

In addition to route of entry, the label may list specific actions needed to prevent poisoning accidents. These statements relate to the route(s) of entry that must be protected.

DANGER labels typically contain statements such as:
- Do not breathe vapors or spray mist.
- Do not get on skin or clothing.
- Do not get in eyes.

You would not deliberately swallow pesticide, so a "Do not swallow" statement is omitted. Specific action statements help you plan what precautions to take and what protective clothing and equipment to use.

Protective clothing and equipment

Some labels fully describe the protective equipment you need, including the kind of respirator to wear. Other labels require the use of a respirator but do not specify type or model. Many labels carry no statement at all.

You should follow all label instructions on protective clothing or equipment. However, a lack of instruction does not mean you need no protection. Likewise, the mention of only one piece of equipment does not rule out the need for additional protection.

Sensible selection of protective equipment depends on a thorough understanding of the pesticide, the job, the weather, the handler and how these factors interact. For example, a WARNING label might state: "Causes skin and eye irritation. Do not get in eyes, on skin or on clothing. Wear goggles while handling." Even though the label does not say so, consider wearing coveralls over regular work clothes, and chemical-resistant gloves and footwear for added protection. Wear a chemical- resistant suit and hat for prolonged contact and for overhead spray applications.

Safe pesticide use depends on risk awareness, proper protective equipment, skill at handling equipment and pesticides, plus careful personal hygiene and regular medical care.

Other precautions

Labels often list other precautions to take while handling the product. Always take the following actions, whether or not they are stated on the label:

- Do not contaminate food or feed.
- Remove and wash contaminated clothing before reuse.
- Wash thoroughly after handling and before eating or smoking.
- Wash clothes daily.
- Not for use or storage in and around a house.
- Do not allow children or domestic animals into the treated area.

First aid or statement of practical treatment

FIRST AID

These statements tell you what first aid to give in case of pesticide poisoning. Typical statements may include:

- In case of contact with skin, wash immediately with plenty of soap and water.
- In case of contact with eyes, flush with water for 15 minutes and get immediate medical attention.
- In case of inhalation, move from contaminated area and give artificial respiration if necessary.
- If swallowed, drink large quantities of milk, egg white or water — do not induce vomiting.

All DANGER labels have a section of First Aid Treatment, Poison Signs or Symptoms, Note to Physicians (or Antidote), and an Emergency Assistance Call telephone number. WARNING and CAUTION labels may have only an Emergency Assistance Call telephone number. Individuals with poisoning symptoms should seek medical attention. They also should take the pesticide label with them. This is very important.

Hazards to wildlife and the environment

Improperly applied pesticides may be harmful to the environment. Some products are classified RESTRICTED USE because of environmental hazards alone. Label statements may include groundwater advisories, for example, or limitations that protect endangered species. Such limitations include restrictions on application rates or methods, or a ban on using the pesticide where endangered plants and animals live. The label also may tell where to find more information. In some cases, you will need more information before you can make a legal application.

If a pesticide is hazardous to specific plants or animals, it will be noted in a special toxicity statement on the label. For example:

- This product is highly toxic to bees.
- This product is toxic to fish.
- This product is toxic to birds and other wildlife.

These statements help you choose the safest product for a job and remind you to take extra precautions.

General environmental statements

These statements appear on nearly every pesticide label. They are reminders of common sense steps to avoid contaminating the environment. The absence of any of these statements DOES NOT mean you can do without precautions.

Examples of general environmental statements include:

- Do not apply where runoff is likely to occur.
- Do not apply where weather conditions favor drift from treated areas.
- Do not contaminate water when cleaning equipment or disposing of wastes.
- Keep out of any body of water.
- Do not allow drift on desirable plants or trees.
- Do not apply when bees are likely to be in the area.
- Do not apply where the water table is close to the surface.

Physical or chemical hazards

This section of the label tells you of any fire, explosion or chemical hazards. For example:

- Flammable — Do not use, pour, spill or store near heat or an open flame. Do not cut or weld container.
- Corrosive — Store only in a corrosion-resistant tank.

Reentry statement

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

REENTRY STATEMENT

Do not enter area within five days after application.

Some pesticide labels contain a reentry precaution. This tells you how much time must past before people can reenter a treated area without protective clothing. These time limits are set by EPA and some states. Time limits set by states are not always listed on the label. It is your job to find out if a time limit exists. It is illegal and dangerous to ignore reentry intervals. Poisoning is a risk to unprotected persons who enter a treated field before the reentry interval expires.

Storage and Disposal

All labels give general instructions for proper storage and disposal of the pesticide and its container. Typical statements include:

- Not for use or storage in or around the home.
- Store away from fertilizers, insecticides, fungicides and seeds.
- Store at room temperatures above 32°F (0°C).
- Do not reuse container.
- Do not contaminate water, food or feed by storage and disposal.
- Open dumping is prohibited.
- Triple-rinse and offer this container for recycling or reconditioning, or dispose of in an EPA approved landfill.
- Use excess or dispose of in an EPA approved landfill.
- Do not reuse bag.

Try to determine the best storage and disposal procedures for your operation and location. For more information on proper pesticide disposal and storage, contact the Texas Water Commission.

Directions for Use

To apply a pesticide correctly, follow the directions on the label. These instructions tell you:

- pests that the manufacturer says the product will control;
- the crop, animal or site to which the product may be applied;
- in what form you may apply the product;
- the proper equipment to use;
- how much to use;
- mixing directions;
- compatibility with other often-used products;

- phytotoxicity and other possible injury or stress problems;
- where you may apply the material; and
- when to apply it.

Agricultural pesticide labels often list the number of days that must pass between the last pesticide application and crop harvest, or livestock slaughter or grazing. These are times set by EPA, based on research, to allow the pesticide to break down in the environment. This prevents illegal residues on food, feed or animal products. It also prevents possible poisoning of grazing animals. This information may appear as a chart or a list just after the application directions.

Federal law *does* allow some uses that are not mentioned in the labeling. Unless you would be violating state law, you may:

- apply a pesticide at any dosage or frequency *less* than that listed on the labeling;
- use a pesticide against any pest, if the application is to a plant, animal or site that is listed on the label;
- use any appropriate equipment or application method that is not prohibited by the labeling;
- mix pesticides with a fertilizer if the mixture is not prohibited by the labeling; and
- mix two or more pesticides, if all the dosages are at or below the rates recommended on the label.

Directions by Reference

Some directions are too long to print on the pesticide label. In the future there may be directions for use (which you must obey) that are referred to on the label, but not included with the product when it is sold. For example, a label may have this statement:

> "You must use this product in a manner consistent with its labeling and with EPA Worker Protection Standards for Agricultural Pesticides, Part 170 of Title 40, Code of Federal Regulations."

This means you are responsible for finding out if the regulation applies to your situation and intended use of that pesticide. If the regulation does apply, you are responsible for complying with it as well as the label and labeling directions. Regulations that may require additional directions are:

- Agricultural worker protection
- Ground and surface water protection
- Endangered species protection
- Pesticide transportation, storage and disposal

EPA's decision to refer to these directions places great responsibility on the pesticide applicator. A paragraph or a sentence on the label may be the only notice you receive that more directions exist for proper and legal application of a product. You must read the label carefully and recognize statements referring to additional directions. Then you must:

- locate and read additional directions;
- determine if they affect the planned use;
- decide how to comply; and
- comply with the additional directions.

Read the Label

Before you buy a pesticide, read the label to determine:

- Is it the pesticide you need for the job?
- Can you safely use the pesticide under the application conditions?
- Where can you use the pesticide? (livestock, crops, structures, etc.)
- Are there any restrictions on use of the pesticide?
- How much product do you need?

Before you mix the pesticide, read the label to determine:

- What protective equipment should you use?
- With what can the pesticide be mixed?
- How much pesticide should you use?
- What is the mixing procedure?

Before you apply the pesticide, read the label to determine:

- What safety measures should you follow?
- When may you apply the pesticide? (including the waiting period for crops and animals)
- How should you apply the pesticide?

Before you store or dispose of pesticide or its container, read the label to determine:

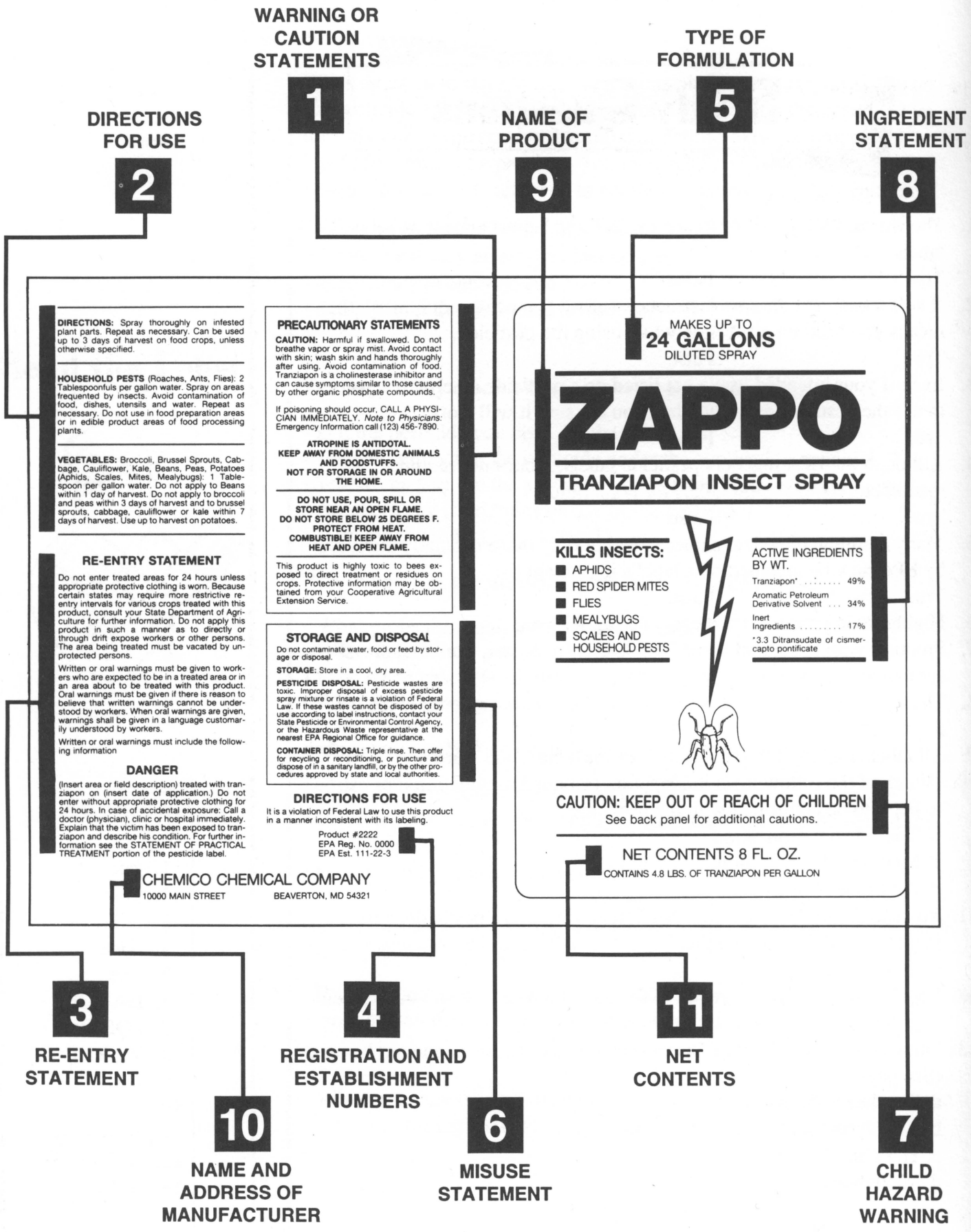
- Where and how do you store the pesticide?
- How do you decontaminate and dispose of the pesticide container?

When you have questions concerning pesticide use, always consult your county extension agent or another recognized expert.

Study Questions

1. The words, "Keep Out of Reach of Children," must appear on all pesticide labels.
   True False
2. If a pesticide label has no instructions about protective equipment, that means you need no protection while using the pesticide.
   True False
3. Even if your intended use is not listed on a pesticide label, it is legal to use the pesticide anyway when you are sure it will work.
   True False
4. Although the EPA registers pesticide labels, it does not require manufacturers to submit labels for registration.
   True False
5. Many common chemical names exist but only those officially accepted by EPA may be included on a label's ingredient list.
   True False
6. Highly toxic products must carry the signal word _____.
7. Products with the signal word DANGER also have a skull and crossbones symbol and the word _____.
8. The signal word _____ is required on labels for moderately toxic products.
9. All labels for slightly toxic pesticides must carry the word _____.
10. Which of the following is information provided in directions for use?
    a. Pests to be controlled with the pesticide
    b. The rate for application
    c. Methods of application
    d. All of the above
11. You should always read the label before you _____ pesticide, before you mix pesticide, before you _____ pesticide and before you store or dispose of pesticide.
12. Legal disposal steps are required for both the pesticide and the pesticide _____.
13. On which of the following insects can the insecticide Zappo *not* be used? (See page 14.)
    a. Roaches and ants
    b. Aphids and scales
    c. Ticks and fleas
    d. Mealybugs and mites

1. true
2. false
3. false
4. false
5. true
6. DANGER
7. POISON
8. WARNING
9. CAUTION
10. d
11. buy, apply
12. container
13. c


WARNING OR CAUTION STATEMENTS
1
TYPE OF FORMULATION
5
DIRECTIONS FOR USE
2
NAME OF PRODUCT
9
INGREDIENT STATEMENT
8
DIRECTIONS: Spray thoroughly on infested plant parts. Repeat as necessary. Can be used up to 3 days of harvest on food crops, unless otherwise specified.
HOUSEHOLD PESTS (Roaches, Ants, Flies): 2 Tablespoonfuls per gallon water. Spray on areas frequented by insects. Avoid contamination of food, dishes, utensils and water. Repeat as necessary. Do not use in food preparation areas or in edible product areas of food processing plants.
VEGETABLES: Broccoli, Brussel Sprouts, Cabbage, Cauliflower, Kale, Beans, Peas, Potatoes (Aphids, Scales, Mites, Mealybugs): 1 Tablespoon per gallon water. Do not apply to Beans within 1 day of harvest. Do not apply to broccoli and peas within 3 days of harvest and to brussel sprouts, cabbage, cauliflower or kale within 7 days of harvest. Use up to harvest on potatoes.
RE-ENTRY STATEMENT
Do not enter treated areas for 24 hours unless appropriate protective clothing is worn. Because certain states may require more restrictive re-entry intervals for various crops treated with this product, consult your State Department of Agriculture for further information. Do not apply this product in such a manner as to directly or through drift expose workers or other persons. The area being treated must be vacated by unprotected persons.
Written or oral warnings must be given to workers who are expected to be in a treated area or in an area about to be treated with this product. Oral warnings must be given if there is reason to believe that written warnings cannot be understood by workers. When oral warnings are given, warnings shall be given in a language customarily understood by workers.
Written or oral warnings must include the following information
DANGER
(Insert area or field description) treated with tranziapon on (insert date of application.) Do not enter without appropriate protective clothing for 24 hours. In case of accidental exposure: Call a doctor (physician), clinic or hospital immediately. Explain that the victim has been exposed to tranziapon and describe his condition. For further information see the STATEMENT OF PRACTICAL TREATMENT portion of the pesticide label.
PRECAUTIONARY STATEMENTS
CAUTION: Harmful if swallowed. Do not breathe vapor or spray mist. Avoid contact with skin; wash skin and hands thoroughly after using. Avoid contamination of food. Tranziapon is a cholinesterase inhibitor and can cause symptoms similar to those caused by other organic phosphate compounds.
If poisoning should occur, CALL A PHYSICIAN IMMEDIATELY. Note to Physicians: Emergency Information call (123) 456-7890.
ATROPINE IS ANTIDOTAL.
KEEP AWAY FROM DOMESTIC ANIMALS AND FOODSTUFFS.
NOT FOR STORAGE IN OR AROUND THE HOME.
DO NOT USE, POUR, SPILL OR STORE NEAR AN OPEN FLAME.
DO NOT STORE BELOW 25 DEGREES F.
PROTECT FROM HEAT.
COMBUSTIBLE! KEEP AWAY FROM HEAT AND OPEN FLAME.
This product is highly toxic to bees exposed to direct treatment or residues on crops. Protective information may be obtained from your Cooperative Agricultural Extension Service.
STORAGE AND DISPOSAL
Do not contaminate water, food or feed by storage or disposal.
STORAGE: Store in a cool, dry area.
PESTICIDE DISPOSAL: Pesticide wastes are toxic. Improper disposal of excess pesticide spray mixture or rinsate is a violation of Federal Law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.
CONTAINER DISPOSAL: Triple rinse. Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by the other procedures approved by state and local authorities.
DIRECTIONS FOR USE
It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.
Product #2222
EPA Reg. No. 0000
EPA Est. 111-22-3
CHEMICO CHEMICAL COMPANY
10000 MAIN STREET BEAVERTON, MD 54321
MAKES UP TO
24 GALLONS
DILUTED SPRAY
ZAPPO
TRANZIAPON INSECT SPRAY
KILLS INSECTS:
APHIDS
RED SPIDER MITES
FLIES
MEALYBUGS
SCALES AND HOUSEHOLD PESTS
ACTIVE INGREDIENTS BY WT.
Tranziapon* 49%
Aromatic Petroleum Derivative Solvent 34%
Inert Ingredients 17%
*3.3 Ditransudate of cismercapto pontificate
CAUTION: KEEP OUT OF REACH OF CHILDREN
See back panel for additional cautions.
NET CONTENTS 8 FL. OZ.
CONTAINS 4.8 LBS. OF TRANZIAPON PER GALLON
3
RE-ENTRY STATEMENT
4
REGISTRATION AND ESTABLISHMENT NUMBERS
11
NET CONTENTS
10
NAME AND ADDRESS OF MANUFACTURER
6
MISUSE STATEMENT
7
CHILD HAZARD WARNING

14. The directions for use on Zappo state that the insecticide may be sprayed on broccoli and peas up to _____ days of harvest.
15. On which of the following vegetables can Zappo not be used?
    a. Broccoli and Brussels sprouts
    b. Carrots and radishes
    c. Cabbage and cauliflower
    d. Beans and peas
16. Unless you wear the proper protective clothing, you must wait _____ hours before you reenter a site treated with Zappo.
17. What is the EPA registration number for Zappo?

14. three
15. b
16. 24
17. 0000

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Formulations 14

A pesticide chemical rarely can be used as originally manufactured. It must be diluted with water, oil, air or chemically inactive (inert) solids so it can be spread evenly by application equipment. Usually the manufacturer combines the pesticide with solvents, wetting agents, stickers, powders, granules or other materials. The final product is called a pesticide formulation. It is ready for use as packaged or diluted with water or other carriers.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Learn the definitions and abbreviations for types of formulations.
- Learn how to choose the best formulation and when to use it.
- Understand the dangers of formulations and how to protect yourself.

Types of Formulations

A single pesticide often is sold in several different formulations. Choose the formulation that best meets your needs for a particular job. Consider these factors: effectiveness against the pest; habits of the pest; the plant, animal or surface to be protected; application equipment; and danger of drift and runoff.

Abbreviations often are used on labels (along with the pesticide name) to describe the type of formulation. Common abbreviations are: WP for wettable powder; F for flowable; G for granules or granular; D for dusts; L for liquid; SP for soluble powder; E or EC for emulsifiable concentrate; SC for spray concentrate; and RTU for ready-to-use products.

Aerosols (A)

An aerosol is a pesticide formulation that can be dispensed as a fog or spray of very fine, airborne droplets. Aerosol dispensers range from small pressurized cans to large truck-mounted equipment.

Advantages: Aerosol droplets are so fine they float and do not stick to surfaces. Aerosols work well against flying insects inside homes and other buildings. Outside, aerosols work well in populated areas against blackflies and mosquitoes. The aerosol penetrates tiny cracks, crevices and heavy vegetation. Canned aerosols are a convenient way to buy small quantities of pesticide. The pesticide does not lose strength in the can during a normal period of use.

Disadvantages: Since very little of the aerosol sticks, there is little residual pest control. As soon as the aerosol floats away, pests can move back in. Drifting fog may cause unwanted contamination. Treated buildings and enclosed areas must be ventilated before anyone reenters. If left within reach, canned aerosols are a hazard to small children. The cans also are dangerous — if punctured or overheated they may explode and injure someone. Don't ever try to burn aerosol cans.

Principal uses: Aerosols are used most often in households, backyards, tents and other small areas. They may be used as sprays for flying insects or as residual sprays. Usually they are used against insects, but some aerosols control plant diseases and weeds. Larger scale uses include treatment of barns, greenhouses and some outdoor pest habitats.

Dusts (D)

A prepared dust is a finely ground, dry mixture that combines a low to medium concentration of pesticide with an inert carrier such as talc, clay or volcanic ash. The dust particles vary widely in size.

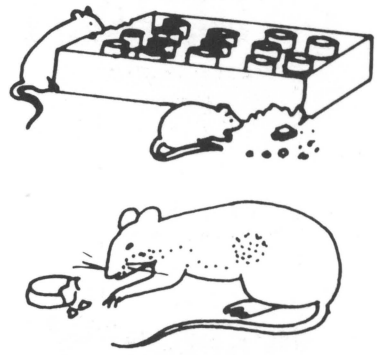
Advantages: Dusts are ready to use as purchased and require no mixing. They can be applied with simple lightweight equipment even in commercial use.

Disadvantages: Dusts may drift long distances and contaminate off-target areas. Drifting dusts are highly visible and may cause public concern. The particles are dislodged easily from outdoor surfaces by wind and rain, and soon become inactive. Never apply dust formulations on a windy day.

Principal uses: Because of drift, dusts are not recommended for large-scale outside use. Outside, use them mainly for spot treatments and home gardens. Dusts work best when applied to dewy surfaces in the early morning. Inside, dusts are used in cracks and crevices for cockroaches and other insect pests. Dusts also control lice, fleas and other external parasites on pets and livestock.

Poisonous Baits

A poisonous bait is a pesticide mixed with food or other substance that will attract and be eaten by pests. Baits often are made into granules, pellets, paste or liquid, and may be provided in ready-to-use dispensers.



Advantages: Baits help control pests such as flies and rats that range over a large area. Often the whole area need not be covered, just those spots where pests gather. Baits may be placed carefully so they do not contaminate food or feed, and can be removed after use. Usually only small amounts of pesticide are used, considering the total area treated, so potential pollution is minimized.

Disadvantages: Baits may be harmful to children, pets, domestic animals and wildlife. Pests may still eat the crop or food you are trying to protect rather than the bait. When rodents or other large pests are killed, the bodies must be disposed of. If not, they may cause an odor and sanitation problem. Other animals that feed on poisoned pests also can be poisoned.

Principal uses: Baits are used in buildings for pests such as ants, roaches, flies, rats and mice. Outside, baits are used in gardens to control slugs, in dumps and similar areas to control rats, and in fields to control slugs and insects such as grasshoppers.

Granules (G)

Like dusts, pesticide granules are dry, ready-to-use low concentrate mixtures of pesticide and inert carriers. Particles in a granular formulation are about the same size. They also are larger than dust particles. A fine granular pesticide pours like ordinary salt or sugar.

Advantages: Ready to use as purchased, with no further mixing. Because the particles are large, relatively heavy and about the same size, granules drift less than most other formulations. There is less risk to the operator of inhaling toxic material. Granules can be applied with simple, multipurpose equipment such as seeders or fertilizer spreaders. Granules also can drop through dense foliage to a target underneath.

Disadvantages: With a few exceptions, granules are not suitable for treating foliage because they do not stick to leaves. Granules may harm wildlife, especially birds.

Principal uses: Granular pesticides often are used on soil — either to control ground pests or to treat plants systemically through their roots. When used on turf, granular herbicides and insecticides often are mixed with fertilizers to save labor. Granular formulations may be chosen for aerial applications when drift is a problem, and for treating mosquitoes where there is heavy foliage over water.

Ready-to-Use (RTU)

These preparations are usually solutions of highly refined oils with low concentrations of pesticide. They generally are used as purchased.

Advantages: Low concentrate solutions should be sprayed as purchased. No mixing is necessary, which lessens the chance of accidents. Most household formulations have no unpleasant odors. Usually the liquid carrier evaporates quickly and does not stain fabrics, furniture, etc.

Disadvantages: Low concentrate formulations are fairly expensive for the amount of actual pesticide bought. The uses for such materials are few and specialized.

Principal uses: Low concentrate solutions may be used in households for flying or crawling insects and for mothproofing clothes. In barns, these solutions are used as a space spray and fly spray for livestock. They also are used as prepared spray for mosquito control and shade tree insect control.

Emulsifiable Concentrates (EC)

These preparations are usually solutions containing a high concentration of pesticide. One gallon may contain as much as 8 pounds or more of pesticide. Most solutions contain wetting agents, stickers and other additives and should be mixed with water or oil.

Advantages: Because these formulations contain more pesticide, the price per pound of active ingredient is lower. Only moderate agitation in the tank is required, so they are very suitable for low-pressure, low-volume weed sprayers, mist blowers and small ground sprayers. Emulsifiable concentrates are not abrasive and do not settle out when the sprayer is off. There is little visible residue, which generally allows their use in populated areas. The high pesticide content prevents having to store, transport or handle a large bulk of chemical for one job.

Disadvantages: It is easy to underdose or overdose because of the high pesticide concentration, if sprayers are not carefully calibrated. Mixtures of emulsifiable concentrates may by phytotoxic. Also, because the liquid form can be absorbed easily through the skin, there may be hazard to the applicator. The hazard of improperly stored concentrates also can be high. Solvents in liquid concentrates may cause rubber hoses, gaskets and pump parts to deteriorate rapidly. Some formulations cause pitting in car finishes.

Principal uses: High concentrate liquids can be diluted and used in many ways — on fruit, vegetables and shade trees; for residual sprays on farm animals and for structural pests. These solutions are suitable for application equipment ranging from household sprayers to dilute hydraulic sprayers, low-volume ground sprayers, mist blowers, low volume aircraft sprayers and ultra-low volume sprayers (usually on aircraft).

Flowables (F)

Some pesticides can be made only as solid materials. Often these pesticides are very finely ground, then suspended in a liquid. In this form, they can be mixed with water and applied. Such formulations are called flowables. They are similar to emulsifiable concentrates and used in the same way. Flowables usually do not clog nozzles and require only moderate agitation.

Wettable or Soluble Powders (WP or SP)

Wettable powders and soluble powders are dry preparations containing a relatively high concentration of pesticide. Wettable powders mix with water to form suspensions. Soluble powders dissolve in water to form solutions. The amount of pesticide in these powders varies from 15% to 95%.

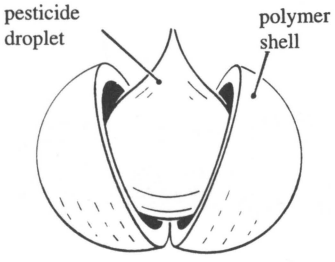
Advantages: As with liquid concentrates, the pesticides in wettable powders are relatively low in cost. The products are easy to store, transport and handle. They are safer to use on tender foliage and usually do not soak through skin as rapidly as liquid concentrates. Powders are easily measured and mixed when preparing spray suspensions.

Disadvantages: Wettable powders may be hazardous if you inhale their concentrated dust while mixing. They require good agitation (usually mechanical) in the sprayer tank and will settle quickly when the sprayer is off. They cause some pumps to wear out quickly. Their residues are more subject to weathering then liquid concentrates, and may soil cars, windows and other finished surfaces.

Principal uses: Liquid concentrates and wettable powders are the formulations most widely used by commercial applicators. Like liquid concentrates, wettable powders can be used for most pest problems and in most spray machinery. Where toxicity to the plant or absorption through animal skin is a problem, use a wettable powder suspension rather than a liquid emulsion or solution of the pesticide.

Microencapsulated Pesticides (M)

A microencapsulated formulation consists of tiny, microscopic capsules. Each capsule is a plastic coating that surrounds a particle or droplet of pesticide. The capsules can be mixed with water and applied as a spray. Handling is the same as with wettable powders. Once applied, the capsules slowly release the pesticide.



Advantages: This formulation is easier and safer to mix, handle and apply. It can prolong the effective life of the pesticide by providing a timed release of the active ingredient. The capsules have less odor than many other pesticides and pose less hazard to animals.

Disadvantages: The tank mix requires constant agitation. Bees sometimes carry capsules back to their hive, where the released pesticide may poison the entire colony.

Principle uses: Microencapsulated insecticides often are used in homes because of low danger to people and pets.

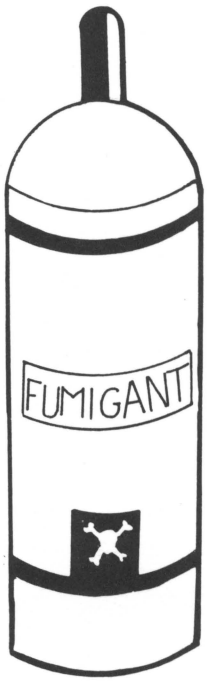
Fumigants

Fumigants are pesticides in the form of poisonous gas that kills when absorbed or inhaled.

Advantages: A single fumigant may be toxic to many types of pests. Therefore, a single treatment with one fumigant may kill insects, weed seeds, nematodes and fungi. Fumigants penetrate into cracks, crevices, burrows and other areas that are not gas-tight and expose hidden pests to the pesticide.

Disadvantages: The area to be fumigated almost always must be enclosed. Even in outdoor treatments, the area must be covered by a tarp or the fumigant must be injected into the soil so the gas doesn't escape. Many fumigants are highly toxic and also burn the skin. Use proper techniques and all recommended protective gear when applying fumigants.

Principal uses: Fumigants are used indoors to control vermin that cannot be reached easily by other pesticide formulations. Fumigants are used in ports of entry and at state borders to treat plants and other materials to prevent introduction of new pests. Stored grain pests often are controlled with fumigants. Soil is fumigated to sterilize it from pests before planting. Structures are fumigated to control wood destroying insects.



Choosing the right formulation can make the difference between a successful control job and a failed application that does more harm than good.

Study Questions

1. When a pesticide chemical is mixed with solvents, wetting agents, stickers, powders, granules, etc., the finished product is called a _____.
2. What is the common abbreviation of each of the following?
   wettable powder _____, emulsifiable concentrate _____, dust _____, granules _____.
3. Which of the following must you consider when choosing the best formulation for your job?
   a. Effectiveness against the pest
   b. The location of the manufacturer
   c. Type of application machinery needed
   d. All of the above
   e. A and C
4. Which pesticide formulation is most often used in households, backyards and other small areas?
   a. Granular
   b. Liquid
   c. Aerosol
5. Which pesticide formulation can be dangerous if its container is punctured or overheated?
   a. Granular
   b. Liquid
   c. Aerosol
6. Why are dust formulations usually *not* used outdoors on a large scale?
   a. They may drift away from the target area.
   b. They are too difficult to measure accurately.
   c. They are less effective outdoors than indoors.
7. For which type of job are dusts *not* often used?
   a. To control external parasites or animals.
   b. To treat recreational turf areas.
   c. To kill indoor pests in cracks and crevices.
8. Which is *not* a type of pest that poisonous bait formulations are used to control?
   a. Ants and slugs
   b. Rats and mice
   c. Centipedes and millipedes
9. Why are poisonous baits often used in small amounts?
   a. Because baits are needed only where pests gather.
   b. So other animals won't eat them.
   c. Because of their high toxicity.

1. formulation
2. WP, EC, D, G
3. e
4. c
5. c
6. a
7. b
8. c
9. a

10. Granular formulations are made of larger, more uniform particles than dust formulations.
    True False
11. What advantage do granules have over dusts and sprays?
    a. They drift less.
    b. The application is simpler.
    c. They penetrate dense foliage better.
    d. All of the above.
12. Why wouldn't you choose a granular if you were going to treat a tree or lettuce crop?
    a. Too much will stick to the leaves.
    b. Not enough will stick to the leaves.
    c. It will damage the plant's appearance.
13. Why choose a low concentrate liquid formulation if you want to be sure to get the right mixture?
    a. There are clear mixing instructions on the package.
    b. It is ready to be sprayed as purchased.
    c. There is a mixing cup attached to the package.
14. What formulation would you choose if you wanted little visible residue and only moderate agitation?
    a. Aerosol
    b. Emulsifiable concentrate
    c. Wettable powder
15. Which formulation is very hazardous because it is highly concentrated and absorbed easily by the skin?
    a. Emulsifiable concentrate
    b. Flowable
    c. Fumigant
16. What is the difference between emulsifiable concentrates and flowables?
    a. Flowables start as solids; emulsifiable concentrates start as liquids.
    b. Flowables start as liquids; emulsifiable concentrates start as solids.
17. Would you choose an EC or a WP if phytotoxicity might be a problem?
18. You should wear a respirator when mixing soluble or wettable powders.
    True False
19. What formulation would you choose if you wanted to penetrate cracks, soil, burrows and enclosed areas?
    a. Aerosol
    b. Dust
    c. Fumigant
20. Which is *not* a disadvantage of fumigants?
    a. Can be applied only in enclosed areas.
    b. Is difficult to apply.
    c. May be toxic enough to require full protective gear.

10. true
11. d
12. b
13. b
14. b
15. a
16. a
17. WP
18. true
19. c
20. b

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15

Filling & Mixing Practices

Some pesticides are used as purchased. These include baits, garden dusts, dry granular materials, aerosols and some liquid household and livestock sprays. However, most certified applicators stock concentrated pesticides, such as wettable powders or emulsifiable concentrates, that must be diluted before use. Most often, water is used to dilute pesticides.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Learn to decide how, when and where to mix pesticide concentrates.
- Understand the importance of protecting the environment from spills.
- Know the safety measures that prevent spills.
- Learn how to determine the compatibility of pesticides.

When to Mix

It is best not to add pesticide to a tank or hopper until just before application. This is most true when you go to a job that you have not checked beforehand. If you wait to mix, you will not have a tankful of the wrong pesticide if the pest is different than you expected. However, when treating a residence, never carry a concentrate inside. Mix the pesticide outdoors in advance.

Safe Mixing Practices

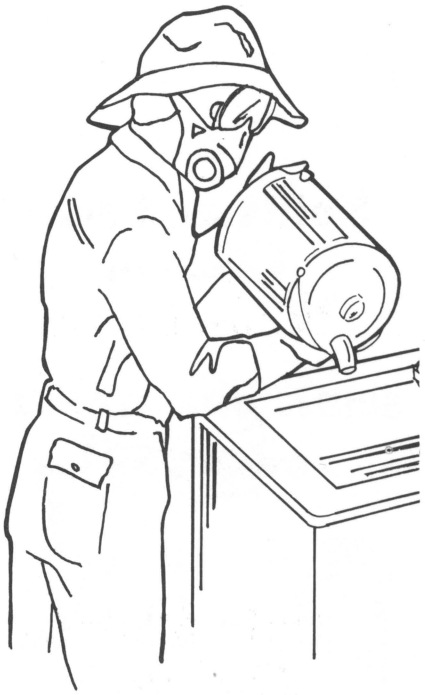
Handling pesticide concentrates, particularly when mixing them, is very hazardous. Mixing poses greater risk of exposure. You may splash liquid concentrate on your skin or in your eyes unless you are protected. You may spill the liquid on your clothing where it can soak through to your skin or expose whoever handles the clothing later. You may breathe particles from wettable powders, granules or dusts. You may contaminate your hands and then rub your eyes or lips, or carry the pesticide to your mouth when smoking or eating.

Always wear adequate protective clothing and equipment, and put them on before handling or opening a pesticide container. Remember to wear a respirator or eye protection if there is risk of pesticide inhalation or eye exposure. Use chemical-resistant gloves, goggles and a respirator when handling moderately toxic materials, even if the label does not call for them. Never use bare hands when mixing a highly toxic material or when cleaning a tank. Keep soap, water and good washing facilities at the mixing site. Never eat, drink or smoke while handling pesticides.

Check and calibrate equipment before using it. The spray tank must be clean so that oil, grease and chemical residues do not cause incompatibility problems. Turn on the agitation system and fill the spray tank about halfway with water before adding pesticide. Always keep your head higher than the level of the fill hole and do not allow the pesticide to spill or splash when putting it in the tank.

Before opening the pesticide, read the label for current mixing and usage directions. This is essential. Directions, including amounts and methods, often change.

Carefully choose the pesticide mixing and loading site. It should be outside, away from other people, livestock and pets. Do not mix pesticides where a spill or overflow could enter a water supply. If possible, mix and load pesticides on a concrete pad so spills can be removed properly. If the handling site must be near a pond or stream bank, grade the site to slope away from the water. If you must work indoors or at night, be sure there is adequate ventilation and light. If possible, do not work alone.



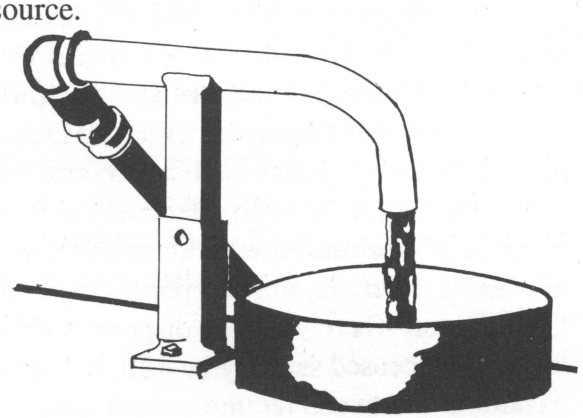
Do not tear paper containers to open them; use a sharp knife or scissors. Keep the tool clean and do not use it for other purposes. When pouring pesticide, keep the container at or below eye level to avoid splashing or spilling on your face and clothing. Never use your mouth to siphon pesticide from a container. Always stand upwind, where pesticide cannot be blown toward you. To prevent spills, close containers after each use. If an accident occurs, attend to it immediately. Remove contaminated clothing and wash yourself thoroughly with soap and water. Quickly clean spills off the floor or ground. Some concentrates can remain at toxic levels in the soil for months.

Measure accurately; follow label instructions and mix only the amount you plan to use at that time. Newer measuring devices, such as "tip and pours," are a great help in handling small amounts of concentrate. Label all measuring devices (spoons, cups, scales) and keep in a pesticide storage area. Never use them for other purposes.

Protecting the Environment

Careless mixing and filling procedures can easily harm the environment. Your work areas are potential sources of groundwater contamination. Two main sources are runoff from pesticide spills and pesticide that back-siphons into a water source.

When adding more water to a spray mixture, keep the water pipe or hose above the level of the mixture. This prevents back-siphoning and contamination of the hose. Equip suction hoses with antisiphoning devices such



as check valves. Otherwise the tank mixture may escape through the hose to a water source. Contact the Texas Water Commission for requirements on antisiphoning devices.

If you allow a tank to run over, the overflow will carry pesticides to a water source or leave toxic puddles on the ground. Never leave a piece of equipment unattended while filling it.

Spills and Safe Cleanup

The most hazardous pesticide work is mixing and loading of concentrates. Use only the amount called for to prevent illegal residues and injury to exposed plants and animals. Do not combine pesticides unless it is called for on the label or you have consulted an authority.

Follow these guidelines for cleaning small spills and spills that cannot reach water. Remember to wear proper protective clothing during the entire cleaning process.

1. **Contain the spill.** Do everything possible to stop the leak or spill immediately. If the material is a liquid, construct a dam to prevent it from spreading.
2. **Isolate the contaminated area.** Rope if off or use chalk to draw a line around it. Keep people at least 30 feet away from the spill.
3. **Soak up the spill.** Spread an absorbent material such as vermiculite, fine sand or sawdust over the entire spill.
4. **Collect the absorbent material for disposal.** Sweep or shovel into a heavy-duty plastic bag.
5. **Decontaminate the area.** For floors, work a decontamination agent (usually hydrated lime or a high Ph detergent) into the spill with a coarse broom. Add fresh absorbent material to soak this up. Sweep or shovel the material into a heavy-duty plastic bag. Repeat this procedure several times for thorough decontamination. For soils, shovel the top 2 to 3 inches of soil into a heavy-duty plastic bag. Next, cover the area with at least 2 inches of lime. Finally, cover the lime with clean topsoil. Minor spills sometimes can be cleaned by immediately applying activated charcoal to the contaminated surface.
6. **Clean contaminated vehicles and equipment.** Use a mixture of liquid bleach and alkaline detergent to clean metal surfaces. Porous materials and equipment such as brooms, leather gloves and sponges cannot be decontaminated effectively and must be discarded.
7. **Dispose of contaminated materials**. Remember, this includes absorbent materials, soil and porous equipment. Ask the Texas Water Commission where you may dispose of these items. Most can be taken to a licensed sanitary landfill, but some are considered hazardous waste and require special handling.

For major spills, or spills that may pollute water, follow the first three steps above. Then call the CHEMTREC telephone number **(800) 424-9300**. A qualified person will answer and tell you what procedures to follow and whom to notify. If necessary, a pesticide safety team may be sent to the site.

Some spills may require calls to other authorities. For a spill on a state road, notify the highway patrol and the state highway department. If food is contaminated, notify state or federal food and drug authorities and city, county or state health officials. If water is contaminated, notify public health authorities; regional, state or federal water quality or pollution authorities; and the state fish and game agency.

Empty and Rinse Procedures

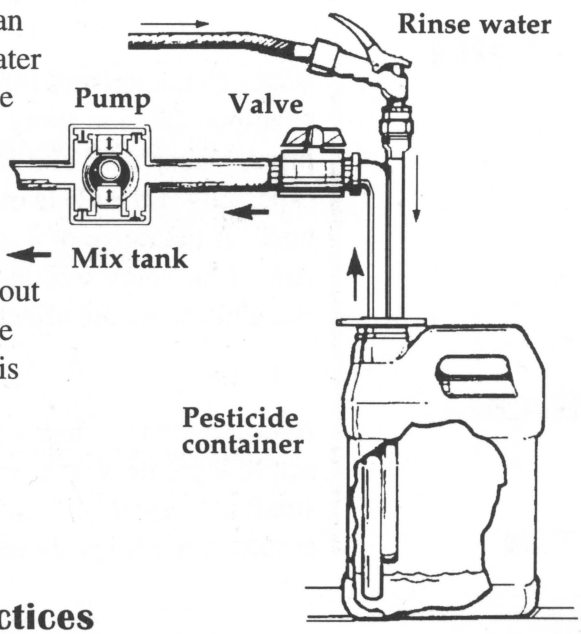
Empty pesticide containers are not truly empty. As soon as you empty a liquid pesticide container, triple-rinse it as described in Chapter 20. Also rinse measuring cups at least three times. Pour the rinsewater into the spray tank. This saves pesticide and prevents disposal problems. Close empty containers, using original caps and lids, and place in safe storage. Keep track of all containers and dispose of properly. Otherwise, they too may end up in a water source or may poison people or animals.

Closed Pesticide Handling Systems

A *closed handling system* allows you to pour pesticide from its original container, rinse the container, and transfer the pesticide and rinse solution to a spray tank without contacting the pesticide. These handling systems greatly reduce your exposure to concentrated pesticides. There are two basic types of closed systems: gravity systems and suction systems.

Gravity systems (sometimes called "punch and drain" systems) can open a container and drain the contents into an equipment tank. This system includes a clean water line that sprays inside the container and drains the rinse to the mixing tank. You remove the rinsed pesticide container for disposal. Use gravity systems only for full, unopened containers.

Suction systems (shown at right) pump pesticide out through a probe inserted into the container. Some containers are equipped with built-in probes. This system also rinses the container and washes the rinsewater into the tank.



Compatibility

Two or more pesticides often are mixed together. Then one application can control more than one pest; for example, an insect and a disease. However, the pesticides must be *compatible*. That means mixing them will not reduce their effectiveness in any way. Some pesticides may be chemically incompatible. A chemical reaction between them may either weaken or strengthen their toxicity.

Pesticides also may be physically incompatible. For example, mixing may cause wettable powders to form lumps and liquids to form solids. A pesticide's label may list its compatibilities. Compatibility charts are available from pesticide trade publications and other sources.

A way to remember the sequence for mixing solids and liquids is W-A-L-E. When mixing different formulations, including wettable powders, water dispersible granules, liquid flowables and emulsifiable concentrates, you must add them in the right order to assure proper blending.

First, fill the spray tank 1/4 full of water. Get the agitation going until the water in the tank is rolling. Then begin the W-A-L-E sequence:

1. Add wettable powders and water dispersible granules first (Ws).
2. Agitate (A) until the Ws are evenly dispersed, meanwhile adding water until the tank is 90% full.
3. Add flowable liquids (L).
4. Pour emulsifiable concentrates (E) in last. Top off the tank. Continue agitation until the pesticides are properly mixed.

It is better to mix liquids with liquids or wettable powders with wettable powders, rather than a liquid with a wettable powder. Small quantities of wettable powders mix more easily if you make a slurry first.

Water pH

Water characteristics influence the effectiveness of some pesticides. For example, alkaline spray water causes chemical breakdown of many organophosphates and carbamates. If your water supply is alkaline, especially if the pH is over 8.0, you should treat the water in the spray tank. A pH range of 4 to 6 is recommended for most pesticide sprays. Adjust the spray solution to this range by adding a buffering agent. Fungicides are not affected by water pH.

Adjuvants

An adjuvant is a chemical additive used in pesticide mixtures to help the active ingredient do a better job. Most pesticide formulations include a small percentage of adjuvants (additives). Wetting agents and emulsifiers help pesticides mix with water. Spreaders and stickers help

the active ingredient spread evenly over the treated surface and stay there in spite of rain, wind or bad weather. Some pesticides, especially herbicides, must be absorbed by the target to be effective. Penetrants help the pesticide get through the outer surface (leaf, root, skin) and into the plant. The formulation, as manufactured, contains enough of these materials for many jobs, but sometimes extra additives are needed. For example, when treating waxy leaf surfaces, a spreader-sticker may be needed. Mix these extra additives directly into the spray tank. Take care to use only the amount recommended. Other types of additives include thickeners, emulsifiers, buffering agents and foaming agents.

Special caution during mixing and filling are well worth your time and effort. Your reward will be safety for you, others and the environment, and perhaps a little money savings too.

Study Questions

1. Which pesticide formulations must be diluted before they are applied?
   a. Wettable powders and granules
   b. Flowables and some aerosols
   c. Wettable powders and emulsifiable concentrates
2. When is the best time to add pesticide to the spray tank?
   a. At least three hours before application
   b. Immediately before application
   c. Whenever you are ready
3. Mixing is the time when you are most likely to be exposed to pesticide poisoning.
   True False
4. Through which routes of entry are you likely to be exposed during pesticide mixing?
   a. Dermal and swallowing
   b. Inhalation and dermal
   c. Swallowing and inhalation
5. _____ devices keep spray mixture in the tank from escaping back through the hose into a water source.

1. c
2. b
3. true
4. b
5. Antisiphoning

6. When you empty a pesticide container, you should rinse it out at least three times.
   True False
7. You can mix all types of pesticides together without any problem.
   True False
8. What does chemical compatibility mean?
   a. Mixing the chemicals will not cause an explosion.
   b. Mixing the chemicals will not produce a highly toxic solution.
   c. Mixing the pesticides will not reduce their effectiveness.
9. How can you find out if two pesticides are compatible?
   a. Call your county extension agent.
   b. Call the manufacturer.
   c. Read the label.
10. An _____ is a chemical added to the pesticide mixture that makes
    an active ingredient more effective.
11. For what kind of job would you use a spreader-sticker?
    a. For weed and brush control
    b. For treatment of waxy leaf surfaces
    c. For treatment of hard-to-reach tree tops
12. The most hazardous activities involving pesticides are mixing and loading concentrates.
    True False
13. For most pesticide sprays, what is the recommended pH level?
    a. From 2 to 3
    b. From 4 to 6
    c. From 5 to 8
14. When a pesticide is spilled accidentally, what should you do first?
    a. Contain the spill.
    b. Call the fire department.
    c. Let it evaporate.

6. true
7. false
8. c
9. c
10. adjuvant
11. b
12. true
13. b
14. a

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Calculations for Mixing Pesticides

When mixing a finished spray, be sure to add the correct amount of pesticide. Too little pesticide may result in a poor job, while too much may cause illegal residues, injury, damage or unnecessary expense. Directions for mixing are on the label. They require only very simple calculations.

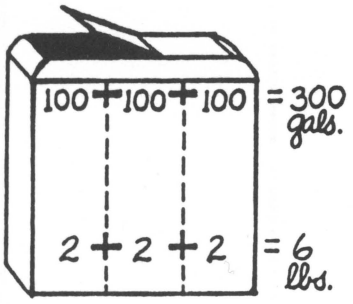
Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Understand the importance of adding the correct amount of pesticide to a mix.
- Learn to do correct calculations for mixing pesticides.

Wettable Powder Mixing



Sometimes the amount of chemical to add to a mix is very easy to figure. For example, suppose the label for a wettable powder tells you to use 2 pounds of powder per 100 gallons of water. You need to fill a 300 gallon tank. Since the tank holds three times the amount of water listed on the label, you must add three times the amount of powder listed. That is, three times 2 pounds. So you would add a total of 6 pounds of powder to the 300 gallon tank.

Other label directions are not so easy to follow for the tank size you have. In such cases, find the amount of chemical to add by figuring how to mix 1 gallon. Then multiply the amount needed for 1 gallon by your tank's volume.

Try this with the label rate of 2 pounds chemical per 100 gallons of water. Divide 2 by 100 to find the rate for one gallon. This equals .02 pound of chemical per gallon of mixture.

Then, for a 10 gallon tank, multiply .02 times 10:

.02 x 10 = .2 pounds of chemical

For a 50 gallon tank, multiply .02 times 50:

.02 x 50 = 1 pound of chemical

Liquid Mixing

Liquids are mixed in the same way. Consider a label that calls for 2 pints emulsifiable concentrate per 100 gallons. A 300 gallon tank will take 6 pints, and 1 gallon will take .02 (two hundredths) of a pint.

How much is two-hundredths of a pint? Remember, 1 pint equals 16 fluid ounces. Multiply 16 times .02 to find the number of ounces needed per gallon:

16 x .02 = .32 fluid ounces per gallon

At this rate (.02 pints or .32 fluid ounces per gallon), how much chemical would you add to a 150-gallon tank?

150 x .02 = 3 pints
OR
150 x .32 = 48 fluid ounces

Per Acre Calculations

Some products may have mixing directions based on pounds or pints per acre. To prepare the mix, first you must know your spray tank capacity and how many gallons your equipment applies per acre. Then follow this formula:

$$\frac{\text{gals. in tank}}{\text{gals. applied per acre}} \times \text{lbs. or pints chemical needed per acre} = \text{lbs. or pints chemical needed per tank}$$

In this formula, the tank capacity divided by the amount applied per acre tells you the number of acres sprayed per tankful. This number times the label rate per acre tells you how much chemical to mix in the tank.

Example: A sprayer applying 20 gallons per acre has a 300-gallon tank. You must apply 2 pounds of a chemical per acre. How much chemical should you add to the tank?

	gallons in tank	300
÷	gallons per acre	20
=	acres sprayed per tankful	15

	acres sprayed per tankful	15
x	pounds chemical per acre	2
=	pounds chemical needed per tank . .	30

Example: Consider the same sprayer and tank used above. You must apply 2 pints of a liquid formulation per acre. How much chemical should you add to the tank?

	acres sprayed per tankful	15
x	pints chemical per acre	2
=	pints chemical needed in tank	30

Percentage Calculations

Some directions tell you to make a finished spray of a certain percentage, for instance, 1 percent spray for ants. Suppose your pesticide is formulated as a 57 percent emulsifiable concentrate. To make a 1 percent finished spray, add 1 part of pesticide to 56 parts of water.

When mixing percentages, remember that 1 gallon of water weighs about 8.3 pounds and 100 gallons weigh about 830 pounds. (Kerosene weighs about 6.6 pounds per gallon.)

To make a 1 percent pesticide mix in 1 gallon of water, you must add .083 pounds of active ingredient (actual pesticide). To make a 1 percent mix in 100 gallons, add 8.3 pounds of active ingredient. The following formulas may be used.

Formula for wettable powders. To achieve a certain percentage of active ingredient (a.i.) in a tank mix, use the formula below. It tells you how much chemical to add when mixing wettable powders.

$$\frac{\text{gals. of spray wanted x percent a.i. wanted x 8.3 (lbs./gal.)}}{\text{percent a.i. in pesticide used}}$$

Example: How many pounds of an 80 percent wettable powder are needed to make 50 gallons of 3.5 percent spray for application by mist blower?

$$\frac{\text{50 (gals. wanted) x 3.5 (percent wanted) x 8.3 (lbs./gal.)}}{\text{80 (percent a.i.)}}$$

$$= 1{,}452.5 \div 80 = 18.1 \text{ lbs. of 80 percent WP}$$

Formula for emulsifiable concentrates. To achieve a certain percentage of active ingredient (a.i.) in a tank mix, use the formula below. It tells you how much chemical to add when mixing emulsifiable concentrates.

$$\frac{\text{gals. of spray wanted x percent a.i. wanted x 8.3 (lbs./gal.)}}{\text{pounds a.i. per gallon of concentrate x 100}}$$

Example: How many gallons of a 25 percent emulsifiable concentrate (2 pounds pesticide per gallon) are needed to make 100 gallons of 1 percent spray?

$$\frac{\text{100 (gals. wanted) x 1(percent wanted) x 8.3 (lbs./gal.)}}{\text{2 (lbs. a.i.) x 100}}$$

$$= 830 \div 200 = 4.15 \text{ gallons of 25 percent EC}$$

Square Feet Calculations

Often a label gives mixing instructions for coverage of a square foot area; for example, 1,000 square feet for turf treatments. In this case, you must adjust the amount of liquid your sprayer releases over the area.

This is called equipment calibration. After calibrating your equipment, add the amount of pesticide needed to apply the recommended dosage. Calibration is explained in Chapter 18.

Useful Facts

1 gallon of water weighs 8.3 pounds
100 gallons of water weigh 830 pounds
1 pound = 16 ounces
1 pint = 16 fluid ounces
1 quart = 32 fluid ounces
1 pound wettable powder per 100 gallons
= 1 tablespoon per gallon (approximately)
1 pint emulsifiable concentrate per 100 gallons
= 1 teaspoon per gallon (approximately)

Study Questions

1. How much wettable powder would you put in a 450-gallon tank, given directions to add 3 pounds WP per 100 gallons of water?
2. How much wettable powder would you put in an 80-gallon tank, given the directions above?
3. How much emulsifiable concentrate would you put in a 300-gallon tank, given directions to add 3 pints EC per 100 gallons of water?
4. How much emulsifiable concentrate would you put in a 50-gallon tank, given the directions above?
5. If one pound of WP is recommended per 100 gallons of water, how many tablespoons of WP would you add to 1 gallon?
6. If two pints of EC are recommended per 100 gallons of water, how many teaspoons of EC would you add to 1 gallon?
7. How much does 100 gallons of water weigh?
8. How much does 100 gallons of kerosene weigh?
9. How many gallons of 25 percent emulsifiable concentrate would you add to a 50-gallon tank to get a 1 percent active ingredient mixture?
10. How many pounds of 25 percent wettable powder must you add to 100 gallons of water to get a 1 percent active ingredient mixture?

1. 13.5 pounds
2. 2.4 pounds
3. 9 pints
4. 1.5 pints
5. 1 tablespoon
6. 2 teaspoons
7. 830 pounds
8. 660 pounds
9. 2.075 gallons
10. 33.2 pounds

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Equipment 17

Pesticide application equipment varies widely from the simple paintbrush and aerosol can to the modern agricultural airplane. There are also several types of support equipment — such as filler pumps, tank trucks, mixing tanks and front-end loaders — that are not used for application but make the spray operation more efficient.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Learn the names and uses of various types of application equipment.
- Learn how to select the best application equipment for the job.
- Understand the basics of operating each type of equipment.
- Know the advantages and disadvantages of each type of application equipment.

Choose Equipment Wisely

Even if you do just one type of pest control, you must make equipment choices. The choice depends on working conditions, pesticide formulation, the site, possible problems and more. While large power equipment may be good for some problems, hand-held equipment may be best for other jobs. By choosing equipment wisely, you save yourself and your customers time and money.

Most application equipment falls in two groups: equipment for dry pesticide formulations and equipment for liquid pesticides.

Dry Formulation Equipment

- **Dusters**
- **Granule spreaders**

Dusters

Dusters blow fine particles of pesticide onto the target surface. These applicators may be very simply made. Often the pesticide package, such as a plastic squeeze bottle, acts as the duster. Even large, powered models are constructed simply. Dusters are used mostly by gardeners and pest control operators for spot treatment of plants or a small area. In some cases, dusts are applied by airplane.

Advantages: Dusters are usually lightweight, relatively cheap and simple to operate. They do not require water.

Disadvantages: Dusts drift easily and are highly visible and difficult to control. Because of this, dusters are less desirable for most crops and large outdoor jobs. Also, dusters need frequent maintenance to prevent clogging.

Granule spreaders

Granular equipment is built to apply coarse, dry particles of the same size. Equipment models are available for applications on soil, water and foliage. Spreaders include such devices as pneumatic whirling discs

(seeders, fertilizer spreaders), multiple gravity feed outlets (lawn spreaders, grain drills), soil injectors (furrow treatments) and ram-air (aircraft).

Advantages: Like dusters, granule spreaders may be lightweight, simple to use and easy to calibrate. They also need no water. Because granules are the same size, they flow easily and are relatively heavy. Seeders and fertilizer spreaders can be used to apply pesticide granules, often without modification.

Disadvantages: Granular formulations have limited uses. Because uncovered granules can poison nontarget wildlife, you need other machinery for controlling most leaf-feeding insects and plant diseases.

Liquid Formulation Equipment

- **Hand-operated sprayers**
- **Low-pressure boom sprayers**
- **High-pressure sprayers**
- **Air-blast sprayers**
- **Low and ultra-low volume sprayers**

More pesticides are applied with sprayers than with any other equipment. That's why there are many types and sizes of sprayers, from hand-held units to machines weighing tons. Some apply dilute pesticide mixtures while others apply concentrates. Some use low pressure and low gallonage (low volume) and have simple roller pumps. Others are high pressure and high volume, and have high-pressure piston pumps. Some apply spray through single nozzles while others have many nozzles linked by pipes to form a boom. The main types of sprayers are described below.

Hand-operated sprayers

Hand-operated sprayers are used commonly by private individuals for small pest problems. However, commercial applicators often find hand sprayers efficient for small jobs and jobs in places to which equipment must be carried. Hand sprayers use carbon dioxide or compressed air to force liquid through a nozzle. They are available with single or multiple nozzle systems. The capacity of hand sprayers generally ranges from 1/2 to 5 gallons.

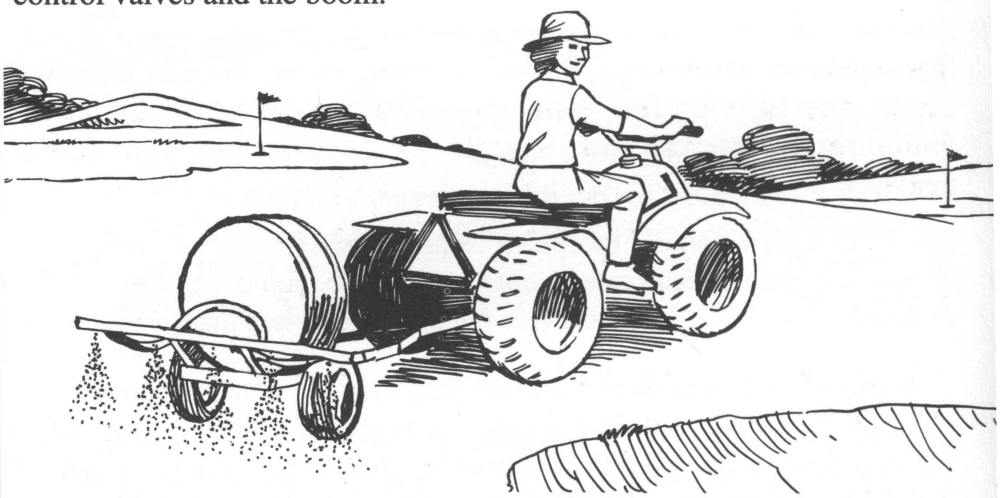
Advantages: Hand sprayers are economical, simple and lightweight. They work well for many situations and problems. Because relatively little pressure is used, you can easily control the spray.

Disadvantages: Hand sprayers are practical for small jobs only. Wettable powders tend to clog nozzles. Poor agitation is common.

Low-pressure boom sprayers

These sprayers usually are mounted on a tractor, truck or trailer. They are made to apply pesticide in swaths while being driven over field crops or large areas of turf. Low-pressure sprayers generally use a low volume

of dilute spray ranging from 10 to 40 gallons per acre applied at 30 to 60 pounds per square inch (psi). Typical low-pressure sprayers use roller or centrifugal pumps. Parts include a pump, tank, agitation system, flow control valves and the boom.



Advantages: Low-pressure sprayers are relatively inexpensive, lightweight, multipurpose and fast. They are usually low volume, so one tankful covers a large area.

Disadvantages: They do not adequately penetrate and cover dense foliage. Because most use hydraulic agitators, wettable powder formulations often settle out. However, mechanical or jet flow agitators solve the problem.

High-pressure sprayers

High-pressure sprayers often are called "hydraulic sprayers." They operate with dilute mixtures and different pressures from 250 psi to several hundred psi. High-pressure and low-pressure sprayers are designed similarly, the only difference being the amount of pressure the sprayer parts can withstand. When fitted with booms, high-pressure sprayers can do any work done by other boom sprayers. They also may be fitted with handguns. Handguns are used for spraying shade trees, ornamentals, livestock, orchards, buildings, brush, rights-of-way, commercial crops and more.

Advantages: High-pressure sprayers are useful for many pest control jobs. For example, they have enough pressure to drive spray through heavy brush, thick cow hair or the tops of tall shade trees. Because they are strongly built, these sprayers are long-lasting and dependable. Standard parts include piston pumps and mechanical or jet flow agitators. The pumps resist wear from gritty or abrasive materials, and the agitators keep wettable powders well-mixed in the tank. With a long hose, targets in hard-to-reach places can be treated.

Disadvantages: Because high-pressure hydraulic sprayers must be strongly built, they can be heavy and costly. They usually use large amounts of water and require frequent filling. The pesticide can be misdirected easily, causing drift and off-target contamination.

Air-blast sprayers

Air-blast sprayers use air and water to dispense pesticide mixtures. The mixture is pumped through a nozzle or series of nozzles and then blown out by an air blast. The rushing air shatters the liquid into tiny droplets and carries them to the target. The droplets may travel 10 to 40 feet, depending on the fan speed. Air-blast sprayers typically are used for tree spraying and for better penetration of foliage on some field crops.

Advantages: Air-blast sprayers provide quick coverage of large areas. Because a small amount of pesticide mixture covers a large area, you spend little time refilling. Air-blast sprayers effectively deliver pesticide to hard-to-reach places and through dense leaves. These sprayers usually are less tiring to handle than hydraulic sprayers.

Disadvantages: Air-blast sprayers are expensive. Wind can disrupt the spray pattern and cause drift. Large sprayers may be difficult to use on wet ground and in small or hard-to-reach places.

Low and ultra-low volume sprayers

(ULVs and mist blowers)

Mist blowers use a fan or whirling disk to break up spray droplets into a fine mist. The mist may be hard to see. These sprayers have a metering device to keep the application at low volume. Low-volume mist blowers use a diluted pesticide mixture, but ULV mist blowers use undiluted concentrate.

These sprayers vary in size from hand-held or backpack units to large truck-mounted equipment. They can deliver from 1 quart to several gallons of mix and may be used indoors or outdoors.

Advantages: These sprayers are economical and easy to use. They save time and labor by limiting the amount of liquid carried. They do not cause a problem with dripping or running liquid.

Disadvantages: Calibration is critical. Overdosing is a potential problem when you work with concentrated pesticides. The potential hazard to you is also greater. Good weather is more essential than with air-blast sprayers. Using more concentrated mixtures makes drift more dangerous. Coverage on some crops may be poor, thus providing less control. Only a few pesticides are labeled for ULV application.

Aerosol Generators

(Foggers)

Aerosol generators break certain formulations into very small, fine droplets (aerosols). One droplet cannot be seen with the naked eye, but great numbers of droplets look like a fog or smoke. This is why aerosol generators commonly are called "foggers." They usually are used to fill an area — such as a greenhouse, warehouse or park — with a pesticidal fog that controls pests on contact.

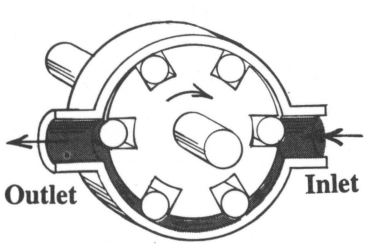
Some foggers — thermal aerosol generators — use heat to break up the pesticide. Other generators break up the pesticide with rapidly whirling discs, air blasts or very fine nozzles. Aerosol dispensers range in size from small pressurized cans to large, heavy truck-mounted equipment. Refillable models generally hold 5 to 10 pounds of formulation. Some aerosol cans are designed for use as needed while others are made for one-time, total release. With special nozzles, aerosol equipment can inject pesticide into tiny spaces.

Advantages: Aerosol cans are ready for use, easily stored and convenient. Large equipment can generate enough aerosol to cover a large area. Aerosols work well indoors to penetrate tiny cracks and crevices. Outdoor foggers work well to penetrate heavy vegetation. Because foggers blanket an area, it is difficult for pests to escape.

Disadvantages: Fine-particle dispensing equipment is expensive and requires frequent maintenance. Most aerosol generators use special formulations instead of a general purpose formulation. Over-application can leave oil-slick surfaces and cause an explosion hazard. Drift from the target site can be a problem with large equipment.

Pumps

- **Flexible-impeller pump**
- **Roller pump**
- **Centrifugal pump**
- **Piston pump**
- **Gear pump**
- **Diaphragm pump**
- **Ground-driven pump**



Roller Pump

Flexible-impeller pump

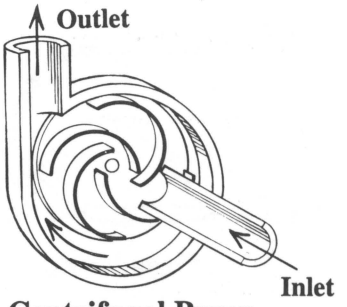
Flexible-impeller pumps have a series of rubber "paddles" attached to a rotating hub. The pump housing is shaped to squeeze the paddles as the rotor turns. This pump has automatic pressure relief. The paddles will not return to the proper position if the pressure is too high. The pump is limited to low pressures (less than 50 psi) and can handle all but highly abrasive materials.

Roller pump

Roller pumps are used widely because they are effective, flexible and inexpensive. The "rollers" fit into slots of a rotating hub inside the housing. As the rollers pass the inlet port, they push liquid around the housing toward the outlet port. As the rollers near the outlet port, they press closer together and push the fluid out. Output from a roller pump decreases as pressure increases because the rollers leak fluid back between rollers. Worn roller pumps are easy and cheap to rebuild.

Centrifugal pump

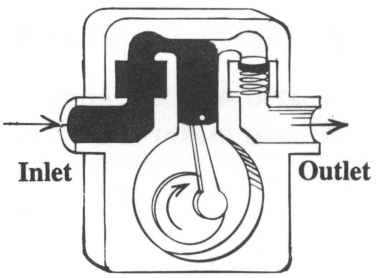
Centrifugal pumps recently have become more popular. They handle abrasive material well and their large capacity provides plenty of hydraulic agitation. They also have an automatic pressure relief feature. One limitation is that the pump must run at high speed to develop pressure. Belt, gear or hydraulic drives are used to speed up the pump, which requires priming unless it is placed below the level of the supply tank. Pump output falls off rapidly at 30 to 40 psi. The steep performance curve is a plus, as it permits control of output with a relief valve. However, it also produces uneven output under some conditions.



Centrifugal Pump

Piston pump

Pistons are "positive displacement" pumps. That means every time the piston moves, the liquid moves. Unlike roller pumps, there is no leakage inside the pump chamber. Nor is there an automatic pressure relief. Piston pump output is virtually unaffected by pressure. The output is usually low and may not be sufficient for hydraulic agitation. Although this is the most expensive pump, it is good for wettable powders and other abrasive mixtures.



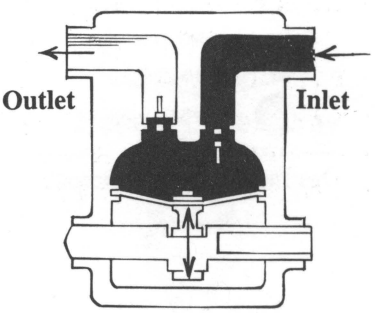
Piston Pump

Gear pump

This is a semipositive displacement pump that was used on many early sprayers. Gear pumps rarely are used today because they wear quickly with abrasive fluids. A gear pump is well-suited to pumping oil suspensions or emulsions at high volumes and pressures. The internal parts (housing and gears) generally are made of bronze and the shaft is made of stainless steel. The pump cannot be rebuilt and must be thrown away when worn.

Diaphragm pump

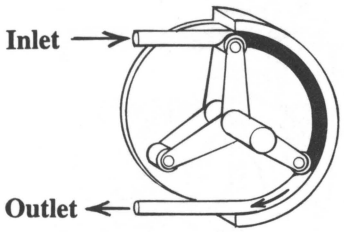
The pumping action in this device is produced by moving a flexible diaphragm. Liquid is drawn into one chamber on the downstroke and forced out of another chamber on the upstroke. These pumps may be made with either one or two diaphragms. The diaphragm is resistant to wear from abrasives, but not from certain chemicals. Diaphragm pumps are priced moderately, and maintenance is easy and economical.



Diaphragm Pump

Ground-driven pump

Ground-driven pumps (metering pumps) are powered by a ground wheel. When wheel speed changes, the rate of pumping changes with it. The main advantage of this is that the application rate holds constant as terrain and surface conditions change. Two types of pumps normally are used on sprayers with ground drives:



Hose Pump

Variable-stroke piston pump. With this pump, you adjust the application rate by changing the length of the piston stroke. Long piston strokes produce more flow; short strokes produce less flow. Once set, flow rate stays the same whether the sprayer travels 1 mile-per-hour (mph) or 5 mph.

Hose pump. The hose pump has a series of rollers on a reel, with a hose stretched over the reel. As the ground wheel drives the reel, the rollers push a fixed amount of fluid around the hose. Flow from this pump cannot be changed.

Sprayer Nozzles

- **Nozzle maintenance**
- **Nozzle materials**

Sprayer nozzles have a major effect on the accuracy of pesticide application. Even practiced applicators often overlook the proper selection and maintenance of nozzles. It is important to realize that you cannot achieve accurate application with improper or worn nozzles.

Nozzles (often called "spray tips") serve three functions. They:

- meter or regulate the flow of liquid,
- atomize the liquid stream into droplets, and
- spread droplets in a set pattern.

A nozzle regulates the flow of liquid with the size of its opening (orifice). The pressure of the liquid is also a factor. With most nozzles, flow rate increases as pressure increases. However, doubling the pressure does not double the flow rate. Pressure must be increased four times to double the flow rate.

Actual droplet sizes

- 500 Microns
- 1,200 Microns
- 5,500 Microns

One Inch = 25,400 Microns

Atomization of a liquid into droplets is caused by the tearing action of air. The nozzle spreads the liquid into a thin sheet that breaks up as it hits the air. Each nozzle produces a range of droplet sizes from very small to large. Droplet size is measured in microns — one micron equals one-millionth of a meter. An increase in pressure increases the tearing action, thus producing smaller droplets. If the droplets are too small, drift occurs. If droplets are too large, they roll off the target. Droplet size is an important point to consider when choosing nozzles. Most nozzle makers give this information in their catalogs.

Nozzle maintenance

Use screens to protect nozzles from grit and dirt. Finely machined edges that control spray pattern can be damaged by the sanding action of dirt and abrasive spray mixtures. Clean clogged tips with a soft bristled brush only; never use a metal object. Use extreme care with soft tip materials such as plastic and brass. Never blow on a dirty, clogged nozzle with your mouth.

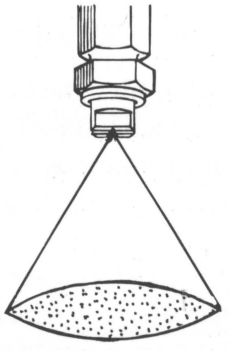
Worn nozzles have poor spray patterns and higher flow rates than new nozzles. Check wear by comparing the flow rates of the used tip and a new one. Using an accurate graduated container, collect liquid for a measured time from each tip. If the flow rate of the used tip is five percent greater than a new one, replace it.

Nozzle materials

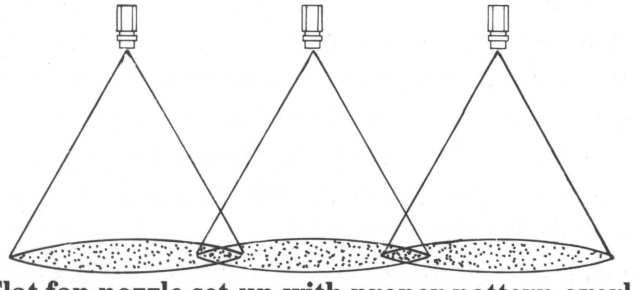
Spray nozzles are made with materials selected for cost and durability. Although other materials are used, the following are most common:

- Brass — the most common; least resistant to wear; relatively inexpensive.
- Plastic and nylon — used for nonabrasive formulations; resists corrosion; inexpensive; not recommended for high pressure.
- Stainless steel — non-corrosive; excellent wear resistance; relatively expensive.
- Hardened stainless steel — useful for highly abrasive formulations; most expensive.
- Ceramic — most durable for highly abrasive and corrosive chemicals.

Hollow-cone and solid-cone nozzles produce a circular pattern. Hollow-cone nozzles generally make finer, smaller particles than the solid cone. Both nozzles are used on handgun sprayers and row-crop sprayers. Each of these nozzles penetrates foliage well. They are used to apply fungicides, insecticides and sometimes herbicides.



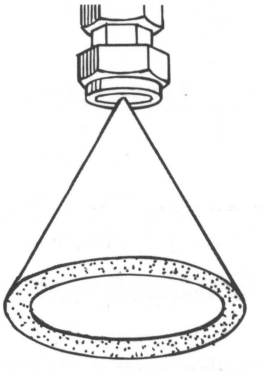
Flat Fan Spray



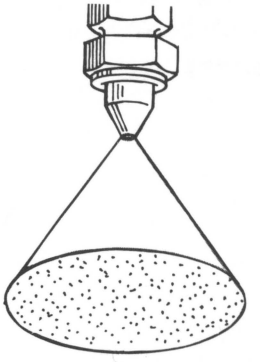
Flat fan nozzle set-up with proper pattern overlap

Flat-spray nozzles are used to broadcast most liquid pesticides. The pattern is fan-shaped with tapered edges. Even coverage across the sprayer width is achieved by overlapping the tapered portion of the pattern. This nozzle often is used to apply structural pesticides to floors and walls.

Nozzle Spray Patterns

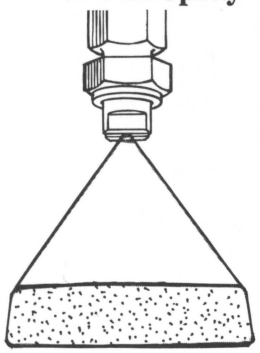


Hollow Cone Spray



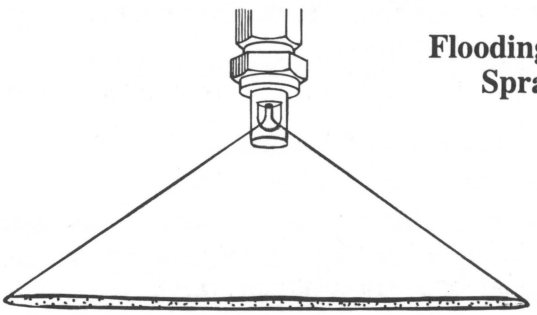
Solid Cone Spray

Even Fan Spray

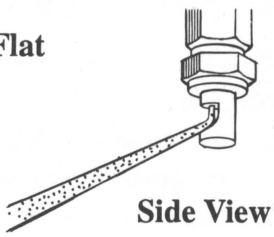


Even-spray nozzles produce a narrow rectangular pattern. They are used for band applications of chemicals, often with planting equipment.

Flooding nozzles often are used to broadcast fertilizer, herbicide and defoliant. They deliver a wide flat spray of large droplets. These nozzles can be mounted on a boom in various positions or used alone for boomless broadcast spraying.



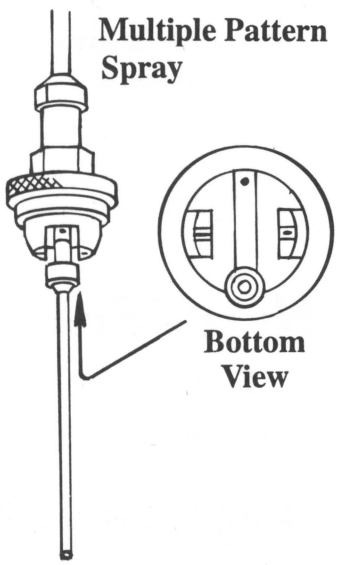
Flooding Flat Spray



Side View

Rear View

Multiple Pattern Spray



Bottom View

Multi-pattern spray nozzles are used on professional hand-held sprayers. Each nozzle provides a choice of several patterns. The choice usually includes two flat fan patterns: one low-volume pattern with fine particles and one high-volume fan with large particles. Another pattern is the pin stream, used to apply pesticide into a hole or crevice. There also may be a "crack and crevice" accessory tool available. You select a pattern by loosening the nozzle collar and turning the nozzle body to the desired pattern.

Other Equipment Components

- **Tanks and agitators**
- **Pressure regulators and guages**
- **Control valves**
- **Filters**

Tanks and agitators

Tanks for liquid pesticides are commonly made from metal, fiberglass or thermoplastic. The tanks should be nonabsorptive and resistant to rust and corrosion. They also should have a large opening for filling and cleaning, a tight-fitting cover, a bottom drain and an external sight guage with a cut-off valve.

Agitators are used to mix pesticides and to keep insoluble mixtures, especially wettable powders, from settling. Hydraulic agitators circulate spray mix through jets near the bottom of the tank. These agitators do not break up material that settles after the pump has been turned off. Mechanical agitators are belt or chain-driven propellers or paddles mounted on a shaft that runs through the tank. These agitators require frequent maintenance and adjustment.

Pressure regulators and guages

Pressure regulators are spring-loaded valves that control the pressure of liquid going to the nozzles. The valves are located between the pump and spray boom or nozzles. When pressure in the system exceeds the pressure of the regulator, the valve opens to let liquid bypass back to the tank. When pressure in the system drops, the valves reduce flow into the tank and produce a constant pressure to the nozzles.

Pressure guages are devices that measure pressure in a range from 1 psi to 1,000 psi. Use a guage that matches the pressure range of your sprayer. Place the guage between the pressure regulator and the nozzles so you can monitor fluid pressure in the system. Recalibrate often.

Control valves

Control valves enable you to stop liquid flow at different points in the spray system. Control valves also help you calibrate various parts of the sprayer. The valves ususally are hand or cable operated or controlled by electric solenoids.

Filters

Strainers, fitted with filter screens of the right size, protect pumps and prevent clogged nozzles. Filters are usually positioned between the tank and pump, between the pump and nozzles, and at the nozzle.

Equipment Care

- **Sprayers**
- **Granular and dust equipment**

All equipment — including hoses, nozzles, pumps, tanks and hoppers — must be cared for properly to be both dependable and safe. Thoroughly drain pumps and other equipment. In freezing weather, circulate alcohol or antifreeze through the equipment. Remove, clean and store nozzles.

Sprayers

Wear appropriate protective clothing while cleaning any piece of application equipment. Clean sprayers after each day's use. Flush with clean water inside and out to prevent corrosion and chemical buildup. When finished for the season or when changing chemicals, thoroughly clean the sprayer with a cleaning agent. Follow these steps (Refer to the table on page 12 for the type and amount of cleaning agent):

1. Wash the inside of the tank and partially fill it with water. Flush this water through the nozzles. Repeat for at least two complete rinses.
2. Take off the nozzle tips and screens. Clean them in a strong detergent solution or kerosene, using a soft brush.
3. Fill and rinse tank a third time, this time adding a cleaning agent.

Cleaning Agents and Rates for Cleaning Sprayers

Pesticide used	2.5 gallons cleaning solution	Instructions
Insecticides[1], fungicides	1 Tbsp. powder detergent[2]	Agitate, flush and rinse.
Hormone herbicides, salt and amine formulations (2,4-D, dicamba, MCPA, etc.)[3]	1/2 cup household ammonia	Thoroughly agitate, flush small amount through system. Let remainder stand in sprayer overnight. Flush and rinse.
	OR 3 Tbsp. washing soda (sal soda)	Same as above except let stand for at least 2 hours.
	OR 1/4 lb. trisodium phosphate	Same as above except let stand for at least 2 hours.
	OR 2 Tbsp. fine activated charcoal and 1-2 oz. powder detergent[2]	Agitate, operate sprayer for 2 minutes. Let remainder stand for 10 minutes, then flush through sprayer. Rinse.
Hormone herbicides, ester formulations (2,4-D, brush killers, MCPA, etc.)[1]	4 oz. washing soda (sal soda) + 1-1/2 cup kerosene + 1 Tbsp. powder detergent[2]	Rinse inside of tank and flush small amount through system. Let stand at least 2 hours. Flush and rinse.
Other herbicides (atrazine, simazine, alachlor, etc.)	1 Tbsp. powder detergent[2]	Rinse with clean water before and after using sudsy solution.

1. *Organophosphate and carbamate insecticides may be detoxified by adding household ammonia to the cleaning solution (1/2 cup per 2.5 gallons).*
2. *Liquid detergent may be substituted for powder detergent; mix at a rate to make a sudsy solution.*
3. *Caution: Just a trace of 2,4-D herbicide can damage sensitive plants. It is risky to apply insecticide or fungicide with a sprayer that has had 2,4-D in it.*

Granular and dust equipment

These application devices also must be cleaned after use. Follow these steps:

1. Remove all pesticide from the device. This may require taking it apart to be thorough.
2. Clean the inside of the hopper.
3. Use sandpaper or a wire brush to clean rusted parts. Then paint the parts.
4. Coat the inside with oil. Oil or grease the bearings.
5. Thoroughly clean and oil the flow control slides or valves.
6. Wipe off excess oil if it will contact the chemical upon the next use.

If you use common sense and choose the right formulation, the right pesticide and the right equipment, you can expect a good pest control job.

Study Questions

1. Which of the following is *not* a type of support equipment?
   a. Filler pump
   b. Front-end loader
   c. Sprayer
2. Which of the following must you consider in choosing pesticide application equipment for a job?
   a. Working conditions and type of target
   b. Pesticide formulation
   c. Possible problems
   d. All of the above
3. Common users of dusters are gardeners and pest control operators for spot treatment of plants or small areas.
   True False
4. Seeders and fertilizer spreaders often can be used to apply granules without equipment adjustments.
   True False
5. A fogger is a good equipment choice when there is a sensitive area nearby and the wind is low.
   True False
6. Which type of sprayer would you probably choose to treat a small garden in a residential area?
   a. Air-blast sprayer
   b. Hand-operated sprayer
   c. Mist blower
7. In general, only homeowners have good use for hand-operated sprayers.
   True False
8. If you had to treat a few acres of forage crop and water was not easily available, what type of sprayer would you choose?
   a. Low-pressure boom sprayer
   b. High pressure sprayer
   c. Hand-operated sprayer
9. What sprayer would you use if the pesticide was formulated only as a wettable powder and the target crop had dense foliage?
   a. Low-pressure boom sprayer
   b. High-pressure sprayer
   c. Ultra-low volume sprayer

1. c
2. d
3. true
4. true
5. false
6. b
7. false
8. a
9. b

10. Does a hydraulic sprayer have low-pressure or high-pressure?
11. What type of sprayer would you use with a wettable powder formulation to treat an oak tree in a backyard?
    a. Low-pressure sprayer
    b. High-pressure sprayer
    c. Air-blast sprayer
12. Which sprayer would you choose to treat the oak tree if water was not readily available and there was no wind?
    a. Low-pressure sprayer
    b. High-pressure sprayer
    c. Air-blast sprayer
13. Which type of sprayer is more likely to lead you to injure crops or wildlife by overdosing with concentrated pesticides?
    a. Low-pressure sprayer
    b. High-pressure sprayer
    c. Air-blast sprayer
14. You must increase pressure _____ times to double the flow rate.
15. From which of the following may nozzles be made?
    a. Brass
    b. Plastic
    c. Stainless steel
    d. All of the above
16. Among nozzle materials, brass is the least resistant to wear.
    True False
17. Which pump does *not* have an automatic pressure relief characteristic?
    a. Flexible-impeller pump
    b. Centrifugal pump
    c. Piston pump
18. What is a major advantage of ground-driven pumps?
    a. Manueverability
    b. Moderate price
    c. Application rate holds constant as speed changes
19. Which is a function of spray nozzles?
    a. To regulate the flow of liquid
    b. To atomize the liquid stream
    c. To spread droplets in a specific pattern
    d. All of the above
20. Worn nozzle tips produce poor spray patterns and _____ flow rates than new nozzles.
21. You should replace a used nozzle when its flow rate varies _____ percent or more from a new nozzle.
22. A sprayer should be cleaned after _____ day(s) of use.
23. When cleaning a sprayer, you should fill and flush the tank with water at least _____times before using a cleaning solution.

10. high
11. b
12. c
13. a
14. two
15. d
16. true
17. c
18. c
19. d
20. higher
21. 5
22. each
23. two

Calibration 18

Unlike weather, the application rate of equipment is under your complete control. Calibration enables you to precisely set equipment output. Calibration also helps you find faulty equipment parts.

Pesticide manufacturers spend millions of dollars to determine the rate at which to apply pesticides. Following these rates ensures that you apply only enough pesticide for effective control. Calibrating equipment is an important part of your responsibility to apply pesticides properly.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Understand the importance of calibrating equipment. Learn how to calibrate different types of sprayers.
- Learn the important facts involved in sprayer preparation.
- Know how to check for mistakes.

Why Calibrate?

Effective use of pesticides depends upon proper application and placement of the chemical. Even when you have the right chemical mixture, it is still possible to apply the wrong amount. Too little leaves an uncontrolled pest problem. Too much leads to potential environmental problems and lost profit. The purpose of calibration is to insure that your equipment uniformly applies the correct amount of chemical over a given area.

Pesticide delivery can change with equipment wear, gauge error, nozzle error, wheel slippage, speedometer error and friction loss. Always pay close attention to calibrating your machinery properly.

Tools needed for calibration

- stopwatch
- measuring tape
- calibrated liquid container
- scale (for dry applications)
- pocket calculator
- pressure guage
- flow meter
- flagging tape

Calibration for Liquid Application

- **Known area method**
- **Boom sprayer method**
- **Band sprayer method**
- **Air-blast sprayer method**
- **Hand sprayer method**
- **Rate change methods**

Known area method — finding gallons per acre

One method of checking overall sprayer performance does not require any arithmetic. First, just mark off an acre. An acre equals 43,560 square feet. That's the same as a square with 209 feet per side or a rectangle 20 feet by 2,178 feet. Fill the spray tank with water and spray the acre as you would with pesticide. Measure the amount needed to refill the tank. This is your total spray volume per acre. If it takes 9.9 gallons to refill the tank, then you are spraying 9.9 gallons per acre. Check your calibration like this throughout the growing season. Note that this method does not reveal the condition of individual nozzles on the sprayer. Examine each nozzle to determine its output and to adjust its delivery.

Boom sprayer method

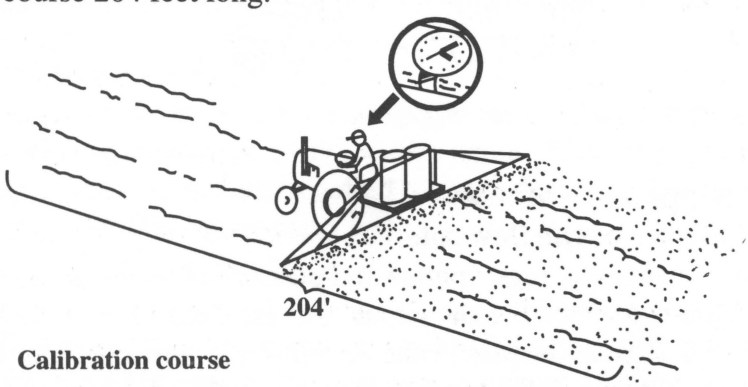
Boom sprayers meter pesticide solution out of several nozzles along a long pipe or structure called a boom. Each nozzle or group of nozzles along the boom should deliver the same amount of pesticide. When using a boom sprayer, follow these cleaning and calibration steps:

Step 1 — Prepare sprayer

- Thoroughly clean all nozzles and screens.
- Make sure all nozzles are the same make and model.
- See that the spray pattern from each nozzle is the same. Replace nozzles that do not have uniform spray patterns.
- Be sure all nozzles have the same volume of delivery. Check this by placing a container under each nozzle to collect the spray. Then measure the contents of each container using a graduated measuring cup marked in fluid ounces. All containers should fill to the same level. Replace any nozzle whose flow rate is 5 percent greater or less than the average flow rate of all the nozzles.
- Select an operating speed (usually 3 to 5 mph). When spraying, use the same speed used for calibrating.
- Select an operating pressure. Set the pressure with the pump running at normal speed. Make sure water is flowing through the nozzles.
- Inspect hoses for cracks and leaks. Replace if necessary.
- Make sure the pressure guage is working properly.
- Find exactly how much the spray tank holds. Do not rely on the manufacturer's rating. Into a completely empty tank, add clean water from a measured container. As the tank fills, mark or engrave it at various levels, or recalibrate the sight guage or dip stick.

Step 2 — Calibrate sprayer

- Measure a test course according to the table below. The length of the course is based on nozzle spacing. A nozzle spacing of 20 inches calls for a course 204 feet long.



Calibration course

Nozzle spacing (in)	12	16	20	24	28	32	36	40
Course length (ft)	340	255	204	170	146	127	113	102

- At your chosen tractor speed, clock the seconds it takes the sprayer to cover the measured distance. Do several runs. For best accuracy, read the time to at least the nearest second.
- With the sprayer motionless, operate at your selected pressure. Catch water from several nozzles for the same number of seconds it took to cover the measured distance.
- Find the average output per nozzle in fluid ounces. This output equals the gallons per acre applied for one nozzle per spacing. For the best accuracy, your collection device should measure to the nearest ounce.

NOTE: For directed spraying applications with two or more nozzles per spacing, multiply the average nozzle output by the number of nozzles per spacing to get the number of gallons applied per acre.

Band sprayer method

Band spraying is the application of pesticide to a strip along a crop row. Calibrate the sprayer using the same method above. However, the application rates for broadcast spraying must be adjusted in this case for the particular band width and row spacing.

Calculate the number of gallons applied per sprayed acre in the band by using this formula:

$$\frac{\text{Gallons per field acre}}{\text{Number of field acres}} \times \frac{\text{Row spacing (in inches)}}{\text{Band width (in inches)}}$$

Sprayed acre — the sum of the area of the treated bands.
Field acre — the total area to be treated.

Example

Application is 10 gallons per field acre in 12-inch bands on 24-inch rows. What is the rate per sprayed acre?

$$\frac{10 \text{ gallons}}{1 \text{ field acre}} \times \frac{24 \text{ inches}}{12 \text{ inches}}$$

The rate per sprayed acre is 20 gallons.

Air-blast sprayer method

Step 1: Measure nozzle flow rate

The nozzle orientation, high volume and pressure of an air-blast sprayer make it difficult to catch nozzle output. For each nozzle, place one end of a tube or hose over the nozzle and the other end into a bucket. Collect spray liquid for 60 seconds and then measure it. This step lets you know how much liquid is applied in one minute and helps you find faulty nozzles.

Step 2: Measure ground speed
Spray application rates vary with ground speed. It is best to measure your forward speed by traveling over actual field conditions and pulling the sprayer with a half-full tank. In orchard applications, you probably will work with tree row volume (TRV) calculations, where the volume of tree foliage dictates how much liquid to apply. For row crops, the application rate is based on area. In this situation, estimate the sprayed width. In either case, you should know exactly how much liquid comes out of each nozzle.

Never rely on your speedometer alone. Wheel slippage and variation in tire size (due to wear) cause as much as 30 percent difference between actual speed and the speed shown on your speedometer. Find your field speed by using a test course. Map out a course 88 feet long, which is 1/60 of a mile. Drive the course at your normal spraying speed. From a running start, record the number of seconds it takes to drive 88 feet. Divide the number of seconds into 60. The result is miles per hour.

Example
If you record 15 seconds while driving 88 feet, divide 15 into 60. The answer is 4. Your field speed equals 4 mph.

Hand sprayer method
Calibration is just as important for hand sprayers as it is for powered sprayers. Generally, manual sprayers are calibrated by finding the amount of liquid required to adequately cover a given area.

Step 1: Measure the area
Measure and mark off an area 10 feet by 10 feet (100 square feet). Practice spraying it with water. The most uniform method for a rectangular area is to spray twice, walking and swinging the nozzle back and forth, making the second application at right angles to the first.

Step 2: Measure the liquid
Once you can maintain a uniform spray pattern, fill the sprayer with water to a known mark and spray the area again. Refill the sprayer and measure the amount of water required to reach the mark. That is the amount used per 100 square feet.

Example
One gallon of water is added to a one gallon hand-operated sprayer. After spraying a 100 square-foot test area, 8 ounces of water are needed to refill the tank. At this application rate, how many square feet could be treated with one gallon?

Answer: One gallon contains 128 ounces. Eight ounces are needed per 100 square feet. Divide by 8 to find how many hundred square feet can be treated with one gallon.

$$128 \div 8 = 16$$

Sixteen hundred square feet — 1,600 sq.ft. — can be treated per gallon of spray mix.

Rate change methods

If your sprayer is delivering too little or too much spray to each acre, you can change the rate by using one of three methods:

Change the pump pressure. Lower pressure means less spray delivered; higher pressure means more spray delivered. This is usually not a good method because pressure change affects the nozzle pattern.

Change the speed of your sprayer. Slower speed delivers more spray; faster speed delivers less spray. Doubling the ground speed of the sprayer reduces the application rate by one-half. Speed change may be practical for small changes in number of gallons, but not for large adjustments.

Change the discs or jets in the nozzles to adjust the amount each nozzle delivers. The larger the hole in the disc, the more spray delivered. This is usually the preferred method.

Granular Application

Granular application equipment varies from small home lawn units to large field units built for covering wide swaths. Each type must be calibrated carefully. Calibration requires you to measure the amount of granules spread over a known area. Because each granular product flows differently, you must calibrate with the product you will actually use. Recalibrate each time you switch products.

Run a calibration test over an area where the granules can be collected (such as a tarp-covered area or concrete driveway). Speed is not a critical factor when the equipment is ground-driven. However, the speed should allow an even flow of material.

Step 1: Measure the area

Mark off the test site and measure it. Apply granules to the site. If you cannot spread over a measured area, then place a bag or catch pan under the spreader to catch the granules. The catch container must not interfere with delivery of the product.

Step 2: Weigh the granules
Collect the granules from the measured area and weigh them. The application rate is the weight of material collected for the area covered (usually per 1,000 sq.ft. or per acre).

Example 1
You are applying insecticide from a chemical box on a corn planter, using a 12-inch band. You place a bag under the drop tube to collect granules and then drive the planter a total of 1,000 feet. The bag collects 1 ounce of insecticide. What is the application rate in ounces per treated acre?

$$\text{Application area} = \frac{\text{band width x 1 foot x distance traveled}}{\text{12 inches}}$$

$$= \frac{\text{12 inches x 1 foot x 1,000 feet}}{\text{12 inches}}$$

$$= 1{,}000 \text{ square feet}$$

$$\text{Application rate} = \frac{\text{1 ounce (dry)}}{\text{1,000 sq ft}} \times \frac{\text{1 pound}}{\text{16 ounces}} \times \frac{\text{43,560 sq ft}}{\text{1 acre}}$$

$$= 2.72 \text{ ounces per treated acre}$$

Example 2
You wish to apply turf chemicals using a push-type drop spreader. Measure a 1,000 sq.ft. test area (20 ft. by 50 ft.) on smooth concrete. Add the chemicals to the spreader and apply over the test area. Then sweep the material up and weigh it. If you find that 6 ounces of chemical is used, what is the application rate?

$$\text{Application rate} = \frac{\text{6 ounces (dry)}}{\text{16 ounces}} \times \frac{\text{1 pound}}{\text{1,000 sq.ft.}}$$

$$= 6 \text{ ounces per 1,000 sq.ft.}$$

Check for Mistakes

After you calibrate application equipment, check it often. Be sure you treat the same size area (in acres or square feet) for each tankful. If you find you are treating more or less area than you planned, stop immediately and recalibrate. If you figured wrong or your equipment malfunctions, you should catch it before you make a major mistake.

Knowing the facts behind calibration makes it simple and easy. A well-calibrated sprayer does a more effective job and saves on materials and money.

Study Questions

1. Even when you have the right mixture in your spray tank, you can still apply the wrong amount of pesticide.
   True False
2. An air–blast sprayer is difficult to calibrate because its nozzle output is hard to catch
   True False
3. Once your sprayer is calibrated, its delivery rate will remain constant.
   True False
4. If your sprayer delivers less spray to each acre than you want it to, how would you change the rate?
   a. Increase pressure
   b. Reduce ground speed
   c. Change to larger nozzles
   d. Any of the above
5. What must you measure to calibrate granular application equipment?
   a. The ground speed of the spreader
   b. The weight of granules spread over a known area
   c. The amount of granules placed in the spreader
6. You must calibrate granular application equipment each time you change granular products.
   True False
7. How many square feet equal one acre?
8. Thirty-two ounces of water was collected from one spray nozzle in 30 seconds. What is the nozzle delivery rate in gallons per minute (GPM)?
   a. .03 GPM
   b. .5 GPM
   c. 1.2GPM
9. Speedometers are accurate enough to use in calibrating pesticide equipment, so there's no need to test your actual speed.
   True False
10. To measure speed in miles per hour, use a test course that is _____ feet long. Record the seconds it takes to drive the course from a running start, and divide the seconds into _____.

1. true
2. true
3. false
4. d
5. b
6. true
7. 43, 560
8. b
9. false
10. 88, 60

Weather-Wise Application

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Weather-wise application can reduce pesticide hazard to the environment. A good applicator carefully checks weather conditions before starting a job. This not only protects the environment, but helps save money. Pesticides that do not reach or remain on the target are wasted. Then you end up using more pesticide, time and money to control the pests.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Learn how weather can help or hinder your work.
- Understand the hazards of application on windy days and who is legally responsible for mistakes.
- Understand the effects of humidity and temperature inversion on pesticide application.
- Learn the advantages of early morning and evening application.

Avoid These Conditions

- **High temperature and low humidity**
- **High winds**
- **Air turbulence and inversions**
- **Rain**

High temperature and low humidity

Temperature and humidity affect pesticide drift. High temperature and low humidity increase pesticide evaporation rates. Small droplets that completely evaporate leave pesticide particles in the air that may be carried miles away (vapor drift).

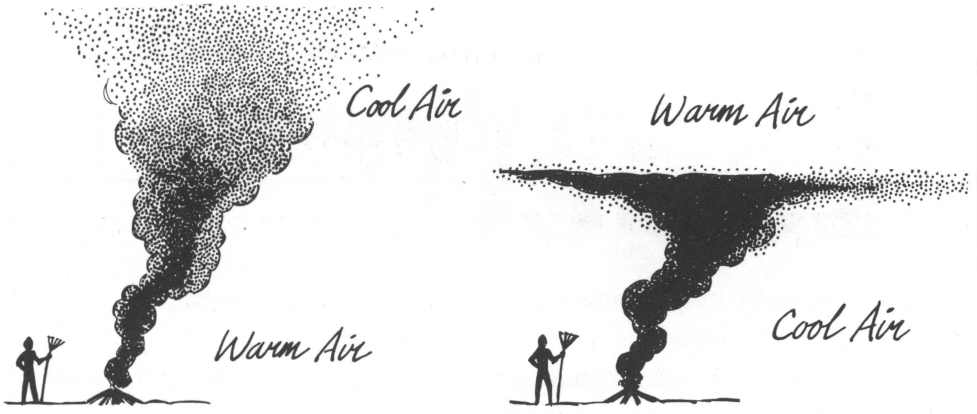
High winds

High winds increase drift and loss of pesticide from treated sites. Drifting pesticides increase the risk of injury to nontarget plants, wildlife, pollinators and domestic animals. The pesticides also may contaminate water, forage, pasture and wildlife areas. Pesticide application on calm days reduces drift. It also reduces the inhalation and contact hazard to you and other people. You are legally responsible for any injury or damage due to pesticide drift. Don't take a chance by spraying in the wind.

Air turbulence and inversions

The drift of pesticides also is affected by air turbulence. Turbulence results from a difference between air temperatures at ground level and above ground level. Normal weather causes heating of the soil. If the air just above the soil becomes warmer than the air aloft, upward air currents begin. The larger the temperature difference between air on the ground and the air above, the stronger the currents. Strong air currents can carry spray droplets and pesticide particles a long way. Do not apply pesticides when such turbulence exists.

An *inversion* occurs when air near the ground is cooler than the air above it. The warm air above forms a cap, blocking upward air movement that otherwise would help disperse airborne chemicals.



Normal conditions:
Smoke rises and disperses

Inversion condition:
Smoke concentrates

Wind helps mix air and reduce inversion conditions. However, low wind during an inversion may leave small spray drops suspended in the air. The droplets eventually will move out of the treatment area as a concentrated cloud. Smoke can be used as a good indicator of an inversion. Do not apply pesticides when such conditions exist.

Rain

Do not apply sprays just before a rain. Rain washes off the pesticide, thus preventing pest control. Rain also causes runoff. Runoff may carry pesticide into sensitive areas where crops or wildlife could be injured. Runoff also may reach surface waters such as farm ponds and streams. In the end, this can cause pollution, fish kills and injury to domestic animals.

Apply in Early Morning or Evening

Usually the early morning and evening have lower wind speed and higher humidity — conditions that greatly reduce drift hazard. Also, children and domestic animals are less likely to be around during these hours. By avoiding full daylight hours, you also lower the contact danger to birds, mammals, pollinators and other wildlife that visit croplands during the day.

Study Questions

1. Wind can actually help reduce air pollution during an inversion.
   True False
2. Weather-wise applications can help you save money by saving the pesticide lost through _____ and _____.
3. Windy day application increases hazard to you and bystanders.
   True False
4. If pesticide drifts onto a nontarget area, causing injury or economic loss, the applicator is legally responsible.
   True False
5. Why must spray applications dry onto a surface before a rain?
   a. So the rain won't cause runoff of the pesticide.
   b. So the rain won't dilute the pesticide.
   c. Because rainwater sometimes reacts with the pesticide and may harm the plant.
6. What harm can pesticide runoff do?
   a. It can harm nontarget plants.
   b. It can harm wildlife.
   c. It can pollute water.
   d. All of the above
7. What weather factors *reduce* drift?
   a. Lack of wind, low temperatures and low humidity
   b. Lack of wind, low temperatures and high humidity
   c. Low wind, high temperatures and high humidity
8. What conditions make early morning or evening a good time for application?
   a. Wind speed is lower and humidity is higher than other times of day.
   b. Both wind speed and humidity are lower.
   c. Both wind speed and humidity are higher.
9. When does an inversion occur?
   a. When air near the soil surface is warmer that the air above it.
   b. When the surfce air has lower humidity that the air above it.
   c. When the surface air is cooler that the air above it.

1. true
2. drift, runoff
3. true
4. true
5. a
6. d
7. b
8. a
9. c

Disposal 20

As an applicator you have two disposal problems. First, you must safely dispose of surplus pesticides (concentrated or tank mixed) that you cannot use or store. Second, you must safely dispose of empty pesticide containers. Careless disposal practices are a common cause of pesticide misuse and pollution. Take the time to dispose of surplus pesticides and empty containers carefully and legally. Never give empty containers away for any purpose.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Learn how to prevent pesticide surplus.
- Know what to do with pesticide surplus.
- Understand and learn the steps to properly dispose of pesticide containers.
- Learn proper procedure for triple-rinsing containers and equipment.

Preventing Pesticide Surplus

There are many ways you can end up with surplus pesticides. The government or manufacturer may cancel the registration of one of your pesticides. The pesticide may break down, the container may get damaged or the label may get lost. You may buy more pesticide than you really need or have some mixture left after a job. Plus, you may have contaminated water left from cleanups and rinsing.

Although you cannot always avoid having surplus pesticides, there are ways to keep them to a minimum. Before you buy, always check that the pesticide is registered by both the EPA and the state. Make sure the pesticide is labeled for your problem. Recommendations may change and new chemicals may be better than old ones. Estimate your needs and buy only what you need. Do not store a pesticide longer than its effective shelf life. Do not stockpile materials. This reduces carryover and the chance of spills, container damage and breakdown. Always check out your job before mixing pesticide in the tank. Then you will not be faced with disposal of the wrong chemical mixture for the pest problem. Mix only enough pesticide for the job at hand so that you finish with an empty tank or hopper. Preventing surplus is the best way to avoid pesticide disposal problems.

What to Do with Surplus Pesticides

If you have pesticides you cannot use or do not want, you must safely and legally dispose of them. Ask the manufacturer if you may return pesticides that are still factory-sealed. For excess pesticide mixture, find out if you can apply the mixture to another site with a pest problem that can be treated with the same chemical. If possible, use rinsewater from your spray tank in a future spray mix of the same pesticide. Be careful with herbicide-contaminated rinsewater around sensitive plants. Do not reuse rinsewater in mixtures of other pesticides. It is not legal and may cause illegal residues. Never dispose of rinsewater in a way that pollutes public or private water or sewage treatment plants.

Farmers may dispose of surplus spray mixture and rinsewater on their own property, if the site complies with the label. If the manufacturer won't take back your concentrates and you cannot use them, you must find other safe and legal ways to dispose of them. Other certified applicators might be able to use your pesticide leftovers to control a similar pest problem. The Resource Conservation and Recovery Act supports regional "Pesticide Waste Cleanup Days" to properly discard hazardous material and waste. Contact the Texas Department of Agriculture to find out dates for such cleanup days.

Place extra pesticides in a locked storage area while you wait to dispose of them. Keep them in their original containers with the label intact. If containers become damaged or leaky, pack them in another container and attach the label.

Empty Pesticide Containers

Empty pesticide containers are not really "empty." They still contain pesticide residue even after proper rinsing. Never toss them into streams, ponds, fields or vacant buildings. Be able to account for every pesticide container used for each job. Never give the containers to children or to uninformed persons for any reason. Check with pesticide manufacturers to learn which containers they accept for recycling. When containers cannot be recycled, follow the guidelines below.

After using containers for liquid formulations:

1. Triple-rinse the container immediately. Follow these steps:
   — Fill the container one-quarter full with the proper diluent (water, oil or liquid fertilizer).
   — Replace the closure, or plug the opening of the container.
   — Rotate the container, making sure to rinse all surfaces.
   — Turn the container upside down.
   — Add the rinsate to the spray tank.
   — Allow 30 seconds for rinsate to drain.
   — Repeat this procedure two more times.
2. Puncture the top and bottom of the container to prevent reuse. Crush flat.
3. Deposit the container in a licensed sanitary landfill.

After using containers for dry formulations:

1. Completely empty the contents of the container into the tank.
2. Open both ends of the container to help remove any remaining pesticide and to prevent reuse of the container.
3. Deposit the container in a licensed sanitary landfill.

After using containers for aerosol formulations:

1. Relieve pressure as much as possible. Do not puncture the container.
2. Deposit the container in a licensed sanitary landfill.

If you save triple-rinsed containers for disposal at a later time, mark them with the date and note that they have been rinsed. Reseal containers that will be recycled and wash them off completely before shipping. Break, puncture or crush pesticide containers that will not be recycled so they cannot be reused. This also saves storage space. Crush metal drums with a backhoe, front-end loader, truck or tractor; carefully break glass containers; and cut apart plastic containers. Place these wastes in locked storage until disposal, keeping them safely away from children and animals.

Containers of organic or inorganic pesticides with mercury, lead, cadmium and arsenic have special disposal rules. Improper disposal could cause serious pollution and long-term health hazards. The label lists legal disposal methods. Also check federal and state regulations. Special methods such as encapsulation may be needed. This involves sealing the used pesticide container inside another container. The new container must be sturdy and waterproof so that its contents cannot possibly get out. Other methods include burial in hazardous waste landfills and burning in special incinerators. When sending containers to these places, you pay the disposal fees and packing and shipping costs. You also must pay for a chemical analysis if you do not know the exact name and concentration of the chemicals.

Disposal Methods

- **Incineration**
- **Burial**

Disposal of pesticides and their containers can be a problem. Return them to the manufacturer whenever possible. Otherwise, choose a method that protects you, others and the environment. Federal and state laws may require certain methods for certain pesticides.

Incineration

In Texas, it is illegal to burn pesticides or their containers. However, burning these wastes in special, high temperature incinerators is permitted elsewhere at EPA-approved landfills. These incinerators reduce pesticides to harmless gases and solid ashes. To find the nearest pesticide incinerator, contact your regional Environmental Protection Agency office. Federal laws that govern incineration are: the Resource Conservation and Recovery Act (RCRA); the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA); and the Clean Air Act.

Burial

This is the least preferred disposal option. It is no longer listed on any pesticide label. Burial is legal only if allowed by state or local laws. Because any burial site may be close to underground water, there is always the risk of chemicals reaching the water. Ground and surface water should be carefully protected. Find out if there is a special pesticide landfill in your area. Do not bury pesticides or containers that held mercury, lead, cadmium, arsenic or inorganic pesticides, even if they are encapsulated. Once a hazardous material is buried, its fate in the environment is never sure. Contact the Texas Water Commission anytime you plan to dispose of pesticide waste by burial.

Take the extra time to dispose of surplus pesticides and empty containers safely. It is well worth your effort!

Study Questions

1. Why should you carefully dispose of surplus pesticides and empty containers?
   a. To prevent escape of pesticide wastes into the environment.
   b. To avoid potential health hazards to people and animals.
   c. To satisfy legal requirements.
   d. All of the above
2. What problems result from buying more pesticide than you can use?
   a. Storage and disposal problems
   b. Loss of pesticide effectiveness during storage
   c. Unnecessary handling risks
   d. All of the above
3. What is the proper way to dispose of surplus concentrated pesticide that is still in its original container?
   a. If it is unopened, return it to the manufacturer or distributor.
   b. Take it to a landfill.
   c. Give it to another certified applicator to use.
   d. A and C
4. If you rinse out an empty pesticide container three times, you can use it for another purpose or let children play with it.
   True False
5. What should you do with rinsewater if you can't add it to the tank mix?
   a. Just spread it over the ground — it's harmless.
   b. Apply it on a site with a similar pest problem.
   c. Save it and add it to the next tank mix.

1. d
2. d
3. d
4. false
5. b

6. How should you dispose of empty cardboard fungicide containers?
   a. Triple-rinse them and bury them.
   b. Dispose according to label instructions.
   c. Triple-rinse and burn them.
7. What should you do to dispose of empty metal, glass or plastic containers?
   a. Bury them.
   b. Burn them.
   c. Try to return them for recycling.
8. _____ seals the pesticide container so that leaking of dangerous chemicals does not occur in the final disposal.
9. Certain methods of incineration are acceptable for pesticide disposal.
   True False
10. Burial of surplus pesticides and empty containers is one of the preferred disposal methods.
    True False
11. Can you incinerate or bury surplus pesticides or containers that have mercury, lead, cadmium, arsenic or other inorganic chemicals in them?
    a. You can incinerate but not bury them.
    b. You can bury but not incinerate them.
    c. You can either incinerate or bury them.
    d. You can neither incinerate nor bury them.
12. Which federal and state laws regulate pesticide disposal methods?
    a. Federal Insecticide, Fungicide and Rodenticide Act
    b. Resource Conservation and Recovery Act
    c. Clean Air Act
    d. All of the above
13. To triple-rinse a pesticide container, you should *completely* fill the container with diluent for each rinse.
    True False
14. The risk of water pollution from burial of empty containers is less than the risk of air pollution from incineration.
    True False
15. How can you prevent pesticide waste surplus?
    a. Buy only the amount of pesticide you need.
    b. Calibrate equipment so you apply only the amount needed.
    c. Reuse pesticide rinsates.
    d. All of the above
16. What type of pesticide container should *not* be punctured for disposal?
17. Why should you dispose of pesticide waste in an EPA-approved sanitary landfill rather than a municipal dump?
    a. Because all peticide waste must be disposed of in a federal facility.
    b. Because municipal dumps are too close to populated areas.
    c. Because EPA-approved landfills meet federal standards of construction and operation.

6. b
7. c
8. Encapsulation
9. true
10. false
11. d
12. d
13. false
14. false
15. d
16. aerosol
17. c

Storage 21

No job is really finished until you properly put away your pesticides, containers and equipment. Get into the habit of storing all materials safely before you clean up and go home or start the next job. Be sure to wear appropriate personal protective equipment. Consider wearing gloves and other protective gear, even if they aren't recommended on the label. Spills and accidental exposure often occur during storage procedures.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Learn how to choose and arrange a storage area for pesticides.
- Understand the importance of handling, storing and disposing of pesticides properly.
- Learn what to do in case of a pesticide spill.

The Storage Building

- **Choose the best site**
- **Equip the building properly**

Most applicators store pesticides in existing buildings. If possible, keep the chemicals in their own separate building. Otherwise, choose a first-floor wing or corner of a building.

If you use a lot of pesticides and equipment, it would be best to construct a special storage building just for them. Before starting, check the latest construction guidelines from sources such as state colleges, chemical companies and county extension agents. Also, when planning any new storage area, be sure to check federal, state and local regulations on storing pesticides.

Choose the best site

When choosing a building or building site, consider these points. The site should be unlikely to flood. It should be downwind and downhill from sensitive areas such as houses, ponds and play areas. There should be no chance that runoff or drainage from the site could contaminate ground or surface water. Select sites with soil, geologic and hydrologic characteristics that help protect water from contamination.

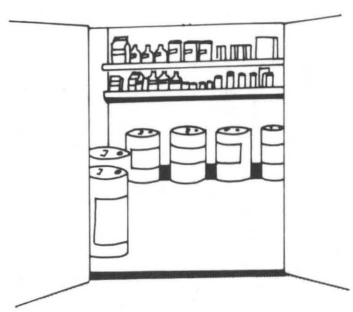
Equip the building properly

Store pesticides in a cool, dry, airy, fireproof room or building. Fans are an important feature of any pesticide storage building. The ventilation system should have a switch outside, so you can turn on the fan before entering the room. The building should be fenced or at least locked tightly. Hang weatherproof warning signs over every door and window. Plan how to control pesticides that may escape in tank rinsings, spills, seepage from storage, and heavy runoff from fire fighting or floods. Dikes, collecting pools and washing slabs with sumps provide a proper drainage system and may be required. Treat collected runoff water as a surplus pesticide and dispose of properly.

A good supply of detergent or soap, hand cleanser and water is a must in the storage area. It's convenient for equipment cleanup and for your own cleanup. It's also quick first aid in a poisoning emergency. Keep clay, activated charcoal, vermiculite, pet litter or sawdust readily available at the storage site to soak up spills and leaks. Also keep hydrated lime and high pH commercial detergent on hand to neutralize pesticide in an emergency. A shovel, broom, dust pan and fire extinguisher are other musts in storage areas.

Storing Pesticides

- **Position containers properly**
- **Avoid temperature extremes**
- **Separate herbicides**
- **Separate highly toxic pesticides**
- **Separate waste materials**



Use pesticide storage space only for pesticides and pesticide equipment. Never store or use food, drinks, silverware, tobacco products or personal protective clothing in the storage or loading area. Never store livestock feed, living plants or seeds with or near pesticides.

Position containers properly

Store pesticide containers with the label in plain sight. Also keep them off the floor, especially if they can be damaged by dampness. Always set rigid containers in an upright position so they cannot spill. Place containers in orderly rows with enough room to allow you and others to walk between them.

Avoid temperature extremes

Never allow any pesticide to become overheated. Some formulations combust if they get too hot, while others lose their strength and break down. Still others vaporize and become a health hazard. Do no store glass and metal containers of liquid pesticide in the sun or near heat sources such as steam pipes and furnaces. Liquids expand when heated, placing the contents under pressure. When you open the container, the pesticide could spray out on you. Do not store liquid pesticide where the temperature can rise above 100°F or fall below 40°F.

Store other pesticides at temperatures above freezing or as directed on the label. Protect sensitive pesticides from freezing. Freezing destroys the usefulness of some products. Freezing also may cause liquids to break their containers, resulting in leakage.

Separate herbicides

Store herbicides in a special place apart from other pesticides and fertilizers, seeds and bulbs. Some herbicides can vaporize and get into other pesticides nearby. When the contaminated pesticide is used, the herbicide in it could injure or kill crops and sensitive plants.

Separate highly toxic pesticides

Store all highly toxic pesticides together in a special area. Then you can take special precautions to prevent exposure when working in that area. Also, you will be less likely to use a highly toxic pesticide by accident.

Separate waste materials

A special area should be used for surplus pesticides and containers being held for disposal. Group them by chemical family and plainly label how you plan to dispose of them. This helps prevent mix-ups resulting in improper disposal and accidental reuse.

Pesticide Containers

Store pesticides in their original containers, with the label plainly visible and the seal cap securely closed. Mark containers with the purchase date. Discard outdated material. To reduce the risk of improper storage, maintain a complete inventory indicating the amount, identity and date of purchase. Never store pesticides in soda bottles, fruit jars, milk cartons, etc. Storing pesticides in improper containers is a common cause of pesticide poisoning. Never dump a little of your tank mix in a jar and give it to someone.

Check all pesticide containers often for corrosion, leaks and loose caps or bungs. Correct these dangerous conditions immediately. If a container is damaged, put it in a sound, suitable larger container that can be sealed and labeled. Often the label from the damaged container can be fastened firmly to the new container. Paper drums or plastic bags placed within another container are handy for this purpose.

Unlabeled pesticides are dangerous since you don't know what they are or how to use them. Set them aside and hold for disposal. Reseal partly empty pesticide containers and return to storage. Never store opened containers of chlorates (often used as weed killers). They can burst into flames at any time.

Equipment

Store all pesticide application equipment in a special area. All movable pesticide equipment should have a sign: "Danger — Pesticides" to warn people to stay away. All items used for handling pesticides, which might be used for other purposes, should be labeled "contaminated with pesticides." Do not remove them from the site unless you thoroughly decontaminate them. Never let children or uninformed people near your equipment. They could receive a harmful dose of pesticide.

Always wash equipment carefully before you store it. Thoroughly rinse the outside while it is parked in a special wash area. Do not allow rinsewater to get on the ground and into streams, ponds or other sensitive areas. Collect the rinsewater and hold for proper disposal. Delivery trucks, nurse tanks and other support equipment also should be rinsed thoroughly and stored.

Have on hand materials such as clay, hydrated lime and high pH commercial detergent for emergency cleanup of spills and leaks. Keep a shovel, broom, dust pan, absorbent material, sprinkler can and disposal container for decontamination and cleanup of spilled materials.

Safety Measures

- **Basic safety**
- **Emergency safety**
- **Monitoring system**

A little care and common sense can help prevent many accidents and emergencies in the storage area. Know basic safety rules and follow them. Also know what to do in case of an emergency. Make a list of safety procedures and post it in the storage area. Be sure everyone follows these rules.

Basic safety

- Follow all safety precautions specified on the label and labeling.
- Inspect all pesticide containers for leaks before handling.
- Do not allow children, pets or uninformed persons in the storage area.
- Wear gloves when handling containers of pesticide concentrates. Use more personal protective equipment if the label says to.
- Do not put your fingers in your mouth or rub your eyes while working.
- Do not store or use tobacco, food or drinks in areas where pesticides are present.
- Wash your hands carefully before eating, drinking, smoking or using the toilet. Wash them as soon as you finish handling pesticides.
- Do not handle pesticide containers roughly; they are not meant to be thrown, dropped or abused.

Emergency safety

In case of spills. In spite of all safety precautions, accidents can happen. If a pesticide spills in your storage area, take action quickly. If the pesticide gets on someone, have the person get out of the area, wash quickly and thoroughly, change clothes and see a doctor if necessary. Clear the storage area except for a small cleanup crew. Be sure the crew wears proper personal protective equipment. Notify authorities as described in SARA Title III, Section 304, Emergency Release Reporting, if the spilled pesticide is covered by SARA; or by contacting federal, state or local pesticide authorities.

If the spill is a liquid, throw activated charcoal, clay, vermiculite, pet litter or sawdust over the entire spill. Use enough to soak up most of the liquid. Then sweep or shovel it into a large drum. If the spill is a dust, granular or powder, sweep or shovel it directly into a large drum. Sweeping compound can be useful when picking up spills of dry pesticides. Next, cover the spill area with a decontamination product recommended for that particular pesticide. Consult the manufacturer or your supplier if necessary. Hydrated lime and high pH commercial detergents often are recommended. Repeat this procedure several times. When you are finished, seal the drum tightly and store for disposal.

Rinse the whole area with plenty of water to wash away any remaining poison. Collect the rinsewater and hold it for proper disposal. Check your storage area carefully to see if any other pesticides were contaminated by the spill. If so, do not take a chance on using them — dispose of them as well.

In case of fire. Inform your local fire department, hospital, public health officials and police of the location of your pesticide storage building. Warn them of possible hazards and of proper protective clothing to wear in case of fire. Suggest that they wear air-supplied respirators and chemical-resistant clothing. They should avoid contacting or breathing smoke and fumes at all times. If they do contact smoke or fumes, they should leave the area fast and wash off. Post signs around the area and, if possible, give fire department officials a floor plan of the storage area. Keep all people without protective gear away from the fire. Remove anyone who might contact smoke, fumes or contaminated surfaces. Because it could be poisonous, all water used in fire fighting should be contained in the storage area drainage system for safe disposal.

Monitoring system

If you store large quantities of pesticides, consider setting up an environmental monitoring system. Arrange to have samples taken from water, wildlife and plants near the storage area. Test the samples to be sure that no pesticides are getting into the environment.

Storage Facility Checklist

Yes	No	
[ ]	[ ]	Separated from offices, workshops, livestock areas
[ ]	[ ]	Separated from wells, streams, lakes, ponds andwildlife
[ ]	[ ]	Separated from food and feed

[ ] [ ] Fire-resistant building materials

[ ] [ ] Impermeable flooring

[ ] [ ] Liquid spill containment (berms, 25% of liquid storage)

[ ] [ ] Anti-spark electrical components

[ ] [ ] Heating system (Maintain above 32° F.)

[ ] [ ] Ventilation system with an outside switch (to vent vapors and maintain at less than 95° F)

[ ] [ ] Locked doors

[ ] [ ] Fenced

[ ] [ ] Warning signs posted

[ ] [ ] Racks for off-floor storage

[ ] [ ] Emergency eyewash and shower immediately available

[ ] [ ] Routine wash-up facilities nearby

[ ] [ ] Spill kit and fire extinguishers readily available

[ ] [ ] Personal protective equipment available

[ ] [ ] First aid kit

[ ] [ ] Prepared emergency response plan on file

[ ] [ ] Pesticide inventory on file

Make it a habit! Store pesticides and equipment properly before you clean up and go home or start the next job.

Study Questions

1. Why wear protective clothing while you store pesticides, containers and equipment?
   a. To protect your street clothes from contamination.
   b. To minimize your exposure in case of a pesticide spill.
   c. To protect the chemicals you're handling from contamination.
2. In case of fire in your storage area, what should fire fighters wear?
   a. Air-supplied respirators and chemical-resistant clothing
   b. Gas masks and chemical-resistant clothing
   c. Regular respirator and rubber clothing
3. Which of these factors should you consider when choosing a storage site?
   a. Nearness to sensitive areas
   b. Whether flooding is possible
   c. If the site is upwind or uphill from sensitive areas
   d. All of the above
4. In what kind of container should pesticides be stored ?
   a. If undamaged, store in the original container.
   b. If damaged, store in a new, clean container and attach original label.
   c. Always store original container, whether it is damaged or not, encapsulated within a larger container.
   d. A & B
5. What is the main problem with runoff water from your storage area?
   a. It could hurt animals that might drink it.
   b. It could contaminate ground or surface water with pesticide residue.
   c. It is a waste of water.
6. How should you treat collected runoff?
   a. As hazardous waste
   b. As surplus pesticide
   c. As rinsewater
7. Why is a good supply of soap and water a "must" in any pesticide storage area?
   a. To make decontamination and cleanup possible.
   b. So you can wash your hands.
   c. To meet health regulations.
8. What other materials should be on hand in a good storage area?
   a. Activated charcoal, clay, vermiculite or pet litter
   b. A water hose to wash away liquid spills
   c. A trash can for disposal of spilled dry pesticides
   d. All of the above

1. b
2. a
3. d
4. d
5. b
6. b
7. a
8. a

9. If you are careful, the storage area also may be used to store your lunch, tobacco and street clothes while you are on the job.
   True False
10. Why should the storage area be kept cool?
    a. To provide a more comfortable workplace.
    b. To prevent condensation.
    c. To stabilize flammable chemicals.
11. Why should herbicides be stored in a special place apart from other pesticides?
    a. They must be stored at a different temperature.
    b. They are more hazardous than other types of pesticides.
    c. They can vaporize and spread into adjacent pesticides.
12. How should you organize the disposal section of your storage area?
    a. Alphabetically
    b. By chemical family
    c. By disposal method
13. What should you do when you discover that one of your pesticide containers is corroding?
    a. Dispose of it immediately.
    b. Wrap it in plastic that can be sealed and labeled.
    c. Put it in a larger container that can be sealed and labeled.
14. How should you store opened containers of chlorates?
    a. Store away from other pesticides.
    b. Store in an airtight container.
    c. Do not store at all.
15. If a customer asks for a little of your tank mix and hands you an empty glass jar, it is all right for you to give him some as long as you warn him carefully.
    True False
16. Cleanup steps for pesticide spills include:
    a. Wearing suitable protection.
    b. Using absorbent materials or sweeping compound.
    c. Collecting used cleaners and soaked up spill and sealing in a drum.
    d. All of the above
17. Materials used to absorb a spill should be treated the same as pesticide waste.
    True False

9. false
10. c
11. c
12. b
13. c
14. c
15. false
16. d
17. true

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Record Keeping & Liability

Besides meeting legal requirements, keeping records of pesticide usage is a wise precaution. Records establish proof of proper pesticide use and help protect you from damage claims. Even the most careful applicators sometimes have a damage claim brought against them. It is important to know what kinds of records to keep as well as what kinds of claims are most commonly made against pesticide applicators.

Texas Agricultural Extension Service

The Texas A&M University System

Learning Objectives

- Learn how pesticide application records can help you.
- Understand the importance of standard forms.
- Recognize and understand the liabilities of incorrect application procedures.
- Learn the steps to take to protect yourself against law suits.
- Understand the importance of insurance.

Records You Should Keep

Records establish proof of proper pesticide use. They also help find the cause of error, if an error has been made. In addition, records can help you: trace residue and damage problems; save money by improving your pest control practices and efficiency; and compare results obtained from different pesticides. Also, careful records from year to year guide you in buying only the amount of pesticides you need.

The more data you keep on record, the more useful your records will be. Do not try to memorize everything. Instead, carry a notebook with you in the field. Fill in a standard form to be sure you get all the necessary data every time. Obtain or make a form that includes these items:

1. Application date and time, plus each time application starts and stops.
2. Person for whom the application is done (owner or lessee).
3. Location of the target site. Include in your files a description and directions that would enable other authorized persons to find the site.
4. Pesticide used, including: product name, EPA registration number, active ingredients, spray diluents and surfactants, rate of active ingredient per unit, total amount of active ingredient, and total volume of spray mix applied per unit.
5. Name of target pest.
6. Name of treated crop, animal or site.
7. Amount or numbers treated (trees, acres, animals, etc.)
8. Wind direction and velocity, air temperature and humidity.
9. FAA "N" number of aerial application equipment, or identification number of other types of equipment, and decal number affixed to the application unit.

10. Additional comments, including applicator's name, severity of infestation and preexisting condition of the target site.

On every record form there should be a space left for additional comments. Use this space to jot down information for your own personal use. This information can benefit your business by helping you improve customer relations or save money. Such records also can be helpful in liability cases.

Remember, the job is never finished until the paperwork is done.

Liability

No matter how careful you are, you may have a damage claim brought against you. The usual claims are for nonperformance, misapplication, personal injury, crop injury, property damage and contamination of nontarget areas. The following sections explain what your liability may be in certain situations. *Liability* is your obligation according to law to compensate for damages.

Drift

Drifting pesticides are a major cause of environmental pollution and off-target damage. In most drift law suits, the applicator and the customer who hired him are held jointly liable. The customer is responsible when he hires or contracts for a "particularly dangerous operation" such as pesticide application. However, don't expect the customer to share costs. He may file a law suit against you claiming you agreed not to cause drift damage. In certain cases, if the label does not clearly warn about drift, the pesticide manufacturer also may be liable.

Target Site

Claims of injury to a treated site (crop, turf, shrub, etc.) and claims of ineffective pesticide involve the dealer, manufacturer and applicator. The courts must decide who recommended or guaranteed the product for specific use on that target. The party in error must accept the blame and pay damages. As the applicator, make sure all pesticides you use are recommended on the label for your purpose. Detailed records of all applications can be used to support your claim of proper pesticide use. Only then may the blame possibly be placed on the manufacturer.

In some cases, the customer or applicator must determine how much damage resulted from the pesticide versus other conditions such as weather and disease. This breakdown is not necessary for sites with great or total injury. Both you and your customer may be held liable for injury caused by negligent application.

Personal Injury

Pesticide application is considered very dangerous or, in legal terms, "ultra-hazardous." As a result, the applicator may be liable for any injury to a person caused by pesticide. The injured person must prove only that he is free of negligence and did not assume the risk of pesticide exposure. Proving the applicator negligent also may be required in some cases.

Wrong Site

If you apply pesticide to a field, crop or site other than the one it was intended for, serious problems can result. If damage or over-tolerance occurs, or if the owner just didn't want the site treated, you may be charged with negligent application. Defense is very difficult. Double-check addresses, site locations and all landmarks before you treat an area. Applying pesticides to the wrong site can be very costly.

Bees

Honeybees are very important to farmers, who often have their own colonies or hives. As insects, bees can be hurt easily by many pesticides. If bees are killed in their hives by drift from your application, you can be sued for damages. However, you are liable only if you failed to notify adjacent landowners before the application.

If roving bees are exposed to pesticides, you are not usually liable. Unless you ignore a label direction that would protect the bees, the courts have ruled the bees are trespassing and that the land doesn't need to be safe to uninvited animals. Play it safe! Know where beehives are located in your area. Warn the beekeeper beforehand when and where you will spray.

Attractive Nuisance

Court rulings on "attractive nuisance" usually involve cases where children are attracted to ground equipment, service vehicles or aircraft and injure themselves. The owner and applicator risk liability for injury to a child, even when the child trespasses, if they fail to take reasonable precautions to guard children from danger. Reasonable precautions are required when children are known to frequent an area.

So beware! Do not leave ground equipment with exposed drive belts, drive wheels, gears or moving parts in areas that children could enter. Never park aircraft in unsecured areas. Never leave pesticides unattended in unlocked or open vehicles. Also, store and dispose containers properly! They too are attractive and dangerous to children.

Noise

Recently claims have been brought against applicators for noise damage. Home owners and others have claimed damage or loss of property value because of noise from aircraft and ground equipment. The claimants must prove direct loss of property due to noise from machinery operated carelessly or negligently. Some cases involve an aerial applicator making an unlawful flight over property without the owner's permission. This can occur when pull-ups over nearby property are necessary. Applicators and owners are liable only if the noise is excessive or unreasonable. Reasonable noise is not legally a nuisance, even though it may be irritating. Successful defense is possible when you can show that noise wasn't the cause of injury or damage.

Cross Contamination

Every year there are reports of pesticide cross-contamination that damages treated sites. There are three ways this may occur:

1. The applicator makes an error in mixing or filling the spray tank, or does not remove all the pesticide left from the last application. In this case, both the applicator and owner may be liable.
2. Open containers of herbicides such as 2,4-D can vaporize (become a gas) and penetrate other nearby pesticides. When the other pesticides are applied, a 2,4-D contamination can seriously injure the site.
3. The manufacturer may make a mistake in labeling, formulating or refilling a container.

You must know which pesticide container was used on the site so it can be tested. Laboratory tests can show whether contamination occurred during mixing and filling or earlier. In cases of herbicide contamination, it is difficult to prove whether the cause was vaporization during storage or manufacturer error. The courts must decide who is to blame.

NOTE: At the time of application, always write the location and date on the label of the pesticide container. Also record the lot number in case cross-contamination does occur. You should keep detailed records of every application.

How to Respond to a Claim

If you become involved in a legal problem, act carefully and promptly. Always be friendly and helpful. Never admit liability. Be careful whom you give information to about your spray operation. Offer to look into the matter immediately and then take the following steps:

1. Examine your records to make sure that you actually were operating in the area at the time of the alleged injury.

2. Make sure all your records are up-to-date, particularly with the identity of equipment used, temperatures, wind direction and velocity, and all other pertinent data.
3. Proceed to the scene immediately and make notes of all essential information when you get there.
4. Write down the presence of adverse conditions you observe at the time of your inspection, particularly insect infestations, disease, water stress, late planting and carry-over effect from other chemicals that may have been used.
5. Photograph each adverse condition you find so the symptoms can be examined by an expert. Use color film and a close focal length.
6. Save the container that was used for the job. If it is not practical to save the whole container, save the label or use close-up color photography to record the label.
7. Notify your insurance company immediately.
8. If you do not have insurance for the loss involved, request permission to have an expert examine the property, so you may have the benefit of his opinions.
9. If a chemical company is involved, notify company officials immediately. They probably will want to send their own experts to the site.
10. Obtain names and addresses of all witnesses who might testify to the nature of the operation and conditions of the site before and after. If the site is a perennial planting or orchard, examine USDA aerial photographs to check the site's condition in previous years.

Insurance

To protect yourself and your business, obtain insurance for pesticide mishaps. Texas requires insurance. Your insurance company must submit proof of your insurance before you can receive a commercial license. There are many types of insurance plans. They include bodily injury, property damage, and restricted or comprehensive chemical liability. Be sure to explore the costs, benefits and drawbacks of each plan before you buy. Know exactly what your coverage includes. An agent who specializes in pesticide insurance is the best person to advise you on your insurance needs.

Public Relations

It is always important to maintain good public relations as a pesticide applicator. Here are some suggested practices:

1. **Always be courteous.** First impressions often are long-lasting. Calm words help to open future discussion.
2. **Listen to the question.** Let the person know you understand the basis for his or her concern.
3. **Be prepared.** Know what materials are being applied, why they are being applied and what their basic characteristics are. Keep accurate records.
4. **Have an answer.** Be as informed as possible but do not give information you are not sure of.
5. **Take information.** Include name, location, date, time and details of the situation and request for information.
6. **Be prompt.** Problems may come up during the busiest times, but dealing with them quickly may make the difference between an easy solution or a complicated expensive one.
7. **Keep good records.** A simple file that includes inquiries and action taken may prove to be important.

Study Questions

1. Besides meeting legal requirements, how can pesticide application records help you?
   a. In case of a damage suit, records can establish proof of proper pesticide use.
   b. Records can help you trace residue and damage problems.
   c. Records can help you make the most efficient and effective use of pesticides, thereby saving time and money.
   d. All of the above.
2. When is the best time to fill out record sheets?
   a. Before you start a job.
   b. In the field (during the job).
   c. After you finish a job.
3. Filling out standard forms . . .
   a. is unnecessary—just jot down the things you need to know.
   b. helps you make sure to get all the necessary data.
   c. is required by law.

1. d
2. b
3. b

4. If you apply a pesticide and the wind carries it off-target, are you liable even though you tried to be careful?
   Yes No
5. If the site you applied a pesticide to is damaged, even though you followed the directions and dosages on the label, who could be liable?
   a. You
   b. The dealer
   c. The manufacturer
   d. The property owner
   e. All of the above
6. Is pesticide application legally considered an ultra-hazardous activity?
   Yes No
7. Can you be sued for applying pesticides to the wrong target site, even if no damage is done?
   Yes No
8. What is the legal standing of bees killed while "visiting" a sprayed field?
   a. The bees are legally protected. You are liable for any harm to them.
   b. The bees are considered "trespassers." You are not liable for them.
   c. The bees are considered trespassers if you gave prior notice to adjacent landowners. Otherwise, you may be liable for harm to the bees.
9. From a legal standpoint, pesticide equipment and containers that are left where children can find them are considered:
   a. An "obvious hazard"
   b. An "attractive nuisance"
   c. A "negligent oversight"
10. Which of the following steps should you take if someone accuses you of pesticide misuse?
    a. Decline comment and refer all calls to an attorney. Obtain references from satisfied customers.
    b. Accept responsibility for the incident and apologize. Suspend employees involved in the incident.
    c. Take notes and photos to document conditions at the site. Identify witnesses. Notify your insurance company.
11. Which of the following is least essential for good public relations?
    a. Good advertising
    b. Keeping good records
    c. Being courteous
    d. Listening patiently
12. Who can best advise you on your insurance needs?
    a. Most lawyers
    b. Insurance agents who specialize in pesticide insurance
    c. Extension agents with a degree in agribusiness

4. yes
5. e
6. yes
7. yes
8. c
9. b
10. c
11. a
12. b

Glossary

Abrasive: Capable of wearing away or grinding down another object.

Absorb: To soak up or take in a liquid or powder.

Acaricide: A pesticide used to control mites.

Accumulate: To increase in quantity, such as within the soil or tissues of a plant or animal.

Active ingredient: The chemical in a pesticide product that kills the target pest or performs the desired function.

Acute effects: Illnesses or injuries that may appear immediately after exposure to a pesticide (usually within 24 hours).

Additive effect: The increase in toxicity that results from combining one pesticide with another.

Adjuvant: Substance added to a pesticide formulation or tank mix to increase the effectiveness or safety of the mix.

Adsorb: To take up and hold on surface.

Aerosol: Very fine liquid droplets or dust particles emitted from a pressurized can or aerosol generating device.

Agitate: To stir or mix.

Agitator: A mechanical or hydraulic device that stirs a tank mixture to prevent contents from separating or settling.

Alkaline: The opposite of acidic; having a pH greater than 7.

Allergic effects: Harmful effects, such as skin rash or asthma, that occur in some people but not most others as a reaction to pesticides.

Annual: A type of plant that passes through its entire life cycle in one year or less.

Antagonistic effect: The reduction in toxicity that results from combining one pesticide with another.

Aquifer: An underground formation of sand, gravel or porous rock that contains water; the place where groundwater is found.

Arthropod: An animal having jointed appendages and an external skeleton, such as an insect, a spider, a mite, a crab or a centipede.

Avicide: A pesticide used to control pest birds.

Back-siphoning: The movement of liquid pesticide mixture back through the filling hose and into the water source. Back-siphoning is prevented by providing an air gap or check valve in the pipe or hose used to fill a spray tank.

Bait: A food or food-like substance used to attract and often poison pest animals.

Beneficial: Helpful in some way to people, such as a beneficial plant or insect.

Biennial: A plant that completes parts of its life cycle in one year and the rest of its life cycle the next year.

Biological control: The action of parasites, predators, pathogens or competitors in keeping another organism's population in check. Biological control may occur naturally or as the result of human manipulation of biological control agents.

Boom: A structure attached to a truck, tractor or other vehicle, or held by hand, to which spray nozzles are attached.

Broad-spectrum pesticide: A pesticide that can control many species or types of pests.

Calibration: The process used to measure the output of application equipment so that the proper amount of pesticide can be applied to a given area.

Carbamate: A class of pesticides commonly used for control of insects, mites, fungi and weeds.

Carcinogenic: Having the ability to cause cancer.

Carrier: The main material used to spread a pesticide; for example, talc in a dust formulation, water in a wettable powder spray, and air in an air blast application.

Caution: The signal word used on labels of pesticides in toxicity Category III or IV; these pesticides have an oral LD_{50} greater than 500 and a dermal LD_{50} greater than 2000.

Chemical-resistant: Ability to repel pesticide. Material through which pesticide cannot move.

Chronic: Pertaining to long duration or frequent recurrence.

Closed mixing system: A device used for measuring and transferring liquid pesticides from their original container to a spray tank. Closed mixing systems reduce chances of exposure to concentrated pesticides. Closed mixing systems are usually required when mixing Category I chemicals.

Collection pad: A safety structure designed to contain and recover spills, leaks, rinsates and other pesticide-containing substances.

Common name: A recognized, nonscientific name. Many pesticides, plants and animals have common names. The Weed Science Society of America and the Entomological Society of America publish lists of recognized common names.

Compatible: The condition in which two or more pesticides mix without unsatisfactory chemical or physical changes.

Concentrates: Pesticides that have a high percentage of active ingredient.

Coverage: The degree to which a pesticide is spread thoroughly and evenly over a target surface.

Cuticle: The outer protective covering of plants and arthropods that aids in preventing moisture loss.

Danger: The signal word used on labels of pesticides in toxicity Category I — those pesticides with an oral LD_{50} less than 50 or a dermal LD_{50} less than 200 or those having specific, serious health or environmental hazards.

Decontamination: Removal of pesticide from surfaces or organisms that are exposed so no further harm or damage can occur.

Defoliant: A pesticide used to remove leaves from target plants, often as an aid in harvesting the plant.

Degradation: The breakdown of a pesticide into an inactive or less active form. Environmental conditions, impurities or microorganisms can contribute to the degradation of pesticides.

Delayed effects: Illnesses or injuries that do not appear immediately (within 24 hours) after exposure to a pesticide or combination of pesticides.

Dermal: Pertaining to the skin. One of the major ways pesticides can enter the body possibly cause poisoning.

Diluent: Anything used to dilute a pesticide.

Dilute: To make less concentrated.

Distributor products: Products that are produced and registered by a manufacturer or formulator and then sold under a different name by a distributor.

Dose: A measured quantity. The size of a dose of pesticide often determines the degree of effectiveness or, in the case of poisoning, the degree of injury.

Drift: Movement of airborne pesticide, usually in a dust, spray or vapor, away from a release site.

Dust: Finely ground pesticide particles, sometimes combined with inert materials. Dusts are applied without mixing with water or other liquid.

Economic Threshold: The point at which the cost of damage caused by a pest exceeds the cost of controlling the pest; therefore it becomes practical to use the control method.

Ecosystem: A system formed by the interaction of a community of organisms with their environment.

Emergence: The appearance of a plant through the surface of the soil.

Emulsifier: Chemical adjuvant that allows petroleum-based pesticides (ECs) to mix with water.

Emulsion: A mixture of two or more liquids that are not soluble in one another. One is suspended as small droplets in the other.

Encapsulation: A process of enclosing tiny liquid droplets or dry particles in small plastic capsules to slow their release into the environment and prolong their effectiveness. Sometimes encapsulation lowers hazards to people mixing or applying pesticides.

Endangered species: Organisms whose survival as a species has been designated by a federal agency to be endangered or threatened by people's activities.

Evaporate: The process of a liquid turning into a gas or vapor.

Exposed: Subjected to contact with pesticides.

Exposure: Coming into contact with a pesticide; getting a pesticide on a surface or organism.

Eyewash dispenser: Commercially available product for flushing contaminants out of the eyes.

Fog: A spray of very small pesticide-laden droplets that remain suspended in the air.

Foliage: The leaves of plants.

Formulation: The pesticide as it comes from its original container, consisting of the active ingredient mixed with inert materials.

Fumigant: Pesticide that is a vapor or gas, or forms a vapor or gas when applied, and whose pesticidal action occurs in the gaseous state. Used to penetrate porous surfaces for control of pests in soil enclosed areas and storage.

Fungicide: A pesticide used to control fungi.

Fungus (plural — fungi): A multicellular lower plant lacking chlorophyll, such as mold, mildew, rust or smut. Fungus normally reproduces through dispersal of spores

General-use pesticide: Pesticides that can be used by the general public in addition to licensed applicators. General-use pesticides usually have minimal hazards.

Granule: A dry formulation of pesticide active ingredient and inert materials compressed into small, pebble-like shapes.

Groundwater: Fresh water trapped in soil or rock beneath the earth's surface; one of the primary sources of water for drinking, irrigation and manufacturing.

Habitat: The place where a plant or animal lives and grows.

Heat stress: Illness that occurs when the body is subjected too much heat.

Herbicide: A pesticide used to control weeds.

Host: A plant or animal on or in which a pest lives.

Host resistance: The ability of a host plant or animal to ward off or withstand attack by pests. Also, the ability to tolerate damage caused by pests.

Incompatible: A condition in which two or more pesticides cannot mix properly, or one of the materials chemically alters the other.

Inert ingredients: Inactive parts of a pesticide formulation; used to dilute the pesticide or to make it safer, more effective, easier to use or more convenient to handle.

Infection: The establishment of a microorganism within the tissues of a host plant or animal.

Infestation: A troublesome invasion of pests within an area such as a building, greenhouse, agricultural crop or landscaped location.

Inhalation: The act of breathing in. A route of entry by which pesticides are drawn through the nose or mouth into the lungs.

Insect growth regulator (IGR): A type of pesticide used for control of certain insects. Insect growth regulators disrupt normal stages of insect development.

Insecticide: A pesticide used to control insects. Some insecticides also are labeled for control of ticks, mites, spiders and other arthropods.

Insoluble: Does not dissolve in liquid.

Instar: The period between molts in larvae of insects. Most larvae pass through several instars; these are usually given numbers such as 1st instar and 2nd instar.

Integrated pest management (IPM): A pest management program that uses pest biology and extensive monitoring to understand a pest and its potential for causing economic damage. Control is achieved through multiple tactics including prevention, cultural practices, pesticides, exclusion,

natural enemies and host resistance. The goal is to achieve long-term control of target pests with minimal impact on nontarget organisms and the environment.

Juvenile hormones: Natural insect chemicals that keep early stages of an insect from changing into the normal adult form.

Labeling: The pesticide product label and all other directions that pesticide users arelegally required to follow.

Larva (plural — larvae): The immature form of insects that undergo metamorphosis.

LC50: The lethal concentration of a pesticide in the air or in a body of water that will kill half of a test animal population. LC50 values are given in micrograms per milliliter of air or water (µg/ml).

LD50: The lethal dose of pesticide that will kill half of a test animal population. LD50 values are given in milligrams per kilogram of test animal body weight (mg/kg).

Leaching: The movement of pesticide in water or another liquid downward through soil or other planting medium, possibly into groundwater.

Liability: Legal responsibility.

Material safety data sheet (MSDS): A pesticide information sheet describing chemical qualities, hazards, safety precautions and emergency procedures.

Micron: A very small unit of measure: 1/1,000,000th of a meter.

Microorganism: An organism of microscopic size, such as a bacterium, virus, fungus, viroid or mycoplasma.

Monitoring: The process of carefully watching the activities and development of pest organisms over time, often using very specific procedures.

Mycoplasmas: The smallest known living organisms that can reproduce and exist apart from other living organisms. They obtain their food from plants.

Natural enemy: An organism that kills a pest; includes predators, pathogens, parasites and competitors.

Nematicide: A pesticide used to control nematodes.

Nematodes: Elongated, cylindrical, nonsegmented worms. Nematodes are usually microscopic; some are parasites of plants or animals.

NIOSH: National Institute of Occupational Safety and Health; the federal agency that tests and certifies respiratory equipment for pesticide application.

NOEL: No observable effect level; the maximum dose or exposure level of pesticide that produces no noticeable toxic effect on test animals.

Nonpoint pollution source: Pollution from pesticides or other materials that arises from their normal or accepted use over a large general area and extended period.

Nonporous surfaces: Surfaces that have no openings to allow liquid to pass through or be absorbed.

Nontarget organism: Any plant or animal other than the pest for which pesticide is applied.

Oral: Through the mouth — a route of entry by which pesticide is swallowed into the body.

Organism: Any living thing.

Organophosphate: A commonly used class of pesticides; organophosphates are organic molecules containing phosphorous. Most break down in the environment very rapidly. Some organophosphates are highly toxic to people.

OSHA: Occupational Safety and Health Administration in the United States Department of Labor.

Oncogenicity: The ability to cause tumors.

Organic matter: Materials and debris that originated as living plants or animals.

Parasite: An organism living on, in or with another living organism (host) for the purpose of obtaining food; may cause injury or death of the host.

Pathogen: A microorganism that causes disease in other organisms.

Penetrant: A chemical that helps pesticide get through a surface and into an object or organism.

Penetrate: To pass through a surface such as skin, protective clothing, plant cuticle or insect cuticle. Also refers to the ability of an applied spray to pass through dense foliage.

Perennial: A plant that lives longer than two years — some may live indefinitely. Some perennial plants lose their leaves and become dormant during winter; others may die back and resprout from underground roots each year. Evergreens are perennial plants that do not die back or become dormant.

Persistent pesticide: A pesticide that remains active in the environment for a long time because it is not easily broken down by microorganisms or environmental factors.

Personal protective equipment (PPE): Devices and clothing worn to protect the human body from contact with pesticides and pesticide residues.

Pesticide: Any substance intended for preventing, destroying, repelling or mitigating any insects, rodents, nematodes, fungi, weeds or other organisms declared to be pests; and any other substance intended for use as a plant regulator, defoliant or desiccant.

Pesticide handler: Person who works directly with pesticides and pesticide equipment, such as during mixing, loading, transporting, storing, disposing and applying.

Pesticide resistance: Genetic qualities of individual pests that enable those pests to resist the effects of certain pesticides that are toxic to other members of that species.

Pesticide runoff: Movement of pesticide away from a release site in water or another liquid flowing across the ground surface.

Petroleum-based: Made from petroleum products. Examples are: xylene, refined oil and kerosene.

Pheromones: Chemicals emitted by an organism to influence the behavior of or attract other organisms of the same species.

Phytotoxic: Injurious to plants.

Plant growth regulator (PGR): A pesticide used to regulate or alter the normal growth of plants or development of plant parts.

Point pollution source: Pollution of the soil or groundwater caused by spilling or dumping quantities of a toxic material in one location.

Porous surfaces: Surfaces with tiny openings that allow liquid to be absorbed or to pass through.

Postemergent: The stage after seedlings have pushed through the soil surface.

Posting: The placing of signs around an area to inform workers and the public that the area has been treated with a pesticide.

ppb: Parts per billion. Example: 1 second in 32 years.

ppm: Parts per million. Example: 1 minute in 2 years.

Precautionary statement: Pesticide labeling statement that alerts you to potential product hazards or indicates specific ways to avoid hazards.

Predator: An organism that attacks, kills and feeds on other organisms.

Preemergent: The stage when plants sprout from seeds but before they push through the soil surface.

Preharvest interval: A time period set by law that must pass after applying pesticide to an edible crop, before the crop can be harvested legally. Pesticide labels provide information on preharvest intervals.

Preplant: Prior to planting crop seeds; the time to use some soil-applied herbicides for weed control.

Protectant: A pesticide that provides a chemical barrier against pest attack.

psi: Pounds per square inch.

Pupa: In insects having complete metamorphosis, the resting stage between larval and adult forms.

Rate: The quantity or volume of liquid spray, dust or granules that is applied to an area over a specified period of time.

Reentry interval: The time period as set by law that must pass after a pesticide is applied before people can enter the treated area again.

Release: When pesticide leaves a container, equipment or system that is holding it and enters the environment. Release can be intentional, as with an application, or accidental, as with a spill or leak.

Residue: Traces of pesticide that remain on treated surfaces or in the environment after a period of time.

Restricted-use pesticide: A pesticide, usually in toxicity Category I, that can be used only by licensed applicators who have demonstrated that they understand the proper methods of handling, using and disposing of these materials.

Rinsate: Water or other liquid that contains pesticide after being used to rinse pesticide from a container, equipment or other materials.

Rodenticide: A pesticide used to control rats, mice, gophers, squirrels and other rodents.

Scouting: Regularly searching for, identifying and assessing numbers of pests and the damage they are causing.

Selective pesticide: A pesticide that affects only a single or small number of pest species.

Sensitive: Particularly vulnerable to harmful effects from pesticides.

Signal word: The word "Danger," "Warning" or "Caution" on a pesticide label; it signifies how toxic the pesticide is and what toxicity category it belongs to.

SLN: Special local needs registration; the registration of a pesticide for treatment of a local or specific pest problem where no registered pesticide is available.

Soluble: Able to be dissolved in another substance, usually a liquid.

Solution: A liquid that contains dissolved substances, such as a soluble pesticide.

Solvent: A liquid, such as water, kerosene, xylene or alcohol, that can dissolve a pesticide (or other substance) to form a solution.

Spot treatment: A method of applying pesticides only in small, localized areas where pests congregate rather than treating a larger, general area.

Structural pest: A pest such as a termite or wood rot fungus that destroys structural wood in buildings.

Surface water: Water on top of the earth's surface, such as in lakes, streams, rivers, irrigation ditches and storm water drains.

Suspension: A formulation that contains fine solid particles mixed throughout a liquid such as water or oil.

Swath: The area covered by one pass of the pesticide application equipment.

Symptom: A sign which indicates the presence of a disease or a disorder such as poisoning.

Systemic pesticide: Pesticide that is absorbed and circulated within a plant or animal, making the plant or animal toxic to pests that feed on it.

Target pest: The pest toward which control measures are directed.

Target site: The location toward which control measures are directed.

Temperature inversion: A condition in which air above an area is warmer than air near the ground. This warm air forms a cap that may cause pesticide vapor or droplets to collect and concentrate.

Tip-and-pour: Built-in measuring device that fills with a certain amount of pesticide when the container is tilted.

Tolerance: The ability to endure the effects of a pesticide or pest without adverse effects.

Toxicity: The measure of a pesticide's ability to cause acute, delayed or allergic effects.

Triple-rinse: A process used to remove most traces of liquid pesticide from a pesticide container. After draining the container into a spray tank for 30 seconds, the container is partially filled with water, capped, agitated and drained into the tank. Rinsing and draining is repeated three times.

Ultra-low-volume (ULV): A pesticide application technique in which very small amounts of liquid spray are applied over a unit of area; usually 1/2 gallon or less of spray per acre in row crops to about 5 gallons of spray per acre in orchards and vineyards.

Use site: The immediate location where a pesticide is being mixed, loaded, applied, transported, stored or disposed of, or where pesticide-contaminated equipment is being cleaned.

Vaporize: To transform into a fog-like vapor or gas.

Volatile: Able to evaporate rapidly; turn easily into a gas or vapor.

Warning: The signal word used on labels of pesticides in toxicity Category II, having an oral LD50 between 50 and 500 and a dermal LD50 between 200 to 2000.

Water-based pesticides: Pesticides that use water as the only diluent or carrier.

Watershed: An area of land that drains its surface water into a watercourse or body of water.

Texas Agricultural Extension Service
The Texas A&M University System

Pesticide Applicator Training Manuals

Structural

Below is a description of study manuals available from the Extension Service to help you prepare for license exan In addition to the general manual and at least one category manual, you will need the publication, *Structural Pest Control Board Laws and Regulations*, from the Texas Structural Pest Control Board. Also contact the Board at (512)835-4066 for information about license requirements, tests, fees, etc.

General Manual:
Commercial/Noncommercial/ Technician -- Addresses subject matter applicable to all categories of certified application established under the Structural Pest Control Act.

Pest Control -- For persons who inspect for or control insect and animal pests which invade homes, stores, restaurants and other structures or which are a general nuisance, but do not normally attack the building itself.

Termite Control -- For persons who inspect for or control termites, beetles and other wood-destroying organisms in buildings, including homes, warehouses, stores, docks and other structures.

Ornamental and Turf -- For persons who inspect for or control weeds, pests and diseases on ornamental plants, shade trees and shrubs in a park or adjacent to a residence, business, industrial plant,institutional building or street.

Fumigation -- For persons enngaged in pest inspe tion or control through fumigation of structures, food stuffs, warehouses, ships, railroad cars, etc

Wood Preservation and Wood Products Treatmen Only for persons who use wood preservatives classified as restricted-use pesticides. Covers use of preservatives to protect wood products from damag by insects, fungi and marine borers. Includes crossti poles, posts, etc.

Use the form below to order these study manuals. Mail this form, along with a check or money order payable to the Extension Service, to: Texas Agricultural Extension Service, P.O. Drawer FS, College Station, TX 77841.

Your order will be shipped within 2 days of receipt. To inquire about your order, call (409) 845-1099.

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B-5074 Pest Control	$ 10		$
B-5075 Termite Control	$ 10		$
B-5066 Ornamental and Turf	$ 10		$
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