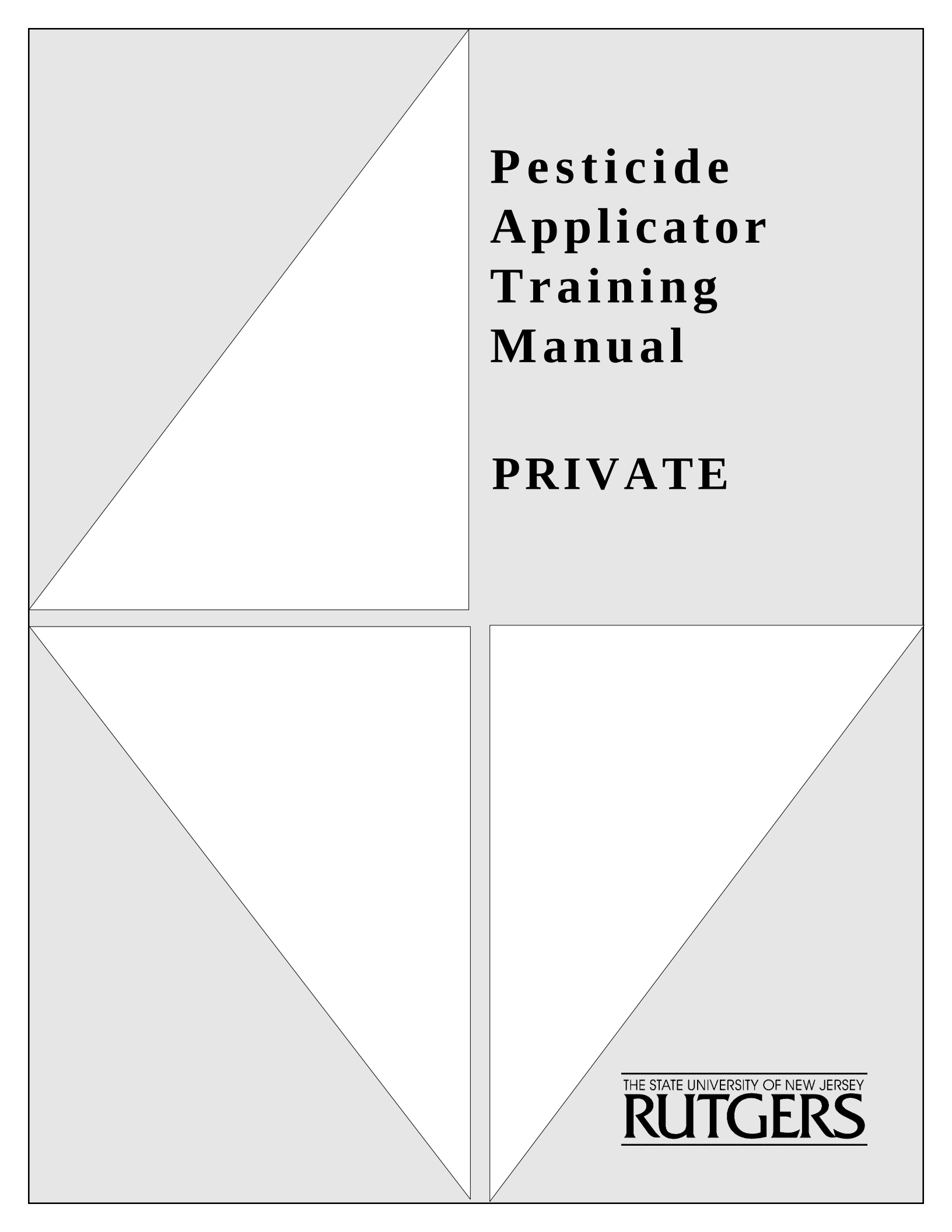




Pesticide Applicator Training Manual

PRIVATE

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Private Pesticide Applicator Training Manual

A Training Manual for the Certification
Of Private Pesticide Applicators

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INTRODUCTION

All pesticide applicators are required to know basic safety and handling rules for pesticide use. The purpose of this manual is to help you learn those facts and skills. By reading each chapter and testing yourself with the Self Study Questions at the end, you can teach yourself what you need to know.

This is the basic manual for all private pesticide applicators. You should study and keep this manual so that you will have a complete and up-to-date reference source.

The study questions at the end of each chapter are designed to help you understand and remember the most important concepts in your reading. If you can answer the questions correctly, you should be able to pass the test for certification. The certification exam is based solely upon the manual rather than any outside information you may already possess.

PESTICIDES ARE NOT FOR AMATEURS. TO PROTECT PEOPLE AND THE ENVIRONMENT, PESTICIDE APPLICATORS MUST BE PROFESSIONALS!

ACKNOWLEDGEMENTS

In addition to the specific sources cited in the text, the Cooperative Extension Service publications of the following universities were invaluable sources of information and material:

Pennsylvania State University
University of Minnesota
University of Wisconsin
Cornell University

CHAPTER ONE

PESTICIDE APPLICATOR CERTIFICATION

Learning Objectives

- * Understand the private pesticide applicator certification requirements and how to become certified.
- * Understand the continuing education process and the recertification requirements.
- * Know how to become a licensed pesticide applicator.

TERMS TO KNOW

Agricultural Commodity - means any plant, or part thereof, or animal, or animal product, produced by a person (including farmers, ranchers, vineyardists, plant propagators, Christmas tree growers, aquaculturists, floriculturists, orchardists, foresters, or other comparable persons) primarily for sale, consumption, propagation, or other use by man or animals.

Certification - means the recognition by the State of New Jersey that a person is competent and will upon licensing be authorized to use or supervise the use of pesticides.

Commercial Pesticide Applicator - means any person (whether or not he is a private applicator with respect to some uses) who uses or supervises the use of any pesticide for any purpose or on any property other than as provided by the definition of "private pesticide applicator." Any employee of a governmental agency who engages in the use and applica-

tion of pesticides as is necessary within the scope of his employment is considered a commercial applicator.

Licensed - means the recognition by the State of New Jersey that a person is authorized to use or supervise the use of pesticides.

Pesticide Applicator Business - means any person who either wholly or in part holds himself out for hire to apply pesticides in the State of New Jersey.

Private Pesticide Applicator - means any person who uses or supervises the use of restricted use pesticides for the purpose of producing any agricultural commodity on property owned or rented by him or his employer or, if applied without compensation, other than trading of personal services between producers of agricultural commodities, on the property of another person.

Responsible Pesticide Applicator - means any individual who is accountable for the use of a pesticide by himself or any person under his direct supervision.

Restricted Use Pesticide - means any pesticide or pesticide use so classified under the provisions of N.J.A.C. 7:30-2, or so classified by the Administrator of the United States Environmental Protection Agency.

Under Direct Supervision - means under the instructions and control of another person who is responsible for actions taken and who is available if and when needed, even if not physically present.

CERTIFICATION STANDARDS

Private Applicator

As a minimum requirement for certification, a private applicator must show that he possesses a practical knowledge of the pest problems and pest control practices associated with his agricultural operations including 2MF, proper storage, use, handling, disposal, and his related legal responsibility.

The practical knowledge of the principles and practices of pest control and safe use of pesticides shall include the ability to:

- (1) Recognize common pests and their damage.
- (2) Read and understand the labeling information.
- (3) Apply pesticides in accordance with labeling instructions and warnings.
- (4) Recognize local environmental situations that must be considered during application to avoid contamination and pollution.
- (5) Recognize poisoning symptoms and procedures to follow in case of a pesticide accident.
- (6) Understand the laws and regulations of applicable state and federal agencies.

GENERAL REQUIREMENTS

Private applicators will be required to become certified if they purchase and use or supervise the use of **restricted-use** pesticides. Commercial applicators will be required to become certified if they purchase and use or supervise the use of **any** pesticide.

CERTIFICATION PLAN

Certification is a one step process for private applicators.

Private Applicators must successfully complete one examination which will cover both Core and higher level topics. The exam shall include such topics as pesticide safety and handling, proper storage, current laws and regulations, pest identification, damage assessment, and proper application tech-

niques. The applicator shall complete the exam at one of the statewide examination centers administered by the Pesticide Control Program.

Call the Pesticide Control Program at 609/530-4133 to receive the materials to register for the exam.

CERTIFICATION EXAM WAIVERS

Reciprocal Applicator Registration

The Pesticide Control Program may waive initial certification testing where an applicant has previously been certified in another state or territory. This waiver exists when there is a valid certification test given in a state or territory of the United States which has adopted a certification program substantially equivalent to New Jersey's and has signed a cooperative agreement with the State of New Jersey.

In addition, reciprocal applicants will receive a 40-question written exam when they apply for reciprocal certification. The exam is taken at home and tests the applicator's knowledge of New Jersey pesticide regulations. There is a \$10.00 fee per exam. A New Jersey Pesticide Applicator Registration will be issued to the individual if the following criteria are met:

- * The PCP receives proof of a valid certification from another state or territory which has signed a cooperative agreement with New Jersey.
- * The registrant demonstrates to the PCP a knowledge of relevant New Jersey Pesticide Control laws and regulations through the take home test; and
- * The PCP receives all applicable fees and registration materials.

The following is a list of states with cooperative reciprocal agreements with New Jersey:

Delaware	South Carolina
Indiana	Tennessee
New York	Vermont
Pennsylvania	Virginia
Rhode Island	

CERTIFIED APPLICATOR LICENSING AND FEES

The requirements needed to be licensed as a pesticide applicator with the Pesticide Control Program are twofold:

- A. Meet all certification requirements as stated above; and
- B. Submit an application for registration. There is no fee for a Private Applicator's license.

PESTICIDE APPLICATOR BUSINESS LICENSE

If a person applies pesticides for hire (examples are businesses such as exterminators, landscapers, tree services, crop dusters, etc.) they must be licensed with the Pesticide Control Program as a pesticide applicator business. The business registration is in addition to any commercial pesticide applicator registration. Each physical location a business works out of and each name a business uses is required to have a separate business license. Also, each business location must employ at least one certified and licensed commercial pesticide applicator. Business registration is accomplished by completing registration forms provided by the Pesticide Control Program and paying the required fee. Applicator business registration is not required for private pesticide applications.

CONTINUING CERTIFICATION REQUIREMENTS

Private Applicators

Private applicators shall be required to accumulate a total of 24 units of instruction over a 5 year period beginning the first October following applicator certification. Each unit represents 30 minutes of instruction time. Eight of the 24 total units must cover various basic topics, such as label comprehension, safety and environmental factors, laws and regulations, etc. The remaining 16 units must cover topic

areas related to pest identification, equipment, pesticide application techniques and other topics which are more technical and specific than basic material.

General Recertification Information

The Pesticide Control Program will award appropriate units for the various courses or pesticide related meetings which will be offered throughout the years. Please contact your County Rutgers Cooperative Extension Office, professional associations, private companies, or other organizations which may offer courses or meetings or have information on course or meeting availability throughout the future years. Having your name placed on any mailing list of the above mentioned organizations would be helpful. ***The Pesticide Control Program does not offer any courses.***

The coordinator of the course or meeting must submit the agenda to the Pesticide Control Program for evaluation. If you are planning to attend a meeting or course, please ask the coordinator if this procedure has been accomplished.

The appropriate continuing certification forms will be distributed at the conclusion of the course or meeting. The units awarded to the course or meeting will be printed on the form. The applicator should retain a copy of the form for record keeping purposes.

If the private or commercial applicator does not complete the continuing certification requirements, the applicator must retake the certification examinations. The Pesticide Control Program prefers that the applicators participate in the continuing certification program since the goal is to ensure that the applicators are knowledgeable in the latest technical advances in their respective field of pesticide work.

If the certification is based on reciprocity with another state, there is an additional recertification option. During the last year of the 5 year New Jersey recertification period, the applicator can send:

- * a copy of the current certification from the state where the applicator was originally certified;
- * a cover letter requesting recertification in New Jersey; and
- * a copy of the Recertification Update Form from New Jersey.

As long as the individual has maintained the original state's certification, New Jersey will recertify the applicator's New Jersey certification.

An applicator's recertification status will be printed on their license renewal. Private applicators will also receive a Recertification Update Form annually which will tell them when their 5 year period is up, how many units they have and how many more units they need.

SELF STUDY QUESTIONS

1. All applicators of restricted-use pesticides or their supervisors must have state certification.

T () F ()

2. Pesticide applicators of restricted-use pesticides may be classified as private applicators if they apply pesticides:

- A) only on their own property.
- B) to produce agricultural commodities primarily on the property of other people.
- C) to produce agricultural commodities on their own property.
- D) on the property of others for hire and their own property.

3. Pesticides in the restricted-use category can be used by the general public without certification if recommended by a state agency.

T () F ()

4. If a commercial applicator wishes to apply any pesticides for the control of pests in agricultural crops, he must obtain certification in each of the appropriate categories.

T () F ()

5. Private applicators must be recertified every _____ years.

- A) two
- B) five
- C) three

ANSWERKEY

- | | | |
|------|------|------|
| 1. T | 2. C | 3. F |
| 4. T | 5. B | |

CHAPTER TWO

NEW JERSEY PESTICIDE CONTROL REGULA- TIONS

Learning Objectives

- * Know the laws and regulations which apply to the use of pesticides.
- * Know how to apply pesticides in a legal manner.

The Pesticide Control Program (PCP) in the Department of Environmental Protection (DEP) is the pesticide regulatory agency in New Jersey, responsible for implementing and enforcing both federal and state pesticide laws and regulations. The New Jersey regulations are codified as New Jersey Administrative Code Title 7, Chapter 30, Subchapters 1 through 11 (NJAC 7:30-1 et seq). These regulations cover topics as varied as pesticide product registration, dealer and applicator licensing, and pesticide storage and use. Following are summaries of the regulations applicable to private applications.

Subchapter 1 - Pesticide Products Registration

This subchapter covers the requirements for registering pesticide products for use in New Jersey. The important thing for pesticide applicators to know is that no pesticide product can be used unless it is registered both with the U.S. Environmental Protection Agency (EPA) and the State of New Jersey. All EPA registered products have an EPA approved label which contains an EPA registration number. You cannot tell from the product label whether or not a product is state registered, but you could be issued violation notices, stop use orders, or fines if you use

unregistered pesticide products. Contact the PCP for the registration status of the pesticide you intend to use.

Subchapter 2 - Prohibited and Restricted-Use Pesticides

This chapter covers which pesticides are prohibited from use and which are restricted-use. Restricted-use pesticides can only be purchased by certified pesticide applicators. They also have more stringent storage requirements. As far as prohibited pesticides are concerned, New Jersey usually only prohibits those pesticides that the EPA prohibits for use. Be aware, however, that New Jersey has the authority to prohibit, limit, or classify for restricted-use any pesticide where a basis exists for such an action.

Subchapters 3 & 4 - Certified Pesticide Dealers and Dealer Businesses

able to obtain restricted-use pesticides from those businesses and individuals who are properly licensed. The individuals must pass a dealer certification exam to be licensed and the business must keep records of all transactions involving restricted-use pesticides.

Subchapters 5, 6, 7, and 8 - Pesticide Operators, Commercial Pesticide Applicator, Pesticide Applicator Business, and Private Pesticide Applicators

These subchapters cover the licensing requirements for users of pesticides. Subchapter 5 covers the training and registration of commercial pesticide operators (people who work under the direct supervision of commercial pesticide applicators), Subchapter 6 the certification and registration of commercial pesticide applicators, Subchapter 7 the registration of pesticide applicator businesses and Subchapter 8 the certification and registration of private pesticide applicators.

Private and Commercial Pesticide Applicators -

It is important to understand the difference between private and commercial applicators. A private applicator is someone using pesticides to raise an agricultural commodity, on land owned or rented by him or his employer. Farmers, nurserymen, greenhouse growers and Christmas tree growers are examples of private applicators. A private applicator needs to be certified and registered only if he is using restricted-use pesticides.

In most cases commercial applicators need to be certified and registered to use any pesticide. Commercial applicators include: anyone applying pesticides as a service; in-house applications to residences (examples: multi-family dwellings, dormitories, rental units, etc.) unless it is to the applicator's own living quarters, in-house applications in commercial buildings in areas where food is prepared, served, or stored (examples: restaurants, taverns, cafeterias, supermarkets, groceries, food processing, storage, or packaging plants, etc.), and in-house applications in other commercial settings where there is an aggregate of more than 10 employees or, if ground maintenance is involved, there are more than 3 acres of grounds. Commercial applicators also include any person who applies pesticides as a part

of their job with any governmental agency (examples: mosquito commissions, public school systems, health departments, etc.).

Certification -

For commercial applicators, the certification procedure entails passing a basic Core exam and then one or more category exams, which are specific to the type of pest control work being done. Once certified a commercial pesticide applicator must register on an annual basis and go through recertification every 5 years. Recertification is accomplished by retaking the certification exams or by attending continuing education sessions and accumulating units of recertification credit.

A private applicator must successfully complete one examination which will cover both Core and higher level topics. The exam shall include such topics as pesticide safety and handling, proper storage, current laws and regulations, pest identification, damage assessment, and proper application techniques. Once certified a private applicator must register and go through recertification every 5 years. Twenty four units are required over the 5-year period which shall include 8 units in Core material and 16 units in Private subject matter. Each unit is worth 1/2 hour of instruction time.

Operators and Agricultural Handlers-

Not every user of pesticides who meets the definition of a private or commercial applicator needs to be a certified applicator. Instead, you can work under the direct supervision of a certified applicator as a commercial pesticide operator or as an agricultural handler. (For details on agricultural handlers refer to Chapter 3.) For commercial applicators, direct supervision means there is an employer-employee relationship and the commercial pesticide applicator is available if and when needed, even if not physically present.

Please note that at least one commercial pesticide applicator in category 11 must be physically present during any aerial application. It is not acceptable for a commercial pesticide operator to make aerial applications on their own!

Applicator Businesses -

If pesticides are being applied for hire, as a service, then the business entity itself must be registered as a pesticide applicator business. Pesticide applicator businesses are companies which contract out their services for compensation. Examples of such businesses are exterminators, landscaping companies, tree care firms, pet groomers and aerial application businesses. Applicator business registration is accomplished by completing initial application forms provided by the Pesticide Control Program. Registration is on an annual basis thereafter.

Each business name and each physical location of a business must also be registered separately. Each business location must employ, at that location, at least one commercial certified pesticide applicator. Businesses are also required to carry general liability insurance, which includes coverage for completed operations and for chemical liability.

Records of Applications -

All pesticide applications performed by commercial and private applicators, or the commercial pesticide operators or agricultural handlers under their direct supervision, are subject to recordkeeping requirements. These records must be kept on file for three years by commercial applicators (except that all records of termiticide applications must be kept for a minimum of five years) and for two years by private pesticide applicators.

The records for private pesticide applications must contain the following information:

1. The date of application;
 - i. For pesticides having a reentry time of 24 hours or more, date of application shall include the hour completed.

2. The place of application;

- i. For pesticide applications to an agricultural crop, place of application shall include the name and address of the farm and the specific field or land area and crop that was treated with the pesticide.

3. The brand or trade name of each pesticide used or symbol representing such name, providing the applicator also keeps a list which clearly correlates the symbols used with full and complete pesticide product name(s);
4. The amount of each pesticide used; and
5. The dosage or rate of each pesticide used.

Subchapter 9 - Pesticide Management

This subchapter covers requirements for special permits for environmentally sensitive applications, such as for aquatic pest control and mosquito/fly control; pesticide storage and disposal; application and protective safety equipment requirements; notification schemes and the reporting of pesticide spills.

This subchapter also covers farm worker safety requirements, which became federal Agricultural Worker Protection Standards (highlighted later in this chapter) on January 1, 1995.

Agricultural Applications -

Agricultural application requirements include reentry time requirements. In certain cases, the posting of warning signs is required. When these applications are made by a commercial pesticide applicator (such as an aerial applicator business, etc.) the land owner must be notified prior to the application as to the reentry time, etc. (See Chapter 3 for federal agricultural requirements.)

Aquatic Applications -

In most cases, applications of pesticides to aquatic sites (ponds, lakes, etc.) require an Aquatic Use Permit. All pesticides labeled for aquatic use are restricted-use pesticides in New Jersey. This includes the copper products. An application of ANY pesticide to an aquatic site requires an Aquatic Use Permit unless it meets the following exemptions:

1. The body of water to be treated is NOT used for potable water and the body of water to be treated has NO outlet structure or outlet stream, and the body of water to be treated and its surrounding shoreline is owned and controlled by one person.

OR

2. The application is for the control of mosquitoes or flies which then fall under the Pesticide Control program's Mosquito/Fly Permit Program.

There may be conditions or additional restrictions beside the labeling requirements placed on the application of the aquatic pesticide. Applications for an Aquatic Use Permit can be obtained from the Pesticide Control Program. Permits are reviewed to help ensure that pesticides applied to an aquatic environment do not cause adverse effects to that environment.

Storage of Pesticides -

Proper storage of pesticides is mandated by regulations. Restricted-use pesticides must be stored in a secure, locked enclosure while unattended, and the enclosure posted with a sign indicating a pesticide storage area. An inventory list of pesticides likely to be in storage must be kept and updated at least annually and kept in a separate location from the storage area. This inventory list, along with a description of the location of the storage area, must be forwarded to the local fire department, so that they can be prepared for hazardous conditions if an emergency situation arises involving the storage area. Please note that if you are required to comply with the

New Jersey Right-to-Know regulations and have completed the Right-to-Know survey forms and forwarded them to the local authorities specified, then you are considered to be in compliance with the inventory reporting requirements of this subchapter.

Restricted-use pesticides must be stored in a room structurally separated from living areas in residential structures and the ventilation must be sufficient to keep fumes out of living areas. In commercial or public buildings, the same requirements apply, but to work areas instead of living areas. Fumigants cannot be stored in multi-unit residential, commercial, or public buildings.

Service Vehicles -

What is a "service vehicle?"

A "service vehicle" is a vehicle which is normally used for transporting pesticides to or from application locations. A common example of a vehicle is a pickup truck which regularly travels on public roads carrying pesticides to and from an application site.

What is not a "service vehicle?"

1. Any vehicle which operates only within the farm boundaries.
2. Vehicles which carry pesticides in the application tank ready for application (boom sprayers, mist blowers, etc.) at a location which is controlled by a private applicator performing or supervising the pesticide application.

Vehicles used to transport pesticides from the point of purchase to the storage area are not considered service vehicles. See page 4 - Chapter 17. If the service vehicle is used by a Pesticide Applicator Business, the business registration number must be on two sides of the vehicle in numbers at least 3 inches in height. All service vehicles must have words, with letters of at least 3 inches in height, and on two sides of the vehicle, clearly indicating that pesticides are most likely being transported or stored

on the vehicle. A business name, such as “Tom’s Pest Control,” is sufficient for this purpose, since “pest control” usually means pesticides are involved. However, a business name such as “Sanitation Service” is not sufficient. Wording such as “Pesticide Vehicle,” “Pest Control Service,” or simply “Pesticides” would have to be included on two sides of the vehicle. Service vehicles used by private applicators must have all of the above requirements except for the business registration number.

All pesticide containers on service vehicles must be stored, supported, braced, etc., so that breakage or spills do not occur. Also, a shovel, absorbent material, and a working fire extinguisher must be carried on board at all times. The pesticide storage area must be physically separate from the driver or passengers. All tanks must have covers or hatches to prevent spillage. Portable equipment and containers must be inaccessible to unauthorized persons, and locked up when unattended.

Containers -

Pesticide containers must be properly labeled at all times, with a legible version of their EPA approved label. Containers which are used for food or drink cannot be used to store pesticides.

All pesticides and pesticide containers must be disposed of according to state and federal laws and regulations. This means they must be disposed of in a manner that will not cause harm or injury to people or the environment, or a significant risk of harm, injury, or damage. State and federal disposal laws are administered by the Division of Hazardous Waste Management and the Division of Solid Waste Management in the DEP.

Application Equipment -

Pesticide application equipment must be properly calibrated and maintained. All necessary and appropriate safety equipment and protective gear must be made available to employees and such equipment must be properly maintained. Employees must be properly trained in the equipment’s proper use.

Notification -

Notification of persons is required before any commercial applications of pesticides are made for the control of household or structural pests at single family residences, multi-family residences, commercial buildings, schools, institutions, parks and similar sites. Notification is also required before any commercial application of pesticides are made for turf or ornamental applications at single family residences, multi-family residences, commercial buildings, golf courses, schools, institutions, parks and similar sites. Notification requirements may include but not be limited to: proposed date of the application(s), the pesticides to be used, label instructions relating to general public safety, a copy of a Consumer Information Sheet and the telephone number of the New Jersey Department of Health and the New Jersey poison Information and Education System.

For pesticide applications performed on aggregate areas of greater than three acres of land or water, community or area wide notification may be required. This notification requires that persons residing in the vicinity of the proposed target site be given notification prior to the proposed application, in the form of newspaper advertisements, etc. Advertisements would include information concerning the specific application to be made (including precautionary statements), applicator information, a required log of calls made to the applicator business in response to the notification, etc. (Note: These provisions may not apply to certain agricultural and mosquito applications - check the full regulations for details.)

Spills -

Applicators are required to report and clean-up pesticide spills if they are of a certain size. Spills that must be reported to the Pesticide Control Program are as follows:

1. Any spill inside a structure of any pesticide of more than 1 gallon of liquid of any combination of pesticide/diluent, or dry formulations containing 1 lb. or more of active ingredient.

2. Any spill outside a structure of any pesticide containing 1 lb. or more of active ingredient.

If the spill meets the above reporting requirements, the Pesticide Control Program must be notified immediately after emergency actions are taken to contain or stabilize the spill. During non-business hours the notification is made by calling the DEP's hotline, which is 609-292-7172. A written report of the incident must be forwarded to the Pesticide Control Program within 10 days.

Subchapter 10 - Pesticide Use

This subchapter covers items such as special restrictions on the use of specific pesticides, the broad-based "use" regulations, special termiticide and aerial application requirements, and pesticide use surveys.

Labels -

States do not have control over the EPA approved label of a pesticide product. However, through their own regulatory powers, they can limit the use of a pesticide or put additional restrictions on the way it can be used. New Jersey has this authority and the Pesticide Control Program has placed some significant limits on specific pesticides.

Most of the use regulations pertain to all applicators. Some of the more important ones follow. No pesticide can be used contrary to the EPA approved label directions or any additional restrictions as mandated by state regulations. A legible copy of the EPA approved label must be at the mixing and use site at all times. Of course, the container, with its attached label, is often what will be present at the mixing and application site to satisfy this requirement.

EPA has an ongoing program to upgrade pesticide labeling to make the pesticide label more effective. Be sure you have the most recent label on file for the pesticide products you use. When new stocks are bought, read the label on that new stock to ensure that you are aware of the information that may have changed or been added to that label. Do not rely on memory or on out-of-date labels.

A pesticide or pesticide container cannot be transported, handled, stored, mixed, loaded, or used in any manner that causes harm, injury, or damage to persons, property, or the environment, or a significant risk of harm, injury, or damage.

Clean-up/Sample Analysis Costs -

Lastly, applicators should be aware that the Pesticide Control Program can issue clean-up orders to direct applicators to decontaminate areas affected by pesticide spills and misapplications; can charge applicators for sample analysis costs when violations are documented; and can ask for pesticide use data on an annual basis.

Subchapter 11 - Emergency Containment and Disposal of Pesticide

Containment -

When an unexpected event results in the possibility that a pesticide may be released to a non-target site all necessary measures must be taken to prevent such movement. The containment is the responsibility of the property owner, the person responsible for the pesticide being on the property and the person responsible for the unexpected event which caused the situation to occur.

Disposal -

Before disposing of any pesticide, a person must submit to the Department of Environmental Protection a written plan outlining the intended procedures of disposal. Such disposal cannot occur until written approval is received.

The information presented in this chapter is only a summary of the N.J. Pesticide Control Regulations.

This information was current as of January, 1996. Always have a copy of the most current regulations on hand for ready reference. Copies can be obtained by writing to the:

NJ DEP - Pesticide Control Program
CN411
Trenton, NJ 08625-0411

SELF STUDY QUESTIONS

1. Pesticide products used in New Jersey must be registered:
 - A) only with the U.S. Environmental Protection Agency.
 - B) only with the State of New Jersey.
 - C) with both the U.S. Environmental Protection Agency and the State of New Jersey.
2. In New Jersey, restricted-use pesticides can only be purchased from a licensed pesticide:
 - A) dealer business.
 - B) operator business.
 - C) applicator business.
3. Someone who uses restricted-use pesticides to raise an agricultural product must be certified and registered as a:
 - A) pesticide operator.
 - B) commercial pesticide applicator.
 - C) private pesticide applicator.
4. Anyone applying pesticides as a service must be certified and registered as a:
 - A) pesticide dealer.
 - B) commercial pesticide applicator.
 - C) pesticide operator.
5. The certification of private pesticide applicators involves passing:
 - A) one exam.
 - B) a dealer exam.
 - C) an operator exam.
6. Companies which contract out their pesticide application services for compensation must be registered as a:
 - A) pesticide operation.
 - B) pesticide applicator business.
 - C) pesticide dealer.
7. Private applicators must keep records of application for a minimum period of:
 - A) 3 years.
 - B) 2 years.
 - C) 1 year.
8. An inventory list of pesticides likely to be in storage must be:
 - A) kept at the storage site.
 - B) updated every 2 years.
 - C) kept separate from the storage site and a copy forwarded to the local fire department.
9. Pesticide storages in New Jersey are subject to regulation if they contain:
 - A) only general use pesticides.
 - B) restricted-use pesticides.
 - C) any pesticides.
10. It is okay to store pesticides and packaged food in the same room if they are no closer than six feet.

T ()

F ()

11. Posting of pesticide storages is required in New Jersey if they contain:

- A) highly toxic pesticides.
- B) restricted-use pesticides.
- C) a large quantity of pesticides.

Answer Key

1. C 2. A 3. C 4. B 5. A
6. B 7. B 8. C 9. B 10. F 11. B

CHAPTER THREE

FEDERAL PESTICIDE LAWS

Learning Objectives

- * Have a general understanding of the federal laws and regulations that may affect private pesticide applicators.
- * Be aware of the importance of having up-to-date knowledge about how to comply with the federal laws and regulations that affect your own operation.

The United States government, mainly through the Environmental Protection Agency (EPA), has set standards for pesticide handling and use. Some practices which were suggested for safe use in the past are now required by law. These include such areas as record keeping, transportation, storage and disposal procedures, reentry or restricted entry intervals, filling and mixing methods, etc. For many applicators these practices are already part of a regular routine. For other applicators some adjustment must be made to meet these new requirements. All the new standards are designed to help make pesticide use safer for both people and the environment.

Federal laws and regulations set the standards for pesticide use. States have the right to be stricter than the federal laws. The applicator is responsible for knowing and complying with the federal laws and regulations in each state they may be working in.

The United States Congress established the Environmental Protection Agency (EPA) in 1970 and has mandated that the agency regulate pesticides. The U.S. Department of Agriculture (USDA) regulated pesticides before EPA was created.

Through its Office of Pesticide Programs (OPP), EPA uses the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) to manage its mandate.

FEDERAL INSECTICIDE, FUNGICIDE & RODENTICIDE ACT (FIFRA)

FIFRA was enacted in 1947 replacing the Federal Insecticide Act of 1910 and has been changed (amended) several times since then. The most important amendment to FIFRA was the Federal Environmental Pesticide Control Act (FEPCA) of 1972 which shifted the emphasis of FIFRA from safeguarding the consumer against fraudulent pesticide products to a role of protecting both public health and the environment.

FIFRA governs the licensing or registration of pesticide products. No pesticide may be marketed in the U.S. until EPA reviews an application for registration, approves each use pattern, and assigns a product registration number. Registration decisions are based upon data demonstrating that the use of a specific pesticide will not result in *“unreasonable human health or environmental effects.”* In other words, FIFRA balances the risks a pesticide may pose with its benefits to society.

FIFRA:

- requires that EPA register all pesticides as well as each use of that pesticide and approves the product label.
- requires the classification of all registered pesticides as either “general use” pesticides which can be used by anyone or “restricted use” pesticides if the environment or user could be harmed

even if the pesticide is used as directed (state requirements are often stricter).

- requires that the users of “restricted use” pesticides be certified as, or under the direct supervision of either “private” or “commercial” applicators. Certification is to be carried out by the states (except in Colorado and Nebraska which have federal programs).
- establishes tolerances for residues that may remain on raw agricultural products or in processed food.
- provides penalties for “use inconsistent with the labeling” of a pesticide.
- makes it illegal to store or dispose of pesticides or containers other than as directed by regulation and provides penalties for illegal handling of containers.
- provides civil penalties when the violation of a regulation is unintentional. Under FIFRA, fines can be \$1,000 for private applicators and others or as much as \$5,000 for each offense by commercial applicators. Before EPA can fine you, you have the right to ask for a hearing in your own city or county.
- provides criminal penalties when the law is knowingly violated. The maximum penalty for private applicators and others is \$1,000 and/or 30 days in prison. Commercial applicators may be fined up to \$25,000 or one year in prison, or both.
- permits states to establish stricter standards, but not more permissive standards.

FIFRA gives EPA the authority to develop regulations. Regulations are interpretations of the law (in this case FIFRA) and have the force of a law. The following are items from EPA’s regulations published in the Code of Federal Regulations (CFR) title 40:

- provides standards for worker protection

- provides reentry standards or restricted entry intervals for treated areas

EPA defines “*Reentry time*” and “*Restricted entry interval*” as the length time immediately following application of a pesticide 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 to be permitted that will expose any person to pesticides, either directly or through drift, excepting those involved in the application.
- if labeling for worker reentry is more restrictive than the general standards specify, the label restrictions must be followed instead of the general regulations.
- when no reentry time is specified, treated areas can be reentered without protective clothing after the spray has dried or the dust has settled, unless the pesticide is exempt from reentry requirements. This is true for all pesticides except agricultural products. Beginning on April 15, 1994, all newly labeled agricultural products will have a minimum 12 hour reentry time.
- warnings of pesticide applications appropriate and timely to the situation are to be given to workers either through oral communication, by posting, or both. Warnings should be given in the language that can be understood by the workers involved. The Worker Protection Standard (WPS) mandates that agricultural workers must be given both verbal and posted warnings for every pesticide application.

FIFRA Amended In 1978

Additional Amendments to FIFRA and the 1972 Act were made September 30, 1978.

IT IS ILLEGAL TO:

- 1) detach, alter, deface, or destroy, in whole or in part, any labeling required under FIFRA.
- 2) store or dispose of pesticides or containers other than as directed by regulations and/or as indicated on the labeling.
- 3) use any pesticide in a manner inconsistent with its labeling unless,
 - a) you are using a dosage lower than directed on the label.
 - b) you are using the pesticide against a pest not listed on the label as long as the application site is listed on the label.
 - c) you are applying the pesticide by a method not listed on the label as long as that method is not specifically prohibited on the label.

PLEASE NOTE: New Jersey has adopted all these amendments to FIFRA in 1978 with the **exception** that a pesticide may not be applied by aerial application methods unless the label specifically allows that application method.

PESTICIDE REGISTRATION

Under FIFRA, EPA has registered approximately 50,000 pesticide products. How the EPA handles each registration application depends on whether the product is new or has one or more uses already registered.

New Pesticides or New Formulations (Since 1972)

The law requires EPA to take into account economic, social, and environmental cost and benefits in making decisions. Pesticide registration decisions are based on Agency evaluations of test data provided by the manufacturer. Required studies include testing to show whether a pesticide has the potential to cause adverse effects in humans, fish, wildlife, and endangered species. Potential human risks include acute reactions or eye irritation, as well

as possible long-term effects like cancer, birth defects, or reproductive system disorders. Data on “environmental fate,” or how a pesticide behaves in the environment, are also required so that EPA can determine, among other things, whether a pesticide poses a threat to ground or surface water. Most registration decisions are for new formulations containing active ingredients already registered with EPA, or new uses of existing products.

Old Pesticides

Old pesticides registered and in use before current scientific standards were established must also be evaluated by the “no unreasonable adverse effects” guidelines applied to new pesticides. This is being accomplished through EPA’s Data Call-In program by issuance of “Registration Standards and Reregistration of registered pesticides.”

FIFRA was amended in 1988 (FIFRA 88) in order to require EPA to expedite pesticide reregistration. FIFRA 88 requires, among other things, that all pesticides registered before 1984 be reregistered by 1997, and it authorizes EPA to collect fees from registrants to support the reregistration program. If registrants do not submit to EPA the required data within the designated time, EPA may cancel the registrations. After examination of the registrant’s scientific studies, EPA will either reregister the pesticide or choose some appropriate regulatory action, such as restricting its use or canceling its registration.

EPA Options for Regulation

In regulating pesticides under FIFRA, EPA chooses from a variety of options. If the risk is to people who mix, load and apply the pesticide, EPA can require:

- personal protective clothing such as gloves, hats, respirators or chemical-resistant suits.
- restriction on uses of the pesticide, or require use only by certified pesticide applicators.

- prohibition of certain formulation types such as dusts, granules, ultra-low volume concentrates or sprays.
- engineering controls such as enclosed cabs or closed mixing/loading systems.
- warning statements on the label such as cancer or birth defect risks, to encourage greater compliance with risk reduction measures stated on the label.
- restrictions on application rates or in the frequency of applications.
- prohibition of certain application methods such as aerial applications or backpack sprayers.
- other integrated pest management practices such as mechanical methods or spraying only where infestation has occurred.

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

- reentry or restricted entry intervals which restrict farmworkers from entering a field for a certain period of time, unless they are wearing label specified protective clothing. (Required for all pesticide applications.)
- restriction in formulation type or application rates.
- oral notification or posting of signs to warn farmworkers that treatment has occurred (required for all pesticide applications).

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

- longer preharvest intervals so that residues will have more time to dissipate.
- changes in the manufacturing process of pesticides to reduce levels of contaminants or impurities.

- restrictions in the frequency of application and/or rates.

EPA can also cancel or deny registration for the uses of a pesticide. In such a case, EPA can either cancel or deny certain uses or all uses where risks are particularly high. It is possible that they may deny or gradually remove a pesticide from the marketplace to allow the development of alternative chemicals or technologies.

EPA can suspend the use of a pesticide on a regular or an emergency basis if the Agency believes the pesticide poses an imminent hazard. Suspension halts the use of a pesticide until a decision on its registration can be made through the cancellation process.

WORKER PROTECTION STANDARD (WPS)

The federal Agricultural Worker Protection Standard (WPS) takes effect on January 1, 1995. These regulations make owners of farms, greenhouses, nurseries, and forest (also known as “agricultural employers”) responsible for many aspects of agricultural worker safety and training. Farm owners and their immediate families are exempt from giving themselves many of the protections required for other workers under these regulations. The exact text of these regulations can be found in Part III of the Federal Register (49 CFR Parts 156 and 170) of August 21, 1992, which most libraries would have.

Worker Protection Standard (WPS) cover three main areas concerning pesticides - these are: (1) exposure reduction, (2) mitigation and (3) exposure which deals with reentry times and pesticide education. Label directions for agricultural pesticides will also be changing because of these regulations. Directions on reentry to treated areas, safety equipment, and oral and posted warning for workers are examples of these changes. Read and follow label directions carefully.

The main WPS responsibilities for farm owners are the following:

- Display of information at a central location, including WPS safety poster, information about the location of emergency medical facilities, and a list of recent pesticide applications.
- Pesticide safety training for workers and handlers.
- Providing decontamination sites.
- Employer information exchange between employers of agricultural workers (i.e. growers) and employers of commercial (for-hire) pesticide handlers.
- Emergency assistance, including transportation to medical care and information to medical personnel or your employees.
- Notice of applications by oral warning or posting treated areas.
- Monitoring of handlers who are using highly toxic pesticides.
- Specific instructions for handlers, including labeling information and safe operation of application equipment.
- Equipment safety, including inspection and maintenance.
- Many duties related to personal protective equipment (PPE) including providing, cleaning, and maintaining it, preventing heat illness and allowing exceptions to PPE.
- Many duties related to early entry including training and instruction, decontamination sites, and providing, cleaning, and maintaining personal protective equipment.

EPA has developed a series of WPS education materials to help agricultural employers learn about the law and assist them to train their workers about pesticide safety. In New Jersey, the Pesticide Control Program (PCP) is responsible for enforcing the WPS. For further information, call the PCP at (609) 530-4146.

THE ENDANGERED SPECIES ACT (ESA) OF 1973

The purpose of the Endangered Species Act (ESA) is to protect endangered species. The ESA 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 remove endangered plants from areas under federal jurisdiction. It also mandates that other federal agencies ensure that any action they carry out or authorize is not likely to jeopardize the continued existence of any endangered species, or to destroy or adversely modify its critical habitat.

The FWS determines whether a species is endangered. An endangered species is a plant or animal which is in danger of extinction throughout all or a significant portion of its range. A threatened species is one likely to become endangered in the foreseeable future. The reasons a species becomes endangered or threatened are complex and difficult to correct. Destruction of habitat is one of the major reasons for the decline of some species. Habitat destruction is usually the result of industrial, agricultural, residential or recreational development. Within the United States about 275 animals and 190 plants have been listed as endangered or threatened. Once a species is listed as endangered, the FWS may designate that its critical habitat be protected from destruction or modification in any way.

EPA is required to ensure that registered pesticide use is unlikely to jeopardize endangered species. Jeopardize means that the action "appreciably reduces the likelihood of survival of the species." To accomplish this, EPA estimates the maximum environmental concentration of each pesticide. If this estimated concentration may affect an endangered

species, the pesticide is referred to the FWS. The FWS determines if the pesticide uses are likely to jeopardize the endangered species. When FWS finds that the uses may cause jeopardy to the endangered species, they will recommend alternatives and/or restrict the use of the pesticide within the habitat of the affected species. If the pesticide will adversely affect the species, but not to the point of jeopardy, FWS provides discretionary conservation recommendations.

EPA responds to the FWS jeopardy opinions by making changes to the pesticide label. The new label language may contain specific restrictions or it may direct pesticide applicators to read an Endangered Species Bulletin with directions for the use of the pesticide where endangered species may be affected.

Ultimately, protection of endangered species from pesticides will fall to the pesticide applicator. Preserving the biological diversity of our planet by protecting endangered species will contribute to the overall quality of life. Each plant or animal is part of a complex food chain; break one of the links and others are adversely affected. One disappearing plant can take with it up to thirty other species that depend on it, including insects, higher animals and even other plants.

FOOD, DRUG AND COSMETIC ACT OF 1938

The Food, Drug and Cosmetic Act (FDCA) of 1938 has been amended several times in its history. It is administered by the Food and Drug Administration of the Department of Health and Human Welfare.

FFDCA governs, among other things, pesticide residue levels in food or feed crops marketed in the U.S. Under the FFDCA, EPA has the responsibility for setting tolerances, or maximum legal limits for pesticide residues on food commodities marketed in the U.S. The purpose of the tolerance program is to ensure that U.S. consumers are not exposed to unsafe food-pesticide residue levels.

The Food and Drug administration has the responsibility for enforcing tolerance levels set by EPA. This law:

- provides for the monitoring of food crops for pesticide residues and enforces tolerances.
- provides for the monitoring and enforcement of food additive tolerances and for the prosecution of violators.
- provides that the FDA work jointly with EPA to register pesticides used on animals
- provides for monitoring of pesticide residue in animals by the Meat Inspection Division of the U.S. Department of Agriculture.

DELANEY CLAUSE

The Delaney Clause is a provision of the FFDCA, and its purpose is to prohibit oncogenic pesticides (a pesticide capable of inducing tumors) from being used in any processed foods. The Delaney Clause prohibits the establishment of any processed-food tolerances for an oncogenic pesticide, regardless of whether or to what extent its residue is judged to pose a hazard to human health.

OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA) OF 1970

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

- requires any employer with eleven 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 recorded. Records must be made if the injury involved medical treatment, loss of consciousness, restriction of work or motion, or transfer to another job.

- requires investigation of employee complaints that may be related to pesticide use, reentry or accidents.

HAZARD COMMUNICATION STANDARD (HCS)

This rule written and administered by OSHA, provides protection for employees exposed to hazardous chemicals. Pesticides are considered hazardous chemicals. An employee is defined as a worker who may be exposed to hazardous chemicals under normal operating conditions or in foreseeable emergencies. Exposure or exposed means that an employee is subjected to a hazardous chemical in the course of employment through any route of entry (inhalation, ingestion, skin contact or absorption), and includes potential (i.e. accidental or possible) exposure.

The HCS regulations apply to all non-farming operations that deal with pesticides.

This law:

- requires employers to read the Standard and understand the provisions and responsibilities of an employer.
- requires a list of the hazardous chemicals in the workplace be made.
- requires employers to obtain material safety data sheets (MSDS) for all hazardous substances on their list.
- requires all containers to be labeled.
- requires that a written communication program be developed and implemented.
- requires that employee training be conducted based upon the chemical list, MSDS and labeling information.

- employers must 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 OF 1976

The Federal Resource Conservation and Recovery Act (RCRA) is administered by the Environmental Protection Agency to manage all hazardous wastes.

Under this Law:

- private applicators (farmers) who properly dispose of pesticide wastes, excess pesticides, and triple rinsed empty containers on their own property are in general exempt from the requirements of this law (state requirements are often more strict).
- others who accumulate 2.2 pounds per month or more of waste containing acutely hazardous chemical or 220 pounds of hazardous waste are regulated; must register as a generator of hazardous waste and obtain an ID number from EPA and follow certain disposal requirements.
- triple-rinsed used containers can be disposed of in EPA approved sanitary landfills without an ID number or further regulation.

Regulated waste includes unrinsed containers, excess pesticide and pesticide dilutions, rinse water, etc. which contain a listed chemical and cannot be properly used.

To find out if a pesticide is listed in RCRA call:

EPA RCRA Hotline 1-800-424-9346
8:30 a.m. - 7:30 p.m. EST
Monday through Friday

- probably any pesticide not listed as hazardous in RCRA should be treated as hazardous because any flammable, corrosive, reactive, or toxic waste is considered hazardous even if it is not on the list. State hazardous waste regulations should also be followed.

TRANSPORTATION SAFETY ACT OF 1974

The Transportation Safety Act of 1974 authorized the U.S. Department of Transportation (DOT) to declare, issue and enforce hazardous materials regulations for all modes of transportation. These regulations, contained in Title 49 of the Code of Federal Regulations (49CFR), cover any safety aspect of transportation hazardous material, including the packing, re-packing, handling, describing, labeling, marking, placarding, and routing of such materials. Many states have adopted these federal regulations and are enforcing them.

The materials include under this regulation are explosives, compressed gases, flammable liquids and solids, poisons and several other classifications of chemicals. Many pesticides are not defined by the DOT as hazardous although most of the hazard classes defined include pesticides.

The shipper who offers a hazardous material for transportation in commerce shall describe the hazardous material on the shipping paper as required by the regulations. The applicator or carrier may not transport a hazardous material unless it is accompanied by a shipping paper. However, in most cases pesticides do not need shipping papers unless the quantity of the material in one package equals or exceeds the "Reportable Quantity" (RQ) listed in the regulations. A pesticide would be 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 the 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 OF 1986 (SARA TITLE III)

SARA Title III is a Federal Right-to-Know law that affects those that produce or store hazardous chemicals. Pesticide producers, distributors, retailers and some pesticide applicators are among those that must comply with this law. It is designed to inform communities regarding hazardous chemicals located in the vicinity and addresses the need for community emergency response plans in the event of an accident.

Title III has many sections, however, the areas that affect the pesticide applicator, applicator business, or dealer are confined to four sections:

- section 302 - Emergency planning and notification describes when notification of the state and local officials is required. EPA has assigned a Threshold Planning Quantity (TPQ) for each active ingredient (not total weight of formulated product). When the product in storage is at or above the TPQ, the State Emergency Response Commission (SERC) must be notified in writing. Each facility is also required to designate 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 describes the safety measures when an accidental release (such as a spill) of any extremely hazardous substance occurs. If all the following occur:
 - the pesticide was spilled.
 - is covered under SARA Title III.
 - the spill quantity was greater than the Reportable Quantity (RQ)
 - and the spill created off-site exposure.

You Must:

1. notify the SERC.
2. notify the LEPC.
3. report the release to the National Response Center (1-800-424-8802).

If a pesticide is applied according to the label, the use is exempt from emergency release reporting.

- section 311 - Material safety data sheet reporting is required under SARA Title III. Employers are required to obtain and keep material safety data sheets and submit copies of each MSDS (or listing of the MSDS that must be maintained) to their local fire department, the LEPC, and the SERC. There is one exclusion for the section 311 requirement. If a chemical is used solely for household, consumer, or agricultural purposes, then notification is not required.
- section 312 - this section states that facilities must submit an annual chemical inventory to their local fire department, LEPC, and SERC. This inventory must include all hazardous chemicals stored at the facility at or above 10,000 pounds and any extremely hazardous chemical stored at or above 500 pounds (or 55 gallons) or above the TPQ, whichever is less. Agricultural producers are exempt from this section.

OTHER REGULATIONS

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

Pesticide regulation is very complex; merging science, public policy, and law. Since scientific knowledge constantly changes, as do the needs of society, the pesticide regulatory process is never at a standstill. EPA continuously updates pesticide decisions as knowledge increases and improves.

SELF STUDY QUESTIONS

1. What is the full name and acronym of the federal agency mandated to regulate pesticides?
2. What is the full name and acronym for the law EPA uses to manage pesticides?
3. What are regulations?
4. Define reentry time.
5. Which federal agency sets food tolerances for pesticides? Which federal agency enforces these tolerances?
6. FIFRA allows states to establish standards. What kind of standards?
7. What is the purpose of the tolerance program?
8. The regulations interpreting the transportation Safety Act are contained in 49 CFR. What do these regulations do?
9. Which federal agency determines what species are endangered?
10. Who ultimately bears the responsibility of protecting endangered species from pesticides?

ANSWERS:

1. Environmental Protection Agency (full), EPA (acronym).
2. Federal Insecticide, Fungicide, and Rodenticide Act (full), FIFRA (acronym).
3. Regulations are interpretations of the law and have the force of law.
4. Reentry time is the time immediately following application of a pesticide to a treated area when unprotected workers may not enter.
5. EPA sets food tolerances; FDA enforces food tolerances.
6. More strict.

7. The tolerance program is to ensure that U.S. consumers are not exposed to unsafe food-pesticide residue levels.

8. The regulations in 49 CFR cover any safety aspect of transporting hazardous material, including the packing, repacking, handling, describing, labeling, marking, placarding, and routing of such materials.

9. Fish and Wildlife Service (FWS) of the Department of the Interior.

10. You, the applicator.

CHAPTER FOUR

TOXICITY OF PESTICIDES

Learning Objectives

- * Explain the difference between acute and chronic toxicity.
- * List three routes by which your body can be exposed to pesticides and name the route that should be of most concern to you.
- * Understand the hazards associated with the use of pesticides.
- * Define the three main chemical "families" of pesticides.
- * Describe how to avoid harmful effects from pesticides.
- * Describe the signs and symptoms of pesticide poisoning.
- * Describe appropriate first aid for pesticide exposures.

Pesticides are designed to control pests. Most control the pest by poisoning it. Unfortunately many pesticides are poisonous to humans, too. Some are very poisonous (toxic) and may kill or seriously injure humans. Others are relatively safe (non-toxic). Even the relatively safe pesticide can irritate the skin, eyes, nose, or mouth. You should use caution whenever you handle any pesticide!

ROUTES OF ENTRY

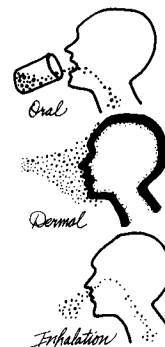
Pesticides can enter the body in three ways. You may be poisoned no matter which way they get in. You can even be poisoned without knowing it, especially if the pesticides enter through your skin or lungs.

Oral - Pesticides may enter the body through the mouth. They may be taken in by mistake while eating or smoking on the job or when improperly stored in food containers.

Dermal - Pesticides can also be taken in through the skin. Wearing clothing which is wet through with pesticides or allowing pesticides to fall directly on the skin while mixing or spraying can be dangerous. Dry materials - dusts, wettable powders or granules - can also be absorbed. Some pesticides do not pass through the skin very quickly. Others, however, can be as dangerous entering through skin as when taken by mouth.

Pesticides pass through the skin on some areas of the body more quickly than on other areas. You must be especially careful with your eyes. The back of the hands and the wrists absorb more than the palms do. The armpits, back of the neck, groin, and feet take in pesticides easily, too. Cuts or scrapes allow pesticide to enter even more easily than usual.

Inhalation - You can breathe in pesticides, too. Pesticides in the form of dusts, spray mist, or fumes can be sucked into your lungs as you inhale. This route of entry is important during mixing of wettable powders, dusts, or granules. You can also be poisoned when fumigating or spraying without the



proper respirator in a closed area, such as greenhouses, apartments, or grain bins. Even inhalation of dilute pesticides can result in poisoning.

Which Route Is More Important? - The dermal and inhalation routes of entry are likely to be more important to the pesticide applicator than the oral route. You do not purposely eat or drink the chemicals you are using. But you may breathe them in, splash them on your skin, or expose yourself to pesticide fallout. You can be poisoned no matter which way the pesticide enters your body.

KINDS OF TOXICITY

Toxicity Means “How Poisonous.” In other words, if you know the toxicity of a pesticide, you know “how poisonous” it is. The toxicity of a pesticide must be measured in more than one way. Many pesticides are dangerous after one large dose. Some pesticides, however, are dangerous after small, repeated doses.

Acute Toxicity is “how poisonous” a pesticide is to an animal (or man) after single exposure. A pesticide with a high acute toxicity is deadly if even a very small amount is absorbed. Usually “how poisonous” one pesticide is compared to another is judged on acute toxicity. It is also the basis for the warning statements on the label. Acute toxicity may be measured as acute oral, dermal, and inhalation toxicity.

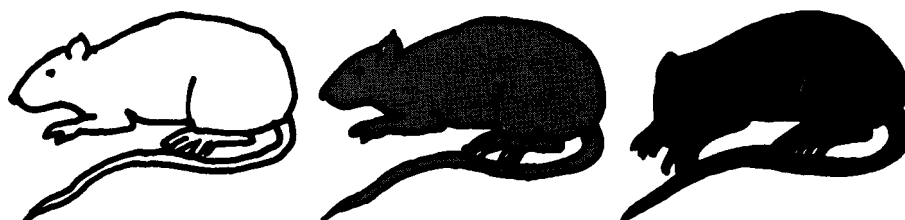
Chronic Toxicity is “how poisonous” a pesticide is to an animal (or man) after small, repeated doses over a period of time. Chronic toxicity is very important because some pesticides can remain in the body for a long time. If you are exposed often to these pesticides they may remain and build up in your body. You can be poisoned without ever getting a large dose of pesticide! Chronic toxicity may be measured as chronic oral, dermal, and inhalation toxicity.

MEASURING TOXICITY

Finding out the toxicity of a pesticide is not easy. Obviously, humans cannot be test subjects. Other animals (usually rats) are used. However, just because a pesticide is very poisonous to rats doesn't mean it is also very poisonous to dogs, cows, man, or wildlife. Likewise, a pesticide which is relatively non-toxic to rats is not always relatively safe to other animals. Toxicity studies are just guidelines. They are used to estimate “how poisonous” a pesticide is compared to another pesticide.

Acute Toxicity Measures - The commonly used measure of acute oral and dermal toxicity is LD_{50} . LD means Lethal Dose (deadly amount), and LD_{50} is the amount of a pesticide that has killed half of the animals in a laboratory test. LD_{50} values are measured from 0 up. The lower the LD_{50} , the less is chemical required to kill half of the test animals and the more poisonous the pesticide. A pesticide with an acute oral LD_{50} of 500 is much less toxic than a pesticide with an LD_{50} of 5. Usually LD_{50} values are measured in milligrams per kilogram. Often you will note the abbreviation “mg/kg” following the number value. “Milligram” and “kilogram” are metric units of weight similar to “ounce” and “ton.” Milligrams per kilogram is the same as parts per million. For example, the oral LD_{50} of Pesticide A is 5 mg/kg. Therefore it would take only 5 parts of Pesticide A for every 1 million parts of body weight to kill 50% of the test animals.

Acute inhalation toxicity is measured by LC_{50} . LC means Lethal Concentration. “Concentration” is used instead of “dose” because the amount of pes-



pesticide inhaled from air is being measured. LC_{50} values are measured in milligrams per liter. The lower the LC_{50} value the more poisonous the pesticide.

Chronic Toxicity Measures - There is no standard measure like LD_{50} for chronic toxicity studies. Often the length of the experiment in days, months, or years and the amount of each dose is stated. For example, a study of chronic oral toxicity might look like this: 8 milligrams of pesticide were fed to rats daily for two years. No symptoms of poisoning appeared.

Two classes of pesticides, the organophosphates and carbamates, can slowly poison by attacking an essential body chemical called “cholinesterase”. The chronic exposure to these pesticides can be measured by monitoring changes in cholinesterase levels in the blood. A low level of cholinesterase means danger. If this occurs, stay away from organophosphates and carbamates until the level is normal again.

LABEL WARNING STATEMENTS

To alert pesticide users to the toxicity of a pesticide, a signal word must appear on labels. Four different categories are used. Signal words are used to tell the user whether the chemical is highly toxic, moderately (medium) toxic, slightly toxic, or relatively non-toxic. Label warning statements are based on acute toxicity. Acute oral toxicity, acute dermal toxicity, and acute inhalation toxicity are all used to determine the correct category for each pesticide. For example, the acute oral toxicity and acute dermal toxicity of a pesticide are in the slightly toxic category. But the acute inhalation toxicity is in the highly toxic category. The pesticide label will have the signal words for a highly toxic pesticide.

HAZARD

Hazard is the risk of danger. It is the chance that danger or harm will come to the applicator, bystanders, consumers, livestock, wildlife, or crops, etc. from the use of a pesticide. Hazard is often confused with toxicity. They are not the same. A highly toxic

pesticide is usually considered “hazardous” because of the high risk that the applicator, bystanders, etc. can be injured. However, safe and careful handling of a highly toxic pesticide can make it a low risk or low hazard. Many factors besides toxicity can make a pesticide hazardous. These include: the target involved, the formulation chosen, the concentration and dosage used, the type of pesticide, and the skill of the applicator.

Target - The location of application is called the target site. It can consist of plants, soil, insects, animals, structures, and many other things. The intended use of a pesticide on a target is to control specific target pests without harming fragile “nontarget species.” The ideal pesticide controls the target pest and poses little or no hazard to nontarget species, as well as the target area itself.

Formulation - The hazard of a pesticide is also influenced by the way a pesticide is put together, or made into a formulation for use. Depending on the original toxicity of the pesticide, formulations that are easily absorbed or inhaled may pose more of a hazard than those that are less easily absorbed or inhaled. Keeping in mind all the factors that influence the toxicity of the pesticide, formulations generally pose the following toxicity hazard in decreasing order: emulsifiable concentrate > oil solution > water emulsion > water solution > wettable powder/flowable (in suspension) > dust > granular. Choose the safest formulation available to do the job.

Concentration and Dosage - Usually, the more concentrated a formulation is the more hazard it poses. Dilute the concentrated pesticide and you reduce the hazard. For example, one ounce of pesticide A contains a lethal oral dose. If the same one ounce of pesticide A is diluted in ten gallons of water, each ounce of the dilute mixture is thus reduced when compared to the concentrate. Use good judgment when figuring out the concentration and dosage of a pesticide; try to use the lowest concentration and/or dosage that is necessary to control the target species.

Table 4.1 Toxicity Levels Corresponding to Label Signal Words.

Signal Word		Categories of Acute Toxicity		
		LD ₅₀		LC ₅₀
		Oral mg/kg	Dermal	Inhalation ppm
I - Highly Toxic	DANGER/DANGER POISON and Skull & Cross-bones	0-5	0-200	0-200
II- Moderately Toxic	WARNING	50-500	200-2,000	200-2,000
III-Slightly Toxic	CAUTION	500-5,000	2,000-20,000	2,000-20,000
IV- Relatively Non-toxic		>5,000	>20,000	>20,000

Type of Pesticide - Some moderately poisonous pesticides are hazardous to the environment because they build up in animals. DDT and other chlorinated hydrocarbons, for example, are known to build up in animals. Some of these long lasting sprays are relatively safe, however, when used inside buildings or homes. Other pesticides, such as many organo-phosphates, are highly toxic but break down quickly in the environment. These are not as hazardous to the environment but are very hazardous in buildings or around people.

Applicator - A skilled, experienced applicator using a highly toxic material may be less of a hazard to himself and others than the homeowner who spreads ant and roach bait around his house. A certified applicator should have the skill and knowledge to handle all pesticides safely. Otherwise he is a hazard to himself, to others, and to the environment.

Synergism - The action of two materials of the same type which used together produce a greater effect than the sum of the materials when used alone is

referred to as synergism. One of the materials when used alone may not affect the pest, but it greatly increases the total of the two when used together. Example: Chemical A kills 60%, Chemical B kills 20%, Chemical A and B together kill 98% of the pests. Synergism may increase control or require less chemical. It may also be more harmful to a non-target organism.

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

SYMPTOMS OF PESTICIDE POISONING

You should be aware of the early signs and symptoms of poisoning. It is important to remove the person from the source of exposure quickly. Remove contaminated clothing and wash off any chemical which has soaked through. You may save a life.

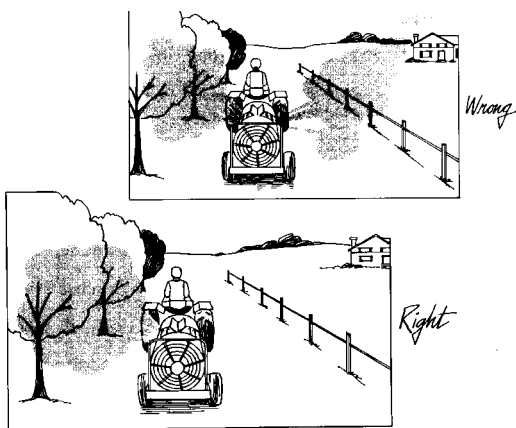
Pesticide Poisoning or Not?

The symptoms of pesticide poisoning are similar to those of other types of poisoning and of other diseases. Heat exhaustion, food poisoning, asthma, and other illnesses are sometimes confused with pesticide poisoning. Just because a person becomes ill after using or being around pesticides is not proof that he is poisoned.

The symptoms of poisoning described here may occur in a person who has been suddenly exposed to large quantities of a toxic material. Or they may occur in a person who has been continuously exposed to smaller quantities of toxic material over longer periods of time. If the symptoms appear, call your doctor and tell him or her what pesticide was involved.

KINDS OF POISONING

Acute poisoning is the severe poisoning which occurs after exposure to a single dose of pesticide. The appearance of symptoms may be sudden and



dramatic or may be delayed.

Chronic poisoning is the poisoning which occurs as a result of repeated, small, nonlethal doses over a long period of time. Many symptoms may appear, such as nervousness, slowed reflexes, irritability, or a general decline of health. Some test animals are unable to reproduce normally after repeated exposure to pesticides.

Medical Doctors Should Be Warned Ahead of Time

Most medical doctors are not well informed as to the symptoms and treatment of pesticide poisoning. This is due to the few cases which they treat. Pesticide poisoning symptoms are similar to those of other illnesses and poisonings. You, the pesticide applicator, should tell your doctor which chemicals you use so that your physician will know the symptoms and treatment and have the antidotes on hand.

GENERAL SYMPTOMS

Unfortunately all pesticide poisoning symptoms are not the same. Each chemical family, i.e., organophosphates, carbamates, chlorinated hydrocarbons, attack the human body in a different way. However, you should be aware of the general symptoms of pesticide poisoning.

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 nose and throat.

Moderate Poisoning or Early Symptoms of Acute Poisoning - nausea, diarrhea, excessive saliva, stomach cramps, excessive perspiration, trembling, no muscle coordination, muscle twitches, extreme weakness, mental confusion, blurred vision, difficulty in breathing, coughing, 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, unconsciousness.

CHEMICAL FAMILIES

Pesticides which are chemically similar to one another are often grouped together into "families." Each pesticide in a family attacks a pest in a similar way. Treatment and antidotes for poisoning are also

the same within each family. It is important that the doctor know which chemical family is involved. The three major chemical families are as follows:

Organophosphates. Many organophosphates are highly toxic via oral, dermal, and inhalation exposure. These include: parathion, TEPP, Phosdrin, Thimet, Systox, Di-Syston, Guthion, phosphamidon, Monitor.

Carbamates. Many carbamates are only moderately or slightly toxic. However, some are highly toxic via oral, dermal, or inhalation exposure. These include Temik, Furadan, Zectran, Carzol SP, Lannate.

Chlorinated Hydrocarbons. Most chlorinated hydrocarbons are considered hazardous because they persist in the environment. However, some are highly toxic via dermal and oral exposure. These include Pentac, Thiodan, lindane and methoxychlor.

If you are in doubt whether poisoning has occurred, let a doctor decide!

FIRST AID FOR PESTICIDE POISONING

Call a Doctor

First Aid is just that. It is the initial effort to help a victim while medical help is on the way. Step one in any poisoning emergency is to call an ambulance or doctor. The only exception is when you are all alone with the victim. Then you must see that he is breathing and that he is not further exposed before leaving him to make your phone call. Always save the pesticide and the label for the doctor.

WHILE WAITING DO THIS FOR:

Skin Absorption

- * Drench skin and clothing with water (shower, hose, faucet, pond). The faster the poison is washed off the patient, the less injury will result.
- * Remove Clothing.

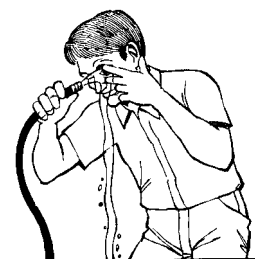
- * Cleanse skin and hair thoroughly with soap and water. Detergents and commercial cleansers are better than soap.
- * Dry and wrap in blanket.
- * **WARNING:** Do not allow any pesticide to get on you while you are helping the victim.

Chemical Burns of the Skin

- * Wash with large quantities of running water.
- * Remove contaminated clothing.
- * Immediately cover loosely with a clean, soft cloth.
- * Avoid use of ointments, greases, powders, and other drugs in first aid treatment of burns.

Poison in the Eye

- * It is most important to wash the eye out as quickly but as gently as possible.
- * Hold eyelids open, wash eyes with a gentle stream of clean running water.
- * Continue washing for 15 minutes or more.
- * Do not use chemicals or drugs in wash water. They may increase the extent of the injury.



Inhaled Poisons (Dusts, Vapors and Gases)

- * If victim is in an enclosed space, do not go in after him without an air-supplied respirator.
- * Carry patient (do not let him walk) to fresh air immediately.
- * Open all doors and windows.
- * Loosen all tight clothing.
- * Apply artificial respiration if breathing has stopped or is irregular.
- * Keep patient as quiet as possible.
- * If patient is convulsing, watch his breathing and protect him from falling and striking his head. Keep his chin up so his air passage will remain free for breathing.
- * Prevent chilling (wrap patient in blankets but don't overheat).
- * Do not give alcohol in any form.

Swallowed Poisons

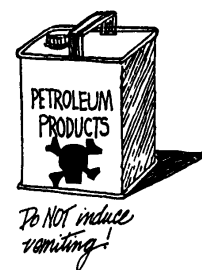
To Vomit or Not to Vomit (should you induce vomiting?)

The most important choice you have to make when aiding a person who has swallowed a pesticide is to vomit or not to vomit. The decision must be made quickly and accurately; the victim's life may depend on it. Usually it is best to get rid of the swallowed poison fast...But:

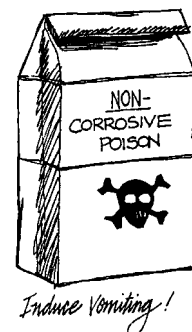
- * Never induce vomiting if the victim is unconscious or is having convulsions. The victim could choke to death on the vomitus.
- * Never induce vomiting if the victim has swallowed a corrosive poison. Find out what poison the person has ingested. A corrosive poison is a strong acid or alkali such as dinoseb. The victim



will complain of severe pain and have signs of severe mouth and throat burns. A corrosive poison will burn the throat and mouth as severely coming up as it did going down.



- * Never induce vomiting if the person has swallowed petroleum products (that is kerosene, gasoline, oil, lighter fluid). Most pesticides which come in liquid formulations are dissolved in petroleum products. The words "emulsifiable concentrate" or "solution" on the pesticide labels



are signals **NOT** to induce vomiting in the poison victim if he has swallowed the concentrates. Concentrated petroleum products (like corrosive poisons) cause severe burns. They will burn as severely when vomited up. If he has swallowed a dilute form of these formulations, he should be forced to vomit immediately.

How to Induce Vomiting

Do not waste a lot of time inducing vomiting. Use it only as first aid until you can get the victim to a hospital. Make sure the victim is lying face down or kneeling forward while retching or vomiting. Do not let him lie on his back because vomitus could enter the lungs and do more damage.

- * First give the patient large amounts of milk or water. One to two cups for victims up to five years old; up to a quart for victims five years and older.
- * If victim is alert and respiration is not depressed, give syrup of ipecac, followed by one to two glasses of water to induce vomiting. Adults (12

years and over): 30 ml (two tablespoons); children under 12 years: 15 ml (1 tablespoon). Activity hastens the effect of the syrup of ipecac.

- * Collect some of the vomitus for the doctor; he may need it for chemical tests.

The best first aid is to dilute the poison as quickly as possible with milk or preferably with water. It is very important that the victim get to a hospital without delay. Many communities now have rescue units with ambulances manned by Emergency Medical Technicians who can communicate with the hospital and can begin treatment en route.

If a rescue unit is not available in your area you will have to transport the patient. Call the hospital emergency room or poison control center for instructions and so they can prepare for the victim's arrival.

Activated Charcoal - If the poison control center agrees, use activated charcoal as a "sponge" to absorb excess poisons after the instructions for corrosive or noncorrosive poisons are followed. It absorbs many poisons at a high rate. Mix it with water into a thick soup for the victim to drink. Activated charcoal is found in aquarium filters or is available from a drug store.



Grosafe - A commercial preparation of activated charcoal is sold for use on pesticide spills or overdoses on crops and soil. In a poisoning emergency this product may be substituted for a pharmaceutical grade of activated charcoal and fed to the victim. Grosafe is distributed in the northeast by farm service and supply stores.

Atropine Sulfate - atropine tablets should **not** be taken in a poisoning emergency. The dose is much too small. Often the victim cannot or should not take oral medicine. The atropine can hide or delay early symptoms of poisoning. The victim may be fooled into thinking he is okay and may even go back to work. Or a doctor may not detect the problem

because the symptoms are hidden by the atropine. **WARNING:** Atropine can be poisonous if misused. It should never be used to prevent poisoning. Workers should not carry atropine for first aid purposes. It should be given only under doctor's directions.

Shock

Sometimes poisoning victims go into shock. If untreated or ignored the victim can die from shock even if the poisoning injuries would not be fatal.

Shock Symptoms

The skin will be pale, moist, cold and clammy. The eyes are vacant and lackluster with dilated pupils. The breathing will be shallow and irregular. The pulse is very weak, rapid and irregular. The victim may be unconscious or in a faint.

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

WARNING: Never try to give anything by mouth to an unconscious victim.

Poison Control Centers

Poison Control Centers have been established to give pertinent information on all types of poisonings including pesticide poisoning. The applicator should post the telephone number of the nearest Poison Control Center near his phone, and his doctor should also have the number available. The number of the New Jersey Poison Control Center is **1-800-962-1253**. There is also a national Hotline number which will connect you with the National Pesticide Telecommunications Network (NPTN). NPTN's number is **1-800-585-7378**.

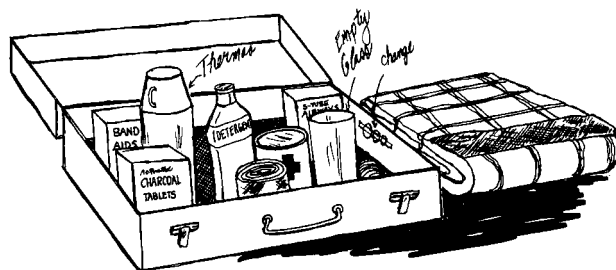
In any poisoning emergency, think first of water. Your first aim is to dilute the pesticide no matter where it is. Then get the victim to a doctor fast.

First-Aid Kit for Field and On-the-Job Use

A well equipped first-aid kit which is always readily available can be important in a pesticide emergency. Make up your own Pesticide First-Aid Kit from a lunch pail, tool box or a sturdy wooden box. It should have a tight fitting cover with a latch so that it won't come open or allow pesticides to leak inside. Label it clearly with paint or a water proof marker.

Contents:

1. A small plastic bottle of a common detergent. It is used to wash pesticides quickly off the skin.
2. A small package or bag of Activated Charcoal. Mixed with water and swallowed, activated charcoal acts as an absorber of all pesticides.
3. A Shaped Plastic Airway for mouth-to-mouth resuscitation.
4. A thermos or large plastic bottle (at least one pint) of clean water. If there is no clean water in an emergency use any pond or stream water available.
5. Simple Band Aids, Bandages and Tape. All cuts and scrapes should be covered to prevent pesticides from easily entering the body.
6. A Blanket is very useful. It should be kept in a place where it will not be contaminated by pesticides.
7. Suitable Coins should always be taped to the inside cover of the first-aid kit. They are for an emergency phone call.



8. A small, plastic empty jar with a tight fitting lid is useful as a drinking glass for the victim in order to induce vomiting or feed activated charcoal. It can be used for collecting vomitus to take to the doctor.

SELF STUDY QUESTIONS

1. The inherent ability of a pesticide to poison organisms is called -

A) danger.
B) toxicity.
C) hazard.
D) risk.
2. In an LD₅₀ equal to 68 mg/kg the 68 milligrams refers to the -

A) pesticide.
B) soil sample.
C) test organism.
D) food sample.
3. The oral LD₅₀ level which represents a highly toxic pesticide is -

A) 640 mg/kg.
B) 5800 mg/kg.
C) 46 mg/kg.
D) 380 mg/kg.
4. The probability of a pesticide causing adverse effects to an organism is called -

A) warning.
B) toxicity.
C) hazard.
D) accident.
5. All pesticides can pass through the skin to enter the blood and significantly affect the nervous system of man.

T ()

F ()

6. The kind of toxicity that results from small, repeated exposures to a pesticide over a period of time is called -

- A) low toxicity.
- B) acute toxicity.
- C) high toxicity.
- D) chronic toxicity.

7. The signal word on a pesticide label indicates the pesticide's -

- A) effectiveness.
- B) toxicity.
- C) compatibility.
- D) formulation.

8. Low toxicity is indicated by low LD₅₀.

T () F ()

9. Acute toxicity is a measure of how poisonous a pesticide is to an animal (or man) from a single exposure.

T () F ()

10. The hazard of a pesticide is -

- A) the same as its toxicity.
- B) the risk of danger from its use.
- C) indicated by the signal word on the label.

11. The symptoms of pesticide poisoning are greatly different from those of other types of poisoning and/or illnesses.

T () F ()

12. After an acute, dermal exposure to a moderately or highly toxic pesticide, the first thing to do is -

- A) remove the contaminated clothing and shower.
- B) drink plenty of water.
- C) vomit if possible.
- D) finish spraying and go immediately to the house.

13. Symptoms of acute pesticide poisoning are similar to those of chronic pesticide poisoning.

T () F ()

14. General symptoms of pesticide poisoning are -

- A) headache and dizziness.
- B) nausea and diarrhea.
- C) excessive perspiration and trembling.
- D) all of the above.

15. Applicators working with highly toxic organophosphate or carbamate insecticides should have their cholinesterase level checked:

- A) before spray season starts.
- B) at mid-season.
- C) at the end of the season.
- D) all of the above.

16. If you are in doubt whether pesticide poisoning has occurred

- A) go to bed.
- B) see your doctor.
- C) take a laxative.
- D) empty the stomach by vomiting.

17. Poisoning which occurs as a result of repeated, small, nonlethal pesticide exposures over a long period of time is called -

- A) chronic poisoning.
- B) mild poisoning.
- C) acute poisoning.
- D) severe poisoning.

18. In case of an accident, always save the pesticide container with the label for the doctor to obtain more information.

T () F ()

19. A supply of clean water, soap, and a basin can be a great first aid help in -

- A) oral pesticide exposure.
- B) dermal pesticide exposure.
- C) inhalation pesticide exposure.

20. For severe dermal exposure to pesticides-

- A) remove contaminated clothing.
- B) drench exposed body areas with water.
- C) dry and wrap in a blanket.
- D) all of the above.

21. Alcohol and barbituates should be included in the first aid supplies of certified pesticide applicators.

T () F ()

22. Artificial respiration may be needed if pesticide poisoning is severe.

T () F ()

23. In a pesticide poisoning emergency think of using water immediately to -

- A) inactivate the pesticide.
- B) break down the pesticide.
- C) remove the pesticide from the bloodstream.
- D) dilute the pesticide and wash it away.

24. Of the following materials, the one which would be most helpful to have on hand when a highly toxic pesticide is spilled on the legs of an applicator is -

- A) aspirin.
- B) soap and water.
- C) vinegar.
- D) milk.

25. The antidote, atropine, can be helpful in first aid treatment of pesticide poisoning if used according to the directions of a medical doctor.

T () F ()

ANSWERS

- | | | |
|-------|-------|-------|
| 1. B | 5. T | 9. T |
| 2. A | 6. D | 10. B |
| 3. C | 7. B | 11. F |
| 4. C | 8. F | |
| 12. A | 15. D | 18. T |
| 13. T | 16. B | 19. B |
| 14. D | 17. A | |
| 20. D | 24. B | |
| 21. F | 25. T | |
| 22. T | | |
| 23. D | | |

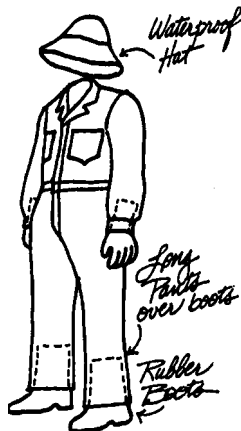
CHAPTER FIVE

SAFETY PRECAUTIONS

Learning Objectives

- * Describe how to protect yourself and others from the hazards associated with pesticides.
- * Understand the term “Reentry.”
- * Know what protective equipment to wear and how to care for this equipment.
- * Understand how pesticides poison and what antidotes to use.
- * Explain the importance of wearing gloves when you handle pesticides.
- * Give reasons why gloves and footwear may fail to protect you.
- * Explain when you should wear protective headgear, and describe appropriate headgear.

You, as an applicator who often works with toxic materials, are interested in safeguarding your health. You also want to protect other people and the environment from pesticide injury. Most pesticide accidents result from careless practices or ignorance. Refer to Appendix C in this manual, “A Checklist for Preventing Pesticide Accidents,” to test your own handling procedures. Learn safe procedures; it’s for your own good!



BEFORE APPLICATION

Many safety precautions can be taken before you begin applying a pesticide. Many applicators are dangerously exposed to pesticides while getting ready to spray, not just during the spraying. Don’t ever decide to spray until all factors are favorable to protect you, others and the environment.

Plan Ahead - Be sure that plenty of soap and/or detergent and water are nearby for emergencies or cleanup. Check the label and wear all the protective gear necessary. Choose a time when weather conditions are right, and choose the safest, effective pesticide available. Always be sure that the intended use is on the label.

Move Pesticides Safely - Whenever a pesticide is in your possession, you are responsible for its safe transport. Do all you can to prevent problems and be prepared in case of an emergency. Carelessness in moving pesticide poisons can result in broken containers, spills and contamination.

Never carry pesticides inside your car or truck cab. Spills on seat covers are very hard to remove. The pesticide could even spill on you or your passengers. Place the containers so they cannot shift, roll or bounce around. If they are glass, pad them to prevent breakage; and if they are larger than five gallons, physically brace them to prevent accidental spills. Never carry pesticides near passengers, pets, fertilizers, seed, food or feed and risk contamination should a spill occur. A spill could cause injury or death.

All containers should be tightly closed and have legible labels. If a label is missing or is illegible, write the brand name or common name, chemical name, percent active ingredient, signal word, and EPA

Registration number on the container. This should also be done for unmarked service containers containing concentrate or dilute pesticides. Secure containers so they will not roll or slide. Protect all containers from moisture and temperature extremes. Never leave your vehicle alone when the pesticides are in an unlocked truck bed or compartment. If the pesticides are left unattended, the legal responsibility for the injury to curious children or careless adults is yours.

Protective Clothing - The need for protective clothing depends on the pesticide being handled. High toxicity is not the only factor; some other factors are formulation, application equipment and degree of exposure. The label will give the precautions necessary for the pesticide being used.

Mixing and Filling - Protective gear is especially important during mixing and filling. Consider using rubber gloves, goggles and a respirator when handling moderately toxic materials even if the label doesn't call for them. Also be sure to:

- * Plan your application so that you mix only what you will use.
- * Use no more than the required amounts to prevent injury to exposed plants and/or animals and to prevent illegal residues in food.
- * Do not combine pesticides unless the combination is called for on the label or you have consulted an authority.
- * Open packages carefully with a knife or sharp instrument to avoid splashes, spills or drift.
- * If a concentrate is spilled or splashed on your clothing, wash and change clothes immediately.
- * If a concentrate is spilled on the floor or ground, clean it up.
- * Some chemicals in the concentrated form will remain in toxic quantities in the soil for many months.

- * Always stand with your head well above the fill hole of the spray tank to keep pesticides from splashing in your face or eyes.
- * Stand with wind from right or left when pouring or mixing.

Equipment - Carefully choose the method of application that will do the job economically and safely. Check your equipment thoroughly before you begin. Be sure it is working properly and calibrated correctly. Use the correct nozzles, pressure, and drop-let size to avoid drift. Use separate equipment when applying hormone-type herbicides (such as 2,4-D). Such herbicides cannot easily be washed out of application equipment and even slight residues may kill sensitive plants.

DURING APPLICATION

While you are applying pesticides there are many safety precautions to follow. You are responsible for the protection of not only yourself but other people, domestic animals and the environment as well. You cannot afford to be careless!

Avoid Exposure - Do not work in drift, spray, or runoff unless properly protected. Be sure to follow these few, simple guidelines:

- * Do not wipe your hands on your clothing if chemicals have been spilled on your gloves. This will contaminate your clothing and may soak through to your skin.
- * Do not blow out clogged hoses, nozzles, or lines with your mouth.
- * Never eat, drink, or smoke when handling pesticides; wash your hands and face thoroughly first.
- * When working with pesticides day after day, even moderately toxic chemicals can poison you. Consider using protective equipment especially a respirator, even if the label doesn't call for it.

Watch out for others, too - Supervise your employees and be sure they follow all safety precautions including the following:

- * Always work in pairs when handling hazardous pesticides. Watch your buddy carefully for unusual behavior or actions.
- * If you feel sick, don't try to "finish up" the job. Get out of the area fast and get help.
- * Keep children, unauthorized persons and pets out of the area to be sprayed.
- * Do not let children or pets play around sprayers, dusters, filler tanks, storage areas, or old pesticide containers.
- * Use the proper rates. Overdoses won't kill pests twice, but may injure humans, plants, or wildlife. An overdose is a misuse of the pesticide.

Avoid Sensitive Areas - Avoid spraying near apiaries, lakes, streams, pastures, houses, schools, playgrounds, hospitals, or sensitive plant material whenever possible. If you must spray, avoid windy days and always spray downwind from the sensitive area. Consider spraying areas near living quarters in the early morning or evening when people and pets are least likely to be exposed. Notify beekeepers and residents when you plan to spray in their area and urge them to take special precautions. Never spray directly into or across streams, ponds, or lakes. Whenever you spray in residential areas, take every precaution. Be sure toys and pet dishes are removed or covered and children are inside.

Avoid Spills, Runoff and Drift - Pesticides which fall anywhere but on the target area can injure plant material, people, and the environment. Avoid applying chemicals when drift or runoff are likely to occur. High winds and heavy rains favor drift and runoff. Choose application equipment, formulations and adjuvants that will minimize drift and runoff hazard. Spills can be avoided by using care and caution.

Avoid Equipment Accidents - Your application equipment can help you use pesticides safely, but poor maintenance and careless use can add to the hazard.

- * Be sure there are no leaks in the pump or tank. Check for leaky hose connections or worn spots in hoses that could burst and splash you or others with poisonous spray. If belts, pulleys, or drive chains are exposed, put guards around them so that children or other people cannot be injured. The spray tank should have a tight lid so that neither you nor others will be splashed and so that spray materials will not leak onto the ground.
- * When the tank is being filled you should stay with the machine. A tank that is not watched often runs over and causes a pesticide spill on the ground or into a stream.
- * If you are working at the end of the spray hose some distance from your equipment, have someone near the sprayer so that children or others will not get caught in or injured by the machinery. The machinery should be shut down if you find it necessary to adjust or repair any moving parts. If nozzles, hoses or lines clog, do not blow them out with your mouth. Even dilute spray mixtures can be toxic.

Safety and caution does not end with the application of the chemical. Proper cleanup and safety measures are still necessary. 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 at the end of the job, spray it on other targets at the recommended dosage. If you spray the extra on plant material, be sure that it is on the label! Never leave partly filled equipment in the field after an operation. When the tank is empty, release the pressure from your application equipment. Close the outlet valves. Return the equipment to the special storage area. Wash off the outside so that people touching it do not get exposed to the pesticides.

Do not leave pesticides or pesticide containers out in the field or at the application site. Be able to account for every container used. Safely dispose of empty containers. **NEVER** give them to children for any use. Partially used pesticides should be stored in tight containers in a locked building. Keep children and uninformed people away from the storage area.

Clean Up. At the end of each day take a shower. Wash your body and scalp thoroughly with soap and water. Spray clothing should be changed daily. If your clothes were exposed to pesticides, place them away from other clothes. Keep them well away from the family laundry. Do not allow children to play in the contaminated clothing. The pesticides on your spray clothes could harm other people who touch them. Warn the person who will be washing your spray clothes of possible dangers. Do not allow the clothes to be washed in streams or ponds. The pesticides could contaminate the water and cause fish kills.

Reentry. Safe reentry times or restricted entry intervals may be on the label. Do not allow workers, children or other persons to reenter the sprayed area until this time has passed. Even with the safest materials wait at least until the spray has dried, dusts have settled, or vapors dispersed. When no reentry times are available, use good judgement in allowing people to reenter sprayed areas.

More restrictive reentry intervals are based on acute dermal toxicity of the active ingredient, eye irritation effects, or skin irritation effects. For example, a 48 hour reentry interval could be established for any organophosphate pesticide in the toxicity Category I.

If you must reenter an area soon after spraying, be sure to wear all the necessary protective clothing as called for on the label.

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!

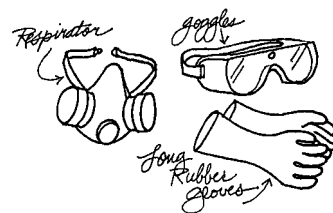
SAFETY PRECAUTIONS FOR HANDLING HIGHLY TOXIC PESTICIDES

The most common cause of pesticide poisoning for applicators is through skin contact. Some pesticides enter the body through the skin quite readily. Concentrates can be especially dangerous. Most of a pesticide spilled on your skin is absorbed in the first few minutes. If any pesticide is spilled on you, wash it off immediately. But it is best to avoid direct contact with pesticides completely by wearing the proper protective clothing. The pesticide label will tell you what protective equipment is necessary. Wear it!

Gloves

Always wear unlined, elbow length chemical-resistant gloves when handling all pesticides except those that are relatively nontoxic (category IV or lower toxicity). The elbow length gloves protect your wrists and prevent pesticides from running down your sleeves into your gloves.

Glove materials include nitrile, butyl, neoprene, natural rubber (latex), polyethylene, and polyvinylchloride (PVC). Current research indicates that nitrile, butyl, and neoprene offer good protection for both dry and liquid pesticides. Neoprene is not recommended for fumigants. Natural rubber is only effective for dry formulations. Never use leather gloves. Never use cotton gloves alone. Cotton and leather gloves can be more hazardous than no protection at all because they absorb and hold the pesticide close to your skin for long periods of time. Check the quality of construction before buying any glove because efficacy varies with the manufacturer. Protection increases with the thickness of the materials, but extra thick gloves may interfere with dexterity. Never use fingerless gloves.



Check your gloves closely for holes by filling the gloves with clean water and gently squeezing. Discard them if any holes appear. When you are finished spraying, wash your gloved hands with detergent and water **before** you remove the gloves. Wash your hands again with lots of soap and water after you remove the gloves.

Nitrile and neoprene gloves can be used for 120 to 160 work hours before being replaced. Replace PVC and natural rubber gloves after 40 work hours. Slash discarded gloves so that they cannot be used by someone else. Wrap in a plastic bag and put with an empty pesticide container for proper disposal.

Body Covering

Regular work attire of long pants and a long-sleeved shirt, shoes, and socks are acceptable for slightly toxic (category III) and relatively non-toxic (category IV) unless otherwise noted on the pesticide's label. Many applicators prefer work uniforms and cotton coveralls that fit the regular-work-attire description and provide equal protection. Applicators should reserve one set of clothing for pesticide use only. Launder and store 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. The sleeves must be long enough to overlap the gloves. Protective suits are one- or two-piece garments, such as coveralls. They should be worn over regular work clothes and underwear.

Cotton coveralls reduce the risk of dermal exposure to pesticides in dust, granule, or powder form. They do not protect the wearer against spills, sprays, or mists and are not recommended for use with liquid pesticides.

Protective suits of nonwoven fabrics resist pesticide penetration slightly better than woven fabrics, but are less comfortable. Most nonwoven suits are disposable and should be discarded after eight hours of use. Uncoated nonwoven fabrics can be used with

pesticides in dust, granule, or powder form. They do not protect the wearer against spills, sprays, or mists and are not recommended for use with liquid pesticides. They should not be worn when using chlorinated hydrocarbons.

Chemical-resistant protective suits of coated or laminated fabrics are a must if you (or your employees) will be in a mist or spray that would wet your clothing. Coated and laminated fabrics resist water penetration, but not all of these fabrics qualify as chemical resistant. Chemical-resistant suits are recommended when handling highly toxic (category I) pesticides.

Apron

Wear a chemical-resistant apron when repairing or cleaning spray equipment and when mixing or loading. This is a good practice for all pesticides. It is essential for pesticides of category I and II toxicity. Nitrile, butyl, and neoprene offer the best protection. PVC and natural rubber are also available.

Boots

Wear unlined chemical-resistant boots which cover your ankles when handling or applying moderately or highly toxic pesticides. Purchase boots with thick soles. Nitrile and butyl boots appear to give the best protection. Do not use leather boots. If chemical-resistant boots are too hot to wear in warm climates or too difficult to put on, try wearing chemical-resistant overboots with washable shoes (such as canvas sneakers or layered socks.) Remember to put your pant legs outside the boots so that no chemicals can drain into the 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 pair of boots on hand in case of accidental contamination.

Goggles or Face Shield

Wear tight-fitting, non-fogging goggles or a full face shield whenever the chemical could contact your eyes. Always wear them when you are pouring or mixing concentrates or working in a highly toxic spray or dust. Clean them often. Be careful of the headband; it is often made of a material which readily absorbs and holds chemicals. Have several spares and change them often or use a rubber strap. If possible, wear the strap under your head covering.

Head and Neck Coverings

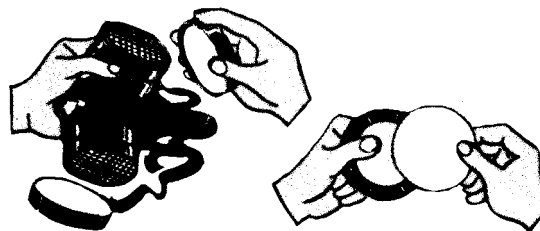
The hair and skin on your neck and head must be protected too. Rubber or plastic rain hats, wide brimmed hats, bill caps, and hard hats which can be washed are good. In cool weather, waterproof parkas with hoods and a bill cap are also good. Avoid cotton or felt hats, they absorb the pesticide.

Respirators

Respirators protect you from inhaling toxic chemicals. They should be worn whenever the more toxic organophosphate (TEPP, parathion, Guthion, Di-Syston, Thimet, Phosdrin) or carbamate (Furadan, Temik) pesticides are applied. The label will tell if a respirator is needed. They are especially necessary whenever you are handling concentrated highly toxic pesticides. Always wear a respirator while mixing or filling highly toxic pesticides. Applicators who will be constantly exposed to small amounts of toxic pesticides for a day or several days, should also wear a respirator.



Cartridge Respirators - The cartridge respirator is usually a half-face mask which covers the nose and mouth only. It contains one or two "cartridges" which absorb toxic fumes and vapors of chemicals and filter the air you breathe. These respirators are used either for relatively short exposure periods to concentrated chemicals or for a long exposure period to low concentrations of toxic chemicals. Goggles, if necessary, are worn separately. The main limitation of this type of respirator is the leakage which usually occurs around the face shield. Make sure the correct replacement cartridge is used.



Gas Masks - Gas mask respirators cover the entire face and protect your eyes as well as your nose and mouth. They contain better filters and more absorbing material to cleanse the air than the cartridge respirators. Gas masks are used when the applicator intends to be exposed to toxic fumes in heavy concentrations or for long periods of time.

Some gas masks are connected to an independent oxygen supply and none of the contaminated outside air is used. These are useful when applicators are exposed to unknown vapors as a result of accidents, fires, or reentering fumigated areas.

USE THE RESPIRATORS CORRECTLY

- * The respirator should fit properly on your face. It should be worn tightly enough to form a seal all around your face. Do not wear the headband too tightly or headaches and/or dizziness may result.

- * Respirator manufacturers make a variety of cartridges to fit their face pieces and each cartridge has its own intended use. It is essential that a cartridge designed to filter out pesticides from the air be selected and used. Having the wrong cartridge may expose the applicator to toxic levels of pesticides. Check the filter (the cloth-like outer layer) of your respirator often. Replace it when it looks dirty or if breathing becomes difficult. Cartridges should be changed after every eight (8) hours of use. If you notice a pesticide odor first check to be sure the respirator is sealed on your face. If the odor persists change the cartridge immediately.
- * 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. Separate tightly closed plastic bags work well for storing facepieces. The filters and cartridges can also be stored in their own plastic bags.

USE COMMON SENSE

Always work in pairs when handling highly toxic chemicals. Watch your buddy carefully for unusual behavior or actions. Remind him/her (and yourself) to wash both face and hands before eating, drinking or smoking. Never use the toilet before washing your hands. It is important to avoid getting toxic pesticide on any area of your body! At the end of the day remove your contaminated clothing carefully and put it well away from the family laundry. Shower and clean yourself thoroughly from head to toe. Pay particular attention to fingernails and hair where pesticides could remain.

Wait a reasonable period of time before returning to the field or area that has been treated. Do not allow others to reenter these areas either, unless they are wearing proper protective gear.

HOW PESTICIDES POISON

Cholinesterase Inhibitors

The organophosphate (OP) and carbamate classes of insecticides cause by far the greatest number of pesticide poisoning in the United States. Organophosphate insecticides include such chemicals as methyl parathion, Azodrin, Diazinon, Di-Syston, Guthion, malathion, Metaxystox-R, Phosdrin, and Thimet. The carbamate compounds include Sevin, Furadan, Lannate, and Temik.

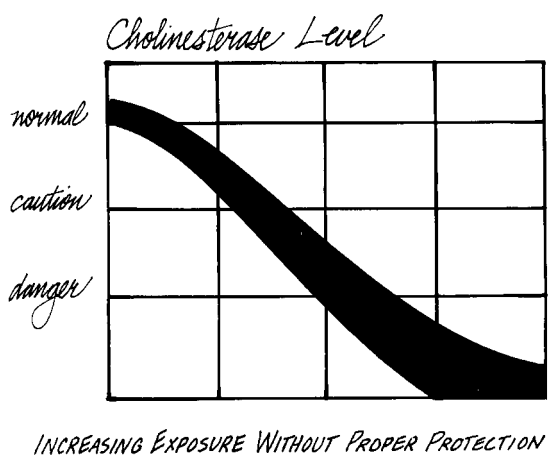
Organophosphates and carbamates inhibit the enzyme cholinesterase (ChE), thus interfering with the normal function of the nervous system. All living animals with cholinesterase in the nervous system, such as insects, fish, birds, humans, and other mammals may be poisoned by these chemicals.

The effects of organophosphate or carbamate poisoning can result in both systemic and topical symptoms. Direct exposure of the eye, for example, can cause topical symptoms such as constriction of the pupils, blurring vision, an eyebrow headache, and severe irritation and reddening of the eyes. Symptoms and signs of systemic poisoning depend on the route of absorption and the severity of the intoxication. Gastric symptoms such as stomach cramps, nausea, vomiting, and diarrhea appear early if the material has been ingested. Similarly, salivation, headache, dizziness, and excessive secretions which cause breathing difficulties, are initial symptoms if the material has been inhaled. Involvement of the respiratory muscles can result in respiratory failure. Stomach/intestinal and respiratory symptoms usually appear at the same time if the pesticide is absorbed through the skin. In children, the first symptom of poisoning may be a convulsion.

In advanced poisonings, the victim is pale, sweating, and frothing at the mouth. The pupils are constricted and nonresponsive to light. Other symptoms include changes in heart rate, muscle weakness, mental confusion, convulsions and/or coma. The victim may die if not treated.

Cholinesterase Testing

Persons who regularly work with organophosphates and carbamates should consider having periodic cholinesterase tests. The blood cholinesterase test measures the effect of exposure to organophosphate and carbamate insecticides. Since cholinesterase levels can vary considerably between individuals, a “baseline” must be established for each person. In fact, a small percentage of the population has a genetically determined low level of cholinesterase. Even minimal exposure to cholinesterase inhibitors can present a substantial risk to these people. Baseline testing should always be done during the time of year when pesticides are not being used or at least 30 days from the most recent exposure. Establishing a baseline value often requires two tests performed at least 72 hours but not more than 14 days apart. If these two tests differ by as much as 20 percent, a third test is



often recommended.

Cholinesterase tests can be repeated during times when organophosphate and carbamate insecticides are being used and then compared with the baseline level. The purpose of routine cholinesterase monitoring is to enable a physician to recognize the occurrence of excessive exposure to organophosphates and carbamates. The physician can then remove the pesticide handler from further exposure before the person exhibits symptoms of pesticide poisoning. Your physician can help to establish the frequency of this testing program.

If a laboratory test shows a cholinesterase drop of 30 percent below the established baseline, the worker should be retested immediately. If a second test confirms the drop in cholinesterase, the pesticide handler or agricultural worker should be removed from further contact with organophosphates and carbamates until cholinesterase levels return to the preexposure baseline range.

Antidotes

Antidotes for acute organophosphate or carbamate insecticide poisoning should be prescribed and administered only by a qualified physician. They can be extremely dangerous if misused.

Atropine sulfate - This antidote is given intravenously to counteract the effects of excessive acetylcholine. It can be given repeatedly as symptoms occur, the need and dosage are based on the body weight of the victim. Atropine can be used for both organophosphate and carbamate poisoning. Atropine should never be used to prevent poisoning.

Protopam chloride (2-PAM) - This antidote, used in conjunction with atropine, helps to reactivate cholinesterase in organophosphate poisoning, but not in cases where carbamates are involved in the poisoning.

SELF STUDY QUESTIONS

1. Most accidents with pesticides happen from careless practices and misuse.

T () F ()

2. The most common cause of pesticide poisoning for applicators is their exposure:

- A) by swallowing the pesticide.
- B) through the lungs.
- C) through the skin.

3. Dangerous exposure to pesticides by the applicator can occur during measuring and mixing as well as application.

T () F ()

4. Storing pesticides inside the car or truck cab is not hazardous if the applicator is the only person using the vehicle.

T () F ()

5. If a highly toxic pesticide is spilled on your skin, it is safest to wash the exposed area with soap and water:

- A) immediately (within ten minutes).
- B) anytime within 2 hours after exposure.
- C) anytime during the day of exposure.
- D) at the usual bathing time.

6. Some gloves offer no protection to pesticide exposure, and can even be more hazardous than working with bare hands. Which of these materials should never be used:

- A) rubber
- B) neoprene
- C) leather

7. For the information concerning the protective clothing to wear when using a given pesticide, it is best to:

- A) check with your dealer.
- B) read the label.
- C) ask your doctor.

8. An applicator with a thick head of hair need not wear a hat to protect from pesticide exposure.

T () F ()

9. The protective safety equipment listed on the label for the use of the applicator is not needed during measuring, weighing, and mixing.

T () F ()

10. Respirators protect from pesticide exposure by:

- A) repelling the pesticide.
- B) absorbing the pesticide.
- C) breaking down the pesticide.
- D) neutralizing the pesticide.

11. Overdosing usually results in better pest control.

T () F ()

12. Applicators using the buddy system (working in pairs) in applying highly toxic pesticides use this safety procedure for the purpose of:

- A) having help to weigh and mix pesticides.
- B) having assistance in case of accidental exposure.
- C) cleaning the equipment.
- D) supervising the work.

13. All pesticides have antidotes listed on the label.

T () F ()

14. Pesticide labeling now has sufficient safety precautions for the protection of certified pesticide applicators.

T () F ()

15. That piece of safety equipment usually not needed when using pesticides with the signal word, CAUTION, is:

- A) rubber gloves.
- B) hat.
- C) coveralls.
- D) respirator.

16. Coveralls and other clothing contaminated with pesticides should be laundered with a suitable detergent:

- A) after each use.
- B) after they get wet with spray.
- C) after six days of use.
- D) when they have a strong odor like the pesticide.

17. Applicator exposure to pesticides is most likely to occur:

- A) by inhalation during spraying.
- B) by eating food with excess residues.
- C) through dermal (skin) exposure.

18. New pesticide labeling indicates what the applicator can do to protect his body from pesticide exposure.

T () F ()

19. It is not necessary for an applicator to wash his hands and face frequently when handling and applying moderate to low dermal toxicity pesticides.

T () F ()

20. Cartridges in a respirator worn by a pesticide applicator should be changed after:

- A) each season.
- B) six to eight hours of use.
- C) one week of use.

21. There is no need to have a blood test when a pesticide applicator is experiencing pesticide poisoning symptoms.

T () F ()

22. Your respirator is working properly if the air you exhale is going through the cartridges.

T () F ()

23. Cholinesterase testing of the blood gives an indication of:

- A) how much pesticide has been applied.
- B) whether a transfusion is necessary.
- C) the resistance of the applicator.
- D) the pesticide's effect on the applicator's body.

24. A good place to store a respirator is:

- A) on the sprayer where it is handy to use.
- B) in a tightly closed plastic bag after it is washed and dried.
- C) in the pesticide storage shed.

Answer Key

1. T	9. F	17. C
2. C	10. B	18. T
3. T	11. F	19. F
4. F	12. B	20. B
5. A	13. F	21. F
6. C	14. T	22. F
7. B	15. D	23. D
8. F	16. A	24. B

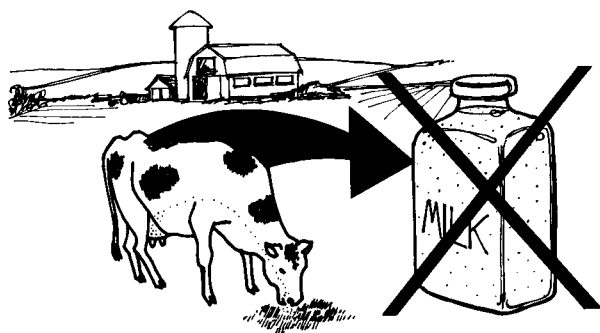
CHAPTER SIX

RESIDUE, TOLERANCE, REGISTRATION

Learning Objectives

- * Understand what residues are, how tolerances are set, what the phrase "days to harvest" means, and how they are important to consumer safety.
- * Understand the importance of the product label in protecting public health.

The use of pesticides on both food and non-food crops is strictly controlled in the United States. Every chemical which has possible use as a pesticide is closely tested and reviewed before it is marketed. The laws controlling the use of pesticides on food or feed crops are even stricter. The amount of pesticide remaining on the crop at harvest must be carefully regulated.



RESIDUES

The pesticide which is on the leaves, skin or other surfaces right after application is the deposit. Sometimes the deposit can be easily seen, as with many dusts or wettable powders. Other times it cannot be seen with the naked eye. If the pesticide deposit remains on the surface for a period of time, it is called a residue. Some pesticides leave little or no residue. Heat, light, moisture, soil organisms, and other chemical reactions in the environment quickly break them down. Other pesticides are not quickly broken down. They leave a residue on plant material or in the environment for weeks, months, or years. Depending on how and where it is used, each pesticide will vary in how long a residue may remain. Therefore, information on residues is required on each crop the pesticide is applied to. A pesticide may drift over from a nearby field and leave a residue on a crop or surface.

A long-lasting residue may be desirable. The pesticide is effective for a longer period of time. It need not be applied as often and thus may be cheaper to use. However, long-lasting residues are not always desirable. The chemicals may remain on food or feed and be hazardous to those eating them. The residues may remain in the soil to interfere with crops that are planted at a later date. Or they may remain on the surface and injure workers or others who reenter the treated area. Clearly it is important to know what residue, if any, remains after a period of time.

TOLERANCES

Many times residues remain on food or feed crops at harvest time. Since these crops are to be eaten, safe amounts of residues must be established. The maximum amount of residue which may remain on a harvested crop is called a tolerance. Federal law requires that a tolerance be set for every food use of each pesticide. The tolerances vary from crop to crop depending on the many safety factors involved. If the residue exceeds the established tolerance, the crop may not be marketed or sold. It is subject to condemnation and seizure by federal or state regulatory agencies.

How Tolerances Are Set. Much information is gathered and studied before a tolerance is set. Studies on test animals are done to determine the acute and chronic toxicity of the chemical. Toxicity to fish, birds, and mammals is also determined. The length of time the pesticide remains in the environment is measured. Possible long-term effects such as buildup in animals or in the environment are studied. All these factors (and others) are taken into account before setting a tolerance.

The tolerance is usually set at least 100 times smaller than the highest dose which has no effect in test animals. For example, if 200 parts per million of Pesticide A has no effect on test animals, the tolerance for Pesticide A on any food or feed crop could be no higher than 2 parts per million (ppm). The “safety factor” is 100 times. The tolerances for Pesticide A may not be as high as 2 ppm. Field tests may show that acceptable pest control is achieved using doses and methods that result in a residue of 1 ppm. Then the tolerance would be set at 1 ppm. [The tolerance is stated in parts per million (ppm) by weight. That is one part of pesticide to one million parts of crop or meat.]

Negligible Residue Tolerances. A residue may be on a food or feed crop even though no pesticide was ever directly applied on it. These residues result from indirect contact with the chemical. The residue may be found, for example, in livestock, which have eaten sprayed forage and grass. Edible meat of

livestock containing residues must have a negligible residue tolerance. When an herbicide is applied before a crop emerges, a residue may be left in the soil. As the crop grows it may pick up a small amount of the herbicide. If the residue is still in the crop at harvest, a negligible residue tolerance must be set. A negligible residue tolerance (usually just “negligible residue”) is set when a very small residue is likely to be on food or feed at harvest. Negligible means small or minor. The negligible residue is usually one tenth (0.1) of a part per million or less. It is far below any toxic level.

Finite Tolerances. When a pesticide will be applied directly on a food or feed crop and animal, a finite tolerance is set. A finite tolerance (often just “tolerance”) is usually larger than a negligible residue. However, it is still well below possible toxic levels. In order for a pesticide to be used on anything to be eaten, a tolerance must have been set, unless it is exempt from tolerance.

DAYS TO HARVEST

Many pesticides break down in the environment. As they break down, the residue on the crop or animal grows smaller. Therefore, the residues remaining at harvest depend on how long before harvest the pesticide is applied. “Days to Harvest” or “Preharvest Interval” is the least number of days between the last pesticide application and the harvest day. (“Days to Slaughter” or “Days to Grazing/



Feeding” are used with livestock.) Both are listed on the label. For example, when Pesticide A is applied on the day of harvest, it leaves a residue of 10 ppm. However, when it is applied 7 days before harvest, it leaves a residue of only 2 ppm. If acceptable pest control is possible by applying 7 days before harvest,

EPA will often set the tolerance at 2 ppm and the “Days to Harvest” at 7 days. If days to harvest, recommended dosages and other label instructions are followed, the residue on the crop should be under the set tolerance.

REGISTRATION

Even though a tolerance is set for a pesticide on a specific crop, it still cannot be legally used until registered. Every pesticide and every use must be registered federally by the Environmental Protection Agency (EPA). EPA reviews all the required information on the pesticide. This includes toxicity studies, wildlife and environmental studies, breakdown and residue studies, chemical studies, etc. Registration will be granted only if the proposed use will control the target pest and protect public health and the environment. EPA reviews and registers all statements which appear on the pesticide label, too. 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, the applicators, to help make sure that all food is safe to eat. Only you can be sure that no illegal residues remain on food crops. Follow label directions carefully. Don't be responsible for seizure of your customer's or his neighbor's crop!

SELF STUDY QUESTIONS

1. Small amounts of some pesticides are allowed in harvested crops.

T () F ()

2. A tolerance status of a pesticide must be established for those uses involving -

- A) a migrant worker.
- B) household pests.
- C) food crops.
- D) certified applicators.

3. The maximum safe amount of a pesticide allowed on a crop is called its -

- A) residue.
- B) deposit.
- C) tolerance.

4. The amount of pesticide found in a crop at harvest is called its -

- A) residue.
- B) deposit.
- C) tolerance.

5. Days to harvest interval is the number of days between the last pesticide application and the time of harvest to avoid -

- A) immaturity.
- B) spray injury.
- C) worker exposure.
- D) excess residue.

6. Persistent pesticides may be undesirable if they last longer than is needed and result in excess residues and/or injury.

T () F ()

7. If a pesticide residue exceeds the tolerance, the crop -

- A) can be washed to get rid of the pesticide.
- B) is subject to condemnation and seizure.
- C) may be fed to livestock.

8. Registration of a pesticide by EPA will be granted if -

- A) the pesticide will control the target pest.
- B) the pesticide does not have an adverse environmental impact.
- C) the pesticide does not pose a public health hazard.
- D) all of the above.

9. Tolerances for pesticides are stated as -

- A) mg/kg.
- B) ppm.
- C) lbs/A.

ANSWER KEY

- | | | |
|------|------|------|
| 1. T | 5. D | 9. B |
| 2. C | 6. T | |
| 3. C | 7. B | |
| 4. A | 8. D | |

CHAPTER SEVEN

ECOLOGY AND ENVIRONMENTAL CONSIDERATIONS



Learning Objectives

- * Explain the meaning of the term "environment" and understand the various mechanisms of pesticide pollution through soil, air, and ground water.
- * Define "endangered species" and understand how pesticides may affect them and other non-target species.
- * List those special applications requiring notification and/or permits.

The words "environment" and "ecology" have been increasingly in the news for the past few years.

People have suddenly begun to fear that their resources - air, water, soil - are running out or becoming unfit for use. Pesticide use and drift can affect air quality; pesticides in the food chain can threaten wildlife populations; and soil may no longer be suitable for optimal crop production. Pesticides are

now recognized to be non-point sources of water pollution which means that the chemicals can seep through the soil and enter the groundwater. As a result, pesticide practices are being closely examined. As pesticide applicators, many of you feel the accusing finger pointed in your direction because you are often blamed for environmental abuse. The ultimate goal is that you, the applicator, will be knowledgeable enough to be able to both control pest populations and at the same time protect the environment.

WHY PROTECT THE ENVIRONMENT?

The human race needs a place to live with clean water and air, food which is not harmful, and an environment which will not threaten our health and safety. Since we share this planet with many other living creatures, we also have an obligation to protect the earth's resources from degradation. Few people will argue with the statement that pollution will grow as our planet's population grows. Population increases will require more food, fiber, and building materials and will create an increasing demand on the earth's finite resources. An additional effect of the population crunch will be an increase in the environmental sensitivity and government regulations to protect the environment from pesticide pollution.



Pesticides enhance public health and the environment when they are used carefully and wisely. For years they have been used to control pests which

could be harmful to man. Rats carrying plague or mosquitoes carrying malaria are good examples. These control programs today are necessary, especially in crowded cities and countries with large numbers of people. However, pesticides can harm the environment, too. Any pesticide which is off-target is a pollutant and can be dangerous. All of the benefits of pesticides can be cancelled through misuse or carelessness.

PESTICIDES AND WATER RESOURCES

Water as a Natural Resource. Water is one of our greatest resources and is essential for all life. Man needs clean water for drinking, cooking, and bathing. Most fish and other marine life can survive only slight changes in their water environment. Farmers must use uncontaminated water for their livestock and to irrigate crops. Half of the U.S. population and 90% of the rural population rely on groundwater for their drinking water. Groundwater makes up 96% of the world's total fresh water resource. Once considered to be safe from pollution, groundwater is now a threatened natural resource.

How Pesticides Pollute Groundwater. Under certain conditions, contaminants - including soil nutrients, wastes, and chemicals - can migrate to groundwater sources. Pesticides applied correctly to a site may be moved downward with rain or irrigation water, reaching the water table below. This method of contamination is called non-point source pollution. Pesticides may enter a well directly from spillage or back-siphonage, thus entering the groundwater directly. This is called point source pollution.

Because groundwater moves slowly, contaminants do not spread quickly. After pesticides reach groundwater they may continue to break down, but at a much slower rate because of less available light, heat, and oxygen. Thus, they can remain underground in slow moving plumes for an indefinite period. When groundwater becomes contaminated, the polluted water may eventually appear in the surface water streams, rivers, and lakes.

Due to the complex nature of groundwater, when the contamination is detected it is often widespread. Even if the contamination is stopped, it may take years before an aquifer can purify itself through natural processes. Once contaminated, groundwater is difficult and expensive to clean. Water from this source may be unusable for years. The best protection against groundwater pollution is prevention.

Factors that Affect the Fate of Pesticides in Water. Various processes affect the fate of pesticides following an application, disposal, or spill. The two basic processes are those that transfer chemicals or influence their movement and those that degrade or break down chemicals. The primary transfer processes are adsorption, volatilization, runoff, leaching, and removal of treated crops or animals from an area. The degradation processes are microbial, chemical, and photodegradation.

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

A soil-adsorbed pesticide is less likely to volatilize, leach, or degrade. When pesticides are tightly bound to soil particles in highly adsorptive soil, they are less available for absorption by plants and microorganisms. However, soil adsorbed pesticides can be lost by erosion. Understanding adsorption factors can reduce damage to sensitive plants, leaching to groundwater, and the presence of illegal residues in food or feed crops.

Volatilization. Volatilization is like evaporation. A solid or liquid can change its state and turn 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. The volatility of a pesticide depends on its vapor pressure and temperature. The volatilization of pesticides increases with higher air temperature and air movement, low relative humidity and when spray droplets are small.

Runoff. Runoff occurs when water carries pesticides, either mixed in the water or bound to eroding soil, to off target points. Rain carries pesticides off plant leaves to foliage near the ground and into the 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.

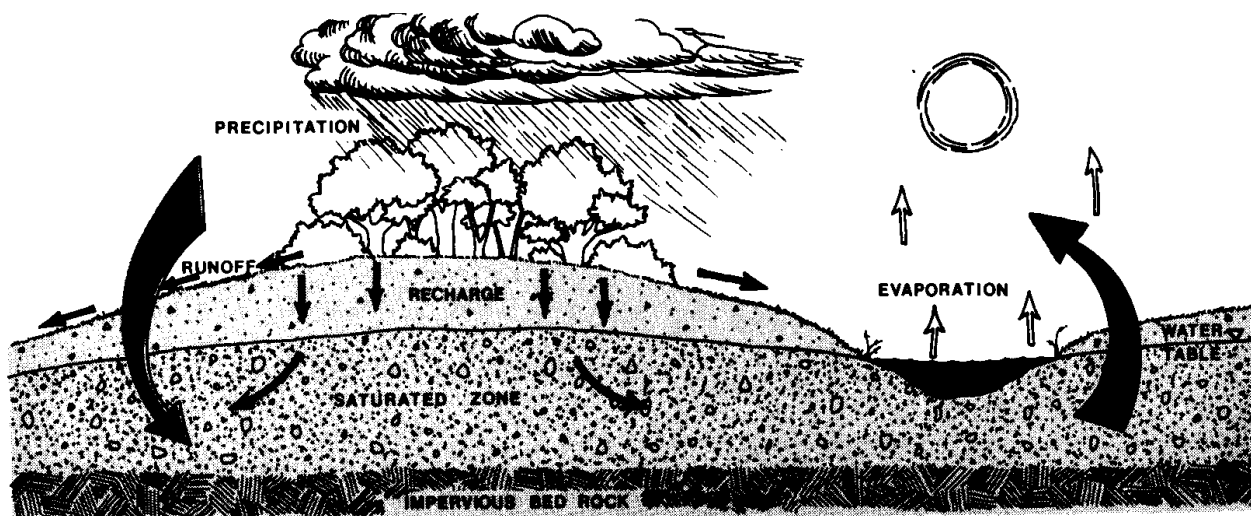
Leaching. Some pesticides move through the soil and leach into groundwater. Several factors influence pesticide leaching. A pesticide that is easily dissolved in water moves with the water as it seeps through the soil. Soil structure and texture influence the rate and depth of pesticide leaching. Sandy and gravel soils have poor adsorption characteristics and allow water and pesticides to leach through quickly. A heavy clay soil does not allow for rapid leaching. Adsorption influences pesticide leaching because pesticides that are strongly adsorbed to soil particles leach less.

The Soil Conservation Service is a good source of information on soil types, characteristics, and geological formations of your area. Leaching of pesticides from treated areas, mixing and rinsing sites, waste disposal areas, and manufacturing facilities are major ground-water concerns.

Groundwater Protection. Polluted water typically enters an aquifer in recharge water originating at the land's surface. Pollution can also be injected directly into an aquifer, for example, by back-siphoning directly into a well.

To minimize pesticide leaching to groundwater sources, consider the following steps:

- * Read the label for any warnings.
- * Evaluate the need, method, and frequency of pesticide use.
- * Use alternative pest control methods whenever possible.
- * Identify and know the vulnerability of the soil and leaching potential of the pesticide you are using.
- * Consider the location of the pesticide application in relation to groundwater and surface water. Know the water table depth and the permeability of the geological layers between the surface and the groundwater. Be cautious around sinkholes or old wells because surface water easily reaches groundwater from these conduits.



- * Reduce pesticide use and handling close to water wells. Groundwater contamination by pesticides or other pollutants can enter a well directly from the surface, through openings in or beneath a pump base, or through soil adjacent to the well. Well location should be far from pollution sources. Avoid pesticide spills at all times and be especially careful in the vicinity of wells.
- * Choose pesticides with the least potential for leaching into the groundwater. Look for characteristics which identify the pesticide as being insoluble, relatively unstable, and readily adsorbed to soil.
- * Follow label directions.
- * Apply pesticides at the appropriate time.
- * Measure the pesticide properly and carefully. Calibrate accurately and often. During calibration, check the equipment for leaks and malfunctions.
- * Avoid spills and back-siphoning.
- * Accurately direct the application to the target site.
- * Dispose of pesticides properly. Triple-rinse containers. Pour the rinse-water back into the spray tank to treat sites or crops which are included on the pesticide label. Pesticides must be disposed of in accordance with New Jersey laws and local mandates.
- * Store pesticides safely. Pesticide storage facilities should be away from wells, cisterns, springs, and other water sources.
- * Maintain records of pesticide use in accordance with Federal and New Jersey laws.
- * Comply with pesticide certification requirements.

AIR AND PESTICIDES

Air must be available for any plant or animal to live. It is the source of oxygen for breathing and receives the carbon dioxide waste. Air has the ability to move particles long distances. Most of the time this ability aids mankind. It causes rain, for example. Unfortunately for the pesticide applicator, this same ability is the cause of drift. Pesticides carried by the air may be harmful to human and wildlife health and safety. Pesticides in the air are not controllable and may settle into waterways, wooded areas, homes, lawns, or barnyards. Drift must be avoided.

Controlling drift is important for the commercial applicator as well as the private applicator. To be effective, the pesticide must be applied precisely on target at the correct rate, volume, and pressure. Drift from the target area may injure people, pets, wildlife, and sensitive plants. Drift of herbicides can damage nearby crops, forests, or landscape plantings. Poorly timed application can kill bees and other pollinators which are working in the area. Beneficial parasites and predators that help control pests may also be killed. Drift can also be a problem indoors. Pest control applicators must be aware that forced air heating systems and air conditioning units can move sloppily applied pesticides.

Vapor Drift. A pesticide that has vaporized (evaporated) can be carried from the treated area by air currents. The movement of pesticide vapors in the atmosphere is called vapor drift. Vapor drift, unlike spray or dust drift, is related to the chemical properties of the pesticide and is not visible. Vapor drift can be caused by vapor leakage. Fumigants and other volatile materials exert pressure on the environment around them. Like air in a balloon, they are actively trying to escape. Stopping vapor leakage from their containers is done by keeping them closed or sealed. Fumigation sites must also be sealed properly to keep the pesticide from leaking. Applying these materials with vapor tight equipment is important.

Application of a volatile pesticide should be avoided when conditions favor volatilization, such as high temperature.

Although the vapor pressure rating of a pesticide may help the applicator know the volatility of a pesticide, these are usually not included on the label. Labels will, however, give warning statements that the applicator must be sensitive to. The following are examples:

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

Particle Drift. Particle drift is influenced by many factors. Particle size, nozzle design and orientation, pressure, temperature, humidity, evaporation, height of release, air velocity, and movement are among several important considerations.

Particle and Droplet Size. The smaller the particle size, the greater the potential for drift. Dust formulations are made of small particles and have a greater potential for drift than granular formulations. Small liquid droplets also tend to drift more than large droplets. Whenever practical, the applicator should use the largest droplet size in obtaining effective pest control.

Nozzle Type, Orientation and Size. In terms of liquid drift control, the nozzle is probably more important than pressure. All nozzles produce a range of droplet sizes. Avoid nozzles which produce small (fine) droplets. Placement of the nozzle in the air stream, especially where airblast and aerial application equipment are concerned, also affect droplet size. Nozzles pointed across the air flow produce smaller droplets. This is caused by wind shear.

Pressure. Droplet size is influenced by pressure. The higher the pressure, the smaller the droplet. Reducing pressure will help to control drift.



Height of Nozzle. Nozzles positioned too high will disperse spray over a wider area, thereby increasing the likelihood of drift. The applicator must decide the desired swath width by striking a balance among nozzle spray angle, pressure, and height above the target. For example, if an operator increases the application pressure and the rate, but maintains the swath width, he/she should lower the nozzle to compensate for the increased pressure. Lowering the nozzle may require switching to nozzles with a wider spray angle.

Air Movement. Both horizontal and vertical air movement can affect drift. Unless it is calm, most pesticide applications are subjected to constant air movement. Thus, wind direction and speed directly affect the direction, amount, and distance of drift.

Temperature and Humidity. The rate of droplet evaporation is determined to a great degree by temperature and humidity. A droplet that evaporates before reaching the target does not control pests.

What Can Be Done To Avoid Drift?

- * Choose non-volatile (those that do not vaporize easily) pesticide formulations.
- * 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 possible to the target.
- * Use a drift control additive.
- * Do not apply when wind, temperature, or humidity are unfavorable.

The careful use of pesticides is of prime concern to everyone today. Many factors interact to influence the distance material will drift from the target area. Even when common sense and good application technology are followed, drift can still be a problem for the applicator. Label instructions must be followed and strict attention must be given to the control of pesticide drift.

SOIL AND PESTICIDE USE

Soil has become more important as the need for food increases. In order to feed the numbers of people, fertile and healthy soil is a must. Poor soil practices and misuse cause poor yield and second class crops, especially if root vegetables or forage crops are being planted. Overdoses of pesticides which remain for long periods in the soil may limit planting to only a few crops which will not be harmed by the chemicals.

PESTICIDE EFFECTS ON THE ENVIRONMENT

Wildlife. Fish, birds, and mammals are assets to man and an essential part of the ecosystem. Parks, farmland, lawns, golf courses, etc., generally provide habitat for wildlife, as well as surrounding wooded areas and waterways. Therefore, care should be taken to protect these areas when applying any pesticide.

Fishing and hunting are very popular sports. If pesticides are carelessly used, these sports can disappear. Pesticide-kills of mammals, birds, and fish in large numbers have already cut down on fishing and hunting activities in some areas. High levels of pesticides in some of these animals have made their meat unfit for people to eat.

Endangered Species. Certain plants and animals have been identified as endangered or threatened species. An endangered species is one on the brink of extinction throughout all or a significant portion of its range. A threatened species is one likely to become endangered.

A major problem for most wildlife is the destruction of habitat, usually the result of industrial, agricultural, residential, or recreational development. If wildlife habitat is threatened or destroyed by incidental exposure to pesticides, the wildlife is in danger as well. Reproduction of fish and wildlife can be affected by sublethal doses of pesticides in diets. Since 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, thus recovery is difficult or perhaps even impossible. It has been estimated that a disappearing plant can affect up to thirty other species, including insects, higher animals, and even other plants that depend ultimately on that plant.

EPA has estimated that approximately 900 U.S. counties are known to contain endangered species. Pesticides can be harmless to wildlife when used carefully and on target. **Every effort** must be made to avoid causing harm to these important populations.

Honeybees. Honeybees and other pollinators are necessary for good farming and food production. In many cases, no pollination means that there will be no crop. Unfortunately, bees are very sensitive to many insecticides.

Pesticides should not be applied to, or allowed to drift to, crops in bloom. Shade trees and weeds should not be sprayed during bloom. Mow cover crops and weeds to remove the blooms prior to spraying because the blooms may attract bees to the area and increase the chances of bee kills. Ideally, pesticides should be applied when there is no wind and bees are not “working” plants in the area. Damage can be minimized if the application is made late in the afternoon with a spray that breaks down within hours. In general, evening applications are the least harmful to bees.

Do not treat near hives. Bees may need to be moved or covered before applying pesticides near colonies. Do not let spray drip and form puddles or accumulate in wheel tracks. General area-wide application of pesticides may be harmful because

bees cannot avoid contact with the spray on flowers or in water. Thus, the total wild bee loss may be sizable.

Check the product labels for specific bee hazards, and contact local beekeepers according to state regulations. Select the pesticide that is least harmful to foraging bees. Dusts present more of a hazard to bees than sprays. Wettable powders are usually more hazardous to bees than either emulsifiable concentrates or water soluble formulations. However, microencapsulated insecticides are minute capsules that bees can carry back to the hive just like pollen. Granular formulations are generally the safest for bees.

Food Chain. Wildlife has an important place in the food chain. The food chain characterizes how animals and plants are interdependent. Each animal has a place in the chain based on the type of food consumed. Animals that consume plants are near the bottom of the chain. Animals which eat these plant-eaters are on the next level. Carnivorous animals are at the top of the chain. Application of pesticides over broad areas may eliminate certain needed food sources. Elimination of food sources can cause wildlife to relocate to other areas, substitute other food sources, or die. Wildlife moving to another area can create additional competitions for food and space with resident species. A predatory animal lacking prey may shift to a valued game species or even domestic livestock. Fish and wildlife can be exposed to pesticides by eating animals poisoned by pesticides or plants containing pesticides. Also, this pesticide transfer could occur with birds feeding on insects, earthworms, etc. In this complex food chain, each animal has an important place.

Food. With the help of pesticides more food per acre can be produced. Diseases, insects and other plant pests can be greatly reduced. There can be improved yields and better crop quality. Less land must be tilled to feed the people. More land is free for wildlife and recreational purposes. Good farm land may become unfit for crops, though. Overdoses of pesticides which remain for a long time in the soil can ruin the land. The crop may absorb the pesti-

cides from the soil and be over the set tolerance at harvest. Or the pesticide may kill all or most plant life and make the land useless for farm or recreational use. Applying too much pesticide increases the chance of illegal pesticide residue in crops and food and could result in an unacceptable health risk to the consuming public. Finally, applying pesticides at higher than labelled rates is a violation of state and federal law.

Recreation. Pesticides can be used to preserve outdoor activities in our parks and camping areas. Fly and mosquito control programs give relief from the annoying pests. Without control programs, outdoor activity is extremely limited for most people. However, drift and overdoses can destroy wildlife, cause trees to lose leaves and ruin recreation areas. Runoff, spills, or drift into streams can cause fish kills and make the water unfit for swimming, fishing, or even boating. Drift and overdose can injure or kill birds and mammals. Parks and camping areas with leafless trees, dying plants, and no wildlife are not acceptable as recreation areas.

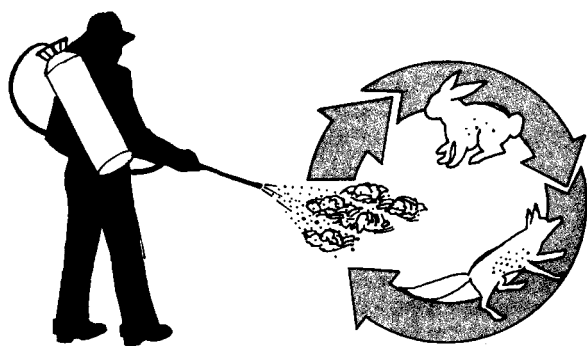
Plants. Pesticides are often used on plants to protect them from pests. Insecticides and fungicides are often used on ornamentals and forest trees to control runaway pests or other serious insects and disease problems. These chemicals aid in keeping forests, parks, and lawns green and enjoyable. However, pesticides can injure plants. The injury can range from light burning or browning of the leaves to death of the whole plant. This injury is called phytotoxicity. Phytotoxicity can result from carelessness or from use of a pesticide which is highly hazardous to plants and trees. The label will state whether phytotoxicity will be a problem and what plants can be injured. Follow the label instructions carefully and cautiously if you wish to avoid injuring desirable plants.

Livestock. Pesticides also protect livestock from harmful and annoying pests. Otherwise the penned animals could not escape from constant irritation. The quantity and quality of livestock products - milk, meat, etc. - is improved when the pests are controlled. Pesticide drift onto forage and pasture land

or into drinking water can injure livestock. The animals may be poisoned by eating contaminated forage and grasses. Once eaten, these pesticides can also lead to illegal residues in the meat and byproducts of the animals. They may be unfit for humans to eat.

Runaway Pests and Useful Insects. Pesticides aid in controlling insects or diseases that get into an area for the first time. Often these pests have few natural enemies in the new environment. Without a good pesticide program, they can rapidly overrun an area. Gypsy moth and Japanese beetles are good examples of runaway pests. Careless use of wide range pesticides can destroy natural enemies (such as predators and parasites) in an area. Runaway insect or pest populations can result. Pesticides misused in this way may actually help the pests! Honeybees and other useful insects are often injured when pesticides are used carelessly.

Accumulative Pesticides. Some pesticides can build up in the body of animals (including man). These are called accumulative pesticides. The chemicals can build up in an animal's body until they are harmful to it. These pesticides also accumulate (build up) in the food chain. Meat-eaters feeding on other animals with built up pesticides may receive high doses of pesticides. If they feed on too many of these animals, the meat-eater can be poisoned without ever directly contacting the pesticide! The build up through the food chain can injure animals which aid man. In fact, man as one of the meat-eaters at the top of the chain could get very high doses of pesticides in this way.



Non-accumulative Pesticides. The pesticides that do not build up in the body of animals or in the food chain are non-accumulative pesticides. These chemicals usually break down rapidly into other relatively harmless materials. Organophosphate pesticides, for example, may have high toxicity at first and may cause local kills. But they do not accumulate so they are not as dangerous to the environment. Usually pesticides which break down quickly in the environment are the least harmful to it.

Persistent Pesticides. Persistent pesticides stay in the environment without change for long periods of time. Persistent pesticides do not necessarily accumulate in animals' bodies or in the food chain. Some pesticides (example: atrazine) persist in the soil but do not seem to build up in animals. Thus, they give long-term control, but do not slowly poison wildlife. Persistent pesticides can be fairly harmless to the environment.

PESTICIDE PERSISTENCE

Persistent Pesticides. Persistent pesticides remain in the environment without breaking down. Although they can be useful for long-term insect, disease, or weed control, sometimes they last in the environment indefinitely. Persistent pesticides do not necessarily accumulate in animal bodies or in the food chain, but they could injure or kill plants in the vicinity afterwards. Some pesticides persist in the soil but do not seem to build up in animals. These pesticides could injure or kill plants which are planted there at a later date.

Microbial Degradation. Some pesticides are destroyed in soils by microbial degradation. This occurs when microorganisms such as fungi and bacteria use a pesticide as food. Microbial degradation can be rapid and thorough under the proper soil conditions. Conditions that favor microbial growth include warm temperature, favorable pH levels, adequate soil moisture, aeration, and fertility. Adsorption also influences microbial degradation because adsorbed pesticides are less available to microorganisms, and they therefore degrade slowly. Certain pesticides require higher application rates to com-

compensate for the pesticide lost through microbial degradation. In an extreme case of accelerated microbial degradation, pesticides that are normally effective for weeks suddenly become ineffective within days. In such a case, previous pesticide applications may have stimulated the buildup of certain microorganisms that were effective in rapidly degrading the pesticide.

Chemical Degradation. Chemical degradation is the breakdown of a pesticide by processes not involving a living organism. The adsorption of pesticides to the soil, soil pH levels, soil temperature, and soil moisture contribute to the rate and type of chemical reactions that occur. Many pesticides, especially the organophosphate insecticides, are susceptible to degradation by hydrolysis in high pH soils or spray mixes. Because the products of chemical degradation are usually nontoxic or nonpesticidal, the amount of pesticide is reduced, as is the potency.

Photodegradation. Photodegradation is the breakdown of pesticides by sunlight. Pesticides applied to foliage, soil, or structures vary considerably in their stability when exposed to sunlight. Like other degradation processes, photodegradation reduces the amount of chemical present and lowers the level of pest control. Mechanical incorporation into the soil during or after application, or by irrigation water or rainfall following application, can reduce pesticide exposure to sunlight.

APPLICATIONS REQUIRING A PERMIT

Aquatic Use Permit

NJAC 7:30-9.3 is the regulation that mandates an Aquatic Use Permit for most applications of pesticides to any “waters of the state” or on aquatic sites. ***All pesticides labeled for aquatic use are restricted-use pesticides in New Jersey.*** This includes the copper products. An application of **ANY** pesticide to an aquatic site requires an Aquatic Use Permit unless it meets the following exemptions:

1. The body of water to be treated is NOT used for potable water and...

The body of water to be treated has NO outlet structure or outlet stream, and...

The body of water to be treated and its surrounding shoreline is owned and controlled by one person.

OR

2. The application is for the control of mosquitoes or flies which then fall under the Pesticide Control Program’s Mosquito/Fly Permit Program.

There may be conditions or additional restrictions beside the labeling requirements placed on the application of the aquatic pesticide.

To apply for an Aquatic Use Permit, fill out an Aquatic Use Permit application, which can be obtained by contacting the Pesticide Control Program, and mail to the PCP with the permit fee and any other required information.

The permit applications are reviewed by the PCP, and the Department’s Water Technical Programs and Division of Fish, Game & Wildlife. However, all permits are issued by the Pesticide Control Program only. The permit review period is 21 days.

APPLICATIONS REQUIRING NOTIFICATION

Beekeeper Notification

Honeybees are extremely sensitive to the toxic effects of pesticides. And since honeybees play such an important role in pollinating plants and agricultural commodities, besides producing an agricultural commodity (honey), special precautions must be taken to protect them.

N.J.A.C. 7:30-9.9 addresses notification to apiarists (beekeepers).

Applicators using pesticides that are labeled toxic to bees must notify registered beekeepers at least 36 hours before making an application within one mile of registered bee yards.

This requirement to notify beekeepers does not have to be followed if the pesticide application is being made for agricultural purposes, **EXCEPT** when a pesticide application is made to the following crops within the dates specified below or when a crop is in the flowering stage:

- | | |
|-----------------|---------------------|
| 1. Apples | April 15 - May 15 |
| 2. Pears | April 15 - May 15 |
| 3. Strawberries | April 15 - May 15 |
| 4. Peaches | April 15 - May 15 |
| 5. Blueberries | April 15 - May 31 |
| 6. Cranberries | June 15 - August 15 |
| 7. Holly | June 1 - June 30 |
| 8. Vine Crops | June 1 - August 31 |
| (Cucurbits) | |
| 9. Sweet Corn | Flowering Stage |

In addition, N.J.A.C 7:30-10.3(l) states that community or areawide applications of pesticide products labeled toxic to bees cannot be applied on hardwood tree species within one mile of a commercial blueberry field during the period April 15 through May 31 unless:

- * The applicator has received written permission from the blueberry growers located within the one mile distance.

Beekeepers must register their beeyards with the PCP by March 1 of each year. A list of registered beekeepers can be obtained by calling the Pesticide Control Program.

Do your part to aid the environment. Your surroundings are worth protecting!

SELF STUDY QUESTIONS

1. The term environment in this chapter means:
A) all organisms.
B) air, soil, water, and other physical elements.
C) the interrelationships of organisms.
D) all of the above.

T () F ()
2. Modern pesticides are formulated in such a manner that there is little chance of polluting water with their use.

T () F ()
3. Food and feed can be produced efficiently and economically without excess pesticide residues.

T () F ()
4. Overdoses of pesticides which remain in the soil for long periods of time may be harmful to future crops.

T () F ()
5. Airborne pesticides can be harmful to man and other organisms.

T () F ()
6. Some pesticides can reduce crop production by killing pollinating insects.

T () F ()
7. A pesticide off target is not a pollutant if desirable organisms are unaffected.

T () F ()
8. Food chain is a way of describing how organisms eat each other.

T () F ()

9. High pesticide residues are most likely to be found in the plant eaters at the bottom of the food chain.

T ()

F ()

10. Pesticides that can build up in the bodies of organisms are called:

- A) additives.
- B) accumulative.
- C) persistent.

ANSWERKEY

1. D 2. F 3. T 4. T 5. T
6. T 7. F 8. T 9. F 10. B

CHAPTER EIGHT

TYPES OF PESTICIDES

Learning Objectives

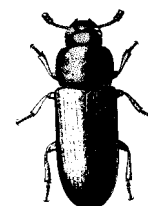
- * Define "pesticide" and understand the manner in which the general categories work to control pests.
- * Know the various unique categories of pesticides, such as herbicides and acaricides; know which type of pest they are used for and how they control the pest.

A pesticide is any chemical which is used by people to control, repel or mitigate the action of an organism or pest. Materials that mitigate or change the behavior of an organism include plant growth regulators (PGR's) and pheromones. Pests may be insects, plant diseases, fungi, weeds, nematodes, snails, slugs, etc. Therefore, insecticides, fungicides, herbicides, etc., all are types of pesticides. Some pesticides must only contact (touch) the pest to be deadly. Others must be swallowed to be effective. The way that each pesticide attacks a pest suggests the best way to apply it to reach and expose all the pests. For example, a pesticide may be more effective and less costly as a bait than as a surface spray.

INSECTICIDES

Insecticides are chemicals used to control insects. Often the word "insecticide" is confused with the word "pesticide." It is, however, just one of many types of pesticides. An insecticide may kill the insect by touching it or it may have to be swallowed to be effective. Some insecticides kill both by touch and by

swallowing. Insecticides called **Systemics** may be absorbed, injected, or fed into the plant or animal to be protected. When the insect feeds on this plant or animal, it eats the systemic chemical and is killed.



Broad Spectrum. Insecticides vary in the number of different kinds of insects they kill. Some insecticides kill only a few kinds of insects. Sometimes you can choose these insecticides when you wish to kill only one insect pest and not kill beneficial insects in the area. Many more insecticides are general purpose or wide range killers. These "broad spectrum" pesticides are used when several different kinds of insects are a problem. One chemical can kill them all. No broad spectrum insecticide kills all insects; each one varies on the kinds and numbers of insects it controls.

Narrow Spectrum. While many insecticides are broad spectrum, killing a wide variety of animals by attacking a system common to all, such as the nervous system, newer groups of insecticides, such as chitin inhibitors, are much more selective. The chitin inhibitors only affect animals with chitin in their exoskeleton (i.e. insects). Growth regulators are even more specific. They affect certain groups of species that have a particular hormone. Finally, pheromones are the most restrictive because they react with only one species or one sex of a single species.

Chitin synthesis inhibitors interfere with the development and molting of immature insects causing their death. 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 attempts to molt.

Insect growth regulators or IGRs mimic the action of an insect's naturally occurring juvenile hormone. They interfere with certain normal processes and prevent immature insects from completing development into normal reproductive adults. The effects of IGRs on insects include abnormal molting, twisted wings, loss of mating behavior, and sometimes death to embryos in eggs. IGRs attack a growth process found only in insects, thus there is a great margin of safety for humans and other vertebrates. However, one disadvantage is that growth regulators act slowly, since they do not kill the insect until it molts into an adult.

Pheromones are naturally produced chemicals used by animals to communicate with each other. There are three basic types of pheromones. Aggregation pheromones attract many individuals together, for example, at a site where food may be plentiful. Sex pheromones are used by one sex of a species to attract a mate. Trail pheromones are deposited by walking insects, such as ants, so that others can follow.

Synthetic pheromones produced in laboratories mimic these natural chemicals. They are used to attract insects into traps, disrupt mating, and monitor populations of insects. Because they do not kill insects, they are often thought of as not being pesticides. This belief, however, is incorrect.

Short Term vs. Residual. Insecticides also vary in how long they last as a killing agent. Some break down almost immediately into nontoxic by-products. These “short term” chemicals are very good in situations where the insects do not return or where long-term exposure could injure non-target plants or animals. For example, short-term insecticides are often used in homes and dwellings where people and domestic animals might be exposed.

Other insecticides remain active killers for a fairly long period of time. These “residual” pesticides are very useful when the insects are a constant control problem and where they will not be an environmental hazard. For example, residuals are often used for fly control in livestock buildings or for termite control in wooden structures.

ACARICIDES

Acaricides (or Miticides) are chemicals used to control mites (tiny spider-like animals) and ticks. The chemicals usually must contact the mites or ticks to be effective. These animals are so numerous and small that great care must be used to completely cover the area on which they live. Miticides are very similar in action to insecticides and often the same chemical kills both insects and mites. The term “broad spectrum”, “short term”, and “residual” are also used to describe acaricides.



FUNGICIDES

Fungicides are chemicals used to control the fungi which cause molds, rots, and plant diseases. All fungicides work by coming in contact with the fungus, because fungi do not “swallow” in the normal sense. Therefore, most fungicides are applied over a large surface area to try to directly hit every fungus. Some fungicides may be **systemic** in that the plant to be protected may be fed or injected with the chemical. The chemical then moves throughout the plant killing the fungi.

Protectant vs. Eradican. There are two basic approaches in the use of fungicides. One is designed to prevent the plant from getting the disease. These fungicides are used as “**protectants**” and are similar in purpose to polio and smallpox vaccinations for humans. They are applied before the disease gets a start. This type of fungicide is very useful when a particular disease or group of diseases is very likely to attack a plant or crop year after year. Protectants, for example, have often been used as a routine precautions on fruit and vegetable crops.

Most protectant fungicides are fungistatic. This means they prevent or inhibit fungal growth. Once the fungistatic action ceases, the controlled fungus may grow again or produce spores. Thus, a protectant fungicide may have to be applied at regular intervals to continue the protection from infection

The other type of fungicide kills the disease after it appears on (or in) the plant. These fungicides called “**eradicants**” are like penicillin or other antibiotics which cure diseases in humans after the sickness appears. Eradicants are less common than protectants because once the fungus is established in a plant it causes damage and is often difficult to get rid of. Eradicants are often used when protectants aren’t available, aren’t applied in time, or are too expensive. Eradicants are also applied when the disease appears unexpectedly on a plant or in an area. For example, a common use is on fruit and vegetables when the protectant spray wasn’t applied on time. Eradicants are also used by orchardists in combating diseases of fruit trees such as apple scab.

HERBICIDES

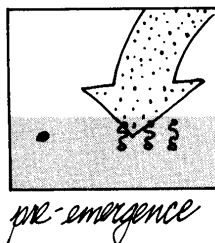
Herbicides are chemicals used to control unwanted plants. These chemicals are a bit different from other pesticides. Some herbicides kill every plant they contact, while others kill only certain plants.

Nonselective herbicides are toxic to all plants. These are often used when no living plant is wanted in an area. For example, nonselective herbicides could be used for clearing under guardrails or for total control of weeds in industrial areas.

Selective herbicides kill some plants with little or no injury to other plants. Usually selective types will kill either most broad-leaved plants or most grassy plants. These are useful for lawns, golf courses or in areas with desirable trees. Some very selective herbicides may kill only certain plants in a group. For example, crabgrass killers on lawns.

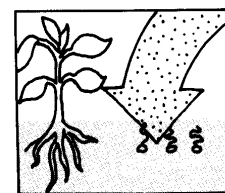
Preplanting vs. Preemergence vs. Postemergence.

The timing of herbicide applications is important. Care must be used to get the job done effectively without hurting desirable plants. The directions on the label will state when to apply the herbicide for best results.

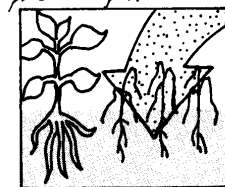


Preplanting treatments are made before planting. These chemicals may be used in seed beds or incorporated into the soil before planting takes place.

Any treatment made before the crop or weed appears is called **preemergence**. The application may be made before both the crop and weeds appear, or after the crop appears but before the weeds appear. The label or directions will state “preemergence to the crop,” “preemergence to the weeds,” or “preemergence to both crop and weeds.”



*post-emerged plant
pre-emerged weeds*



post-emergence

When the herbicide treatment is made after the crop or weeds appear, it is called **postemergence**. Postemergence applications must be very selective. They must control the weeds but leave the crop unharmed. Often the chemical will be applied postemergence to the crop, but preemergence to the weeds.

GROWTH REGULATORS, DEFOLIANTS, DESICCANTS

These chemicals are used to alter the crop itself. A **defoliant** causes the leaves of a plant to drop off early. A **desiccant** draws moisture from a plant causing it to wither and die. Defoliants and desiccants are often used to make crops easier to harvest. A **plant growth regulator** (or **plant regulator**) increases, decreases, or changes the normal growth or reproduction of a plant. Fertilizers and other nutrients are not included. Some growth regulators are used to move up or to move back the normal harvest date for the crop. Others are used to obtain better quality and/or yield of crop. Electric power utilities could use growth regulators to slow the growth of a tree threatening power lines, thus saving the tree from being cut.

RODENTICIDES

Rodenticides are chemicals used to control rats, mice, other rodents, and bats. Chemicals which control other mammals, birds, and fish are also grouped in this category by regulatory agencies. Most rodenticides are stomach poisons and often applied as baits. Even rodenticides which act by contacting the pest are usually not applied over large surfaces because of the hazard to domestic animals or desirable wildlife. They too, are usually applied in limited areas such as runways, known feeding places, or as baits.

NEMATICIDES

Nematicides are chemicals used to control nematodes. Nematodes are tiny hair-like worms. Many live in the soil and feed on plant roots. Very few of these worms live above ground. Usually soil fumigants are used to control nematodes in the soil. However, a few insecticides and fungicides are also effective against these tiny worms. These usually kill by contact.



MOLLUSCICIDES

Molluscicides are chemicals used to control snails and slugs. Usually the chemicals must be eaten to work. Thus, baits are often used to attract and kill many snails or slugs in an area.

REPELLENTS

A repellent is a pesticide that makes a site or food unattractive to a target pest. They are registered in the same way other pesticides are and must be used according to the label. Insect repellents are available as aerosols and lotions and can be applied to skin, clothing, or plants to repel biting and nuisance



insects. Vertebrate repellents are available as concentrates to be mixed with water, powders, and granules. They can be sprayed or painted on nursery crops, ornamental plantings, orchards, vineyards, vegetables, and seeds. Repelling deer, dogs, birds, raccoons, and others can protect sites from damage.

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

SELF STUDY QUESTIONS

1. A pesticide is any chemical used by man to control pests.

T ()

F ()

Match the following pests with the pesticides in questions 2, 3, and 4 below:

- | | |
|-------------------|----------|
| a) Insects | b) Mites |
| c) Plant diseases | d) Weeds |

2. Fungicides are used to prevent -

a ()

b ()

c ()

d ()

3. Herbicides are used to control -

a ()

b ()

c ()

d ()

4. Acaricides are used to control -

a ()

b ()

c ()

d ()

5. A pesticide that is absorbed in one part of a plant or animal and transported to another part where it kills a pest is called a -

- A) contact pesticide.
- B) volatile pesticide.
- C) residual pesticide.
- D) systemic pesticide.

6. After the crop has been planted, which type of herbicide application should be made to control the weeds before they appear?

- A) preplanting.
- B) preemergence.
- C) postemergence.

7. If an insecticide is effective against a wide variety of insects, it is a broad spectrum insecticide.

T () F ()

8. Most fungicide applications are made as -

- A) protectants.
- B) eradicants.
- C) dessicants.

9. It is almost impossible to spray a crop with a herbicide to kill the weeds without injuring the crop.

T () F ()

10. Insecticides kill insects and herbicides kill weeds. The kind of pesticide that kills snails and slugs is called a -

- A) snailicide.
- B) slugicide.
- C) molluscicide.

11. Preemergence, postemergence, and selective are terms used in describing the use of -

- A) miticides.
- B) herbicides.
- C) fungicides.
- D) insecticides.

12. Systemic pesticides are transported in plants from one part to another; they travel-

- A) from roots to foliage but not from foliage to roots.
- B) from foliage to roots but not from roots to foliage.
- C) from foliage to roots and/or from roots to foliage depending upon the pesticide.

13. A rodenticide is used to control -

- A) mice but not rats.
- B) rats but not mice.
- C) both rats and mice.

14. It is usually best to use a residual pesticide lasting more than one season when making applications to the soil.

- A) for the control of termites near the foundation of a house.
- B) for the control of weeds in a corn field.
- C) for the control of cabbage maggots in a cabbage field.

15. According to pesticide regulations, fertilizers are not considered to be pesticides.

T () F ()

ANSWER KEY

- | | | |
|------|-------|-------|
| 1. T | 6. B | 11. B |
| 2. C | 7. T | 12. C |
| 3. D | 8. A | 13. C |
| 4. B | 9. F | 14. A |
| 5. D | 10. C | 15. T |

CHAPTER NINE

SELECTION OF A PESTICIDE

Learning Objectives

- * Evaluate the pest problem and decide whether pesticide use is necessary after considering alternatives.
- * Understand the advantages and disadvantages of the various types of pesticide formulations and be able to select the most appropriate one for the application.

Before choosing and buying a pesticide for any job, there are several points to consider. Frequently a pesticide application is not the answer. Other methods may control the pest or the damage may already be done for the present growing season.

IDENTIFY THE PEST

An applicator cannot wisely choose the right pesticide for a job until the pest has been identified. Sometimes an insect or disease which is very noticeable is blamed for damage it did not cause. Or sometimes damage from small, obscure insects or diseases is thought to be caused by weather conditions or other pests. For example, damage from scale insects on ornamentals may be mistaken for injury from lack of water. However, watering the shrub does not clear up the injury. The scale must be identified, then controlled. If help in identifying the pest is needed, it may be obtained from county extension agents, local pesticide dealers, state colleges or reference bulletins that are available.

Besides knowing what the pest is, it is also important to know the pest's life cycle in order to determine what stage and time it can best be controlled. Usually a pest can be controlled best during

one particular stage of its development. Unfortunately this stage is not the same for all pests. Therefore, to choose the best method of control for each pest, the applicator must know what the pest is, when it can best be controlled, and which chemicals, if any, will control it.

DETERMINE IF CONTROL IS NECESSARY

Not all insects or diseases that are seen on trees, shrubs or crops are pests. Insects may simply be resting on the plants. Or they may be feeding on other insects that are pests. If damage does show, the pest which caused it may have already left the area or may not be causing any further damage. Sometimes the damage may appear too late in the season to be important. Plant diseases or insect pests may be present, but the damage may not be as great as the cost of the pesticide application.

CONSIDER THE ALTERNATIVES TO PESTICIDE APPLICATION

Methods of control may be used that do not require a chemical treatment. Cultivation may control weeds as well or better than herbicides can. Mosquitoes in an area can be permanently controlled if their breeding areas are drained or filled with dirt. Leaf diseases on trees or shrubs may be lessened by collecting and destroying diseased leaves. Damage from crop pests such as seed corn maggot can be greatly reduced by changing the date of planting. A pesticide treatment is not always necessary or economical. Check all possibilities before deciding to spray.

CONSIDER INTEGRATED PEST MANAGEMENT

Sometimes two or more methods are used to control or manage a given pest. This system is called “Integrated Pest Management” or IPM. Natural enemies of the pest such as predators and parasites may be used in such a program. Also, numerous cultural methods have been found which help control some pests. These include fall planting, changing planting dates, rotation of crops or the use of plants that have a repellent effect on the pest. Often cultural methods, natural enemies, and careful use of the selective pesticides are used for a successful integrated pest management program. For example, a simple integrated pest management could be used on a golf course for grub proofing against Japanese beetle larvae. A chemical pesticide would be used to protect the more valuable sodded areas of the fairways. Milky disease spores which are a commercially produced biological control for Japanese beetle larva would be applied in the roughs. The chemical pesticide would give immediate protection of the sodded areas while the milky disease becomes established in the rough. Then as the chemical breaks down in the more valuable areas, milky disease would move in. Once milky disease is established, no more chemical treatment is usually needed to protect the turf.

For optimum success of the integrated pest management system, it is advised that monitoring be employed. Monitoring entails collecting samples of pests to determine the severity of the pest problem. This enables the grower to use pesticides only when really necessary and at appropriate doses. Monitoring can be very effective in saving money and time in pesticide management.

HOW TO CHOOSE THE RIGHT PESTICIDE FOR THE JOB

After the certified applicator has identified the pest, determined that a control measure is necessary, and considered other methods of control, it may be decided that the only practical method is to use a

pesticide. Now is the time to choose the best pesticide for the job. He/she must choose a pesticide that:

- * Is effective against the pest.
- * Has directions on the label for the intended use.
- * Will not cause injury to the plant (phytotoxicity) or other surface to which it is applied.
- * Will cause the least damage to beneficial organisms (bees, parasites and predators) within the treated area.
- * Will not move off the treated area and persist in the environment to harm fish and wildlife.
- * Is the right type (formulation) to work well in the machinery that the applicator intends to use.

A pesticide that meets these qualifications may not turn out to be the cheapest to buy, but may very well be the most economical in the long run.

Don’t apply pesticides more often than they are needed. Look at the damage to see if there are enough pests to make it worth your time and money to apply a pesticide.

PESTICIDE FORMULATIONS

The component of a pesticide that controls the target pest is called the ACTIVE INGREDIENT (a.i.). Before a pesticide product is sold, active ingredients are mixed with liquid or dry INERT INGREDIENTS (non-pesticidal). These mixtures of active and inert ingredients are called PESTICIDE FORMULATIONS. Formulations make an active ingredient more convenient to handle; safer, easier, and more accurate to apply; and in some cases, more attractive to the pest.

Types Of Formulations

Pesticides are available in a wide variety of formulations. It is not uncommon to find some active ingredients formulated in at least a half dozen different ways. The more common pesticide formulations are:

- Emulsifiable concentrates
- Solutions
- Soluble powders
- Wettable powders
- Flowables
- Water dispersible granules
- Dusts
- Baits
- Granules
- Aerosols
- Fumigants

Formulations vary in their:

- Safety to the user
- Potential hazard to the environment
- Application equipment/method required
- Likelihood of causing phytotoxicity
- Cost
- Efficacy of pest control

Choose the best formulation for a particular job. The following section describes the most common formulations and some of the advantages and disadvantages of each.

Emulsifiable Concentrates (EC or E)

Emulsifiable concentrates are liquid formulations with the active ingredient dissolved in one or more petroleum solvents. An emulsifier is added so the formulation will mix readily with water for application. Emulsifiable concentrates usually contain between 2 and 8 pounds of active ingredient per gallon, and when added to water usually form a milky-white emulsion.

EC's are very versatile and can be adapted for use with many types of spray equipment.

Advantages:

- Relatively easy to handle, transport, and store
- Little agitation required
- Nonabrasive to equipment
- No plugging of screens and nozzles

Disadvantages:

- High concentrations of active ingredient reduce the margin for error when mixing or applying
- May have high phytotoxicity hazard
- May be easily absorbed through the skin of humans and animals
- Solvents may cause equipment deterioration
- May be corrosive, causing pitting or discoloration of painted surfaces
- Should be stored away from heat; petroleum solvent makes them flammable

Solution (S)

Solutions are formulations with the active ingredient dissolved in one or more liquid solvents. They are often ready-to-use without further dilution, or they can be diluted with a specially refined oil or petroleum solvent. High concentrate (Ultra Low Volume, ULV) solutions contain 8 or more pounds of active ingredient per gallon, while low concentrate solutions usually contain less than 2 pounds of active ingredient per gallon. The advantages and disadvantages of solutions vary dramatically, depending on the solvents used, the concentration of the active ingredient, and the type of application equipment involved.

Soluble Powders (SP)

Soluble powders are dry, powdered formulations containing from 25 to 80 percent active ingredient. Soluble powders dissolve in water to form solutions.

Advantages:

- Reasonable cost
- Easy to store, transport, and handle
- Lower phytotoxicity than some liquid formulations, especially EC's
- Slower skin and eye absorption than EC's

Disadvantages:

- With dust-like consistency, they may be hazardous if the handler breathes the dust during mixing. However, some soluble and wettable powder formulations are available in soluble packets. The contents are premeasured and the packet dissolves in the spray tank, thus minimizing handling and inhalation exposure to the powder.

Wettable Powders (WP)

Wettable powders are also dry, finely ground formulations containing from 25 to 80 percent active ingredient. Unlike the soluble powders, wettable powders do not dissolve in water. Wettable powders are mixed with water, and applied as suspensions. Wettable powders share all the advantages and disadvantages of soluble powders. In addition to the inhalation hazard, other disadvantages of wettable powders include:

- Constant agitation is required to avoid settling of the particles
- Wear to nozzles and pumps from abrasive spray mix
- Clogging of sprayer screens and nozzles
- Difficult to mix in very hard or alkaline water
- Visible residues on treated surfaces

Flowables (F)

Flowable formulations are finely ground solid particles suspended in a liquid carrier. The solid in a flowable is similar to a wettable powder, except it is formulated to stay suspended in a liquid. Because flowables usually contain 4 or more pounds of active ingredient per gallon of formulation, they should be handled with the same care as EC's and solutions.

They are mixed with water for application and have similar advantages and disadvantages as wettable powders, except they seldom clog nozzles and need only moderate agitation to stay in suspension. Flowables usually do not present an inhalation hazard when mixing.

Water Dispersible Granules (WDG)

Water dispersible granule formulations are similar to wettable powders, except the active ingredient is in a granular form rather than a powder. The granules are mixed with water and upon contact with water, they disperse or break apart. The resulting spray mix has all the characteristics of a flowable or a finely dispersed wettable powder in water. Water dispersible granules share all the advantages and disadvantages of wettable powders except:

- They are more easily measured and mixed,
- The reduction in the number of dust-like particles lowers the inhalation hazard to the user during pouring and mixing

Dusts (D)

Dust formulations contain a low percentage of active ingredient (0.5 to 10 percent) plus a finely ground inert substance such as talc, clay, nut hulls, or volcanic ash. Dusts are always used dry; most are ready to use as purchased without further mixing.

Advantages:

- Easily handled with low-cost application equipment
- Effective where a liquid formulation can cause damage
- Ease of applying in hard-to-reach areas

Disadvantages:

- Easily drift into nontarget areas
- Easily moved from treated surfaces by wind and rain
- Relatively expensive for the small amount of active ingredient
- May be irritating to user

Baits (B)

A bait formulation is an active ingredient mixed with an edible substance or some other attractant. The bait either attracts pests or is placed where the pest animal will find it. The pest must eat the bait to be affected.

Baits may be used to control certain insects, snails and slugs, rodents and other pest mammals, and birds. Most bait formulations contain a low percentage of active ingredient (less than 5 percent).

Baits are often used in kitchens, gardens, granaries, food storage/processing facilities, and refuse disposal areas.

Advantages:

- Ready to use with no further mixing or special application equipment
- Used only when needed and then removed when the pest is not present

Disadvantages:

- Baits may be attractive to children and pets
- Domestic animals and wildlife may be affected
- The target pest may not be controlled by baits because other available sources of food are more attractive
- Application costs are high relative to the amount of active ingredient in the formulation
- Dead pests may cause an odor or sanitation problem

Granules and Pellets (G,P)

Granular formulations are dry, ready-to-use materials usually containing from 2 to 15 percent active ingredient. Most granules are prepared by applying the active ingredient as a liquid to a coarse, porous, solid material such as clay or ground corn cobs.

Granules are often used to control soilborne pests. Because many of the active ingredients in granules possess systemic properties, granular formulations are applied to the soil where the active ingredient can then be absorbed by the roots and translocated through the plant.

Advantages:

- Ready to use without mixing and easy to apply
- Low drift hazard since the particles are relatively heavy
- Lower hazard to user since there is usually little dust associated with granules
- Inexpensive application equipment

Disadvantages:

- More expensive than WP's or EC's relative to the amount of active ingredient in the formulation
- Do not stick to foliage
- May need soil incorporation, or require moisture to activate pesticide
- May be hazardous to nontarget species. Pellets differ from granules only in their precise uniformity, larger size and shape.

Aerosols

Aerosols are those formulations containing an active ingredient in solution (usually a petroleum distillate) and packaged in a pressurized container. "Bug bombs" contain a small amount of active ingredient mixed with a propellant that forces the contents from the can in a spray or mist.

Advantages:

- Ready to use and easily stored

Disadvantages:

- Relatively high cost
- Risk of inhalation injury
- Difficulty in confining the pesticide to the target site or pest
- Very hazardous if containers are punctured or used/stored near a heat source

Fumigants

Fumigants are pesticides that are active as gases. Some fumigants are formulated as liquids under pressure and become gases only when released. Others are solids that release gases under conditions of high humidity.

Fumigants are nonselective in their action. A single fumigant can kill insects, weed seeds, nematodes, rodents, fungi, and other pests. Fumigants can leak from any area that is not airtight. The use of fumigants is, therefore, generally limited to soil and closed structures such as buildings, granaries, and greenhouses.

Advantages:

- Toxic to a wide range of pests
- Can penetrate cracks, crevices, wood, and tightly packed areas such as soil or grain
- Single treatment usually required

Disadvantages:

- The most hazardous of all pesticide formulations
- Often require extensive protective equipment, including respiratory protection devices
- May be formulated with an odorous warning gas, but this gas usually is also highly toxic
- Treatment area must be enclosed or covered to prevent the gas from escaping during application and for a specific period after application

PESTICIDE MIXTURES

Mixtures of pesticides offer the advantage of controlling more than one pest with a single application. Mixtures can save time, labor, and fuel. Pesticides are frequently combined by the manufacturer as premixes, but they are more often mixed by the applicator.

It is important to remember that not all pesticides work well in combination. Two or more pesticides which can be mixed together are said to be COMPATIBLE. Pesticides that cannot be effectively

mixed to form a sprayable mix are INCOMPATIBLE. Chemical or physical separation of ingredients into layers, globules, clumps, precipitates or gels, indicates the products are incompatible. Incompatibility can result in:

- loss of effectiveness against the target pests
- phytotoxicity
- increased hazard to the applicator or treated animals
- clogging of equipment lines, pumps, and tanks

Before mixing two or more pesticides, or a pesticide and fertilizer, read the label. Although tank mixing is a common and legal practice, the compatibility of many pesticide combinations is still unknown. Therefore, applicators may need to do some compatibility testing of their own by conducting the simple jar test described below.

Pesticide Compatibility Test

1. Wear the proper protective gear to prevent inhalation, skin, or eye exposure during the test.
2. Use a large, clean, clear glass container - like a one quart jar.
3. Use the same water you will use in your tank mix.
4. Add the products in question in the same proportions as you will mix them, in the same sequence, and at the same temperature at which they will be sprayed. Unless labels specify otherwise, pesticides should be added in this order: wettable powders, flowables, soluble powders, surfactants, and EC's. Agitate after each addition.
5. Shake the jar vigorously and let it stand for approximately 15 minutes. If scum, clumps, or any precipitates form, the mixture is probably incompatible.
6. Do not use any mixture that gives off heat. This is an indication that a chemical reaction has occurred. Properties of some of the products could be changed drastically.
7. Test the mix on the plant species to which it will be applied (under similar conditions, if possible).

ADJUVANTS

An ADJUVANT is a chemical added to a pesticide formulation or mixture to improve its performance and safety. Many formulations contain at least a small percentage of one or more adjuvants.

Many adjuvants include a surfactant. SURFACTANTS are “surface active agents” that alter the dispersing, spreading, and/or wetting properties of spray droplets. Wetting agents and spreaders are the adjuvants most frequently used by pesticide applicators; they are often referred to simply as surfactants. Wetting agents and spreaders reduce the surface tension of spray droplets. A spray droplet must “wet” the treated surface and spread uniformly over the treated area to provide maximum pest control. Applications to plants with very waxy or hairy leaves often require the inclusion of an adjuvant to the spray mixture.

Stickers and penetrants are additional adjuvants that influence the adherence, absorption, or safety of a pesticide mixture on a treated surface. Buffers, compatibility agents, emulsifiers, and antifoaming agents affect the mixing, handling, and longevity of a pesticide mixture. Foaming agents, drift retardants, and thickeners reduce drift during application.

Care should be exercised before using adjuvants. Some labels very clearly prohibit their addition; others are quite specific as to the type of adjuvant that can be used and when it should be added to a spray mixture.

SELF STUDY QUESTIONS

1. To achieve the most efficient pest control, the first thing to find out before making an application of a pesticide is:

A) the quantity of pesticide needed.
B) if the weather is o.k. to apply a pesticide.
C) the identity of the pest.

D) how much pest damage can be tolerated.

2. The pesticide chosen for the control of a pest should:

A) have a low LD₅₀.
B) be soluble.
C) break down rapidly.
D) be efficient.
3. The use of a pesticide chosen for the control of a pest should not:

A) create other pest problems.
B) be stable.
C) stay exactly on target so it will kill over a larger area.
D) be toxic to the applicator.
- 4) Most formulations of pesticides work in any sprayer.

T () F ()
- 5) To double check your choice of a pesticide for the pest control job at hand:

A) refer to the yellow pages.
B) check with the news media.
C) look at your application records of past years.
D) read the label.

ANSWERKEY

1. C 5. D
2. D
3. A
4. F

CHAPTER TEN

INTEGRATED PEST MANAGEMENT

Learning Objectives

- * Define “Integrated Pest Management.”
- * Understand how to monitor a pest problem and explain alternative means of control.
- * Understand how to evaluate and select from the alternatives to set up an “Integrated Pest Management” program.
Pesticides alone cannot solve the problems of

controlling pests. Diminishing effectiveness, increased cost, and safety considerations are all legitimate concerns surrounding pesticide usage. In response, many agricultural professionals have turned to Integrated Pest Management (IPM). In New Jersey, IPM programs are developed and implemented by IPM agents, county agricultural agents, and specialists who work for Rutgers Cooperative Extension Service and the New Jersey Department of Agriculture.

To understand the IPM concept, let’s look at the meaning of the words in the term Integrated Pest Management.

INTEGRATED: a focus on the interactions of pests, crops, control methods, and the environment rather than on individual weeds, insects, or diseases. All available tactics and how they fit in with other agricultural practices are examined.

PEST: an unwanted organism (animal, plant, bacteria, fungus, virus, etc.)

MANAGEMENT: a way to keep pests below the levels where they can cause economic damage. Management does NOT mean eradicating pests. It means finding tactics that are both effective and economical and that keep environmental damage to a minimum.

Some of the different pest control tactics used in an IPM program include:

- MONITORING

Traditional pest control programs have been based on the calendar sprays that were applied at certain times of the year, regardless of whether the pests were present. In an IPM program, regular plant inspections are an essential way to monitor pest populations (insects, weeds, and nematodes, for example). Scouting and trapping systems are commonly used to monitor insects and their activity. Weather conditions can also be monitored to predict an outbreak of certain insects and diseases. Temperature data used to accumulate degree day information are helpful in following an insect’s life cycle or in predicting how long it will take a certain insect to develop.

- CULTURAL CONTROLS

These are routine management practices that can prevent pests from developing. These include crop rotation, tilling the soil, varying the time of planting, destroying crop residues, and pruning, thinning, and fertilizing plants. These practices tend to disrupt the normal association between a pest and its host, making the environment less favorable for the survival, growth, or reproduction of the pest.

- PHYSICAL CONTROLS

These are widely used in pest control and include manipulation of water or humidity, and temperature; the use of electric shock, light or other radiant energy; and the use of sound waves. Physical controls kill the pests, disrupt their life cycles, or make the environment unfavorable for pests.

- BIOLOGICAL CONTROLS

This method involves the introduction and encouragement of plants and animals that are parasites or predators of a pest species. The New Jersey Department of Agriculture operates a laboratory in which many beneficial organisms are raised for release throughout the state.

- GENETIC CONTROLS

This group involves the use of plants and animals that are resistant to attack by pests.

- LEGAL CONTROLS

These limit the development of pest populations by restricting human activities. This is done by a series of laws at the federal and state levels. These include quarantines, inspections, compulsory crop destruction and eradication of pests.

- CHEMICAL CONTROLS

Despite concern over their use, pesticides are still important in many IPM programs. Often problems occur because people rely too much on pesticides. IPM seeks to restore balance so that pesticides are used only when they are really needed.

HOW TO SET UP AN IPM PROGRAM

Planning is important in an IPM program. Every crop has pests that need to be considered. If you wait until problems arise during a growing season, you will rely on pesticides more and more.

A good IPM program has four parts: (1) identifying problems, (2) selecting tactics, (3) considering economic factors, and (4) evaluating the program.

(1) Identifying Problems

You have to know what is happening in your field before you can make management decisions. Scouting is the key feature of an IPM program. It is important to scout your crops often and on a regular basis. To scout effectively you have to:

- Know the crop's growth characteristics so that you can recognize damaged plants.
- Identify the cause of the problem so that you know what kind of pest you are dealing with. If you cannot identify the pest, consult your county extension agent.
- Determine the stage of growth of the pest and the crop.
- Decide whether the infestation is increasing or decreasing.
- Assess the condition of the crop.
- Map out the problem areas. It may be possible to limit the area that needs treatment.
- Use the right scouting method for the specific pests.

(2) Selecting Tactics

Once the problem has been identified, you should consider how to control it. Your goal in selecting tactics is to use methods that are effective, practical, economical, and environmentally sound. To select the best control tactic, you have to:

- Understand the life cycle and habits of the pest. In insect control, the application of an insecticide should coincide with the presence of a susceptible life stage. In some cases the susceptible

stage is only the adult, or the larva. In most cases the insecticide does not affect the eggs. In general, the younger the life stage, the more susceptible the insect is to pesticides.

- Decide whether the infestation is serious in terms of economic loss.

(3) Considering Economic Factors

Economics must be a primary consideration in pest control. Pesticides should be used in an IPM program only when the benefits (yield, quality, aesthetic value) exceed the cost of control.

It is not easy to determine when it pays to use pesticides. There are many variables: the pest population, variety, crop growth stage, value of the crop, weather, and cost of control.

The following economic concepts help in determining the point at which it pays to use pesticides.

- Economic damage occurs when the cost of preventable crop damage exceeds the cost of control. For example, if a bushel of corn costs \$2.00 and an insecticide costs \$14.00 an acre,

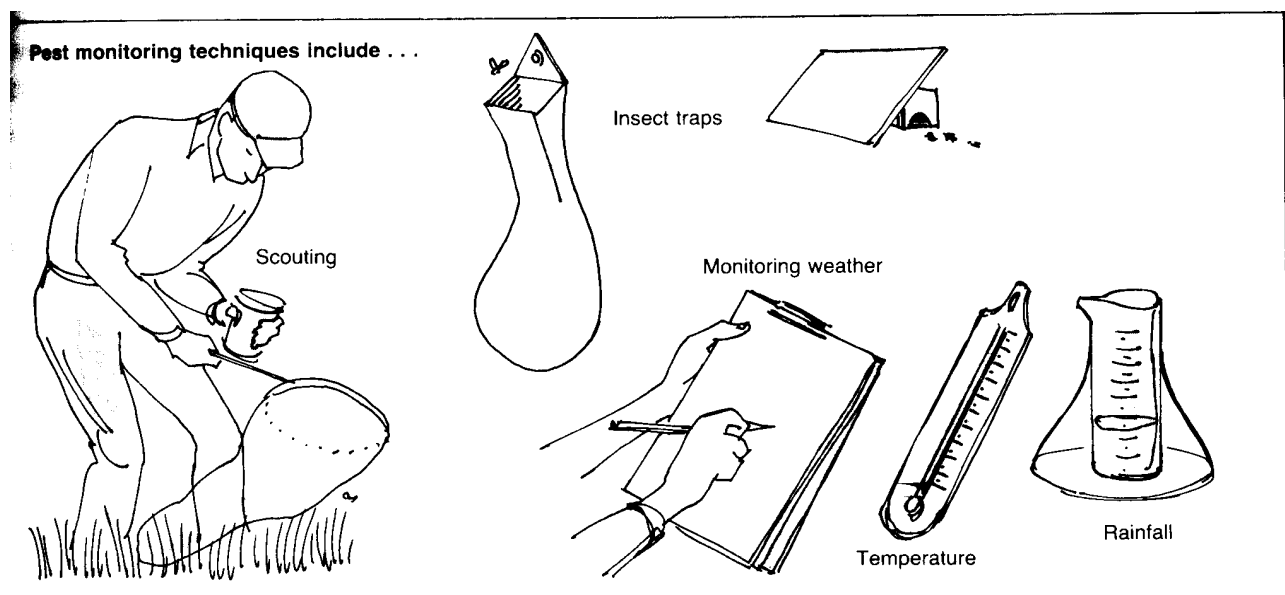
then economic damage occurs when insect damage causes a yield loss of seven or more bushels an acre.

- Economic injury level (EIL) is the lowest pest population that will cause economic damage.
- Economic threshold (ET) is the level of a pest population where control measures need to be applied to prevent the pest from reaching the economic injury level. Economic threshold values are not static. Some factors that influence the economic threshold are the current value of the agricultural product being produced, its stage of development, the cost and effectiveness of control measures, and the anticipated yield.

(4) Evaluating Your IPM Program

In deciding how effective your IPM program is, you should:

- Monitor your fields and keep records. Every time you visit your fields, note crop and pest conditions, record crop yields and quality, and record the count on pest populations. Scouting and trapping systems are commonly used to monitor insects and their activity.



- Record control measures. Include dates, weather conditions, count on pest populations, application rates and timing, and costs.
- Compare effectiveness. Whatever method you choose, use an opposite method on some strips. Then you can compare which worked better.

For information on IPM on specific crops, contact Rutgers University, Cook College, New Brunswick, N.J. 08903.

SELF STUDY QUESTIONS

1. Integrated pest management means using two or more pesticides mixed together to control all the pests in one application.

T () F ()

2. When insect pests are present, even in small numbers, it is best to apply chemical controls rather than wait for threshold numbers and/or increased damage.

T () F ()

3. Integrated pest management procedures can be used in controlling agricultural pest problems but are not useful or needed in other pest problem situations.

T () F ()

4. Satisfactory alternatives to the use of pesticides are available for the control of most pests if we could afford the expense.

T () F ()

ANSWERKEY

1. F
2. F
3. F
4. T

CHAPTER ELEVEN

VERTEBRATE PEST MANAGEMENT

Learning Objectives

- * Understand the various aspects of “wildlife” damage and control.
- * Appreciate the various constraints legal; economic and social - on control of wildlife in agricultural areas.
- * Diagnose the specific problem and understand the various means of control.

Fish, amphibians (frogs, toads, salamanders), reptiles (snakes, lizards, turtles), birds, and mammals are classified as vertebrates. All share with humans a common characteristic - a backbone. Each vertebrate species has evolved a set of unique characteristics that are specific to its environment.

Wild vertebrates, often referred to as “wildlife,” depend on food and shelter as do humans. The same environment furnishes these necessities to both humans and wildlife. Wildlife species are important to humans because of their economic, social, recreational, and ecological values. However, in varying times and places, these values may change.

Control of wildlife damage is one of the more complex and controversial aspects of wildlife management. Some species, in certain circumstances, may cause significant damage to surrounding natural resources, including other wild species; to forest and agricultural crops; and to livestock. Or they may

endanger the health or safety of humans. Although such damage is often due to an excess population of the species, it also may result from other less apparent reasons. Problems of ecological competition or the struggle of a species to survive in a changing environment are important to evaluate.

The potential for conflict is created when human activities encroach on the natural environments of wild species. The encroachment may be a corn field adjacent to a forest frequented by deer, crops planted



on bottomland adjacent to a marsh roost of redwinged blackbirds, or a cabin built in prime forest habitat of the whitefooted mouse. The ecological consequences are often predictable and the conflict should be evaluated on this basis.

Control of wildlife damage is further complicated by differing social views of the problem. A growing number of people see the positive values of most wild species, and some question the need for control programs. Persons who experience economic and ecological damages are quick to recognize the desirability of preventing such losses. A wildlife damage control program should recognize these different views.

PRINCIPLES OF VERTEBRATE PEST DAMAGE CONTROL

The essential principles of vertebrate pest management are:

- * Wildlife may have both positive and negative social and economic values. Certain species may adversely affect other wildlife or interfere with human interests, requiring prevention or control.
- * Techniques known to be of value in counteracting damage situations include: a) exclusion or mechanical protection; b) use of repellent chemicals or devices; c) environmental or biological control; and d) reduction of the offending population by transfer or by lethal methods.
- * Lethal control methods must be socially and economically acceptable and should be the minimum necessary to bring damage within tolerable limits.
- * Control methods must be efficient, safe, economical, humane, and as selective as possible; they must conform to local, state, and federal laws and regulations.

- * Control programs must not be conducted if they would be hazardous to any endangered species of wildlife.

LEGAL CONSIDERATIONS

Wildlife occupies a unique position as a natural renewable resource. It is public property held in trust for all people in accordance to state and federal laws. Some of the federal laws enacted to protect wildlife include the Lacey Act which prohibits the movement between states of wildlife taken in violation of state laws, the Bald Eagle Act which protects eagles, and the Marine Mammal Act which protects aquatic mammals. The federal Endangered Species Act legally protects endangered and threatened species and their habitats from adverse or detrimental effects that could threaten their survival. Pesticides must be screened for their potential impact on the endangered species. Some pesticides may be prohibited from being used in areas inhabited by these plants and animals.

State agencies, rather than federal agencies, have the primary responsibility and regulatory authority to enforce the laws that protect and manage most wildlife. The authority includes enforcement of both federal and state laws. All states have designated wildlife agencies although their laws may vary. In New Jersey, the Division of Fish, Game and Wildlife is the regulatory agency responsible for wildlife management.

The state laws define and regulate the taking of certain wildlife species not protected by federal laws. State laws may specify control methods and procedures that can be used when confronted by damage from wildlife. As a matter of policy, the New Jersey Division of Fish, Game and Wildlife should be contacted before any lethal methods are used to control pest wildlife.

When choosing wildlife control methods, be aware of local ordinances or regulations. For example, discharging firearms in urban areas may be prohibited by a local ordinance. The use of scare

devices based on noise may conflict with ordinances prohibiting unreasonable noise and/or disturbing the peace.

DIAGNOSIS OF PROBLEM AND NEED FOR CONTROL

One of the primary considerations in vertebrate pest control is determining the need for control. Individuals may differ in their attitudes toward vertebrate pests; some people are willing to accept animal damage which would be considered intolerable by others. However, control would be justified if wild-life pests were endangering human health and safety or destroying agricultural crops or facilities.

The advisability of vertebrate control efforts would not be questioned if it could be demonstrated that a pest or pests were endangering human health through the threat of disease or that human safety was being threatened, such as by concentrations of birds at airports where aircraft and bird collisions have resulted in loss of human lives.

Protection of agricultural crops is justifiable; and in some circumstances, pest control is probably warranted. This is an area where opinion varies. It is generally agreed that many farmers, for example, support wildlife in numbers on their farms; in so doing, farmers are willing to accept some damage to their crops by wildlife. The extent of depredation acceptable to growers depends on the species causing the problem and on the grower's individual philosophy. It is unlikely that any grower would accept mice in a orchard or rats in a corn crib. On the other hand, a grower might accept depredations from wild turkeys because this bird is generally valued by most people.

Protection of structures, tools, and equipment may be justified when vertebrate depredations threaten the usefulness of these facilities. Bird droppings on surfaces susceptible to deterioration or rats gnawing holes in buildings are examples of this kind of damage.

Regulatory agencies will make a final determination in any dispute over the justification for vertebrate pest control. The complainant should be able to demonstrate damage before undertaking pest control, especially when protected species are involved.

When robins damage ripening fruit, a federal permit would be required to kill the offending birds. However, the use of protective netting to exclude the birds does not involve a lethal method and no permit would be needed.

Identification of the problem-causing pest frequently causes confusion in vertebrate pest control. Misidentification or misnaming the pest complicates control programs because the choice of material or method to be used depends upon correct identification. One method or material might be effective against one pest but might be illegal or ineffective when used against another pest. Meadow mice are frequently misidentified as moles, yet different control techniques must be used on each of these pests. Occasionally, identification is made by observing the pest "in the act." More frequently, however, identification must be made from signs left behind by the pest.

Knowing the vertebrate species in the area and their habits helps in identifying pest damage. The process of identification is often one of elimination. Proper identification may involve consideration of the time of year; nature and extent of damage; size of involved species as indicated by tracks, teeth marks,



and droppings; and location of damage. Once the species has been identified, it should be correctly named. Generally accepted common names are adequate. But colloquial names should not be used because they often lead to confusion, especially when attempting to develop an effective and legal pest management program. Most legal control recommendations are based on accepted common names, although scientific names are usually added so that there is no confusion in identifying the regulated species. Since restrictions on vertebrate pest control are highly specific, identification of the pest must be accurate.

In most vertebrate pest control activities, there are several choices of materials and/or methods for combating the problem. Choose the program that uses only properly registered and legal methods or materials, and use the methods or materials as prescribed on the label. Using registered materials in any way other than those specified on the label is as unacceptable as the use of unregistered materials.

Many times damage can be controlled within tolerable limits by nonlethal materials or methods. Except for a few species, a program designed to limit damage without sacrificing the offending species is preferred over a program involving lethal means.

Alternative means of damage prevention by pests include making the crop or facility inaccessible; moving the pest unharmed to an environment where it will not be a problem; using a repellent which makes the susceptible crop or facility undesirable; altering the environment to make it unattractive to the pest; and presenting the pest with alternative commodities or facilities. These alternatives should be considered even when lethal controls appear to be the only answer. Another choice may present fewer hazards to the environment and to other wildlife species. However, in most instances legal restraints result in limited available options.

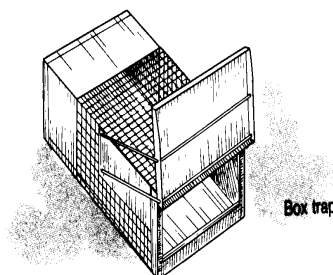
VERTEBRATE PEST CONTROL METHODS

Mechanical

Damage by wild animals can be stopped by placing wire guards around trees and shrubs to prevent rodent gnawing, setting mechanical traps to capture the offending species, or covering ripening fruits with netting to exclude birds. These methods are also alternatives to chemical toxicants.

Environmental

Damage from vertebrates can often be solved by environmental methods. These include relocation of susceptible crops away from the depredating species, such as removal of a crop from the forest edge where deer are likely to feed on the crop. Use of resistant varieties, such as corn with tough, heavy husks may reduce the attractiveness of a crop to birds. The implementation of good sanitation and management practices for stored grains and feeds helps to reduce the attractiveness of these areas to birds and mammals.



Chemical

Chemical repellents can make treated crops or stored products unacceptable by odor or taste and thus deter feeding. In this way, the offending animals may be forced to find a new food source in a different location. Toxic chemicals can sometimes reduce the numbers of an offending species, as in the use of rodenticides to reduce orchard mouse populations.

Very few pesticides are registered for use in vertebrate pest control programs, and it is unlikely that the number will increase significantly in the near future. Those that are registered must have labels which name the offending or target species, the

details of application, and precautions to be taken. Ideally, a control chemical should affect only the target species or the environment. While certain pest control chemicals now in use are more toxic to some species than to others, very few materials are toxic to only the intended species.

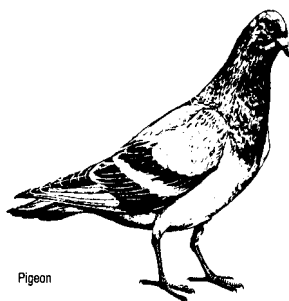
Careful use of chemicals minimizes the hazard to nontarget species. Factors to consider are:

- * the bait on which a toxicant is used
- * the time of year the control is undertaken
- * the method of chemical placement
- * the area of placement

It is possible to use a broad-spectrum pesticide (affecting several species) selectively; however, knowledge of the chemical and the target vertebrate species is critical. The program must also be carefully supervised. Pigeons may be controlled during the winter months in the northern parts of the country when most beneficial birds have migrated south.

Pigeon bait placed on the tops of flat roofs is less likely to be found by other bird species. Toxicants for pigeon control may be used on bait particles too large to be eaten by most other birds. These precautions make it possible to use a chemical

for selective purposes that is generally toxic to many species. Orchard mouse baits placed in holes, covered runways, or under protective cover is another example of selective vertebrate pest control. Labor costs increase when these special precautions are taken; however, unless and until selective materials are developed, existing ones must be carefully used to guard against accidental kills of nontarget species. If society continues to permit the use of existing toxic materials, it must be willing to absorb the added costs of careful pest control methods that protect the environment and beneficial species.



Reproductive inhibitors that control vertebrate populations show promise with some species. Research is continuing and may develop birth control for pest species as an acceptable means of combating pest problems. In many species the annual population turnover is great. This means that the number of births must at least equal the number of deaths annually if the species is to increase or exist at present numbers. If it were possible to prevent this replacement even over a single generation, the population of a specific pest would be significantly reduced. Theoretically, the numbers of a pest species could then be held at tolerable levels. Certain problems in the field use of reproductive inhibitors must be overcome before the method can be widely used.

SOURCES OF ASSISTANCE

Vertebrate pest damage control often requires help from a public regulatory agency with responsibilities for wildlife protection. Information on identification of depredating species, legal status, permits, and other assistance can be provided by the U.S. Fish and Wildlife Service, Washington, DC 20240, and by state fish and wildlife agencies. Contact the New Jersey Division of Fish, Game and Wildlife, CN400, Trenton, NJ 08625-0400.

SELF STUDY QUESTIONS

1. The primary responsibility and regulatory authority to enforce the laws which protect and manage most wildlife falls mainly on ____ agencies.

A) state
B) federal
C) county
2. When identifying a species, one should avoid using _____ names.

A) scientific
B) colloquial
C) common
3. Pigeons may be more selectively controlled during the winter months in the northern parts of the country because:

A) their digestive system is more vulnerable in the cold.
B) pigeons tend to “huddle” together this time of year, making their mass killing much easier.
C) the other more beneficial bird species have migrated south for the winter.
4. To minimize the hazard to nontarget species, all of the following are factors to consider **except**:

A) the higher cost of the more selective pesticides.
B) the bait on which a toxicant is used.
C) the area of placement.

ANSWERS:

1. A
2. B
3. C
4. A

CHAPTER TWELVE

MANAGEMENT OF INSECTS AND MITES

Learning Objectives

- * Have a general understanding of how insects are categorized.
- * Be familiar with physical characteristics of insects and how they reproduce and mature.
- * Be familiar with other insect-like pests.
- * Understand how to manage these pests as illustrated by programs to control the alfalfa weevil and apple pests.
- * Recognize how pest resistance to pesticides can develop.

Identification of pests is extremely important because you must know what pest you are trying to control. Although most plants and animals also have common names, scientific names are given to each species of plant and animal on earth assigning an organism one name to be used regardless of where it is found. This naming system categorizes animals based on their similarities: animals with common characteristics are placed into large groups, then subdivided into smaller groups, and finally given a name.

All insects and related animals such as mites and ticks belong to a large group (phylum) called Arthropoda. Members of this group are called arthropods and have segmented bodies; segmented appendages, some of which are modified for feeding; and a hard exoskeleton (exterior). On the basis of common characteristics, arthropods are separated into

smaller groups called classes. The common classes of arthropods are Insecta, Arachnida, Crustacea, Chilopoda, and Diplopoda. Most arthropod pests are insects or arachnids (mites or ticks from the class Arachnida).

INSECTS

Insects bear unique external features and undergo developmental processes unlike other organisms in the animal kingdom. An understanding of these characteristics is important for identification of pest insects and implementation of pest control programs.

PHYSICAL CHARACTERISTICS

The external characteristics of insect adults that set them apart from other animals are a body that has three regions (head, thorax, and abdomen), three pairs of jointed legs and in many cases wings.

Head - The head contains one pair of antennae, two compound eyes, ocelli (simple eyes) if present, and mouthparts. Antennae vary in size and shape but contain many sensory receptors for smell, wind, and temperature.

The compound eyes are made up of many small facets which allow insects to discern images. Ocelli, on the other hand, perceive motion rather than actual images. The four general types of mouthparts are chewing, piercing-sucking, sponging, and siphoning. CHEWING MOUTHPARTS have toothed mandibles that bite and tear food. Cockroaches, grasshoppers, ants, and beetles have chewing mouth parts. PIERCING-SUCKING MOUTHPARTS have a long slender tube which penetrates the plant

or animal tissue to suck out fluids or blood: true bugs, aphids, mosquitoes, and sucking lice have this type. SPONGING MOUTHPARTS have a tubular tonguelike structure with a sponge tip to suck up liquids. This type of mouthpart is found on flies; the best known example is the housefly. SIPHONING MOUTHPARTS are formed into a long tube for sucking nectar. Butterflies and moths have this type.

Thorax - The thorax consists of three segments (prothorax, mesothorax, metathorax) with one pair of jointed legs per segment. (If one pair of wings is present they will be on the second segment. If two pairs of wings are present they will be on segments two and three. These are called the forewings and hind wings respectively).

The forewings are modified in different insect groups. Beetles have forewings that are hard and shell-like; grasshoppers have forewings that are leathery. Forewings of true bugs are part membra-

nous. Forewings of moths and butterflies are membranous but covered with scales. Most hind wings of insects are membranous.

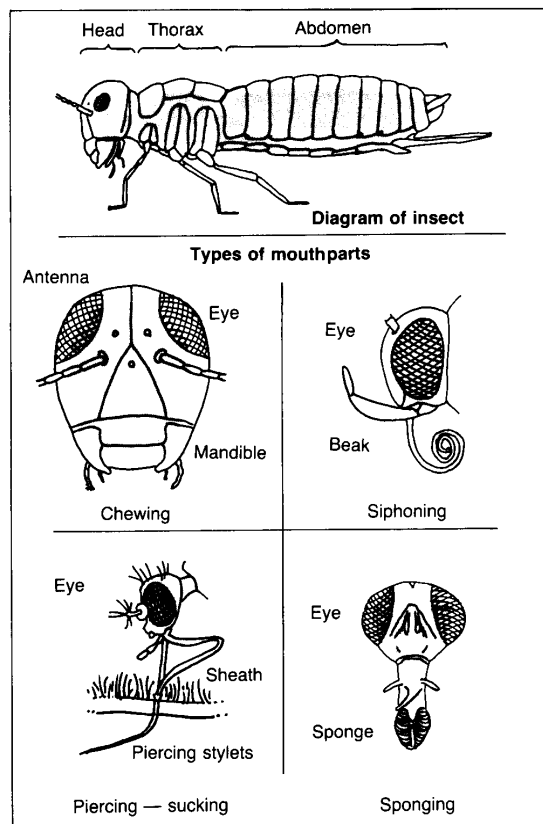
Abdomen - The abdomen has as many as eleven segments, although the number is commonly eight or fewer visible segments. The abdomen houses a large portion of the digestive tract, the reproductive system, and other vital organs. The abdomen also houses the external genitalia. The external reproductive structures of insects are often highly specialized and complicated. This is particularly true in male insects.

DEVELOPMENT AND METAMORPHOSIS

The series of events from egg to adult constitutes an insect life cycle. The life cycle varies in each insect species, but knowledge of the life cycle is absolutely essential to apply correct control procedures.

Most insect reproduction is sexual, that is any egg cell from the female develops only after union with a sperm cell from the male. The females of many insect species lay eggs and are said to be OVIPAROUS. Some insects also have special modes of reproduction. One example is PARTHENOGENESIS, the development of an insect from an unfertilized egg. The number of eggs produced by females varies from one egg to many thousands for some social insects.

A newly hatched insect differs in size and often in form from the parents. The change that must take place before the young insect assumes the adult form is called METAMORPHOSIS. The degree of change varies widely in different insects. In some it is slight and gradual; in others it is rather abrupt and complete. These variations have led to the classification of metamorphosis. Some very primitive insects, such as Collembola (springtails) and Thysanura (silverfish), have body proportions and internal organs that remain similar after each molt (ecdysis). Insects with this type of development are categorized as having no metamorphosis.



If the changes are slight and gradual, if the young or nymphs resemble the adults and feed in the same habitat, and if wing development is external, it is termed **gradual metamorphosis**. However, the majority of insects have a pupal stage and undergo drastic alterations. Development is termed **complete metamorphosis** when the insect goes from egg to larva to pupa to adult.

INSECT-LIKE ARTHROPODS

The Arthropod classes closely related to insects are Arachnida, Crustacea, Chilopoda, and Diplopoda. Although these closely related classes are often called insects, they are not insects. The four classes contain species that are detrimental to humans and the environment. We will cover some of the biology of each class and how to tell them apart.

ARACHNIDA

Included in this class are the spiders, ticks, mites, scorpions, pseudoscorpions, whipscorpions, sun spiders and harvestmen (daddy longlegs). The physical characteristics of arachnids are four pairs of legs, two body segments called the cephalothorax and the abdomen. Arachnids do not have antennae. Except for certain mites, arachnids are carnivorous and terrestrial. The life cycles of the arachnids are variable and complex. The tick, for example, has a complex life cycle with each stage requiring a different host. Some ticks require three different hosts for a life cycle which may take up to three years to complete.

Many arachnids have poison glands that produce toxins used to kill prey. Bites and stings from these arachnids are painful and sometimes dangerous to humans. The black widow spider, brown recluse spider and some scorpions, for example, produce toxins that are harmful to humans.

Mites are the most destructive arachnid pests of plants. Many species of mites are capable of attacking a wide variety of hosts; they generally damage the chlorophyll producing tissues.

CRUSTACEA

This large class consists of approximately 50,000 species possessing a head, thorax, and abdomen. Crustaceans also possess mandibles, two pairs of antennae, and five or more pairs of legs. Most crustaceans are aquatic. One common terrestrial species called the sow bug is commonly found in damp decaying wood or under objects such as bales of hay that are beginning to decay. Sow bugs are not harmful but may be pests if present in large numbers.

CHILOPODA

Centipedes have a long body divided into a head and a multisegmented trunk. The head has a pair of moderately long antennae, a pair of mandibles, and two pairs of maxilla (additional jaws). The main characteristic of centipedes is that each segment has one pair of legs.

Centipedes usually hide during the daytime and become active at night. Their food consists of other arthropods, earthworms, and slugs. Although efficient in killing prey, the toxin from the poison gland is rarely dangerous to humans.

DIPLOPODA

The millipedes represent another group that has a body separated into a head and trunk. The head contains a single pair of short antennae, a pair of mandibles, and a single pair of fused maxilla. The main characteristic of millipedes is two pairs of legs per segment.

Most millipedes are found in rotting logs, leaf litter, and under stems where they feed mainly on decaying vegetative materials and fungi. When disturbed, they often roll into tight coils to gain protection with their hard exterior. Many have specialized glands to secrete noxious fluids, such as hydrogen cyanide, to repel predators.

DAMAGE CAUSED BY INSECTS AND INSECT-LIKE PESTS

Insects, ticks, and mites damage plants, animals, and structures in different ways. The damage often provides clues as to the identity of the pest, as well as the fate of the host. For example, defoliation by insects in the spring is usually more detrimental to a plant than defoliation in late summer because the plant is preparing to drop its leaves anyway. Different types of pest damage can be classified as presented below.

PLANT PESTS

Defoliators - Insects that feed on plants are called herbivores. One of the more obvious types of damage done by herbivores is defoliation caused by the eating of leaf tissue. The most economically important group of defoliators is the caterpillars of the order Lepidoptera (butterflies and moths). Examples of this group include the gypsy moth that feeds on trees and the imported cabbage worm that feeds on cabbage leaves. There are defoliators in other orders such as the Coleoptera (beetles). Examples from this order include the Colorado potato beetle and the Mexican bean beetle.

Internal feeders - Internal feeders are larvae that feed and develop (even pupate) inside fruit, grain, or other plant parts. Some good examples of internal feeders are the boll weevil, rice weevil, birch leaf miner, and codling moth. Internal feeding insects often cause losses that are not easily detected until the damage is extensive.

Stalk or stem borers - Many larval stages of insects bore into stalks or stems. This destroys tissues, weakening the stalk and preventing translocation of water and nutrients within the plant. Weakened plants may blow over or wilt as a result of the damage. Examples of insects that cause this type of damage are the European corn borer, squash vine borer, and dogwood borer.

Plant sucking pests - Many arthropods have mouthparts adapted to sucking juices from plants. They include two large groups of insects, the Hemiptera (plant bugs, squashbugs, etc.) and Homoptera (aphids, leafhoppers, whiteflies and scales), and one group of arachnids. Symptoms of plant damage caused by sucking pests include the curling and stunting of leaves and stems, wilt caused by the blockage of water conducting tissues, and dead areas caused by the injection of toxins by the pest during feeding.

In addition to the feeding damage, an important economic effect of plant sucking pests is the vectoring (transfer) of plant pathogens (disease causing organisms). This is also discussed in Chapter 4. Aphids as well as other homopterans also excrete honeydew that drips onto the lower parts of the plant. This sticky material makes an excellent substrate for a fungus which produces a black sooty mold that can be detrimental to the plant if the insect is not controlled.

Cut off at ground level - As the name suggests, the cutworms, belonging to the order Lepidoptera, sever plants at ground level. Cutworms are hard to see because they are nocturnal in their feeding habit and remain underground during the day. These characteristics can make them very difficult to control.

Subterranean feeders - Numerous insects cause damage by feeding on the roots of plants. They usually are very difficult to identify because they cannot be seen without uprooting the plants. Root feeding can lead to goose necking in corn, or plants that have poor color and reduced vigor. Some examples of insects that feed on roots are corn rootworm, black vine weevil, and many maggots of flies.

ANIMAL PESTS

The insects, ticks, and mites that attack humans and animals have mouthparts similar to those of the plant feeders but utilize blood and vertebrate tissues rather than plant tissues.

Mosquitoes, lice, and ticks are blood sucking pests. Cattle grubs, the ox warble of cows, and the bot fly of horses are examples of internal feeding insects. Face flies, houseflies, and gnats annoy and cause discomfort. Some pests are vectors of disease causing organisms; the pests introduce bacteria, viruses, or other parasites into animals as they feed. In the U.S., mosquitoes carry encephalitis and ticks carry Rocky Mountain spotted fever and Lyme disease.

MANAGING INSECTS AND INSECT-LIKE PESTS

A few basic principles are necessary for a successful management program. One step rarely discussed in textbooks is that one must visit the fields regularly and be observant as to what is taking place. Being a keen observer leads one into the first step of identifying the pest or pests involved in damaging a product or property. Once a pest is recognized, one must learn its biology, what kind of damage it can do, and what control tactics are available.

The next step is to monitor the area in question and to determine whether the population level warrants immediate suppressive action. The population level of the pest may be tied to an economic threshold. In other words action is often recommended when the pest level is high enough to reduce crop value by an amount greater than the cost of implementing the pest management action.

The simplified steps outlined above provide the basis for any management program, but keep in mind that an established integrated pest management program is based on previous research. The general tactics for managing pests include biological control, host plant resistance, genetic control of the pest, cultural control, physical and mechanical control, and chemical control through the use of insecticides, acaricides and pheromones. After you have evaluated the tactics that are available, put together a management system that best suits your situation. Some of the tactics, such as variety selection and certain cultural control methods, must be considered at planting time or prior to the occurrence of the pest.

ALFALFA WEEVIL INTEGRATED PEST MANAGEMENT PROGRAM

The alfalfa weevil program illustrates many of the principles of insect pest management. The alfalfa weevil can overwinter as an adult or an egg. Some eggs are deposited in the fields in the fall and survive the winter. However, about 90 percent of the eggs are deposited in the spring, with most of them laid before mid-May. Larvae that hatch from these eggs move to the tips of the plants and feed on the leaves. This feeding results in reduction of both alfalfa yield and quality.

The small, green, curved larvae, with dark brown to black heads, reach maturity in approximately three weeks. They pupate in small, round, delicate, loosely woven cocoons attached to plant debris, leaves, and stems. The cocoons are usually found near ground level.

After the insect larvae spin their cocoons, damage can be considered complete for the year, because there is very little weevil activity during the summer and fall. Alfalfa weevil injury is almost entirely limited to the first cutting, with some possible damage to the regrowth of the second cutting. You can be reasonably certain the alfalfa weevil season is over by mid-June. The new brood of adult weevils emerging at this time spends the summer in protected sites both in and outside the alfalfa fields.

Sampling for alfalfa weevil - Noticeable feeding injury to the plant tips provides the signal to start monitoring your alfalfa fields. The month of May is the crucial time for weevil control sprays to be applied, if needed. Resampling of fields at weekly intervals in May is recommended. This is especially important if your fields are prone to weevil damage or if you are undecided about whether to spray.

Determining the economic threshold - Many factors must be considered when determining the economic threshold for alfalfa weevil.

1. The number of pests present in a field. The sample used is the number of larvae (all sizes combined) on 30 stems. Research has established that a 30-stem sample provides a reliable indication of the weevil larvae population in a properly monitored field. Crop losses from weevils are predicted on the amount of foliage one larva per sample of 30 stems will destroy in relation to the development of the crop.

For example, on alfalfa 12 inches high, one larva per 30-stem sample will reduce the hay equivalent yield by .00159 ton per acre or 3.18 pounds.

2. Development of plants. This is the height of the plants when the fields are monitored. Small plants infested with weevils suffer greater losses than large plants with equal numbers of weevils.
3. Value of the crop. The higher the value of the crop, the fewer the number of weevil larvae that can be tolerated.
4. Cost of control application. As costs of control measures increase, losses from the pest can also be higher before a spray application is warranted.

Early spray applications generally are very hazardous to certain parasites that feed on weevils, and for this reason early spraying should be avoided if possible. Insecticides that have long residual action are more likely to kill the weevil parasites than are short residual insecticides. Therefore, in most situations, short residual insecticides are suggested when chemical control is needed.

Whether to spray before harvest - Some of the more difficult decisions come near harvest time for the first crop. A crop that is in full bud probably should be harvested rather than sprayed. However, if harvesting is impossible for at least three days and the pest population is increasing or holding steady, then apply a short residual insecticide that will leave no residue on the hay at harvest.

Previous sampling records can be very helpful at this time. By comparing the last several samples from the field, you can determine if the weevil population is increasing, has reached a plateau, or is decreasing. A decreasing population does not need to be sprayed because the weevil season is over.

Whether to spray after harvest - The stubble of all fields should be checked from four to six days after mowing. First check those fields that were not sprayed or were sprayed fairly early in the season. If the weevil larval population is fairly high, regrowth of the second crop can be drastically held back. If weevil cocoons are present and the larval number is low, the weevil season is practically over and little additional damage is likely to occur.

An average of two or more larvae per crown indicates a stubble spray will be profitable. Apply it as soon as the forage is removed from the field.

APPLE INTEGRATED PEST MANAGEMENT PROGRAM

The Apple Integrated Pest Management Program also illustrates important principles of insect and mite pest management. An integrated program on apples can result in the use of less pesticide, the more efficient use of time and orchard equipment, and the use of native predators as a major part of the mite control program. Such a program requires sprayers matched to tree size, close attention to the mite and predator populations in the orchard, and a knowledge of the proper materials and their rates and times of application. The program is based on the alternate middle (alternate rows) system of sprays with short intervals between these half sprays.

For effective insect and mite control:

1. Use a sprayer capable of partial coverage of the nonsprayed side of each tree row.
2. Be aware of the small black ladybird beetle, Stethorus punctum, for biological control of the European red mite. Regular mite and Stethorus counts are needed.

3. Adjust the interval between half sprays as pest pressures increase or decrease.

The program depends largely on a miticide to suppress mites until the *Stethorus punctum* population reaches levels high enough to keep the mite population below economic injury levels. The predatory mite *Amblyseius fallacis* has also been found in many commercial orchards and aids *Stethorus punctum* in mite control. An orchardist should not attempt to eliminate the entire pest-mite population, as that may destroy the predatory mites. In addition to the advantages described above, an integrated apple pest management program can reduce the likelihood of pests developing resistance to pesticides.

POTENTIAL PROBLEMS ASSOCIATED WITH INSECTICIDE USAGE

Insecticides often have a significant role in pest management programs. Their use requires planning and care to avoid problems, particularly the development of resistant pest populations and the injury of nontarget species.

PEST RESISTANCE

Cross and multiple resistance to insecticides are becoming more common. Cross resistance is when a pest develops resistance to two or more compounds, usually chemically related with a similar mode of action. Multiple resistance occurs when a pest can tolerate insecticides from different classes of compounds with unlike modes of action. The approaches to a resistance problem may involve using new or altered insecticides, changing insecticide use patterns, and applying ecological tactics.

New or Altered Insecticides - Single compounds or mixtures of compounds that have more than one mode of action are usually more difficult for the pest to develop resistance to than are compounds that attack only one chemical site in the pest. Synergists applied with insecticides may reduce resistance development by interfering with the detoxifying en-

zymes in a pest that allow it to survive an insecticide treatment.

New compounds with different modes of action will also lessen the likelihood of resistance development. These include compounds that may be very selective as to which insects they kill and compounds that can modify the mating or feeding behavior of the pests.

Insecticide Use Patterns - When insecticide dosages are reduced, fewer pests die so the pressure to develop resistance is decreased. Rotation of compounds with different modes of action may limit resistance. The timing and placement of pesticides also affects resistance. Applying pesticides over limited areas reduces the proportion of the pest population exposed; the tactic limits the development of susceptible genes in the population. Also, treating alternate generations of pests decreases the selection for resistance.

Ecological Tactics - Biological and behavioral factors involving the reproductive characteristics and mobility of pests are related to insecticide resistance. For example, the greater the number of generations per year and offspring per generation, the greater the chances of insecticide resistance appearing in a pest population. Similarly, behavioral factors such as insect mobility and migration influence insecticide management strategies. The frequency of resistant genes in a population is diluted when insecticide susceptible individuals move into an area and interbreed with the resistant population. This tends to slow the pace of resistance development in the pest population.

Managing resistance is a continuation of integrated pest management. Resistance must be detected when it is at a very low level and then controlled by using all of the available techniques to extend the useful life of our current insecticides.

SELF STUDY QUESTIONS

1. All insects and related animals such as mites and ticks belong to a large group (phylum) called:
 - a) Mitopoda.
 - b) Arthropoda.
 - c) Bitiopoda.
2. The external characteristics of insect adults that set them apart from other animals are a body that has ____ regions and ____ pairs of jointed legs.
 - a) three, three
 - b) two, three
 - c) two, two
3. Spiders, mites and scorpions belong to the class:
 - a) Crustacea.
 - b) Chilopoda.
 - c) Arachnida.
4. The following is true concerning animal pests:
 - a) Their mouth parts are different from plant feeders.
 - b) Some are vectors of disease.
 - c) They only attack animals when plants are unavailable.
5. Concerning the establishment of a population level of animal pests, all of the following are true **except** that it:
 - a) determines whether immediate suppressive action is warranted.
 - b) can be established without actually monitoring the area.
 - c) may be tied to an economic threshold.
6. When a pest develops resistance to two or more compounds, usually chemically related with a similar mode of action, this is called:
 - a) cross resistance.
 - b) multiple resistance.

- c) balanced resistance.
7. When a pest can tolerate insecticides from different classes of compounds with unlike modes of action, this is called:
 - a) multiple resistance.
 - b) cross resistance.
 - c) balanced resistance.

ANSWERKEY

- | | | | | | | | |
|----|---|----|---|----|---|----|---|
| 1. | b | 2. | a | 3. | c | 4. | b |
| 5. | b | 6. | a | 7. | a | | |

CHAPTER THIRTEEN

WEEDS AND WEED CONTROL

Learning Objectives

- * Describe the various problems caused by weeds.
- * Identify the four major life cycle groups of weeds with their characteristics.
- * Understand the four general weed control strategies with emphasis on herbicide types and how and when they are applied.
- * Understand that weeds can develop pesticide resistance and what the applicator must do to minimize this.
- * Know how to select a herbicide.

A weed can be any plant that grows where it is not wanted. Dandelion is a weed in a Kentucky bluegrass lawn. Quackgrass is a weed in a corn field. Some crop plants may even be considered weeds. One of the worst weeds in soybeans when soybeans follow corn in a rotation, is volunteer corn. Weeds adversely affect the use and value of the land they infest, reducing the yield and quality of crops and increasing the costs of production and harvest.

In addition to competing with other plants, weeds may threaten the health and safety of humans and domestic animals. The medical problems caused by weeds include pollen induced hay fever and allergies, skin irritations from toxic chemicals in weed sap, and serious illness or death from ingestion of toxic plants. Livestock ailments range from skin irritations and abrasions from thorns and woody stems to fetal abnormalities and death.

Only about 5 percent of the millions of weed seed beneath every acre of land germinate in any one growing season; the rest remain dormant until the right conditions exist for germination. Proper diagnosis of weed problems and avoidance of the conditions that promote weed seed spread and germination enhance the success of weed control programs. The first step in a successful program is weed identification.

WEED TYPES

Pigweed, lambsquarters, foxtails, crabgrass, and Canada thistle are common weeds. In different areas of the country they may have different names. To avoid confusion, almost all plants, common or uncommon, are categorized in a plant classification system and given a scientific name to identify them anywhere in the world.

Weeds are also classified according to their life cycles (how long they live). The four major life cycle groups are summer annuals, winter annuals, biennials, and perennials. The difficulty in controlling weeds is understanding the control program for each weed or group of weeds.

SUMMER ANNUALS

Summer annual weeds germinate, mature, produce seed, and die in one growing season. Crabgrass and pigweed are examples of troublesome annuals.

Seed from most summer annual weeds germinate during the two month period in the spring. Most of the nongerminated seed lies dormant until the next spring. Although a few seeds of most annual species germinate during summer or fall their numbers sel-

dom equal the spring flush. Germinating summer annual weeds are the greatest problem in the spring when annual crops are planted and new seedlings of perennial crops are made because seeds germinate readily in disturbed soil.

Control methods for summer annuals include planting the crop at the right time, crop rotation, clean tillage, and herbicides. One of the simplest methods of solving a weed problem is to avoid it. For example, fall seedings of winter wheat or barley are seldom bothered by summer annual weeds. Planting a crop in early spring before annual weed seed germination, a practice successful with normal plantings of spring oats, also reduces the potential for weed problems.

A crop rotation including perennial crops, such as alfalfa, greatly reduces summer annual weed problems. Since these areas are usually grazed or cut for hay, weeds that do germinate do not produce seed. When small grains or forages are planted as part of the rotation, most summer annual weeds that were a problem in the field are controlled naturally by crop competition and an unprepared seedbed.

Since the life cycles of summer annual weeds are synchronized with annual crops such as corn and soybeans, summer annual weed problems are common and a herbicide often is needed. Weeds can be suppressed by planting a good population at the right time and establishing a competitive crop stand. Herbicides are used for those weeds which cannot be controlled by normal cultural practices.

Preplant or preemergence herbicides are the most commonly used herbicides for the control of summer annual weeds. The terms “preplant” and “preemergence” can be used in reference to either the weed or the crop. Depending on how the herbicide works, the weed is killed in the seedling stage either before or soon after it emerges through the soil surface. Most preemergence and preplant herbicides have little effect on established weeds.

Postemergence herbicides are applied after weeds have emerged. Weeds should be controlled within the first two or three weeks after emergence to minimize competition and avoid yield reduction. The larger or more mature the annual weed, the more difficult it is to control. Late postemergence treatments often require a higher herbicide rate or a “hotter” herbicide and this often increases the chance of injury to the desired plants. For these reasons, post emergence treatments are often used only to clean up or control those summer annuals not controlled by previous control methods.

Spraying summer annual weeds in late summer is unnecessary. Ripe seed will probably already have been produced and the remaining vegetation will usually die after the first killing frost.

WINTER ANNUALS

Winter annual weeds germinate in late summer or fall, mature, produce seed, and then die the following spring or summer. Common chickweed, annual bluegrass, and field pepperweed are all winter annuals.

Seed of most winter annual weeds are dormant in the spring but germinate in the late summer or fall. Some weeds, such as common chickweed, can germinate under snow cover to resume growth at the first sign of spring, then bloom and produce ripe seed by mid-May or June. This means that some weeds can reseed themselves before land is prepared for spring planted crops, such as soybeans or sorghum. The growth cycle of winter annuals is also synchronized with fall planted small grains, such as winter wheat or barley. Several weeds such as field pepperweed, are so closely synchronized that the weed produces ripe seed at the same time that the grain matures. The weed seed is thrashed along with the grain and unless the grain is cleaned, the weed seed is fed to cattle and spread back on the field in manure. Uncleaned grain used for seed also poses an immediate weed problem.

Control methods for winter annuals include competition and herbicides. Competition from the crop or desired plants should be the first weed control weapon. Select optimum seeding rate and planting date to give a good stand and manage plants (e.g., fertilize) to promote maximum competition. Those weeds not controlled by good management practices will require herbicides for control.

BIENNIALS

Biennial weeds grow from seed anytime during the growing season. They normally produce a rosette of leaves close to the soil surface the first year; then flower, mature, and die during the second year.

A true biennial never produces flowers or seeds the first year. Such weeds are well adapted to lawns, pastures, hay fields, and orchards where grazing or mowing removes very few of the rosette leaves growing close to the soil. Consequently, growth and energy storage in the roots or crown continue until a killing frost. The large amount of stored energy initiates spring growth well ahead of pasture, forage, or other desirable species. Unless the weed flower stalks are mowed off or plowed under, they will flower and produce mature seed before the plant dies.

Control of biennials, like all other weeds, is best done in the seedling stage. This is also the best time for desirable plants to compete with and possibly crowd out the weeds. Once established, the only practical means of controlling biennial weeds is usually the use of herbicides. Soil applied herbicides are usually ineffective because the pesticide moves deep enough to contact only a small portion of the weed's large and deep root system; as a result, not enough herbicide is absorbed to kill the weed. Foliar-applied herbicides, such as 2,4-D or dicamba, are absorbed through the foliage and translocated to the root system, killing the whole plant. However,

because 2,4-D and dicamba selectively control most broadleaf species without damaging grassy species, they cannot be used where you may want to save certain broadleaf species, such as legumes in a legume-grass pasture. These herbicides can be used very effectively to control broadleaf weeds in pure grass areas such as lawns, orchards, and some pastures.

PERENNIALS

Perennial weeds become established by seed or by vegetative parts, such as rootstocks or rhizomes. Once established they live for more than two years. Dandelions, plantains, and quackgrass are perennial weeds.

Since perennial weeds live indefinitely, their persistence and spread is not as dependent upon seed as the other three weed groups. Seed is, however, the primary method of introducing these weeds into new areas. Perennial weeds are often spread during soil preparation and cultivation. Most perennial weeds that spread by rhizomes or rootstocks will spread in patches if left undisturbed. In cropped fields, patches of quackgrass, Canada thistle, and johnsongrass spread in oblong patches in the direction the field is worked.

Control of perennial weed seedlings is no more difficult than any other kind of weed coming from seed; but once established, perennial weeds are the most difficult to control. Two primary approaches are used to control perennial weeds. The first is to starve the weed to death through mechanical and/or chemical methods. The second is to use herbicides which "shut down" the metabolic functions of the plant.

Perennial weeds store energy in underground roots, stems, bulbs, and crowns during summer and fall. If these weeds are prevented from storing energy, they will be weakened and may not survive the winter (winterkill). Several methods are used to reduce energy storage of weeds. These include mowing on a regular schedule, heavy grazing with

animals, or defoliation with contact herbicides such as paraquat. Grazing or mowing should be continued until frost to prevent the weed from recovering from continued defoliation. If weed leaves and stems are removed or destroyed, no sugar can be produced through photosynthesis, and there can be no buildup of energy. This is seldom sufficient to control a perennial weed effectively, but can be a good first step in weakening the plant so a future treatment can work better.

Photosynthetic inhibiting herbicides such as atrazine prevent the weed from using sunlight, although the leaves and stems may be left on the plant. These herbicides can be used anytime during the growing season, but timing is critical because the weed should not be allowed to recover from a treatment. Repeated applications may be required if the initial application does not kill the weed. These herbicides are ineffective when weeds are not photosynthesizing in the winter; they should not be applied later than six or eight weeks before a killing frost.



Quackgrass

Following the above treatments, the weaker weeds starve or are winterkilled, whereas the stronger ones will survive the winter. The initial growth in the spring uses energy reserves from underground roots, stems, bulbs, and crowns. Grazing or mowing can be used to defoliate these weeds again in the spring, but should be delayed until weeds have 8 to 12 inches of new growth. At heights beyond a foot, the weeds will start replacing some of the energy reserves through photosynthesis. The weeds become more resistant to control the longer they are allowed to build up energy reserves.

The starvation method is used in the control of quackgrass in corn. The ideal time to begin a control program is in the spring. Atrazine applied in early spring (March or April) forces the quackgrass to use reserve energy for growth. For conventional tillage, the quackgrass should be plowed under after it has used up some energy reserves to make 6 to 8 inches of new stem growth. Unfortunately, tillage or a single atrazine treatment will only hold the quackgrass back for six to eight weeks and, if nothing else is done, the quackgrass will recover by fall. To prevent this from happening, application of atrazine, or another photosynthetic-inhibiting herbicide such as simazine at the time of corn planting prevents the quackgrass from utilizing sunlight for another six to eight weeks. Corn plants tolerate these herbicides so they will provide competition and shading which will limit the growth of the surviving quackgrass and other weeds during the growing season. Many perennial weeds such as quackgrass require a series of treatments for effective control. A combination of both chemical and nonchemical control methods helps avoid a strict reliance on herbicides.

Although perennial weeds can be difficult to control, as the above example illustrates, they are more easily controlled at certain times of the year. One of the best times to control deep rooted perennial herbaceous and woody species is in late summer or early fall before they have a chance to build up large energy reserves prior to winter. At this time of year, actively growing plants will more efficiently translocate herbicides down to the root systems. In general, perennial broadleaved weeds have a deep

root system, and soil applied herbicides that leach only 4 to 6 inches are usually ineffective because herbicide contact is with less than 5 percent of the total root system and insufficient herbicide is absorbed for control. Therefore, foliar applied herbicides such as 2,4-D, dicamba, or glyphosate are more effective on perennial weeds such as dandelion, Canada thistle, hedge bindweed, horsenettle, and hemp dogbane. These herbicides work by shutting down metabolic functions in one way or another and work as well on weeds with large energy reserves as they do on those with low energy reserves. The best time to apply these herbicides is six to eight weeks before a killing frost or in the spring after the weed is growing actively and has sufficient foliage to intercept and absorb adequate amounts of the herbicide.

GENERAL WEED CONTROL STRATEGIES

In summary, weed control encompasses four general methods:

Cultural

1. Purchasing weed free seed - the kind and percentage of weed seeds present in commercial seed should be listed on the bags.
2. Crop rotation - certain weeds tend to plague a given crop. Rotation should include a crop with growth and cultural characteristics that are in sharp contrast to the previous crop and weeds.
3. Planting schedule - establishing the crop prior to the emergence of weeds, when possible.
4. Proper cultural practices - keep plants vigorous. Insect and disease control create healthy plants that can compete more successfully with weeds for the available light, water, and nutrients.

Mechanical

1. Hand pulling/hoeing - best for seedlings and young annuals or biennials in small gardens or flower beds.
2. Mulch - smothering with nonliving materials. Hay, manure, grass clippings, wood chips, and plastic film are a few examples of materials used to exclude light from weed seedlings. Mulch is used in various ornamental and vegetable crops.
3. Mowing - reduces seed production. Used for weed control primarily in lawns, meadows and pastures, along roadsides, and in waste areas.
4. Machine cultivation or tillage - cultivating tools bury small weeds and disrupt the weed/soil relationship. Tillage leads to desiccation and depletes energy reserves in the roots of perennials.

Biological

Biological weed control involves the use of other living organisms such as insects and diseases for the control of certain weeds.

Chemical

Herbicides are chemicals capable of killing plants; or more importantly, killing certain plants without injuring others.

Herbicide Characteristics

A herbicide can be characterized in various ways. These include the pathway by which the herbicide enters a plant, the herbicide movement within a plant, herbicide persistence in the soil, and the result that is obtained from an application.

Foliar-Contact-Nonselective

These herbicides, when applied to the weed foliage (in the absence of a crop or when directed underneath a crop), kill all the foliage covered (non-selective), with little or no translocation (contact) to underground parts of the weed. Since biennial and perennial weeds normally have dormant and protected buds in the crown or root systems that produce new growth, these weeds will recover after treatment. Small annual weeds are completely and permanently controlled. For example, paraquat, applied before no tillage corn planting, or used as a directed spray underneath fruit trees, will control seedling annual weeds. Diquat is used as a preharvest aid to kill potato vines and make harvest easier.

Since contact herbicides normally do not have residual activity beyond the initial contact, they are commonly mixed with a residual herbicide to control the regrowth of the biennial and perennial weeds plus any newly emerging weeds growing from seeds.

Foliar-Contact-Selective

These herbicides also kill weeds by a contact-burning effect on the foliage. These herbicides control only seedling weeds; biennial and perennial weeds with dormant buds will grow after the foliage is killed. Generally, these are contact herbicides (not translocated), but some may have a short residual effect in the soil. Due to differences in plant structure or leaf surfaces, certain crops and weeds are tolerant of the herbicides. This makes the herbicides selective. Acifluorfen, for example, is used for annual morning-glory control in soybeans. Soybeans are not killed because hairs on the leaf intercept the acifluorfen before it reaches the leaf surface. Morning-glory has a smooth leaf and more herbicide comes in contact with the leaf surface. Bromoxynil is used to control broad-leaf annual weeds in small grains. Its selectivity results in part from differences in the leaf orientation of the grass and broadleaf weeds.

Foliar-Systemic-Nonselective

These herbicides are applied to the foliage to be absorbed and translocated throughout the plant (systemic). Movement into the plant root system enables these compounds to control perennial weeds. Since they are nonselective, they cannot be applied when a crop is present; but some can be used before planting or after harvesting. Glyphosate, for example, has been labeled for many such uses. Glyphosate has no soil residual activity, so it will not control dormant weeds or weeds germinating from seed after herbicide application. A residual herbicide is commonly applied after the nonselective herbicide to give continued weed control for the rest of the season.

Foliar-Systemic-Selective

This group includes some of the oldest and most widely used herbicides. These herbicides are applied to the foliage and translocated throughout the plant (systemic). Because they are also selective, they may be applied to weeds with little or no injury to the crop or desirable plant that is present. The best example of this type of herbicide is 2,4-D. It takes dandelions out of lawns or broadleaved weeds out of oats, wheat, barley, and corn. Dicamba is used for tough-to-control weeds such as thistle, common milkweed, horse nettle, and hedge or field bindweed in corn; it is also used in grass pastures, small grains, and rangelands.

Soil-Short Residual Non-selective

Only a few herbicides belong to this group. The most common is the fumigant methyl bromide. Applied as a liquid, it turns into a gas at normal air temperature and dissipates into the air if the treated area is not covered with a sheet of plastic or other gas-tight cover. Most seeds, including weed seed, are killed by methyl bromide. The cover must be kept on the treated area for about twenty-four hours for best results; another twenty-four hours is required to aerate the soil after the cover is removed.

After this period of forty-eight hours, anything can be planted without injury, making methyl bromide one of the shortest residual herbicides available.

Soil-Short Residual-Selective

This group contains any herbicide applied to soil prior to planting or immediately after planting that has residual activity of less than one year. It includes almost all the herbicides used for weed control in vegetable and agronomic crops as well as for other specialized crops such as flowers and ornamentals. Because the crop is present at the time the herbicide is applied, or is planted soon after application, the herbicide must be selective and should not cause injury to the crop. These herbicides are often referred to as preplant or preemergence-type herbicides. For example, atrazine on corn, linuron on potatoes, and EPTC on ornamentals have residues that last from six weeks to an entire summer. These herbicides are applied to the soil because they are primarily root or shoot absorbed, although some herbicide may be absorbed through foliage present at the time of application.

Soil-Long Residual-Non-selective

Herbicides used to control all vegetation for as long as possible are desirable for use around such areas as parking lots, buildings, oil storage areas, and warehouses. For example, bromacil and simazine, at high rates of 10 to 25 pounds active ingredient per acre, remain active for three to five years. Bromacil will kill all brush and trees present in a treated area or essentially any plant that absorbs it. Simazine may not kill deep-rooted trees since it does not leach into the root zones as readily as bromacil.

Soil-Long Residual-Selective

These herbicides are used to control weeds in deep rooted crops, such as fruit trees, nut trees, can fruits, and grapes. They may be applied to the foliage of the weeds, although most of the herbicide is eventually absorbed through the weed root system.

These herbicides have a low solubility in water and do not leach readily; therefore, they seldom get down to the root systems of the deeper rooted crop. They have residual activity and will give weed control for more than one year. For example, simazine applied at rates of about 5 pounds per acre will control shallow rooted weeds without injuring deeper rooted crops. At higher rates, more will leach, selectivity is lost, and it becomes a nonselective herbicide.

HERBICIDE RESISTANCE

Weeds that have developed resistance to one or more herbicides are becoming more common. The most notable resistance has been to triazine herbicides. Triazine herbicides have been widely used for weed control in corn and sorghum since the early sixties. Atrazine is still the most widely used herbicide for weed control in corn, with cyanazine and simazine also being very common. As a result of repeated use of triazine herbicides on the same land, over forty weeds have developed resistance to the triazines since 1960. The more common triazine resistant weeds with widespread populations are smooth pigweed and common lambsquarters, with lesser populations of common ragweed, velvetleaf, yellow foxtail, and wild turnip having been identified.

It is believed that in any population of weeds, a few plants of any weed species have sufficient tolerance to survive any herbicide used. Since only the survivors can produce seed, it is just a matter of time until the population of resistant weeds outnumbers the susceptible weeds. This apparently takes about twenty generations of selection for most weeds since weeds normally produce one generation a year.

The following conditions seem to be necessary for rapid buildup of a resistant weed population (twenty years or less).

- * A few resistant plants have to exist from the beginning, although quite possibly in very small numbers
- * The same herbicide or herbicides of the same family must be used repeatedly for about twenty years on the same land

- * Mechanical tillage or other nonchemical methods of weed control are used at a minimum
- * The same crop usually has been planted every year so it is possible to use the same herbicide each year.

To reduce the rate at which resistant weed populations build up, one or more of the above conditions must not be met. Do not use the same herbicide or herbicides of the same family every year, or at least use tank mixtures of herbicides representing two or more families. Mechanical tillage or other nonchemical methods of weed control will most likely control both the resistant and nonresistant weeds and slow the increase of the resistant population. Use of crop rotations makes it easier to, and indeed may require, use of herbicides of a different family for the next crop.

It is unlikely that these precautions can prevent the buildup of herbicide resistance in weeds, but they should slow the process so it may take forty or fifty years for resistance to build up. Today's herbicides will probably have been replaced by better herbicides in less than forty years, and weeds will have to start the herbicide resistance process again.

Herbicide Use

The perfect herbicide does not exist. No single herbicide has the capability of controlling all weeds that can develop in a crop. Since every herbicide has advantages and disadvantages, selecting the right herbicide is crucial.

Consider these points before you choose or apply a herbicide:

1. Is it registered for use on the crop you want to treat? If it is, the directions for use and rate of application will appear on the label.
2. Will it control the weeds that are causing the biggest problem? Many weed control measures fail because the herbicide will not control the weeds present.
3. Can it be used at the current stage of crop or weed growth? Very few herbicides can be applied at any stage during the growth cycle of a plant. Alachlor is one of the best examples of how stage of growth affects herbicide performance. It is one of the best herbicides for annual grass control when applied before the grassy weed emerges. However, it is useless if applied after the weed has emerged.
4. Can the crop be used after treatment for the intended purpose? For example, paraquat used to desiccate red clover or crownvetch before harvesting for seed will make the forage useless for feed due to paraquat residue on the forage.
5. Will the herbicide leave a residue that might affect the crop you want to plant next in rotation? Certain long residual herbicides can injure or kill sensitive crops which follow in rotation.
6. Have you thought about the appropriate method of application (i.e., broadcast, band, directed)?
7. Should an adjuvant be added to the spray mix to improve herbicide performance?
8. Can the herbicide injure plants in adjacent areas? Exercise caution to avoid drift, runoff, leaching to groundwater, and cross contamination of other materials. Be especially alert to potential for residues in equipment.
9. For more information, contact your county cooperative extension office, chemical dealer, or technical representative.

SELF STUDY QUESTIONS

1. The four major life cycles of weeds are summer annuals, biennials, perennials and:

- A) fall annuals.
- B) winter annuals.
- C) semi-annuals.

2. The most commonly used herbicides for the control of summer annual weeds are herbicides.

- A) preemergence
- B) postemergence
- C) non-selective

3. All of the following are true concerning postemergence herbicides **except**:

- A) weeds should be controlled two to three weeks after emergence.
- B) a lower herbicide rate is needed in comparison to preemergence pesticides.
- C) their use is recommended only after previous control methods have been undertaken.

4. One way to weaken perennial weeds is to prevent them from storing enough energy to make it through the winter. One way to prevent such energy storage is to:

- A) discontinue routine mowings.
- B) discontinue animal grazings.
- C) defoliate with a contact herbicide.

5. A foliar-contact-selective herbicide works by:

- A) a contact-burning effect on the foliage.
- B) being absorbed and translocated throughout the plant.
- C) killing the predator before it attacks the plant.

6. Weeds are becoming increasingly resistant to herbicides. The most notable resistance has been to ____ herbicides.

- A) triazine
- B) all granular
- C) all foliar-contact-selective

7. All of the following conditions will increase the likelihood of developing herbicide resistant weeds **except**:

- A) not varying the herbicides used.
- B) mechanically tilling often.
- C) rotating the crops, which will mean rotation of herbicides.

ANSWERKEY

- | | | | |
|------|------|------|------|
| 1. b | 2. a | 3. b | 4. c |
| 5. a | 6. a | 7. a | |

CHAPTER FOURTEEN

PLANT DISEASES AND PLANT HEALTH

Learning Objectives

- * Define “Pathogen.”
- * List and understand the main types of plant pathogens.
- * Generally describe the nature of plant diseases and the various methods of plant disease control.
- * Understand what must be done to diagnose plant diseases and how to choose the correct chemical for control.

Plants may be diseased when their appearance or function is not normal. Plant diseases can reduce the quantity and quality of food, fiber, and ornamental products from the time of planting through harvest, sale and usage and they continue to influence the costs of crop production, and ultimately the costs of plant products to the consumer.

THE PATHOGENS

Certain fungi, bacteria, viruses, and nematodes cause plant diseases. They are called *PATHOGENS* and can be spread from diseased to healthy plants. A plant invaded by a pathogen is called a *HOST*. Spotted leaves, wilting, stem cankers, and rots are examples of *SYMPTOMS* that may appear on a host as a result of disease.

Fungi

Fungi are the most common plant pathogens. Fungi lack chlorophyll and, therefore, cannot manufacture their own food through photosynthesis. Fungi obtain their food from green plants or organic matter, and live as saprophytes or parasites. The diseases they cause induce a variety of symptoms. Any part of a plant’s roots, stems, leaves, flowers, fruits, or seeds may be infected. Fungi also attack harvested products, such as grain, bulbs, and wood, while they are in transit or in storage.

The body of a fungus is thread-like, branching filaments are called *MYCELIUM*. Fungi reproduce chiefly by *SPORES* which need water or high humidity to germinate and grow into mycelium.

Fungi (spores or mycelium) can be spread from healthy to diseased plants by wind, rain or irrigation water, soil, machinery, humans, and animals. Some fungi can penetrate healthy tissues directly. In other instances they enter through wounds.

Bacteria

Bacteria are microscopic organisms that quickly increase in number, especially in wet, humid weather. The number of major plant diseases caused by bacteria is smaller than those caused by fungi. Still, certain bacterial diseases such as fire blight on pear and apple, and citrus canker can cause significant damage. Bacteria are most important in post harvest decays and spoilage of fresh fruits and vegetables while enroute to or at the market, or at home in the refrigerator.

Bacteria cannot penetrate through intact plant surfaces but they can enter through natural openings and wounds. The bacterium that causes fire blight can be spread on pruning tools. Foliar diseases caused by bacteria are often spread by wind-driven rain or splashing rain. Insects also introduce certain bacteria into their feeding wounds.

Viruses

Viruses are smaller than bacteria and reproduce only when associated with living tissues. Viruses cause a variety of diseases and symptoms (commonly mosaics or stunts) that most frequently cause reduced yields and poor quality products rather than killing the host. Practically all plants can be infected by one or more viruses.

Viruses enter healthy plants only through wounds or during pollination. Sucking insects, i.e. aphids, leafhoppers, and whiteflies, as well as chewing insects such as beetles, can transport virus laden sap from one plant to the next. Some viruses are spread by nematodes and fungi. Viruses can be carried in cuttings, tubers, and other parts (i.e., graft rootstocks or scions and buds) that are vegetatively propagated from a virus-infected plant.

Nematodes

Nematodes are microscopic, unsegmented, worm-like animals. There are two kinds of nematodes, root feeding and foliar feeding. Root feeding nematodes are the most common, destroying root systems which reduces the uptake of water and minerals by plants. The symptoms of most nematode diseases (wilting, stunting, lack of plant vigor) result from a poorly functioning root system. Root feeding nematodes may cause additional damage by introducing other pathogens into the plants while feeding. Diagnosing a nematode disease is often difficult and requires both root examination and a soil analysis to detect the pathogenic nematodes. Plant pathogenic nematodes feed near root tips, enter the plant and feed from within. Nematodes obtain their food by sucking the contents of a cell through a hypodermic-like mouth inserted into a cell.

Not all nematodes feed on roots. The foliar nematode of chrysanthemum feeds on the foliage and causes triangles of brown, dried tissue to develop on the leaves late in the season. A nematode species that infects cereal grains reproduces and turns what was once a seed into a mass of weather resistant nematodes capable of remaining dormant for twenty years or more.

THE NATURE OF PLANT DISEASES

Details of plant disease can be overwhelming. Plant diseases are caused by many unique pathogens, and plant disease can be influenced by the varieties grown, the cultural practices, and the weather. One view of plant disease which integrates some of these factors is called the disease cycle. Once the disease cycle is understood, the hows and whys of plant disease management become clearer.

The Disease Cycle

The disease cycle is circular and inoculum of a pathogen is needed for the first phase of the cycle. Inoculum is any part of the pathogen (such as a fungal spore, a single bacterium, or a nematode) that can cause infection. When moisture and temperature conditions are favorable for development of the pathogen, infection occurs as the pathogen enters the host. Pathogens are very specific as to what and when they can infect. A passerby will not know a plant is being infected because infection occurs at a microscopic level.

Infection is followed by colonization, a period during which the pathogen grows within the host. Disease symptoms usually develop during or following this period. Once the pathogen is established in the host, reproduction usually occurs. Fungi produce spores. Nematodes produce eggs; most plant pathogenic bacteria duplicate themselves into more bacteria. Viruses increase by inducing a host to make more viruses. Reproduction results in the production of enormous amounts of inoculum. This inoculum may reinfect the host; it may be spread by

wind, rain, or equipment to other host plants; or, in some cases it may remain in the soil to infect a plant at a later date.

Disease causing organisms vary in reproduction rates, as well as when they can infect a host. For some pathogens the inoculum is produced only once for a short period during the season. Other pathogens, such as those causing apple scab and late blight of potatoes, produce new inoculum many times during the season.

Signs are the evidence that verify the presence of the disease agent. For example, often a sign of powdery mildew on lilac or turfgrass is the white, fuzzy mycelium on the infected leaves. The “green stuff” on moldy bread is the sign of a mold fungus. Some signs are inside the plant. An example is sweet corn afflicted by a disease called Stewart’s Wilt. When the stem of a diseased corn plant is cut, the knife edge often has a stringy, sticky thread stuck to the blade. The long thread is the sticky bacterial pathogen, the sign of this disease. Sometimes signs do not develop on a diseased host.

Pathogen Life Cycle

The characteristics of a disease cycle depend on the life cycle of the pathogen. Understanding the life cycle and the factors that affect development, reproduction, spread, and survivability of a pathogen are often essential for successful disease control.

PLANT DISEASE CONTROL

Plant diseases usually cannot be cured, so control means preventing or reducing the occurrence or severity of disease. A single procedure may reduce the likelihood of disease, but satisfactory control usually requires an integration of methods. A well conceived disease control program should accommodate the cultural and climatic requirements of the crop, while minimizing the likelihood of a pathogen becoming established and spreading.

General approaches to plant disease management include: avoid the pathogen, exclude the pathogen, eliminate the pathogen, use sound cultural practices, use resistant varieties, and use chemical pesticides. Cultural practices, crop management strategies, and chemical methods for these approaches are described in the following sections.

Avoid the Pathogen - Disease causing organisms can be avoided through careful selection of planting site, planting date, and planting materials. If pathogens are avoided, infection and subsequent disease development can be prevented.

Choose the planting site - Avoid fields infested with disease causing organisms such as those where *Verticillium* or *Fusarium* wilt have been a problem. Avoid fields where crop residues serve as a source of inoculum. No-till and minimum-till cropping leave crop residues that can harbor pathogens from season to season. However, despite a greater threat of disease, satisfactory disease control can be achieved in no-till cropping.

Choose the best planting date - Plant when temperature and moisture conditions are more favorable for the crop than for its pathogens. For example, beans planted in advance of cool, rainy weather may produce a thinner stand than beans planted in advance of warm, rainy weather. Damping-off and root rots of seedlings thrive when soil temperatures are low (below 65 degrees F). Plants can also be resistant to certain diseases at specific stages of their development.

Use disease-free planting stock - Disease-free planting stock provides one of the most effective means of disease control for seed, tuber, or plant-borne disease organisms. Disease-free planting stock is “certified” to be disease free when it is purchased. Plants can be grown in disease free conditions to provide farmers clean planting stock. Grass seed, potato seed, and seeds of other crops are available as certified disease-free seed.

Certified plants are less important for those crops afflicted by pathogens not carried in the planting stock.

Exclude the Pathogen - Disease causing organisms may be excluded from a crop production area. Common methods to keep pathogens out of a crop production area include disinfecting plant materials and equipment, eliminating carrier insects, and inspecting materials before planting.



Another practice is to quarantine (restrict) diseased plants to areas where they can be grown without threatening other crops.

Disinfect plant materials - Seeds, tubers, corms, and other propagated parts of plants can be disinfected by heat, gas, or chemicals to destroy pathogens. Disinfecting plants or plant parts can halt the introduction of disease organisms to a new area. Farmers often wash harvested potatoes in chlorinated water to eliminate the organisms responsible for rots during storage.

Disinfecting equipment, tools, and clothing may also be required to prevent the spread of pathogens from an infected area to a disease free area. Disinfecting and sanitizing are particularly important when soil, plant parts, or weeds stick to equipment.

Exclude or restrict by plant quarantine - Plant quarantines restrict potentially harmful pathogens to or from an area. Quarantines are effective when the natural movement of a pathogen by wind or rain is unlikely.

A pathogen is rarely restricted early enough to make a quarantine effective. A disease like citrus canker in nursery stocks often becomes a significant problem before a quarantine can be instituted. Nurseries and newly established plantings with diseased plants must be destroyed to ensure effectiveness of a quarantine.

Eliminate insect carriers (vectors)- Many plant pathogens are carried by insects. If the insect (vector) population is effectively reduced, the threat of insects introducing the pathogen is also reduced.

Eliminate the Pathogen - Several methods can be used to eliminate a pathogen from a planting area. Crop rotation, sanitation, eradication of an alternate host, and a variety of physical or chemical treatments can interrupt the pathogen life cycle, create conditions unfavorable for pathogen growth, or directly kill the organism.

Crop rotation - A three to five year crop rotation can sometimes reduce the threat of disease caused by soilborne pathogens. A successful rotation requires the successive planting of a less susceptible crop. Pathogens that do not infect these subsequent crops may not grow and reproduce. This reduces the amount of inoculum in the field and lessens the likelihood of disease occurrence. Crop rotation has worked well with many field, forage, and cereal crops.

Sanitation - Sanitation is the removal (roguing) or destruction of diseased plants or plant parts. Sanitation may prevent or slow disease increase by eliminating sources of the pathogen. Sanitation is critical when producing disease-free plantings.

Potato cull piles, fallen leaves or pruned branches from diseased plants, and sometimes even grass clippings can harbor disease inoculum. Their removal or destruction can aid in plant disease control.

Alternate Hosts - Some pathogens require more than one host for a completed life cycle. Eradicating the alternate host of certain rust fungi has been used since the 1930's to break the pathogen's life cycle. For example, the eradication of gooseberry plants within about a quarter of a mile of white pine trees has effectively controlled white pine blister rust in many areas. Similarly, the eradication of barberry plants has reduced the incidence of new outbreaks of black stem rust of wheat in the Eastern United States.

Physical or chemical treatments - Pathogens can be destroyed in stored plant parts by heat, fumigation, and other chemical applications. Treatments to reduce the numbers of pathogens in the soil may also be used. Soilborne pathogens may be killed by chemicals, heat, flooding, fallowing, composting, or by the sun's energy.

Most fumigants kill all organisms in the soil. Fumigants must be used before a crop is planted. Because disease organisms must be eliminated from the root zone of the crop, a large volume of soil must be fumigated. A great quantity of a fumigant is needed to treat an acre when compared to the amount of insecticide or herbicide used to control insects or weeds on the same acre. Fumigants are also used to destroy pests in grain silos, in cargo bays of ships, in railroad cars, and other storage areas.

Use Sound Cultural Practices - Integration of proper cultural practices can increase the success of a disease control program. For example, improved air circulation in a greenhouse will reduce the humidity around a flower or leaf. This modified environment reduces the likelihood of infection by many fungal and bacterial pathogens.

Proper planting techniques and site preparation help assure thrifty growth. Corn planted with a tractor moving at 5.5 mph rather than 6.5 mph leads to more uniform plant stands. Azaleas planted in the plastic wrap they were transported in or tulip bulbs planted too deeply are examples of poor planting techniques. Both hinder growth and may render the plants more susceptible to disease.

Thrifty, well-kept plants tend to have a better chance of withstanding disease than poorly cared for plants. Fertilization, pruning, mowing, and irrigation can each influence disease occurrence and severity. Choosing cultural practices best for the crop (and hopefully worst for the pathogens) is essential to avoid or minimize the effects of plant diseases.

Storage diseases can be prevented or minimized when environmental conditions favor the healing of wounds on stored fruits and vegetables. Stored produce and grain cannot be allowed to get too dry, so the relative humidity must be high enough to prevent excessive drying, yet low enough to inhibit fungal and bacterial growth. Each crop has unique environmental requirements for storage, curing, or the maintenance of quality. These requirements must be compared to the environment favorable for disease development, and a choice made to ensure good quality of the stored product.

Use Resistant Plants - Use of disease resistant plants can be one of the most effective, long lasting, and economical ways to control plant disease. Disease resistant plants tend to have some disease; but in contrast to susceptible plants, disease resistant plants usually tolerate the amount of disease that occurs. In addition, the impact from disease on product quality and quantity is acceptable to the farmer and consumer.

Resistance is essential in some situations; with certain crops, resistant varieties or cultivars are the only way to reduce the losses that result from a plant disease. Planting a disease resistant variety may be one of the few options to control disease for those crops where chemical control is too costly or there is no effective chemical available for disease control.

The effectiveness of genetically based disease resistance may vary with the amount of disease pressure. Environmental conditions that favor the growth of the pathogen and the development of disease over the vigor of the host will result in disease pressure likely to cause some crop loss.

Use Chemical Pesticides - The use of chemical pesticides is one of the quickest, most effective, and sometimes the only means of plant disease control. For bacteria, viruses, and nematodes, the pesticides are called bactericides (most commonly antibiotics), viricides, and nematocides, respectively. Pesticides that control fungal pathogens are called fungicides. The greatest number of pesticides available for disease control are fungicides.

Most fungicides provide protection and are called *PROTECTANTS*. These fungicides prevent the pathogen from infecting a plant. Effective protection of susceptible plant parts requires a protectant to be in place on the plant before the pathogen infects the plant. Protectant fungicides may prevent spore germination, cause abnormal spore germination, or they may prevent germinated spores from penetrating the plant.

Fungistatic action - Most protectant fungicides are *FUNGISTATIC*. This means they prevent or inhibit fungal growth for a specified time. Once the fungistatic action ceases, such as when there is no longer enough fungicide on the plant surface, the controlled fungus may grow again or produce spores. Thus, a fungistatic fungicide must be applied at regular intervals to inhibit pathogen infection and inoculum production. Frequent applications are common in the production of fruit and vegetable crops because different disease threats occur throughout the growing season, and repeated infection periods for one pathogen are common. On the other hand, if a disease has a limited time period during which infection occurs or when fungicide treatment is possible, only one application of a fungistatic fungicide may be necessary. For example, control of snow mold on turf may require only a single fungicide application made prior to the arrival of snow on the turfgrass.

Effective dosage - An effective dosage of a fungicide must be applied to prevent infection. Insects moving over a treated surface come into repeated contact with insecticides. In contrast, most fungal pathogens do not migrate once they land on a host plant. Evenly distributed fungicide deposits are a prerequisite for effective plant disease control, and unevenly distributed fungicide deposits may be of limited value. Maintaining an effective dosage of a protectant fungicide in order to control foliar diseases is usually possible only by repeated regular applications. For example, sprays that control late blight of potato must be applied every few days when cool, moist conditions favor infection.

Secondary infections contribute to disease spread in a crop. A limited number of the newer fungicides prevent reproduction of the pathogen in an infected host. Fungicides that inhibit (prevent) spore production in existing leaf infections reduce the likelihood of more inoculum and new (secondary) infections. This type of fungicide can protect treated apple leaves against new apple scab infections, and prevent spore production in existing leaf infections.

Seed treatment - Seeds are treated with fungicide to control fungi in or on the seeds. Chemical seed treatment may also protect seeds from organisms that cause seed or seedling rots and it can protect seedlings from infection by damping-off fungi in the soil.

Soil applications - In-row or spot applications of soil fungicides at the time of planting protect young seedlings from many soil organisms. Soil fungicides may also be used to protect the roots of established plants from infection by pathogens. These pesticides are applied as drenches and must penetrate the soil into the root zone and be at a concentration high enough to inhibit the growth of fungi.

Eradicants - Eradican fungicides are less common than protectant fungicides. Eradicants have therapeutic action. They can be applied after infection has occurred. Eradican fungicides kill the pathogen on contact, or prevent reproduction and further growth of the pathogen within the host. This is in contrast to protectant fungicides that prevent new infections. Some fungicides are systemics - they are translocated within the plant and away from the point of absorption. *Benomyl* for example, is a root absorbed fungicide that is translocated to the foliage. Some systemic fungicides have both eradican and protectant properties.

Other pesticides and disease control - Pesticides other than fungicides may be useful in plant disease control. Nematicides are used to control nematodes. Insecticides and acaricides control insects and mites which may transmit pathogens or render some plants more susceptible to disease through injury. Herbicides eliminate weeds which

may harbor plant pathogens, or they may kill alternate hosts of pathogens and interrupt the disease cycle.

EFFECTIVENESS OF CHEMICALS FOR DISEASE CONTROL

The effectiveness of chemicals in disease control is dependent on the appropriate use of the right chemical in the right situation. Appropriate use requires the correct amount of pesticide be applied at the correct time with equipment suited for the job. Choosing the right chemical means knowing what disease needs to be controlled. *DIAGNOSIS* is identifying the cause of the problem. Diagnosis should precede pesticide selection.

Even with this careful approach to disease control with chemicals, there remains an array of factors that can reduce the effectiveness of disease control programs. Included in these factors are:

- * Weather conditions encourage or deter disease development and can influence the effectiveness of pesticides. For example, rain following a spray application may wash some pesticide from the treated surface. Ultraviolet radiation from the sun can degrade certain pesticides and reduce their activity.
- * Pathogen characteristics such as life cycle, the amount of sources of inoculum, and the methods of pathogen movement (i.e., insects, wind, pruning) determine which control methods are appropriate.
- * Host characteristics such as stage of growth when the host is most susceptible, and the part(s) of the plant requiring treatment, determine if and when a chemical is needed, and how it should be applied.
- * Laws at federal, state, and local levels regulate pesticide usage. Legal restrictions to be considered prior to an application are residue tolerance levels, interval to harvest, and applicator certification requirements.

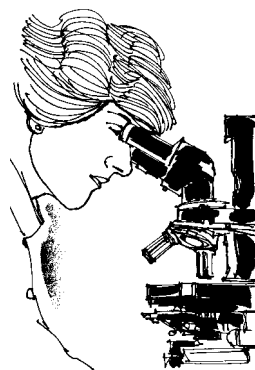
- * Pathogen resistance can result from repeated use of certain pesticides. This means the chemical will no longer control the disease, and other pesticide is needed for disease control. Read the label on the pesticide container; manufacturers may indicate recognized resistance problems and alternatives in dealing with them. Techniques such as fungicide combinations and rotations can be used to avoid resistance problems.

DISEASE DIAGNOSIS

A successful disease control program begins with an accurate diagnosis. Diseased plants are recognized by disease symptoms and signs of the pathogen, and by comparing plants suspected of being diseased with healthy plants. Symptoms are clues that aid diagnosis, but they may not ensure accurate disease identification.

ABIOTIC DISEASES are caused by nonliving agents such as frost, mechanical injury, or improper applications of fertilizers or pesticides. Abiotic and pathogen caused diseases frequently may have similar symptoms. In many instances, the only way to identify the cause of disease is to find the signs of the casual agent. Certain plants can be plagued by a number of problems at the same time (insects, diseases, and abiotic). Also, the part of the plant showing symptoms may or may not be the primary site of the problem.

Disease symptoms usually are easy to see, but the significant questions are often whether the disease can cause a loss and does it warrant a chemical control. Some diseases cause symptoms that alarm farmers yet cause little crop loss. Conversely, other diseases appear innocuous but are responsible for significant losses.



If necessary, seek assistance in diagnosing disease problems from your county cooperative extension office and other knowledgeable sources. Positive identification through clinical analysis is required to diagnose diseases. Contact your county extension agent for details concerning analysis of diseased plants.

SELF STUDY QUESTIONS

1. Organisms which cause plant diseases and which can spread from diseased to healthy plants are called:
 - A) spreaders.
 - B) pathogens.
 - C) infectors.
2. The body of a fungus is thread-like, branching filaments are called:
 - A) branchii.
 - B) tubullium.
 - C) mycelium.
3. Fungi reproduce chiefly by:
 - A) spores.
 - B) sexual reproduction.
 - C) branching.
4. Bacteria are microscopic organisms that quickly increase in number, especially when the weather is:
 - A) cold and dry.
 - B) wet and humid.
 - C) warm and dry.
5. Viruses:
 - A) are larger than bacteria.
 - B) usually kill the host.
 - C) usually cause reduced yields and poor quality products.
6. The most common nematodes are:
 - A) root feeding.
 - B) foliar feeding.
 - C) desiccating.

7. Once a plant becomes infected, the following period of time where the disease organism grows within the host is called:

- A) the growth stage.
- B) incubation.
- C) colonization.

8. Plant quarantines:

- A) are effective when the natural movement of a pathogen by wind or rain is unlikely.
- B) are usually done early enough to make the process effective.
- C) do not require that newly established plantings with diseased plants be destroyed.

9. When one attempts to eliminate the pathogen by the use of crop rotation, the crops should be rotated at least once every __ year(s):

- A) three to five
- B) ten to fifteen
- C) eight to ten

10. All of the following are true concerning soil fumigation **except**:

- A) fumigants must be used after a crop is planted.
- B) only a large volume of soil must be fumigated.
- C) a large quantity of fumigant is needed to treat an acre in comparison to insecticides or herbicides.

11. Eradicant fungicides:

- A) kill the pathogen on contact.
- B) are more common than protectant fungicides.
- C) do not include systemic pesticides.

ANSWERKEY

- | | | | | | |
|------|------|------|-------|-------|------|
| 1. b | 2. c | 3. a | 4. b | 5. c | 6. a |
| 7. c | 8. a | 9. a | 10. a | 11. a | |

CHAPTER FIFTEEN

THE LABEL

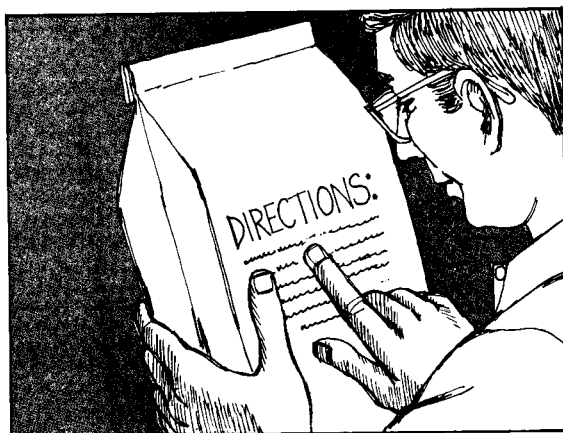
Learning Objectives

- * Determine from the label how to properly use a pesticide.
- * Determine the hazards (for humans, animals, wildlife and the environment) involved when using a pesticide, and the precautions required when handling, mixing and applying a pesticide.
- * Know the first aid treatment required in case of pesticide poisoning.
- * Know the pesticide storage and disposal requirements.

The pesticide label is important to every user. The information and instructions on it come from years of costly tests and studies. The label tells how to safely and correctly use the pesticide. The label, when properly followed, provides protection for applicators, consumers, and the environment. Completely read all labels for every pesticide you use. Don't rely on your memory.

IDENTIFY THE CHEMICAL HAZARDS

First, the label identifies the chemicals in the container. The contents are listed in a standard form so that you know exactly what you are applying. Mistaken uses of chemicals can cause plant injury, poor control, or illegal residues which make a crop unfit for market. As the applicator, you are legally responsible for any losses.



Signal words are used on most labels to state the toxicity of the pesticide to humans. The label also lists the protective equipment needed for proper handling and use of the chemical. This may include masks, gloves, respirators, etc. The applicator who often works with these chemicals must be especially careful. Don't take chances with your health - follow the simple safety suggestions on the label.

REGISTERED USES

The label lists the uses for the pesticide that are approved by the Environmental Protection Agency (EPA). If the intended use is not on the label, the product should not be used! You are legally responsible for any accident or damage which results from using materials which are not approved. Certain formulations of a particular pesticide may be intended for a specific use only, for example on livestock. The label in this formulation may list only the uses for livestock even though the pesticide is also registered for other uses. Generally, however, any non-labeled use is a misuse and the applicator may be taken to court.

RECOMMENDED DOSES

Recommended doses and directions for applying approved uses also appear on every label. These suggestions can be helpful to you because they state the maximum dosages permitted by law. However, local conditions may not require maximum doses to achieve good control of the pest. You should use no more pesticide than is needed.

COMPATIBILITY

The label will usually state which other chemicals can be mixed with the pesticide. Often other pesticides or fertilizers can be combined with the pesticide for one application. Sometimes the chemicals cannot be mixed without destroying their effectiveness. Check on compatibility before you mix.

PHYTOTOXICITY

The label will also tell whether injury to plants is likely. Some plants are more sensitive than others to pesticide chemicals. The injury to the plants can range from slight burning to complete loss of leaves to death of the plant. Choose a pesticide which is not phytotoxic to the target plant.

THE PESTICIDE LABEL AND THE LAW

The label is the law. Pesticide users are forbidden to use a pesticide in a way contrary to its labeling. Any use not indicated on the label is prohibited. It is also illegal for consultants or sales persons to recommend a pesticide be used contrary to its label. The information found on the label has passed strict government requirements. The label itself, not just the pesticide product, must be registered by the EPA before it is used. The EPA reviews and approves each statement which is on the label. The toxicity warnings come from tests required by the government. The EPA Label Improvement Program updates pesticide labels in areas that contribute to health and environmental safety. According to the program, pesticide manufacturers revise

product labels so both the applicator and the regulatory agency can delineate legal and safe uses for pesticides released after April 30, 1988. The pesticide and the label are registered by EPA only when the applicators, consumers, and the environment are protected. If the label statements are carefully followed no illegal residues will be found on any crop. Getting a single pesticide ready for registration and use can take seven to nine years and usually costs the chemical company \$20-40 million dollars. Surely, if it costs that much, the label is worth reading!

Each pesticide you buy has a label which gives you instructions on how to use the product. Labels vary greatly depending on what the product is used for, when it was issued or last reviewed, size of the package, and company format.

LABELING

Labeling is all the information that you receive from the manufacturer about the product. It includes the label on the product container, plus any supplemental information including brochures, leaflets, and information handed out by your dealer or a recognized authority. It is the responsibility of the applicator to comply with all of this information.

LABEL

The label is the information printed on or attached to the container of pesticide.

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

All labels will tell you how to use the product correctly!

PARTS OF THE LABEL

Brand, Trade, or Product Names - Each manufacturer has a brand name for its products. Different manufacturers may use different brand names for the same pesticide active ingredient. The brand name shows up plainly on the front panel of the label. Applicators should avoid choosing a pesticide product by brand name alone. Many companies use the same basic name with only minor variations to designate entirely different pesticide chemicals. For example:

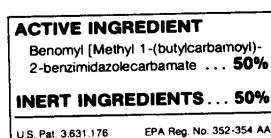
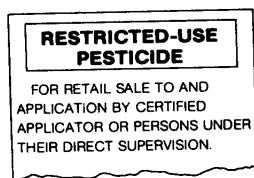
Tersan LSR = zinc and maneb
Tersan SP = chloroneb
Tersan 1991 = benomyl
Tersan = thiram

Classification - Every use of every pesticide will be classified by the U.S. Environmental Protection Agency as either "general" or "restricted."

Every pesticide product which has been federally restricted must carry the following statement in a prominent place at the top of the front panel of the pesticide label:

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

When a pesticide is classified for general use, the words "General Classification" will appear immediately below the heading "Directions for Use."



NOTE: EPA continually reclassifies pesticide products based on all available scientific information. Therefore, the absence of a RESTRICTED USE statement does not necessarily indicate that the product has a low hazard level. Use the signal word and the precautionary statements to judge the toxicity hazard of all pesticide products. Also, the state of New Jersey may restrict pesticides which will not have the use classification listed on the label.

Ingredient Statement - Each pesticide label must list what is in the product. The list is written so you can see quickly what the active ingredients are and the amount (in percentage) of each ingredient listed. The ingredient statement must list the official chemical names and/or common names for the active ingredients. Inert ingredients need not be named, but the label must show what percent of the total contents they comprise.

Xylene	30%
Inert Ingredients:	16%
Total:	100%
EPA Reg. No. 100-461 AA	
EPA Est. No. 100-AL-1	

Chemical Name - The chemical name is a complex name which identifies the chemical components and structure of the pesticide. This name is almost always listed in the ingredient statement on the label. For example, the chemical name of Sevin 50% WP is 1-naphthyl methyl carbamate.

Common Name - Because pesticides have complex chemical names, many are given a shorter "common" name. Only common names which are officially accepted by the U.S. Environmental Protection Agency may be used in the ingredient statement on the label. The official common name may be followed by the chemical name in the list of active ingredients. A label with the trade name Sevin 50% WP would read:

Active ingredient:

carbaryl (1-naphthyl methyl carbamate).....50%
Inert ingredients.....50%

Type of Pesticide - This type of pesticide usually is listed on the front panel of the pesticide label. This short statement usually indicates the kind of pests that the product will control. Examples:

- * insecticide for control of certain insects on fruits, nuts, and ornamentals,
- * soil fungicide,
- * herbicide for the control of trees, brush, and weeds,
- * algicide.

Net Contents - The front panel of the pesticide label tells you how much is in the container.

Name and Address of the Manufacturer - The law requires the maker or distributor of a product to put the name and address of the company on the label.

Registration and Establishment Numbers - These numbers are needed by the pesticide applicator in case of accidental poisoning, claims of misuse, faulty product, or liability claims.

Registration Numbers - An EPA registration number appears on all pesticide labels unless an older label has a USDA number. This indicates the pesticide label has been approved by the federal government. Most products will contain only two sets of numbers, for example, EPA Reg. No. 3120-280; the first set of numbers 3120, is the manufacturer's identification number and the second set, 280, is the product identification number. Sometimes additional letters and numbers are part of the EPA Registration Number, for example 3120-280-AA-0850. The letters AA are alpha (alphabetical) letters required by a particular state and appear on a few labels. The 0850 is the distributor's identification number appearing on some labels.

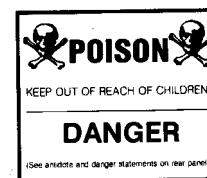
In some cases, **Special Local Needs (SLN)** pesticide products may be approved by a state. These registrations are designated, for example, as EPA SLN No. KS-770009. In this case, SLN indicates "special local need" and KS means that the product is registered for use in Kansas. SLN numbers may not appear on the package label, but are part of the supplementary label.

Establishment Numbers - The establishment number (for example, EPA Est. No. 5840-AZ-1) appears on either the pesticide label or container. In case something goes wrong it identifies the facility that produced the product.

Signal Words and Symbols - Almost every label contains a signal word giving you a clue to how dangerous the product is to humans. Knowing the product's hazard help you choose the proper precautionary measures for yourself, your workers, and other persons (or animals) which may be exposed.

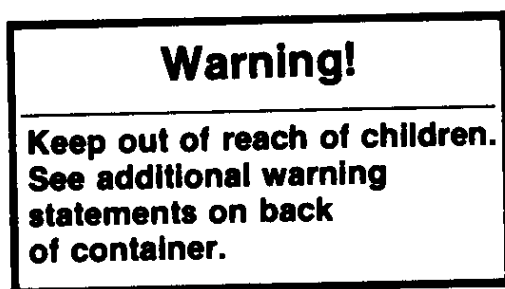
The signal word must appear in large letters on the front panel of the pesticide label. It usually is next to the statement, "Keep Out of Reach of Children" which must appear on every pesticide label.

DANGER - Any product which is highly toxic via oral, dermal or inhalation exposure, or causes severe eye or skin burning will be labeled DANGER. These materials will also carry the word POISON printed in red and the skull and crossbones symbol. As little as a taste to a teaspoonful taken by mouth could kill an average sized adult.



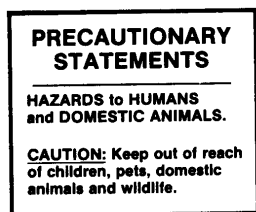
The word DANGER is sufficient if the highly toxic rating is due to severe, corrosive damage to skin or eyes.

WARNING - Any product which is moderately toxic via oral, dermal or inhalation exposure, or causes moderate eye and skin irritation will be labeled WARNING. A teaspoonful to a tablespoonful by mouth could kill the average sized adult.



CAUTION - Any product which is slightly toxic to relatively non-toxic via oral, dermal or inhalation exposure, or causes slight eye and skin irritation will be labeled CAUTION. An ounce to more than a pint taken by mouth could kill the average adult.

Precautionary Statements - All pesticide labels contain additional statements to help you decide the proper precautions to take to protect yourself, your helpers, and other persons (or domestic animals) which may be exposed. Part or all of the pesticide label may be written in other languages; the same label requirements apply regardless of the language.



Routes of Entry Statements - The statements which immediately follow the signal word, either on the front or side of the pesticide label, indicate which route(s) of entry (mouth, skin, lungs) you must particularly protect. Many pesticide products are hazardous by more than one route, so study these statements carefully. A "Danger" signal word 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 label 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.

These statements are not uniform on all labels, so many variations may be found. More than one or even all four precautions may be stated on the same label.

Typical WARNING label statements include:

- * Harmful or fatal if swallowed,
- * Harmful or fatal if absorbed through the skin,
- * Causes skin and eye irritation.

Statements on a WARNING label may be exactly like those found on a DANGER label or a CAUTION label. Or they may be a combination of the two; for example, "harmful or fatal."

Typical CAUTION label statements include:

- * Harmful if swallowed,
- * May be harmful if absorbed through the skin,
- * May be harmful if inhaled,
- * May irritate eyes, nose, throat, and skin.

These statements may vary considerably. They usually are more moderate than the statements found on a DANGER label, using "harmful" instead of "fatal" or "poisonous"; "irritant" instead of "corrosive"; and qualifying the warnings with "may" or "may be." This is in keeping with products possessing a CAUTION label.

Specific Action Statements - These statements usually follow the route of entry statements. They recommend the specific action needed to prevent poisoning accidents. These statements are

directly related to the toxicity of the pesticide product (signal word) and route(s) of entry which must particularly 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 the pesticide, so the “Do not swallow” statement is omitted.)

CAUTION labels generally contain specific action statements which are much milder than those on the DANGER label:

- * Avoid contact with skin or clothing,
- * Avoid breathing dust, vapors, or spray mists,
- * Avoid getting in eyes.

These statements indicate that the toxicity hazard is not as great.

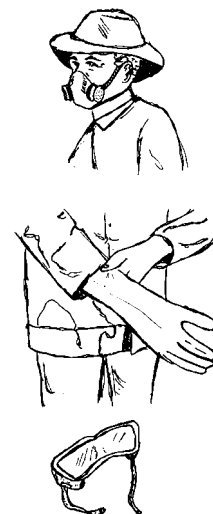
The specific action statements help you prevent pesticide poisoning by taking the necessary precautions and wearing the correct protective clothing and equipment.

Hazards to Wildlife - The label may indicate that the product causes undesirable effects in the environment. In this case, the precautionary statement may tell you what to avoid doing. Some labels indicate toxicity to bees, birds, fish, and crustaceans. Labeling may indicate limitations imposed to protect endangered species. These limitations may include reduced rates, restrictions on types of application, or a ban on the pesticide’s use within the species range. The label may also tell you where additional information can be obtained.

Protective Clothing and Equipment Statements - Pesticide labels vary in the type of protective clothing and equipment statement they contain. Many labels carry no statement at all. The best way to determine the correct type of protective clothing and equipment is to use the signal word, the route of entry statements, and the specific actions statements, along with the basic guidelines listed in the chapter on safety.

You should follow all advice on protective or equipment which appears on the label. However, the lack of any statement or the mention of only one piece of equipment does not rule out the need for additional protection.

A WARNING label, for example, might carry the statements: “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 specifically require them, you should wear a long-sleeved shirt, long-legged trousers, and gloves. You should consider wearing rubberized or waterproof clothing if you will be in prolonged contact or wet by an overhead spray application.



Some pesticide labels fully describe appropriate protective clothing and equipment. A few list the kinds of respirators which should be worn when handling and applying the product. Others require the use of a respirator but do not specify type or model to be used.

Other Precautionary Statements - Labels often list other precautions to take while handling the product. These are self-explanatory:

- * 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.

These statements represent actions which a competent applicator should always follow whether they are present or not.

First Aid or Statement of Practical Treatment - These statements tell you the first aid treatments recommended in case of poisoning. Typical statements 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 medical attention,
- * In case of inhalation exposure, 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,
- * If swallowed, induce vomiting.



All DANGER labels and some WARNING and CAUTION labels usually have a section on First Aid Treatment, Poison Signs or Symptoms, Note to Physicians, or Antidote and an Emergency Assistance Call telephone number. WARNING and CAUTION labels usually do not provide this infor-

mation although some may provide an Emergency Assistance Call telephone number near the signal word or precautionary statements. Individuals experiencing poisoning symptoms should seek medical attention. The pesticide label is an extremely important document which should be taken with the victim to the treatment facility.

Environmental Hazards - Pesticides may be harmful to the environment. Some products are classified **RESTRICTED-USE** because of environmental hazards alone. Label warnings may include groundwater advisories and protection information. Watch for special warning statements on the label concerning hazards to the environment.

Special Toxicity Statements - If a particular pesticide is especially hazardous to wildlife, that will be stated 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 alert you to the special hazards that use of the product may pose. They should help you choose the safest product for a particular 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 actions to follow to void contaminating the environment. The absence of any or all of these statements does not indicate that you do not have to take adequate precautions.

Sometimes these statements follow a "specific toxicity statement" and provide practical steps to avoid harm to wildlife. Examples of general environmental statements include:

- * Do not apply when runoff is likely to occur,

- * Do not apply when weather conditions favor drift from treated areas,
- * Do not contaminate water by cleaning of equipment or disposal 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.

Physical or Chemical Hazards - This section of the label will tell you of any special fire, explosion, or chemical hazards the product may pose.

Forexample:

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

NOTE: Hazard statements (hazards to humans and domestic animals, environmental hazards, and physical-chemical hazards) are not located in the same place on all pesticide labels. Some newer labels group them in a box under the headings listed above. Other labels may list them on the front panel beneath the signal word. Still other labels list the hazards in paragraph form somewhere else on the label under headings such as “Note” or “Important”. You should search the label for statements which will help you apply the pesticide more safely and knowledgeably.

Reentry or Restricted Entry Interval Statement - Some pesticide labels with the signal word DANGER or WARNING (especially cholinesterase-inhibiting pesticides) contain a reentry precaution. This statement tells you how much time must pass before people can reenter a treated area without appropriate protective clothing. These reentry intervals are set by both EPA and some states.

Reentry intervals set by states are not always listed on the label; it is your responsibility to determine if one has been set. This is true for all except

agricultural products. Beginning on April 15, 1994, newly labeled agricultural products will have a minimum 12 hour reentry interval. Agricultural workers are also specially protected by the Worker Protection Standard (WPS). The WPS mandates that agricultural workers be warned of reentry entry intervals both verbally and by a centrally located written warning. It is illegal to ignore reentry intervals.

The minimum legal protective clothing for early reentry following agricultural and other outdoor treatments is:

- * Long-sleeved shirt,
- * Long-legged trousers or coveralls,
- * Hat,
- * Sturdy shoes with socks.
- * Gloves are suggested. For early reentry in enclosed areas, a respirator may be necessary.

The reentry statement may be printed in any one of several places such as under “General Information”, “Directions for Use,” etc.

If no reentry statement appears on the label or is set by your state, then you must wait at least until sprays are dried or dusts have settled before reentering or allowing others to reenter a treated area without protective clothing. That is the minimum legal reentry interval.

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

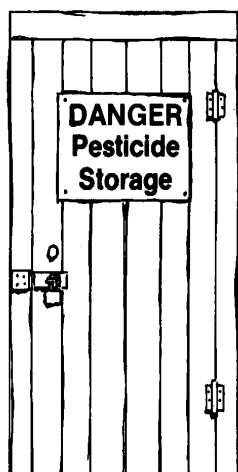
REENTRY STATEMENT

Do not enter area within five days after application.

Storage and Disposal - All pesticide labels contain general instructions for the appropriate storage and disposal of the pesticide and its container. State and local laws vary considerably, so specific instructions usually are not included. Typical statements include:

- * Not for use or storage in or around the home,
- * Store away from fertilizers, insecticides, fungicides, and seeds,
- * Store at 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 in an approved landfill or bury in a safe place,
- * Use excess or dispose in a approved landfill or bury in a safe place,
- * Do not reuse bag. Burn or bury in a safe place.

You should try to determine the best storage and disposal procedures for your operation and location. These statements may appear in a special section of the label titled "Storage and Disposal" or under headings such as "Important," "Note," or "General Instructions." For additional information on proper pesticide disposal and storage, contact your state regulatory agency.



Directions for Use - The instructions on how to use the pesticide are the best way you can find the right way to apply the product.

The use instructions will tell you:

- * the pests which the manufacturer claims the product will control. (Federal law legally allows you to apply a pesticide against a pest not specified on the labeling if the application is to a crop, animal, or site which the labeling approves, but your state may not permit such a use.)
- * the crop, animal, or site the product is intended to protect,
- * in what form the product should be applied,
- * the proper equipment to be used,
- * how much to use,
- * mixing directions,
- * compatibility with other often-used products,
- * phytotoxicity and other possible injury or staining problems,
- * where the material should be applied,
- * when it should be applied.

Labels for agricultural pesticides often list the least number of days which must pass between the last pesticide application and harvest of crops, or slaughter, or grazing of livestock. These are intervals set by EPA to allow time for the pesticide to break down in the environment. This prevents illegal residues on food, feed, or animal products and possible poisoning of grazing animals. This information may appear as a chart or it may be listed just after application directions for the target crop or animal.

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

- * whether it is the pesticide you need for the job,
- * whether the pesticide can be used safely under the application conditions.



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

- * what protective equipment you should use,
- * what the pesticide can be mixed with (compatibility),
- * how much pesticide to use,
- * the mixing procedure.

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

- * what safety measures you should follow,
- * where the pesticide can be used (livestock, crops, structures, etc.),
- * when to apply the pesticide (including the waiting period for crops and animals),
- * how to apply the pesticide,
- * whether there are any restrictions for use of the pesticide.

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

- * where and how to store the pesticide,
- * how to decontaminate and dispose of the pesticide container,
- * where to dispose of surplus pesticides.

SELF STUDY QUESTIONS

1. The label or labeling of a pesticide is an official and legal document approved by EPA.

T () F ()

2. The label on the container may not have all the registered uses and the complete directions for proper and safe use of a pesticide formulation.

T () F ()

3. The best applicator reference for directions on how to use a given pesticide is his records of past years use.

T () F ()

4. Three names of a pesticide sometimes appear on the labeling - the trade name, the chemical name, and the common name. Of these three names for a pesticide, the name that is most frequently missing is the:

- A) trade name.
- B) chemical name.
- C) common name.

5. The name of the pesticide that most accurately identifies the active ingredients is the:

- A) trade name.
- B) chemical name.
- C) common name.

6. The name of the pesticide which most accurately identifies the formulation is the:

- A) trade name.
- B) chemical name.
- C) common name.

7. If the label states that a pesticide may be mixed with other pesticides and/or fertilizer it is said to:

- A) be a broad spectrum pesticide.
- B) be compatible.
- C) have a synergistic action.
- D) be an additive.

8. The signal word(s) for moderately toxic pesticides is:

- A) Danger, Poison.
- B) Warning.
- C) Caution.
- D) Keep out of the reach of children.

9. The information on the pesticide label:

- A) gives the date of manufacture and/or packaging.
- B) is good for as long as the container lasts.
- C) gives the necessary, special storage instructions for the pesticide formulation.

10. The directions on the pesticide labeling states:

- A) how much pesticide to buy.
- B) the dosage rate to use.
- C) the storage life of the chemical.

ANSWERKEY

- | | | |
|------|------|-------|
| 1. T | 5. B | 9. C |
| 2. T | 6. A | 10. B |
| 3. F | 7. B | |
| 4. C | 8. B | |

LABEL QUESTIONS

(Refer to label on following pages)

1. The common name of the active ingredient in Furadan is:

- A) Furadan.
- B) Carbofuran.
- C) 2,3-Dihydro-2,2-dimethyl-7-benzofuranylmethylcarbamate

2. The EPA registration number for Furadan is:

- A) 279-3023.
- B) 15G.
- C) 279-.

3. The signal word for Furadan 15G is:

- A) Warning.
- B) Keep out of Reach of Children.
- C) Restricted Use Pesticide.

4. Within 10 months use of this product, it would be unacceptable to plant:

- A) grapes.
- B) peppers.
- C) peas.

5. Applicators and other handlers must wear:

- A) at least a short-sleeved shirt.
- B) long pants.
- C) non-waterproof gloves.

6. Concerning the use of Furadan 15G, all of the following are true **except** that it may:

- A) be used on Long Island, N.Y..
- B) not be used on corn.
- C) not be used on sorghum.

7. This product should be stored under the following conditions:

- A) a cool, dry place.
- B) a warm, dry place.
- C) warm, humid place.

8. To control nematodes on cucumbers in Florida, one should apply Furadan 15G at a rate of pounds per ____ linear feet of row:

- A) 2 ; 500
- B) 3 ; 800
- C) 1.5 ; 1000

ANSWERKEY

- | | | | |
|------|------|------|------|
| 1. b | 2. a | 3. a | 4. c |
| 5. b | 6. a | 7. a | 8. c |

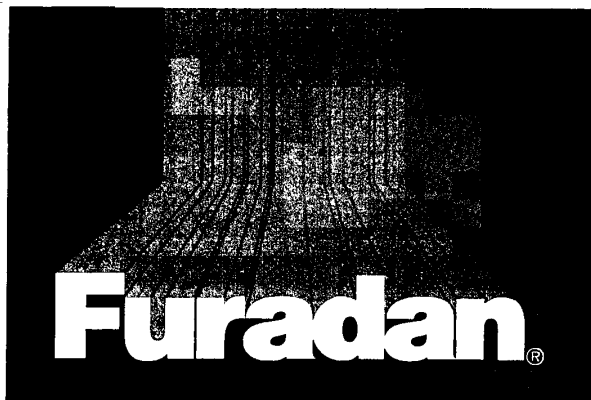
Code 3669

RESTRICTED USE PESTICIDE

Due To Avian Toxicity

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

Net Weight



15 G Insecticide— Nematicide

For Agricultural or Commercial Use Only

EPA Reg. No. 279-3023

EPA Est. 279-

Active Ingredient:

*Carbofuran 15.0%

Inert Ingredients: 85.0%

*2,3-Dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate 100.0%

KEEP OUT OF REACH OF CHILDREN

WARNING

AVISO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

FMC

FMC Corporation
Agricultural Chemical Group
Philadelphia PA 19103

4/94

STATEMENT OF PRACTICAL TREATMENT

If swallowed: Drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person. Get medical attention.

If in eyes: Flush with plenty of water for at least 15 minutes. Get medical attention.

If on skin: Wash skin immediately with soap and water.

Antidote:

Note to Physician: Carbofuran is an N-methyl carbamate and a reversible cholinesterase inhibitor. Do not use oximes such as 2-PAM. Start by giving 2 mg. atropine intramuscularly. According to clinical response, continue until signs of atropinization occur (dry mouth or dilated pupils). If in eye, instill one drop of homatropine.

For Emergency Assistance Call (800) 331-3148

See Side Panel For Additional Precautionary Information.

PRECAUTIONARY STATEMENTS

Hazards to Humans (and Domestic Animals)

Warning

Poisonous if swallowed. May be fatal or harmful as a result of skin or eye contact or by breathing dust. Causes cholinesterase inhibition. Warning symptoms of poisoning include weakness headache, sweating, nausea vomiting, diarrhea, tightness in chest, blurred vision, pinpoint eye pupils, abnormal flow of saliva, abdominal cramps, and unconsciousness. Atropine sulfate is antidotal.

Personal Protective Equipment:

Applicators and other handlers must wear: long-sleeved shirt and long pants, waterproof gloves, shoes plus socks, and a dust/mist filtering respirator (MSHA/NIOSH approval number prefix TC-21C).

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

User Safety Recommendations:

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

Environmental Hazards

This pesticide is toxic to fish, birds and other wildlife. Birds feeding on treated areas may be killed. Birds killed by carbofuran pose a hazard to hawks and other birds-of-prey; contact your state wildlife agency or the U.S. Fish and Wildlife Service upon finding birds or other animals that may have been poisoned. Cover or incorporate granules in spill areas. Runoff from treated areas may be hazardous to fish in neighboring areas. Do not apply directly to water. Do not contaminate wells, wetlands or any body of water by cleaning of equipment or disposal of waste.

Notice: It is a Federal offense to use any pesticide in a manner that results in the death of a member of an endangered species.

The use of Furadan 15 G may pose a hazard to the following Federally designated endangered/threatened species known to be found in certain areas within the named locations.

Attwater's Greater Prairie Chicken—Texas counties including: Aransas, Austin, Brazoria, Colorado, Galveston, Goliad, Harris, Refugio and Victoria

Aleutian Canada Goose—California counties including Colusa, Merced, Stanislaus and Sutter

Kern Primrose Sphinx Moth—Walker Basin of Kern County, California.

This product may not be used in areas where adverse impact on the Federally designated endangered/threatened species, noted above, is likely. Prior to making applications, the user of this product must determine that no such species are located in or immediately adjacent to the area to be treated. If the user is in doubt whether or not the above named endangered species may be affected, he should contact either the regional U.S. Fish and Wildlife Service office (Endangered Species Specialist) or personnel of the State Fish and Game office.

Carbofuran is a chemical which can travel (seep or leach) through soil and can contaminate ground water which may be used as drinking water. Carbofuran has been found in ground water as a result of agricultural use. Users are advised not to apply carbofuran where the water table (ground water) is close to the surface and where the soils are very permeable, i.e., well-drained soils such as loamy sands. Your local agricultural agencies can provide further information on the type of soil in your area and the location of ground water.

DIRECTIONS FOR USE

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

Do not use this product on Long Island, N.Y. Do not use this product on corn or sorghum after 8/31/94.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), notification to workers, and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 48 hours.

Exception: If the product is soil-injected or soil-incorporated, the Worker Protection Standard under certain circumstances, allows workers to enter the treated area if there will be no contact with anything that has been treated.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is: Coveralls, waterproof gloves, and shoes plus socks.

Notify workers of the application by warning them orally and by posting warning signs at entrances to treated areas.

STORAGE AND DISPOSAL

Pesticide Storage

Do not store in or around the home.

Keep out of reach of children and animals. Store in original containers only. Store in a cool, dry place and avoid excess heat. Carefully open containers. After partial use, fold and roll back bags, clamp and close tightly. Do not put concentrate or dilute material into food or drink containers. Do not contaminate other pesticides, fertilizers, water, food or feed by storage or disposal.

In case of spill, avoid contact, isolate area and keep out animals and unprotected persons. Confine spills. Call FMC: (800) 331-3148.

To confine spill: If liquid, dike surrounding area or absorb with sand, cat litter or commercial clay. If dry material, cover to prevent dispersal. Place damaged package in a holding container. Identify contents.

Pesticide Disposal

Pesticide wastes are acutely hazardous. 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

Completely empty bag into application equipment. Then dispose of empty bag in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

General Use Instructions

Cover or incorporate granules in spill areas.

Do not plant with any crop other than alfalfa artichokes bananas, barley coffee, corn (field pop or sweet) cotton cranberries, cucurbits (cucumbers, melons, pumpkins, squash), flax, grapes, non-bearing fruit, oats, ornamentals, peanuts, peppers, potatoes, rice, seed crops (Bermuda-grass, spinach), sorghum, strawberries, soybeans, sugar beets, sugar-cane, sunflowers, tobacco, or wheat for at least 10 months following use of this product.

Cranberries—Washington Only

Insects Controlled	Rate of Application	Method of Application
Black Vine Weevil	13.3 Pounds per acre	Spread granules uniformly over soil surface using a rotary spreader. Make one application about June 15 to 25 and repeat one month later. Incorporate granules by following each application with sprinkler irrigation.
For use only on cranberry bogs that are sprinkler irrigated and are not flooded for purposes of irrigation or harvest. Do not apply within 60 days of harvest.		

Cucurbits (Cucumber, Melons, Squash, Pumpkins)—Southeastern States Only

Insects Controlled	Rate of Application	Method of Application
Nematodes (Dagger, Lesion and Root-Knot)	1½ pounds per 1,000 linear feet of row	Apply in a 12 to 15 inch band and incorporate into the top 3 inches of soil.

Pine Seedlings in Pine Progeny Tests

Insects Controlled	Rate of Application	Method of Application
Pales Weevil Pitch-Eating Weevil Nantucket Pine Tip Moth Pitch Pine Tip Moth	7 grams (¼ teaspoon) per seedling	Apply at transplanting. Distribute the granules in a 6 inch radius on the soil around each seedling. Cover granules with soil.
Do not use at transplanting if seedlings were treated with Furadan 4F slurry root dip.		

Note: FMC will sell this product in conformity to volume limitations agreed to with EPA.

Dealers Should Sell in Original Packages Only.

Terms of Sale or Use: On purchase of this product buyer and user agree to the following conditions:

Warranty: FMC makes no warranty, expressed or implied, concerning the use of this product other than indicated on the label. Except as so warranted the product is sold as is. Buyer and user assume all risk of use and/or handling and/or storage of this material when such use and/or handling and/or storage is contrary to label instructions.

Directions and Recommendations: Follow directions carefully. Timing and method of application, weather and crop conditions, mixture with other chemicals not specifically recommended and other influencing factors in the use of this product are beyond the control of the seller and are assumed by the buyer at his own risk.

Use of Product: FMC's recommendations for the use of this product are based upon tests believed to be reliable. The use of this product being beyond the control of the manufacturer, no guarantee, expressed or implied, is made as to the effects of such or the results to be obtained if not used in accordance with directions or established safe practice.

Damages: Buyer's or user's exclusive remedy for damages for breach of warranty or negligence shall be limited to direct damages not exceeding the purchase price paid and shall not include incidental or consequential damages.

CHAPTER SIXTEEN

APPLICATION OF PESTICIDES

Learning Objectives

- * Recognize the various types of sprayers, foggers and other application equipment and their accessories.
- * Understand the advantages of the different types of equipment and how to calibrate and use them.
- * Calculate site areas.
- * Determine how much pesticide is required for an application and calculate the dilution rate.

Today's agriculture requires modern equipment to apply a variety of pesticides. Pesticides may be applied as sprays, dust, granules, gases (vapors), fogs, baits, rubs, or dips. The vast array of equipment on the market must be matched to the pesticide material as well as the size and type of job to be done. To make an effective, safe, and efficient application; the equipment must be properly selected, operated, calibrated, and maintained. To obtain desired control without harming the environment, label directions must be read and followed.

The target is the area or item to be treated. It may be a spot, such as a patch of thistles in a pasture field. It may be an entire field, such as weeds in corn. The target may be a band, such as in-row treatment for corn rootworm; or it may also be an enclosure, such as a greenhouse or grain bin. Sometimes the target may be an animal, fruit or shade trees, grapevines, or turf; while other times the treatment may be directed at a waterway, a fence line, a driveway, or a ditch.

APPLICATION EQUIPMENT

The equipment or device used must apply the pesticide to the target at the proper rate. Information on the label specifies the proper dosage and sometimes suggests the appropriate equipment for use of the material. The application equipment can be an aerosol can, hand equipment, or power equipment, including aircraft. The equipment may be carried, towed, or self-propelled.

The most common type of pesticide application equipment in the United States is the sprayer; nearly 90 percent of all pesticide is formulated for spraying. A hydraulic (liquid) sprayer uses water as a diluent and as a carrier for the pesticide, except in ultralow volume spraying where the pesticide is applied directly as formulated. In any case, pressure from either a pump or compressed gas or air is used to atomize the spray mix at the nozzle. Hydraulic sprayers may be used to apply most pesticides.

The air-blast (or mist) sprayer uses both water and air. The pesticide is diluted with water (except with ultra-low-volume spraying) as with the hydraulic sprayer, but uses both water and air as a carrier. Spray droplets are formed with hydraulic nozzles, air-shear nozzles, or rotary nozzles and delivered to the target by an air stream (blast). Air-blast sprayers are typically used for disease and insect control on fruits, vegetables, Christmas trees, and shade trees.

Special applicators are designed to apply pesticides formulated as granules in either band or broadcast patterns. Band applicators are often combined with planting or cultivating equipment to place a band

of pesticide over a row. Broadcast applicators may also be combined with a disk or harrow when incorporation (mixing) with the soil is desired.

Hydraulic Sprayers - Hydraulic sprayers are used for spot, band, broadcast, and specimen spraying. The sprayer may have one or several nozzles on a boom or in a cluster, and they may be permanently mounted or hand held. Hydraulic sprayers are usually powered and can be towed, self-propelled, or mounted on other equipment, including aircraft. However, for small jobs a hand-carried compressed-air backpack sprayer is often used.

Since hydraulic sprayers use water to dilute and carry the pesticide, a tank is necessary to contain the spray mix. The tank should be large enough to eliminate frequent refills but not so large that the weight (when filled) becomes a problem. The tank should be made of or coated with a material that does not corrode and can be easily cleaned. Corrosion and dirt often clog screens and nozzles and therefore increase wear. Large tanks should have an opening in the bottom to aid cleaning and draining. A large top opening is useful for filling, cleaning, and inspection; however, the opening should have a water tight cover to prevent spillage. If a wettable powder is used, the tank should have an agitator, either jet or paddle, to ensure uniform mixing of the pesticide and water. Constant mixing produces a uniform spray mixture (suspension) and an even application of chemicals.

Air-blast Sprayers - With air-blast (mist) sprayers, the pesticide is also mixed with water. Tank and agitation requirements are similar to those of hydraulic sprayers. The spray mix is also atomized into droplets with nozzles or similar devices.

The difference is that a high volume fan is used to produce an air stream that carries the droplets to the target area. The fan displaces air in the tree or space being sprayed; the air from the sprayer carries the spray droplets. The droplets are deposited on the target, usually trees or row crops, according to plant size, shape, and distance from the sprayer.

Wind is the biggest problem with air spraying. Uniform coverage is very difficult in winds over 5 miles per hour. Many people operate at night or very early in the morning to take advantage of the generally calmer air conditions. Also, the relative humidity is higher at night; this slows evaporation of the small droplets, especially important with low-volume application.

Nozzle selection is critical for air-blast sprayers. The most common uses of air-blast sprayers are for disease and insect control and for plant growth regulation. These applications require a fine spray to ensure large numbers of droplets for complete coverage. For this reason, air sprayers are normally equipped with cone nozzle tips or air-shear nozzles.

Sprayer Pumps - Hydraulic sprayers usually have roller, centrifugal (impeller), piston, or diaphragm pumps. Since most hydraulic farm sprayers are boom sprayers for weed control and low pressure is adequate, roller and centrifugal pumps are very popular. Weed spraying is usually done at 10 to 40 psi (pounds of pressure per square inch). Where wettable powders are used, the centrifugal pump is especially good because wear is relatively slow and there is plenty of flow capacity for jet agitation.

Most air-blast sprayers have piston, diaphragm, or multistage centrifugal pumps to produce the necessary high pressure. Any of these will handle wettable powders with minimum wear. An exception to the high pressure pump is those sprayers with air-shear nozzles where the low pressure requirement makes a single-stage centrifugal pump practical.

Roller pumps - are widely used because of their low initial cost, wide range of pressures (available up to 300 psi), and because they can be directly mounted on a tractor power take off (PTO) shaft. Their volume is adequate for most weed spraying needs. Roller pumps wear relatively fast, especially when pumping abrasive formulations. However, rebuilding kits are available to replace the rollers, gaskets,

and in some cases, the seals. Rebuilding a roller pump is an easy job that can usually be completed in about half an hour using simple tools.

Centrifugal pumps - Although initially somewhat more expensive, centrifugal pumps are longer lasting. Since the pressure is produced by an impeller rather than one part moving against another, wear is much slower than in roller or piston pumps, especially with wettable powders. Centrifugal pumps have high volume capacity (up to 125 gallons per minute) but their low pressures limit them to applications of 50 psi or less (for single impeller units). Centrifugal pumps must operate at rated speeds to produce rated volume and pressure. Centrifugal pumps are built to operate in the 2,500 to 4,000 rpm range. Therefore, they cannot be directly mounted on a PTO shaft, but must be driven with a speed increaser. Or the pump may be driven by a direct-connected hydraulic motor operated from the tractor hydraulic system. A motor will maintain a uniform pump speed and output and free the tractor PTO for other purposes. Since performance of these pumps is poor when the inlet is restricted in any way, the inline screen should be placed in the outlet (pressure) line of the pump rather than using screens in the suction line. The diameter of the inlet line should not be reduced.

Piston pumps - are high pressure units operating at up to 600 psi or more. They are wear resistant but low in volume and high in purchase cost. Piston pumps can operate at PTO speeds, but the size of the multi-cylinder models (for higher volumes) may not permit direct mounting. Piston pumps often are powered by separate gasoline engines, however, they can be mounted on the sprayer and driven through a PTO shaft. A piston pump produces a pulsating output so a small surge tank should be used to smooth out the pulses. These pumps should be used where high pressure is needed, such as a handgun for shade tree spraying or sprayers for insecticides and fungicides.

Diaphragm pumps - are also high pressure pumps with operating pressures, capacities, and initial costs similar to those of piston pumps. They have become popular in the United States after an

earlier introduction in Europe. Many of the new high pressure sprayers are equipped with diaphragm pumps because maintenance is easier and less expensive. Replacement of diaphragms is the most common repair and it can be done by the sprayer operator, often without removing the pump from the sprayer.

Sprayer Nozzles - Nozzles are a very important part of a sprayer. They control the amount of material applied, the formation of the droplets, the distribution of the droplets (pattern), and thus the uniformity of application.

Nozzle tips are available in various materials including brass, plastic, stainless steel, and ceramic. Wear destroys the proper working of a nozzle, so worn nozzles should be replaced. To reduce wear rates, especially with wettable powders, use nozzle tips made of a hard, wear-resistant material such as hardened stainless steel or ceramic. The purchase price is more, but in the long run, nozzles of hardened stainless steel and ceramic may be better than brass because of their long life. Brass tips should never be used to apply the abrasive wettable powders because they wear too fast.

Nozzles determine spray patterns. The flat-fan nozzle, for instance, produces a fairly coarse spray in a fan pattern that provides uniformity with proper pattern overlap along a boom. It is well suited to most weed control practices and those insecticide applications where foliage penetration is not required. Flat-fan nozzles produce patterns with various spray angles. A wide angle nozzle, for instance, can be operated closer to the ground to minimize drift. Normal operating pressure for a flat-fan nozzle is 20 to 40 psi. A newer flat-fan tip is available to help minimize drift; the nozzle operates at 15 to 20 psi but provides approximately the same fan angles and flow rates. Also available is an extended pressure range flat-fan tip that operates at 15 psi to minimize drift and up to 60 psi to maximize coverage.

Flooding-fan spray nozzles can spray a wide swath while operating close to the spray surface. These nozzles are normally placed at 40-inch spacings on a boom. Operating at 10 to 20 psi on a boom,

the nozzles produce patterns that are resistant to drift and satisfactory for broadcast distribution of herbicides. It is recommended, however, that at least 30 gallons of carrier per acre be used when applying contact herbicides. The flooding-fan nozzle is also ideal for applying postemergence chemicals to the row middle of growing crops because of the low discharge level.

Both the hollow and solid cone nozzles are designed to operate at high pressure (40 to 400 psi) and break the spray into small droplets. This design provides more complete coverage of the sprayed area, however, the production of smaller, lighter droplets increases the likelihood of fogging or drifting. Cone nozzles are generally used for insecticides, fungicides, and growth regulators where complete coverage and foliage penetration are needed.

Air-shear nozzles use a high speed air stream to break the liquid into droplets. These nozzles are used with an air-blast sprayer with high speed (170 to 190 mph) air delivery. It is important that the high air speed be maintained for good atomization.

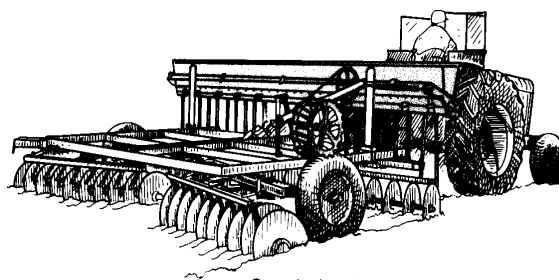
With hydraulic nozzles, the size of the nozzle orifice (opening) and the pressure control the discharge rate of each nozzle. Booms can be equipped with tips to provide from 2 to 150 gallons per acre depending on nozzle size, spacing, pressure, and driving speed.

The best nozzle arrangement for broadcast application is uniformly spaced tips on a boom. This setup can provide the uniform application required for good weed control. Adjust the boom height so patterns overlap on each side (about 40 percent of spacing between the nozzles for flat-fans and 50 percent for flooding-fans). For example, if the flat fan nozzles are 20 inches apart, the adjacent patterns should overlap 8 inches.

Clusters of nozzles do not provide good distribution, even in still air. A slight wind can produce serious pattern distortion and drift problems. One of the few places they may be used is where you want to spray past obstructions, such as trees in a park or fence line.

Single nozzles or up to four in a group may be hand held in a gun arrangement. The gun may have a pistol valve for on-off control. These are used for spot treatment of weeds, tree and shrub spraying, or animal treatment.

Granular Applicators - Granular applicators are available for either band or broadcast application. They may be operated as separate units but are often attached to other equipment such as planters or disks, combining two operations. They usually have gravity feed, a rotating feed valve or agitator, and an adjustable opening to regulate flow. Granular formulations are manufactured for direct application without mixing. Refill time is short since extra granules can be taken to a treatment site.



Granular broadcast applicator on disk

Band applicators use hoses or tubes with deflectors on the bottom; broadcast applicators use a system of tubes and deflectors or a spinner to spread the granules. The spinner units are convenient to use around trees, especially in orchards; however, they should be used only when there is little or no wind. The application rate is affected by the ground speed; granule size, shape, and density; field terrain; and even relative humidity and air temperature. Where multiple band applicators are used on row crop planters, each individual unit must be calibrated with the specific material applied to ensure accurate application.

Dusters - Dusters account for a very small percentage of all powered pesticide application equipment. Their major use is for disease and insect control on vegetables and field crops by small-scale farmers.

Dusters have three major parts: power unit, hopper with an adjustable flow regulator and fan distribution system. The power may come from an auxiliary engine or from the tractor PTO.

Hoppers are available in various sizes; the amount of material they can hold depends on the density of the dust. Hoppers may have agitators to prevent bridging over the opening. The flow regulators are adjustable to deliver dust at rates of 5 to 50 pounds per acre.

Centrifugal fans are used in the distribution system. Because these fans must operate at 2,000 to 3,000 rpm, they cannot be directly driven from the tractor PTO. The dust is distributed through hoses with nozzles on the ends. The number of nozzles varies with the application.

A good time to apply dust is early morning when the wind is calm and dew helps the dust stick to the plants. Do not attempt to apply dust in winds greater than 5 miles per hour; this is both for your protection and the protection of the surrounding area.

MISCELLANEOUS APPLICATION EQUIPMENT

Additional types of application equipment include:

- * Rubs, walk-through sprayers, and dipping vats for controlling pests on animals
- * Bait dispensers for control of rodents, insects, and predators
- * Irrigation systems for greenhouses and field crops
- * Fertilizer spreaders for pesticide impregnated fertilizer

EQUIPMENT MAINTENANCE

Pesticide application equipment requires maintenance for continued accurate and effective operation. Maintenance saves time and prevents frustration in getting equipment into working order the next season. Cleaning is the most important maintenance

practice. Avoid cleaning and disposal problems by mixing only the amount of spray solution needed, thus ending the job or day with an empty tank.

Appropriate protective clothing and equipment should be worn when cleaning or repairing equipment; check labels for any specific instructions.

Cleaning Sprayers - After each day's use, sprayers should be flushed with water inside and out to prevent buildup of chemicals. When chemicals are changed or spraying is completed for the season, clean the sprayer thoroughly with a cleaning agent. Choose the washing area carefully to avoid contamination of water supplies and injury to plants or animals. Do not create standing puddles that might be accessible to children, pets, farm animals, or wildlife.

The following steps are suggested for thoroughly cleaning a sprayer:

- 1) Hose down the inside of the tank and partially fill it with water. Flush the cleaning water through the nozzles by operating the sprayer.
- 2) Repeat step 1.
- 3) Remove nozzle tips and screens. Clean them in strong detergent solution or kerosene using a soft brush such as an old toothbrush. Avoid wire, knives, or other hard objects that might scratch the orifice.
- 4) Partially fill the tank with water and add a cleaning agent and empty.

Cleaning Granular Applicators and Dusters - Granular applicators and dusters must be cleaned following use. The following steps are recommended:

- 1) Remove all pesticide from the applicator. You may have to disassemble certain parts to do a thorough job.
- 2) Thoroughly clean the inside of the hopper.
- 3) Clean rusted or corroded parts with sandpaper, emery cloth, or wire brush. Paint with rust preventative primer and machinery paint.
- 4) Wipe inside and outside with a coat of oil. Oil or grease bearings, if appropriate.

- 5) Thoroughly clean and oil the flow control valve and adjustment.
- 6) Clean and oil any steel tubes that were used.
- 7) Wipe off oil that may come in contact with granules or dust.

Preparation for Storage - All parts of a sprayer, especially the pump, should be protected from deterioration during storage. Clean the sprayer inside and out. If the sprayer has no rubber parts, put new or used motor oil (2 to 5 gallons for large sprayers) in the tank prior to final flushing. As the water is pumped from the sprayer, the oil will leave a protective film on the inside of the tank, pump, and plumbing. Remove nozzle tips and screens and store them in a can of light oil or kerosene. Place tape over nozzle openings to prevent entry of dirt or insects. Drain all parts that are prone to freeze damage.

If the sprayer contains rubber parts but the pump does not, disconnect the pump and put two tablespoons of oil in each outlet connection. If the pump has rubber parts, use antifreeze or radiator rust-inhibitor instead of oil. Rotate the pump shaft by hand to coat the inside surfaces.

Granular applicators and dusters that are cleaned according to the instructions will be adequately prepared for storage.

Any equipment with an auxiliary engine should be prepared for winter storage. Thoroughly clean the outside of air-cooled engines. Either drain the fuel system or add a stabilizer fluid to the fuel tank. Remove spark plugs and pour one ounce of rust preventative oil into each cylinder. Turn the engine shaft four or five revolutions to distribute the oil, but do not start the engine.

Check for worn, deteriorated, or broken parts; order replacements early. Store equipment in a clean, dry building.

EQUIPMENT CALIBRATION

Equipment is manufactured to be adjustable. Charts or tables may be provided to guide the operator in making the settings. However, these rates are only approximate and may change due to particular situations. A calibration check is simply making a check run on some known area and measuring the amount applied with your chosen equipment, material, and adjustments.

Why do a calibration check?

- * Because every production cost is important. Chemicals need to be applied at the proper rate to be effective. Too little pesticide may fail to control the target pest. Too much pesticide can result in damage to the treated plant, animal, or surface; can produce illegal residues; and can cause adverse effects to the environment and nontarget organisms.
- * Because catalog data for nozzles and other equipment may not be accurate in your field conditions due to gauge error, wheelslip, speedometer error, and friction loss.
- * Because application of a pesticide at a greater than the specified rate is illegal.

Investing time in calibration is time well spent. Accurate calibration to determine the actual application rate with your particular operating conditions is important for economics, efficiency, and safety. The methods suggested below have proved to be reasonably accurate and easily done.

Boom Sprayers - The following cleaning and calibration steps are recommended before you use a boom sprayer:

- 1) Check to be sure that all nozzles are the same, are made by one manufacturer, and have the same part number.
- 2) Thoroughly clean all nozzles and screens to ensure proper operation.

- 3) Check the uniformity of spray patterns of all nozzles. Check the volume of delivery by placing similar containers under each nozzle. All containers should fill at the same rate. Replace nozzles that do not have uniform patterns or do not fill containers at the same rate.
- 4) Select an operating speed (generally 3 to 5 mph). Note the tachometer reading and gear used. When spraying, be sure to use the same speed used for calibrating.
- 5) Select an operating pressure. Adjust pressure to desired psi while pump is operating at normal speed and water is actually flowing through the nozzles. This pressure should be the same during calibration and field spraying. Caution: High pressure may increase drift.

Either a special calibration jar or a homemade one can be used to calibrate. If you buy one, carefully follow the manufacturer's instructions. Any quart or larger container, such as a jar or measuring cup if marked in fluid ounces, can be easily used.

Make accurate speed and pressure readings and jar measurements. Make several (three to five) checks. Keep in mind that you are collecting less than a quart of liquid to measure an application rate of several gallons per acre for many acres.

- 1) Measure a course according to nozzle spacing as follows:

Nozzle spacing (in)	12	16	20	24	28	32	36	40
Course length (ft)	340	255	204	170	146	127	113	102

- 2) Measure the time in seconds it takes the sprayer to cover the measured distance at the desired spraying speed. Average several runs.
- 3) With the sprayer standing still, operate at selected pressure and pump speed. Catch the water from several nozzles for the number of seconds measured in step 2.
- 4) Determine the average output per nozzle in fluid ounces. The ounces collected per nozzle equals the gallons per acre applied for one nozzle per spacing. If two (or three) nozzles per spacing are used, multiply the average nozzle output by two

(or three) to get the gallons applied per acre.

Band Sprayers - Follow the method of calibration above. However, the rates of application, as well as figures given in tables by nozzle manufacturers are for broadcast spraying and must be adjusted for the particular band width and row spacing used. Calculate the number of gallons applied per sprayed acre in the band by using the following formula:

Gallons/sprayed acre =

Gallons/field acre x	$\frac{\text{Row spacing (in inches)}}{\text{Band width (in inches)}}$
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For example, assume application is 5 gallons per field acre in 12-inch bands on 36-inch rows. The rate per sprayed acre is 15 gallons (5 gallons x 36/12). In other words, the spray is concentrated on one-third of the field acreage.

Air-blast Sprayers - Air-blast Sprayers must also be calibrated to ensure proper application rate. With low volume (less than 100 gallons per acre) spraying, uniform and accurate applications are absolutely essential. Consult your dealer for correct nozzle size and placement on the manifold. An air-blast sprayer can be checked using the following steps:

- 1) Select a plot of known area such as an acre or some part of an acre. Do not use less than 1/4 acre. An acre is 43,560 square feet. In an orchard you can use tree spacings as measurements.
- 2) Fill sprayer tank full or to some known level with water only.
- 3) Spray check plot only, being careful not to lose water by splashing.
- 4) Measure the amount of water required to refill tank to previous level. Be sure to park sprayer in same position.
- 5) Calculate the gallons per acre. For example, if 28 gallons are required to refill the tank after spraying a 1/2-acre plot, the application rate is 56 gallons per acre.

Adjusting Sprayer Application Rates - After completing a calibration check, the application rate can be increased by slowing the travel speed, increasing the pressure, or using nozzles with larger orifices. For decreasing the application rate, speed up the tractor, decrease the pressure, or use nozzles with smaller orifices. Some sprayers have other means of adjustments; check operator's manual.

Make adjustments and repeat calibration runs until the desired rate of application is achieved. Then, continually check the rate as you make the application. Changes can occur.

Adding the Chemical - The amount of chemical needed per tankful depends on the recommended application rate and the area you can treat per tank of spray. To determine the number of treated acres per tank, divide the tank capacity (gallons) by the application rate (gallons per acre). Multiply the number of treated acres per tankful by the labeled pesticide rate per acre to find the amount of chemical to add to the tank. Refer to the section at the end of the manual "Conversions and Calculations" for further explanation and examples on calculating the amount of pesticide formulation to add to a spray tank or apply to a given area.

Granular Applicators - Calibration of granular applicators must be done with the exact same material that is to be applied. Therefore, the calibration method must provide means for collecting and weighing the granules.

For broadcast applicators, select a plot of known area (an acre or less). Disconnect the spreading mechanism (if one is used) and attach a catchpan, plastic or other bag, or any appropriate container to catch the granules. Operate the applicator at the desired settings and ground speed with the same pesticide to be applied. Be careful to operate over only the measured plot and to catch all the material that flows through the unit.

For example, if you are spreading a 30-foot swath and want to use a 1/4 acre plot, you would drive 363 ft. [$1/4$ of $(43,560 / 30)$]. Assume you catch and measure 10 pounds of granules. The application rate would be 40 pounds of granules. The application rate would be 40 pounds per acre (10×4). Adjust settling and rerun until desired rate is achieved.

Since granular band applicators cover such a small area, it is easier to calibrate by band or row length. Disconnect the drop tubes and collect the granules in a bag or can while operating over 1,000 feet. The granules collected should be measured by weight since volume measurements may cause errors due to variation in settling of the materials. The pesticide will amount to only a few ounces; this can be weighed on a postal scale or a no longer needed baby scale. Check the amount actually delivered with the recommended rate. If the recommendation is given in pounds per acre rather than ounces per row length, refer to the table for conversion. For example, if 7 pounds of chemical per acre is recommended on 38-inch rows, you should collect 8.1 ounces while your equipment moves 1,000 feet. Adjust the applicators and repeat calibration runs until the desired delivery rate is obtained from all applicators.

Band Application of Granular Pesticides

Row Spacing (inch)	Row Length per acre (ft)	Wt (ounces)/ 1,000 ft of row			
		1 lb/A	5lb/A	7lb/A	10lb/A
20	26,136	0.61	3.1	4.3	6.1
24	21,780	0.73	3.7	5.1	7.3
28	18,669	0.86	4.3	6.0	8.6
30	17,424	0.92	4.6	6.4	9.2
32	16,335	0.98	4.9	6.9	9.8
34	15,374	1.04	5.2	7.3	10.4
36	14,520	1.10	5.5	7.7	11.0
38	13,756	1.16	5.8	8.1	11.6
40	13,068	1.22	6.1	8.6	12.2

Hint: Values in the columns can be added. For example, to determine the amount to collect for a 15-pound per acre rate, add the value in the 5-pound per acre column to the value in the 10-pound per acre.

Calibration should be repeated for any change in conditions (temperature, humidity, lot number of granules), when using a different chemical, driving at a different speed, or changing the agitator speed.

FILLING AND MIXING PESTICIDES

Some pesticides are used just as purchased. These include baits, garden dusts, dry granular materials, those contained in pressurized cans, and some liquid household and livestock sprays. However, most custom applicators will stock concentrated pesticides such as wettable powders or emulsifiable concentrates that must be diluted with other liquids before using. Water is the most common liquid used. The pesticide is added to the sprayer tank during filling or at the area to be treated.

Where to Mix - Whenever possible it is best not to add the pesticide to the tank or the granules to the hopper until just before you are ready to apply. This is particularly true when you are going on a job that you have not checked previously. If the pest is different than you expected, you are not faced with the use or disposal of a tankful of the wrong pesticide for the problem. On the other hand, a pest control operator treating an apartment should not carry any concentrate into the apartment. Therefore, the applicator may have to mix the pesticide beforehand.

Safe Practice for the Applicator - The applicator is most likely to be dangerously exposed to pesticides when mixing since the concentrated forms are being handled. Liquid concentrates may splash on the applicator's skin or in his/her eyes unless they are protected. Chemicals may spill on clothing where they may soak through to the skin, or expose whoever handles the clothing later on. He/she may breathe particles from highly concentrated wettable powders or from granules or dusts. It is easy to contaminate hands then unintentionally carry the

pesticide to the mouth when smoking, eating, or rubbing lips or eyes. It is especially important that all safety precautions called for on the label be followed during mixing. Never use bare hands when mixing a highly toxic material or when cleaning a tank. It is also important that soap, water and good washing facilities be maintained at the mixing area.

Protect the Environment - The environment is also easily harmed by careless mixing and filling procedures. If suction hoses are not equipped with good anti-siphoning devices such as check valves, the spray mixture from the tank may escape down the hose into the water source stream, pond, or well. If the applicator allows the tank to run over when filling, the overflow carrying pesticides will usually end up in the water source or as toxic puddles on the ground. The applicator should never leave a piece of equipment unattended that is being filled.

Empty and Rinse - "Empty" pesticide containers are not truly empty. As soon as they are emptied, containers with liquid pesticides should be rinsed. Rinse the measuring cup too! Rinse them at least three times with the same liquid that the tank is being filled with. Then empty the rinsate into the sprayer tank. All containers must be accounted for and properly disposed of. Otherwise, they may end up in the water source or poison other people or animals. Rinsing can save you money, too!

Compatibility - Often two or more pesticides are mixed together in the sprayer tank in order to control more than one pest with the same application. However, the pesticides must be compatible, that is, they must be able to be mixed together without reducing their effectiveness in any way. The pesticides may be chemically incompatible. A chemical reaction between them may result in loss of pesticidal activity, increased toxicity to the applicator, or injury to the treated surface. It is also possible that the pesticides may be physically incompatible. Mixing the pesticides may cause wettable powders to form lumps. Liquids may settle into layers or form solids that settle out. The label often lists compatibilities of the pesticide involved and compatibility charts are available in college recommendations, pesticides

trade publications, etc. It is better to mix liquids with liquids, or wettable powders with wettable powders rather than a liquid with a wettable powder. If you do not know whether two pesticides are compatible, it is wise to mix a small portion of the pesticides together in a glass jar with water to see if any problems appear.

Adjuvants - An adjuvant is a chemical added to a pesticide mixture that helps the active ingredient do a better job. Most pesticide formulations include a small percentage of adjuvants (additives). Wetting agents and emulsifiers are needed so that the pesticide chemical will mix with water. Spreaders and stickers help make 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 aid the pesticide to get through the outer surface (leaf, root, skin) and into the plant. The formulations as manufactured contains enough of these materials for many jobs, but sometimes extra additives are called for. For example, when treating waxy surfaces such as cabbage or onion leaves, a spreader-sticker may be needed. These extra additives are added directly in the spray tank. Care must be taken to use only the amount recommended or the result may be less deposit rather than more, resulting in poor control. Other types of additives include thickeners, invert emulsifiers, 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 saving a little money, too.

WEATHER WISE APPLICATIONS

Weather-wise application can reduce pesticide hazard to the environment. A good applicator carefully checks the weather conditions before beginning spray procedures. Not only do a few simple precautions protect the environment, but in terms of dollars and cents, they aid the applicator. Pesticides

which do not reach or remain on the target areas are wasted. More pesticide, more time, and thus more money must be used to control the pests in the target area.

Avoid Windy Days - High winds increase drift and result in loss of the pesticide on treated areas. Drifting pesticides increase the possibility of injury to wildlife, pollinators and domestic animals. They may settle on forage, pasture or wildlife areas or contaminate water. Pesticide application on quiet days reduces the inhalation and contact hazard to the applicator and the bystander. Drift onto sensitive crop areas can also be avoided in this way. The applicator is legally responsible for any injury or money loss on crops due to pesticide drift onto non-target areas. Don't take a chance by spraying in the wind.

Avoid Application Just Before Heavy Rains - Spray applications should not be made just before a heavy rain because the pesticide washes off and the pests are not controlled. Some protectant fungicide sprays are put on the leaves before and during a rain. Heavy rains cause runoff and tend to wash the pesticide away from the target area. The runoff can carry the pesticide into sensitive areas where crop injury may result. Runoff often reaches farm ponds, streams and waterways causing contamination, fish kills, or injury to domestic animals such as dairy cows.

Consider Early Morning or Evening Application - Wind speed is usually lowest at these times each day and drift hazard is greatly reduced. Children and domestic animals are less likely to be in sprayed areas during these hours. Avoiding full daylight hours lowers the contact danger to wildlife - birds, mammals, pollinators - who often visit crop lands only during the day.

PESTICIDE FORMULATIONS

A pesticide chemical can only rarely be used as originally manufactured. The pesticide must be diluted with water, oil, air, or chemically inactive (inert) solids so that it can be handled by application

machinery and spread evenly over the area to be treated. Usually the basic chemical cannot be added directly to water or mixed in the field with solids so the manufacturer must further modify the product by combining it with other materials such as solvents, wetting agents, stickers, powders, or granules. The final product is called a pesticide formulation and is ready for use, either as packaged or diluted with water or other carriers.

Types of Formulations - A single pesticide is often sold in several different formulations. The applicator should choose the formulation that will best meet the requirements for a particular job. Considerations in making a choice include effectiveness against the pest; habits of the pest; the plant, animal or surface to be protected; application machinery; danger of drift and runoff; and possible injury to the protected surface. Abbreviations are sometimes used to describe the type of formulation involved. These abbreviations are often used on labels and in recommendations. Some of the common ones are: WP for wettable powder; F for flowable; G for granules or granular; D for dusts; SP for soluble powder; EC for emulsifiable concentrate; SC for spray concentrate.

These abbreviations may also be preceded by a number. This number tell the user something about how much active ingredient is present in the formulation.

For dry formulations, such as wettable powders, dusts, and granules, the number refers to the percentage of active ingredient that is present in the formulation. Therefore, 50WP means that 50% of the formulation is active ingredient.

In the case of liquid formulations, such as emulsifiable concentrates, the number refers to the pounds of active ingredient present per gallon of formulation. Therefore, 4EC means that the formulation contains 4 pounds of active ingredient (a.i) per gallon of formulated material. This number also gives the user a rough approximation to the percentage of active ingredient in the formulation. The following table illustrates these approximations:

Amount per gallon	% a.i.
2 lbs	20
3 lbs	30
4 lbs	40
5 lbs	50
6 lbs	60

Pressurized Cans - Pressurized cans (aerosols, "bug bombs") contain a small amount of pesticide or a combination of pesticides that is driven through a fine opening by a chemically inactive gas under pressure when the nozzle is triggered. Usually they are small, weighing about one pound.

Advantages - Pressurized cans are very convenient in that they are always ready to use. They are also a convenient way to buy small quantities of a pesticide. They are easily stored and the pesticides do not lose their strength (potency, activity) while in the can during their normal period of use.

Disadvantages - Pressurized cans are only practical for use in small areas. There is not much active ingredient in any one can. Because of this it is an expensive way to buy pesticides. They are also attractive playthings for small children and if left within reach are a hazard. Aerosols can be dangerous if punctured or overheated. They may explode and injure someone. Don't ever try to burn the cans.

Principal Uses - Pressurized cans are most often used in households, backyards, tents and other small areas. They may be used either as space sprays for flying insects or as residual sprays. Usually they are used against insects, but some are designed for plant diseases or weed killers. There are commercial models available for use in greenhouses, barns, etc. These are larger models holding five to ten pounds of materials, and they usually are refillable.

Dusts - A prepared dust is a finely ground, dry mixture combining a low concentration of the pesticide with an inert carrier such as talc, clay or volcanic ash. There is a wide range in size of the dust particles in any one formulation.

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

Disadvantages - Because dust particles are finely ground they may drift long distances from the treated area and may contaminate crops, pastures, and wild areas. While drifting they are highly visible and may cause public criticism. When used outside they are easily dislodged from the treated surface by wind and rain and soon become inactive. Never apply dust formulations on a windy day.

Principal Uses - Because they drift badly, dusts are not recommended for large scale outside use. Outside they are used principally for spot treatments and home gardens. They work best when applied to dewy surfaces in the early morning. Inside they are used in cracks and crevices for roaches and other domestic insects. Dusts are also used to control lice, fleas and other parasites on pets and farm animals.

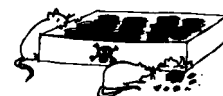
Poisonous Baits - A poisonous bait is a food or other substance mixed with a pesticide that will attract and be eaten by pests and cause their death.

Advantages - Baits are useful for controlling pests such as flies, rats or blackbirds that range over a large area. Often the whole area need not be covered; just those spots where the pests gather. Baits may be carefully placed in kitchens, gardens, granaries and other agricultural buildings so that they do not contaminate food or feed, and can be removed after use. Usually only small amounts of pesticide are used in comparison to the total area treated, so environmental pollution is minimized.

Disadvantages - Within the home, baits are often attractive and dangerous to children or pets and must be used with care. Outside they may kill domestic animals and wildlife as well as the pest. Often the pest will prefer the protected crop or food rather than the baits, so the baits may be ineffective. When larger pests are killed by baits the bodies must be disposed of. If not, they may cause an odor problem in houses. Other animals feeding on the poisoned animals may also be poisoned.

Principal Uses - Baits are used inside buildings for pests such as ants, roaches, flies, rats and mice. They may be used outside in gardens for control of slugs, in dumps and similar areas for rat control, and in fields to control slugs, some insects, and blackbirds (under government supervision).

Granules (pellets) - Like dusts, pesticide granules are dry, ready to use, low concentrate mixtures of pesticide(s) and inert carriers. However, unlike dust, almost all of the particles in a granular formulation are about the same size and are larger than those making up a dust. A fine granular pesticide pours like ordinary table salt or sugar.



Advantages - Granules are ready to use as purchased, with no further mixing necessary. Because the particles are large, relatively heavy, and more or less the same size, granulars drift less than most other formulations. There is little toxic dust to drift up to the operator's face and be inhaled. They can be applied with simple, often multipurpose, equipment such as seeders or fertilizer spreaders. Also, they will work their way through dense foliage to a target underneath.

Disadvantages - With a few exceptions granulars are not suitable for treating foliage because they will not stick to it.

Principal Uses - Granular pesticides are often used for soil treatments to control pests living at ground level or underground. They may be used as soil systemics, that is, formulations applied to soil that are absorbed into the plant through the roots and carried throughout the plant. Granular herbicides or insecticides, or both, are frequently applied in combination with fertilizers on turf, thereby saving labor. Granular formulations may be the choice when applied by agricultural aircraft where drift is a problem or when treating water for mosquitoes where there is a heavy cover of foliage over the water.

Low Concentrate Liquids - These preparations are usually solutions in highly refined oils that contain low concentrations of the pesticide. They are generally used as purchased.

Advantages - Low concentrate solutions are designed to be sprayed as purchased. Because of this, no mixing is necessary and this lessens the chances for making mistakes. Household formulations have no unpleasant odors; and usually the liquid carrier evaporates quickly and does not stain fabrics, furniture, etc.

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

Principal Uses - Low concentrate solutions may be used in the household for flying or crawling insects and for moth proofing clothes. In barns they are used as space sprays and fly sprays for livestock. In the field they are used as prepared sprays for mosquito control and shade tree insect control.

High Concentrate Liquids, Spray Concentrates - These preparations are usually solutions containing a high concentration of the pesticide. Most of them are designed to be mixed with water (emulsifiable concentrates) or oil and so contain wetting agents, stickers, and other additives. They may contain as much as eight or more pounds of the pesticide per gallon of concentrate. Ultra low volume (ULV) concentrates are designed to be used without further dilution and contain little other than the pesticide itself.

Advantages - These formulations contain a high concentration of pesticide so the price per pound of active ingredient is rather low. Only moderate agitation is required in the tank so they are especially suitable for low pressure-low volume weed sprayers, mist blowers, and small home grounds sprayers. They are not abrasive and do not settle out when the sprayer is not running. There is little visible residue which generally allows their use in populated areas.

Because of the high pesticide content, the applicator is not required to store, transport and handle a large bulk of chemical for a particular job.

Disadvantages - It is easy to underdose or overdose because of the high concentration of pesticide if directions for mixing are not carefully followed. Mixtures of emulsifiable concentrates may be phytotoxic. Also because of the high concentration and liquid form which is usually easily absorbed through the skin, there may be hazard to the applicator. The hazard of improperly stored concentrates can also be high. Because of their solvents, most liquid concentrates cause rubber hoses, gaskets, and pump parts to deteriorate rapidly unless they are made of neoprene rubber. Some formulations cause pitting in car finishes.

Principal Uses - High concentrate liquids can be diluted and used in many ways - on fruit, vegetables, shade trees, for residual sprays, on farm animals, for structural pests. They are adaptable to many types of application equipment ranging from household sprayers to dilute hydraulic sprayers, low volume ground sprayers, mist blowers, low volume agricultural aircraft sprayers, and ultra low volume sprayers (usually on aircraft).

Flowables - Some pesticides can be manufactured only as solid materials, not as liquids. Often these pesticides are formulated as flowables.

Flowables are made from finely ground solid materials which are suspended in a liquid. In this form they can be mixed with water and applied. Flowables are similar to high concentrate liquids and are used in the same way. Flowables do not usually clog nozzles and require only moderate agitation.

Wettable Powder, Soluble Powders - These are dry preparations containing a relatively high concentrate of pesticides. Wettable powders are mixed 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 it is true with liquid concentrates, the pesticides in wettable powders are relatively low in cost and easy to store, transport, and handle. They are safer to use on tender foliage and usually do not absorb through the skin as rapidly as liquid concentrates. They are easily measured and mixed when preparing spray suspensions.

Disadvantages - Wettable powders may be hazardous to the applicator if their concentrated dust is inhaled while mixing. They require good agitation (usually mechanical) in the sprayer tank and will settle out quickly if the sprayer is turned off. They cause some pumps to wear out quickly. Their residues are more subject to weathering than liquid concentrates, and because they are more visible, they 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 the skin of an animal is a problem, use a wettable powder suspension rather than a liquid emulsion or solution of the pesticide.

Fumigants - Fumigants are pesticides in the form of poisonous gases that kill when absorbed or inhaled.

Advantages - A single fumigant may be toxic to many different forms and types of pests. Therefore, a single treatment with one fumigant may kill insects, weeds seeds, nematodes, and fungi. Fumigants penetrate into cracks, crevices, burrows, partitions, soil and other areas that are not tight and expose hidden pests to the killing action of 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 incorporated into the soil so it doesn't escape. Frequently fumigants are highly toxic, so proper techniques and all recommended protective gear must be used when applying them. Most fumigants will burn the skin.

Principal Uses - Fumigants are used inside dwellings or other buildings to control vermin that cannot easily be reached by other pesticide formulations. They are used in ports of entry and at the state borders for treatment of plants and other materials to prevent introduction of new pests into an area. Stored grain pests are often controlled by fumigants. Soil is fumigated to sterilize it from pests before planting.

Choice of the right formulation can make the difference between a successful control job with minimal hazard to the environment or a failure that does more harm than good.

CALCULATIONS

In mixing a finished spray it is most important to add the correct amount of pesticide to the mix. Too little may result in a poor job, while too much may result in injury to the treated surface, illegal residues on food crops, or unnecessary expense. Directions for mixing are given on the label and only very simple calculations are necessary.

Wettable Powder Mixing - You may be given directions to add 2 pounds of pesticide in 100 gallons of water and you wish to fill a 300 gallon tank. Since you know that 300 gallons is 3 times 100 gallons, you simply add 3 times 2 pounds, or 6 pounds in 300 gallons. If you wish to mix only 20 gallons of finished spray you must use some simple arithmetic. Follow these steps:

1. Find what part 20 is of 100

$$20/100 = 2/10 = 1/5$$

OR 20 goes into 100 five times

So, 20 gallons is 1/5 of 100 gallons.

2. Therefore, you must add 1/5 of 2 pounds of pesticide to your finished spray.

1 pound contains 16 ounces; 2 pounds contain 32 ounces.

1/5 of 32 oz. = 32 divided by 5

Another way to handle the above situation would be to figure that at 2 pounds per 100 gallons, 0.2 (two tenths) pound is required for every 10 gallons.

$$2 \text{ lbs}/100 \text{ gal} = 0.2 \text{ lbs}/10 \text{ gal}$$

0.2 of 16 ounces = 3.2 ounces, so every 10 gallons requires 3.2 ounces. Twenty gallons would require 6.4 ounces.

Liquid Mixing - Liquids are mixed in the same manner. If your directions call for 2 pints emulsifiable concentrate per 100 gallons, 300 gallons will take 6 pints, and 20 gallons will take 0.2 (two tenths) of 2 pints.

Example:

2 pints (1 quart) = 32 fluid ounces.
0.2 of 32 = 32 X 0.2 = 6.4 fluid ounces.

A used plastic 2-cycle engine oil container with fluid measurements stamped on the side makes a good measure for liquid amounts up to one quart. The top should be cut off above the 1 quart mark for easy filling and pouring.

Percentage Mixing - Sometimes you will find directions telling you to make a finished spray of a specific percentage, for instance a 1% spray for ants. The pesticide may be formulated as a 57% emulsifiable concentrate. To make a 1% finished spray you would add 1 part of pesticide to 56 parts of water. For example, 1 fluid ounce in 56 fluid ounces (1 3/4 quarts) of water.

When mixing percentages you should remember that 1 gallon of water weighs about 8.3 pounds and 100 gallons weigh about 830 pounds. Thus, to make 1% mix of pesticide in 100 gallons of water you must add 8.3 pounds of active ingredient of pesticide to 100 gallons of water. The following formulas may be used for reference.

Formula for Wettable Powder Percentage Mixing.

To figure amount of wettable powder to add to get a given percentage of active ingredient (actual pesticide) in the tank:

$$\frac{(\text{gal of spray wanted}) \times (\% \text{ a.i. wanted}) \times 8.3 \text{ lbs/gal}}{(\% \text{ a.i. in pesticide used})}$$

Example:

How many pounds of an 80% wettable powder are needed to make 50 gallons of 3.5% spray for application by mist blower?

$$\frac{50 \text{ Gal} \times 3.5\% \times 8.3 \text{ lbs/gal}}{80\%} = \frac{1452.5}{80} = 18.2 \text{ lbs } 80\% \text{ WP}$$

Formula for Emulsifiable Concentrate Percentage

Mixing. To figure amount of emulsifiable concentrate to add to get a given percentage of active ingredient (actual pesticide) in the tank use the following formula:

$$\frac{(\text{gal of spray wanted}) \times (\% \text{ a.i. wanted}) \times 8.3 \text{ lbs/gal}}{\text{lbs a.i./gal} \times 100}$$

Example:

How many gallons of a 25% emulsifiable concentrate (2 pounds pesticide per gallon) are needed to make 100 gallons of 1% spray?

$$\frac{100 \text{ Gal} \times 1.0\% \times 8.3 \text{ lbs/gal}}{2 \text{ lbs a.i.} \times 100} = \frac{830}{200}$$

Square Feet Mixing

Often the label will give mixing instructions in terms of quantities of pesticide to be used per 1000 square feet as in turf treatments, or per acre as in commercial vegetables. In this case you will have to determine and adjust the amount of liquid your sprayer applies over a given area. This is called calibrating the equipment. When the equipment is calibrated you can add the proper amount of pesticide to give the recommended dosage per area.

USEFUL FACTS TO REMEMBER

- * 1 gallon of water weighs about 8.3 pounds.
- * 100 gallons of water weigh about 830 pounds.
- * 1 pound = 16 ounces = 453.6 grams.
- * 1 pint = 16 fluid ounces = 473 milliliters.
- * 1 quart = 32 fluid ounces = 946 milliliters = .946 liters.
- * 1 pound wettable powder per 100 gallons = 1 tablespoon per gallon (approximately).
- * 1 pint emulsifiable concentrate per 100 gallons = 1 teaspoon per gallon.
- * One gallon of kerosene weighs 6.6 pounds. One hundred gallons weighs 660 pounds.

RODENTICIDE APPLICATIONS

N.J.A.C. 7:30-9.5 requires that tamper resistant bait boxes for rodenticides be used in areas accessible to children (person under 18 years of age), pets or wildlife.

Rodent control bait boxes, whether they are required to be tamper resistant or not, must either have a copy of the EPA registered label attached to the bait box **OR** have attached to the bait box the following information:

- * Brand or trade name of the rodenticide;
- * EPA registration number;
- * Name and percentage of active ingredient(s) in the bait box; and
- * Appropriate signal word from the label; that is Danger-Poison, Warning, or Caution.

This bait box labeling requirement is met if the bait that is used is packaged with the label on it; for example, throw packs.

SELF STUDY QUESTIONS

The following kinds of pesticide application equipment are used in New Jersey:

- A) ULV applicator
- B) Speed sprayer
- C) Mistblower
- D) Low pressure boom sprayer
- E) 1 gal, pump sprayer
- F) High pressure sprayer with hand gun
- G) Hand operated, 3 ft swath, granular application
- H) Ground fogger on a truck

Select the kind of application equipment from the list above which is best for the type of work described below:

1. The kind of equipment which is most useful to spray shade trees on a private property is:

B () C () D () F ()

2. The kind of equipment which is most useful to the pest control operator doing cockroach control work is:

C () D () E () G ()

3. The kind of equipment which is most useful to the commercial vegetable grower is:

A () B () D () F ()

4. The pesticide equipment which uses air as a medium to transport pesticides to the target is a:

- A) high pressure sprayer.
- B) mistblower.
- C) low pressure sprayer with boom.

5. The pesticide application equipment which uses water as a medium to transport pesticide particles to the target is:

- A) an aerosol generator.
- B) a mist blower.
- C) a low pressure, boom sprayer.

6. The pesticide application equipment, the operation of which is least subject to drift, is called a:

- A) fogger.
- B) mist blower.
- C) row-crop, airblast sprayer.
- D) hydraulic sprayer.

The gallonage output of a sprayer depends upon a number of factors including the gallons per minute capacity of the pump, the size of the opening in the nozzle, the pressure (psi), and the speed of travel (MPH).

7. The gallonage output of a sprayer can be increased by:

- A) increasing the speed of travel.
- B) increasing the number of nozzles.

8. The gallonage output of a sprayer can be decreased by:

- A) decreasing the RPM's of the sprayer motor.
- B) decreasing the speed of travel.

9. The dosage applied by a sprayer (like a mist blower or row crop sprayer) can be increased by:

- A) decreasing the size of openings in the nozzles.
- B) decreasing the speed of travel.

10. An increase in pressure causes a decrease in spray droplet size.

T () F ()

11. Traveling at the rate of 540 feet per minute is approximately:

- A) 2 MPH
- B) 6 MPH
- C) 4 MPH
- D) 8 MPH

12. Weighing, measuring, mixing, and filling are usually considered to be more hazardous to the applicator than spraying because:

- A) the wind blows the pesticide away faster in spraying.
- B) the applicator wears a respirator, gloves, and other safety equipment while spraying.
- C) there is less exposure time in spraying.
- D) in measuring, mixing, and filling the applicator may come in contact with more concentrated pesticide.

13. When mixing two pesticides together, wettable powders may form lumps or the liquids may separate into layers; the most likely reason for this is:

- A) not enough agitation.
- B) too fast a mixing.
- C) mixed too slow.
- D) incompatibility.

14. Adjuvants are chemicals that are added to a pesticide mixture or to a pesticide spray to:

- A) aid in mixing with water.
- B) increase adhesiveness of the spray to a surface.
- C) help the spray spread evenly over a treated surface.
- D) all of the above.

15. To avoid incompatibility between two pesticides mixed together it is usually best to mix a wettable powder with:

- A) emulsifiable concentrates.
- B) dusts.
- C) wettable powders.
- D) soluble concentrates.

16. Mixing and filling for spraying can be done next to a stream or body of water without danger of pollution if supervised by a certified applicator.

T () F ()

17. Early morning and in the evening are good times to spray pesticides because:

- A) the applicator is less susceptible to toxic pesticides at these times.
- B) the pests eat more at these times of day.
- C) the weather is more desirable for spraying at these times of day.
- D) the pesticide is less effective when applied in bright sunlight.

18. The formulation of the pesticide, Methoxychlor 50W, is:

- A) 50%.
- B) methoxychlor 50%.
- C) 50% wettable powder.
- D) wettable.

19. The meaning of EC in the pesticide, Malathion 2EC, is:

- A) extra chemical activity.
- B) emulsifiable concentrate formulation.
- C) efficient control.

20. The major disadvantage of using dust formulations is:

- A) they are less effective.
- B) they drift off target.
- C) they are too heavy for the applicator to handle.

21. Low concentrate liquids are used in ULV (ultra low volume) pesticide applications.

T () F ()

22. Care must be used when placing baits for pests because:

- A) they may be attractive to children or pets.
- B) rodents may refuse them if they are not hidden.
- C) they are not an effective means of control.

23. The use of pesticides at dosages greater than that on the label can result in crop injury, illegal residues, and unnecessary expense.

T () F ()

24. When using a fungicide to spray fruit at the rate of 2 lbs. 50WP per 100 gallons of spray and applying 400 gallons of spray per acre, the amount of fungicide formulation needed to spray 6 acres of fruit is:

- A) 12 lbs.
- B) 24 lbs.
- C) 36 lbs.
- D) 48 lbs.

25. When using the dosage rate of 1/2 pound a.i. of weed killer 2E in 50 gallons of water per acre, the amount of weed killer needed to treat 8 acres is:

- A) 1 gallon.
- B) 2 gallons.
- C) 4 gallons.

26. If the directions call for two pints of a pesticide per 100 gallons of spray mixture, the amount to use in 12 gallons of spray is approximately:

- A) 2 ounces.
- B) 4 ounces.
- C) 8 ounces.

27. A 10,500 square foot sod area is sprayed with an insecticide at the rate of 1 1/2 fluid ounces per 1,000 square feet. At this rate the amount of pesticide formulation needed to spray 10,500 square feet of lawn is (approximately):

- A) 1/2 pint.
- B) 1 pint.
- C) 1 1/2 pints.

28. 600 gallons of spray containing 3 gallons of Sevin 4F were used to spray 12 acres of tomatoes. The dosage rate of Sevin used was:

- A) 1/4 gallon Sevin 4F per acre.
- B) 1/3 gallon Sevin 4F per acre.
- C) 1/2 gallon Sevin 4F per acre.
- D) 50 gallons Sevin spray per acre.

ANSWERKEY

- | | | | |
|------|-------|-------|-------|
| 1. F | 8. A | 15. C | 22. A |
| 2. E | 9. B | 16. F | 23. T |
| 3. D | 10. T | 17. C | 24. D |
| 4. B | 11. C | 18. C | 25. B |
| 5. C | 12. D | 19. B | 26. B |
| 6. D | 13. D | 20. B | 27. B |
| 7. B | 14. D | 21. F | 28. A |

CHAPTER SEVENTEEN

STORAGE AND DISPOSAL OF PESTICIDES

Learning Objectives

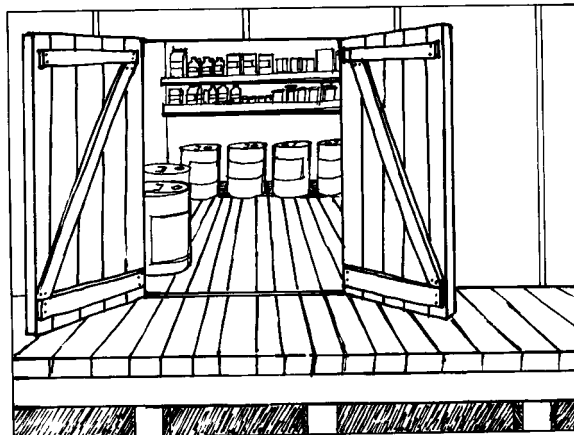
- * Explain the precautions which should be taken when transporting pesticides in a vehicle.
- * Describe the requirements for setting up and maintaining a safe pesticide storage site.
- * Describe what to do with surplus pesticides and what action is necessary in the event of a pesticide spill.

PESTICIDE STORAGE

No job is really finished until the pesticides, the containers, and your equipment have been put away properly. Get into the habit of storing all your materials safely away before you clean up and go home or on to the next job. While you are cleaning up and putting away the pesticides, containers and equipment, you should wear all the protective clothing you used on the job. Consider wearing gloves even if they weren't recommended on the label. Spills and accidental contamination often occur during storage procedures.

THE STORAGE BUILDING

Most applicators use existing buildings or areas within existing buildings for pesticide storage. However, if you use large amounts of pesticides and/or equipment, you may decide to build a special storage building just for your pesticide needs. Before you



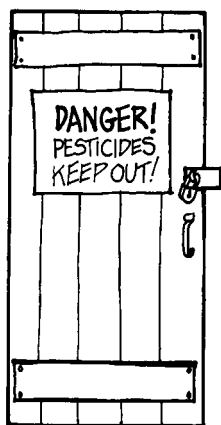
start the building you may wish to look into suggestions and plans for pesticide storage areas which are put out by the state colleges, chemical companies, county extension agents, etc. When you are setting up any new storage area, you should check federal, state and local regulations on chemical storage buildings. Use a separate building for your pesticide storage if possible. If you do not have a separate building, choose a wing or corner on the first floor of a building.

Choosing the Best Site - Whether you are choosing a site to build a new storage area or using existing buildings, you need to consider several points. The site should be in a area where flooding is unlikely. It should be downwind and downhill from sensitive areas such as houses, ponds and play areas. The site should also be chosen where windblown pesticide dusts and particles would not cause problems. There should be no chance that runoff or drainage from the site could contaminate surface or underground waters.

Setting Up the Storage Area - Pesticides should be stored in a cool, dry, airy room or building which is fireproof. The storage area should be fenced in and should always be locked tightly when unattended. Weatherproof warning signs should be hung over every door and window. These should say something like: **DANGER-PESTICIDES, KEEP OUT.** Windows are good so that fire hoses and other fire fighting equipment can be used through them in case of fire. They should, however, be barred so that children and other curious people cannot get in. Concrete flooring should be used, and a drainage system should be built to collect any runoff water. Pesticides which may be in tank rinsate, spills, seepage from the storage and heavy runoff from fire fighting or floods must be controlled. Otherwise they may contaminate surface or underground water. Dikes, collecting pools and washing slabs with sumps would provide a proper drainage system. All the

collected runoff water should be treated as a surplus pesticide and disposed of properly. A good supply of detergent or soap, hand cleanser, and water is a must in the storage area. It's convenient for filling tanks, cleaning off equipment and for you and your help to clean up with. It's also quick first aid in a poisoning emergency. In the event that material may enter the eyes during mixing, loading, or cleaning, and eye-

wash station or apparatus should also be maintained in the storage area. Absorptive clay, activated charcoal, vermiculite, pet litter, or sawdust should be readily available at the storage site to soak up spills and leaks. Hydrated lime and sodium hypochlorite (Clorox or other bleach) should also be on hand to neutralize the pesticide in emergency. A shovel, broom and dust pan and a fire extinguisher are a "must" in any storage area.



ARRANGING YOUR STORAGE AREA

A pesticide storage area, whether it is a room or whole building, should be used only for pesticides and pesticide equipment. Never store or use food, drinks, silverware, tobacco, smoking equipment, or protective equipment in the storage or loading area. Livestock feed, living plants, seeds, fertilizer or lime should not be stored with or below pesticides either.

Avoid Hot Place - Glass and metal containers of liquid pesticides should be stored where they are not in the sun or near other sources of heat such as steam pipes. Heat will cause the liquid to expand so that the contents will be under pressure. When the container is opened the pesticide may splash out on you. **No** pesticides should be allowed to become overheated. Some formulations will catch on fire if they get too hot. Others lose their strength and break down when they are exposed to heat. Also, protect sensitive pesticides from freezing. Freezing will destroy the usefulness of some pesticide products. Consult the label for temperature requirements. Freezing may also cause liquid pesticides to break their containers, resulting in leakage.

Special Areas - Herbicides should be stored in a special place apart from other pesticides. Some herbicides can volatilize (become a gas) and get into other pesticides nearby. When the contaminated pesticide is used, the herbicide vapors in it may injure or kill sensitive plants. All highly toxic pesticides should be stored together in a special area too. Then you and your helper working in that area can take special precautions to keep from being exposed. Also you are less likely to use a highly toxic pesticide by accident. A special "disposal" area should be used for surplus pesticides and their containers being held for disposal. They should be grouped together according to how you plan to dispose of them and plainly labeled. This will help prevent mixups resulting in improper disposal and even accidental reuse.

HANDLING PESTICIDE CONTAINERS

Pesticide containers should be stored with the label in plain sight. They should be stored up off the floor especially if they can be injured by dampness. Rigid containers should always be set in an upright position so they cannot spill easily. All containers should be placed in orderly rows with enough room to allow you and your helpers to walk between them.

Damaged Containers - All pesticide containers should be checked often for corrosion, leaks, loose caps and bungs. You must correct these dangerous conditions immediately. Pesticides should be stored in their original containers if possible. Other containers often are not properly labeled with dosages, uses and safety precautions. If a container is damaged, however, you should put the pesticide in a sturdy container which can be sealed. Be sure to label the new container. Sometimes you can take the label from the damaged container and firmly fasten it to the new container. If this is not possible, mark the container with the brand name, common chemical name, the EPA registration number, the percent active ingredient, and the signal word. Unlabeled pesticides are worthless since you don't know what they are or how to use them. They should be treated as surplus pesticides and held for disposal. Partly empty pesticide containers should be resealed and returned to storage. If their container is damaged, place the pesticide in a tight container and carefully label it. Paper drums or plastic bags placed within another container are handy for this purpose. Opened containers of chlorates (often used as weed killers) should not be stored. They can burst into flames at any time.

Improper Containers - Pesticides should be stored in their original containers, with the label plainly visible and the seal cap securely closed. Containers should be dated when purchased. Out dated material should be discarded. Never store pesticides in anything used as a food or drink container even for a short time. Pesticides stored in coke bottle, fruit jar, milk carton, etc. are a common cause

of accidental pesticide poisoning. Never dump a little of your tank-mix in a jar and hand it to your customers. You will not be doing them a favor.

See Chapter 2 for Pesticide Storage Area Requirements

PESTICIDE EQUIPMENT STORAGE

All pesticide application equipment should be stored in a special area, too. Often the equipment is contaminated with pesticides. All items used for handling pesticides at the storage site, which might be used for other purposes, should be labeled "contaminated with pesticides" and should not be removed from the site unless thoroughly decontaminated. Never let children or uninformed people play on or around your machines. They could pick up a harmful dose of pesticide. Do not store pesticides next to food, feed, or other articles intended for consumption by humans or animals.

Always wash your equipment carefully before you store it. Thoroughly rinse off the outside while it is parked in the special wash area. Do not allow rinse water to get on the ground and into streams, ponds, or other sensitive areas. Collect it and hold for proper disposal. All movable pesticide equipment should have a sign: "Danger...Pesticides" to warn people to stay away. Delivery trucks, nurse tanks and other support equipment should be rinsed thoroughly and stored, too. Materials such as adsorptive clay, hydrated lime, and high pH commercial detergent should be available for use as appropriate emergency cleanup agents for spills or leaks. Keep a shovel, broom, dust pan, absorbent material, container for disposal, and sprinkler can for decontamination and cleanup of spilled materials.

SAFETY MEASURES

A little care and common sense can help prevent many accidents and emergencies in the storage area. You and your helpers should know the basic safety rules and follow them. You should 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 that everyone follows the rules.

Protect Yourself and Others:

1. Do not allow children, pets or uninformed persons into the storage area. Lock the storage area when unattended.
2. Wear gloves, when you are handling containers of pesticide concentrates. Use more protective clothing if the label says to.
3. Do not put your fingers in your mouth or rub your eyes while you are working.
4. Do not store or use tobacco, food, or drinks in areas where pesticides are present.
5. Wash your hands carefully before eating, drinking, smoking or using the toilet. Wash them as soon as you are finished handling the pesticides.
6. Do not handle pesticide containers roughly; they are not meant to be thrown, dropped or abused. Check all containers for leaks before you handle them.

Spills - In spite of all safety precautions, accidents will happen. If a pesticide spills in your storage area, quick action must be taken. If the pesticide gets on anyone, wash it off immediately. Have him/her change clothes, get out of the area and see a doctor if necessary. Clear the storage area except for a small clean-up crew. Be sure the crew wears the proper protective equipment. Notify the authorities as described in Chapter 3 under 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 over one gallon of liquid or one pound of dry active ingredient is spilled, it must be reported to the NJDEPE after cleanup.

If the spill is a liquid, throw activated charcoal, absorptive 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, then sweep or shovel it directly into a large drum. Sweeping compounds can be useful when picking up spills of dry pesticides (absorbent materials are not useful for dry spills). Next cover the area with hydrated lime or sodium hypochlorite (bleach) to neutralize the pesticide. Rinse the whole area with plenty of water to wash away any remaining poison. Collect the rinse water and hold it for proper disposal. Check your storage area over 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 too. When you are all finished, seal the drum tightly and store for disposal.

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 proper protective clothing. They should avoid breathing or contacting the smoke or fumes at all times. If they do contact the smoke or fumes, they should get out of the area fast and wash off. Post signs around the area and give fire department officials a floor plan of the storage area, if possible. Keep all people without protective gear away from the fire. Everyone who might contact the smoke, fumes, or contaminated surfaces must be removed from the area. All water used in fire fighting should be contained in the storage area drainage system for safe disposal. It can be poisonous too.

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. The samples should be assessed to be sure that no pesticides are getting out into the environment.

Make it a habit! Store your pesticides and equipment away properly before you clean up and go home or on to the next job.

DISPOSAL OF PESTICIDES AND THEIR CONTAINERS

As a custom applicator you have two disposal problems. First, you must safely dispose of surplus pesticides - concentrated or tank mixed - that you have no use for. Secondly, you must safely dispose of empty pesticide containers. Careless disposal practices are a common cause of pesticide misuse and environmental contamination. Take the time to dispose of surplus pesticides and empty containers carefully. Never give them to homeowners, children or uninformed persons for any purpose.

Surplus Pesticides

There are several ways in which you may end up with surplus pesticides. The government may cancel the registration on the chemical or the use may no longer be effective. You may buy more pesticide than you really need or you may have some left in the tank after the job is done. You may have contaminated water left over from cleaning operations, spills, or rinsing. The pesticide may have lost its strength in storage, the container may be damaged, or the label may be missing.

Preventing Pesticide Surplus - Sometimes you cannot avoid having surplus pesticides. However, there are ways to cut down on pesticide surplus. Always check to be sure the pesticide is fully registered and is effective against the pest before you buy it. Recommendations may change and newer chemicals may be better than older ones. The storage period may also exceed the effective shelf life of the product. Estimate your needs and buy only what you need for one year. This will reduce carryover and the chance of spills, damaged containers, and loss of strength of the pesticide. Avoid mixing the pesticide in the tank until after you have checked out the job. Then you are not faced with the disposal of a tank load of the wrong pesticide for the problem. Mix only enough pesticide for the job at hand so that you end up with an empty tank or hopper. Preventing pesticide surplus is the best way to take care of your disposal problem.

What To Do With Surplus Pesticides - If you have pesticides which you cannot use or do not want, you must take steps to safely get rid of them. Pesticides which are still in the original container or still in the concentrated form may be returned to the manufacturer. Check with the company and see if they will take your surplus back. *If you mix too much pesticide for a job, try to find other areas with the same problem or a site listed on the label and use up any extra tank mix or rinse water on these.* Be careful with herbicide-contaminated rinse water on sensitive plants. It is not legal to reuse rinse water in mixtures of other pesticides. Never dispose of pesticide contaminated rinse water in a manner that will contaminate public or private water sources or sewage treatment facilities. If the manufacturer won't take back your concentrates and/or you cannot use up your pesticides, you must find other safe ways to dispose of your surplus. Store your extra pesticides in your regular locked storage area while you are waiting to dispose of them locally. Keep them in their original containers with the label if possible. Otherwise 55 gallon steel drums with clamps covers make good storage containers for smaller empty containers or other surplus pesticides.

Empty Pesticide Containers - Empty pesticide containers are not really "empty." They still contain small amounts of pesticide even after they have been rinsed out properly. Never toss them in streams, ponds, fields or empty buildings. Be able to account for every container you used for the job. Never give them to children to play with or allow uninformed persons to have them for any use. Dispose of all your pesticide containers carefully and properly. You should separate the empty containers for disposal into three main types: those that will burn, those that will not burn, those that contain mercury, lead, cadmium, arsenic or inorganic pesticides. ***All empty containers regardless of their type should be rinsed three times before disposal.*** The rinse water should be dumped in the tank if possible. Otherwise you must treat it like a surplus pesticide and dispose of it properly. Never dump rinse water out on the ground!

Do not burn or bury empty pesticide containers. Follow your local, state, and federal regulations when disposing of containers.

Containers with mercury, lead, cadmium, arsenic or inorganic pesticides must be handled differently from other pesticide containers. The containers may be wood, cardboard, paper, metal, plastic or glass. They are special because the type of pesticide they contained is very persistent and hazardous in the environment. Special methods such as encapsulation may be necessary for their safe disposal. Encapsulation means to seal the pesticide and “empty” container in a sturdy, waterproof container so that the contents cannot possibly get out. Check federal and state regulations for disposal of these containers. You may wish to store your empty containers of this type while waiting to dispose of them. They can be crushed and placed in a 55 gallon drum. Keep these containers in a different drum than the one containing regular non-burnable pesticide containers. Do not burn empty containers which held mercury, lead, cadmium, arsenic or inorganic pesticides. Wood, cardboard and paper containers of this type should be crushed and stored in the 55 gallon drum with the other containers.

HOW TO TRIPLE RINSE CONTAINERS

Triple rinsing may be accomplished in the following manner:

Drain the container by holding the container in a vertical position for 30 seconds. Add a solvent capable of removing the pesticide from the pesticide container so that it is approximately 1/4 full. Agitate the container thoroughly, then drain the liquid (rinsate) into the spray tank, holding it in a vertical position for 30 seconds. Repeat the same operation twice.

In practice, the material capable of removing the pesticide is the material listed on the label which is generally mixed with the pesticide (i.e., water, oil, etc.). Once triple rinsed, the container should be crushed, punctured and disposed of in a facility licensed to manage waste type #27. Information on

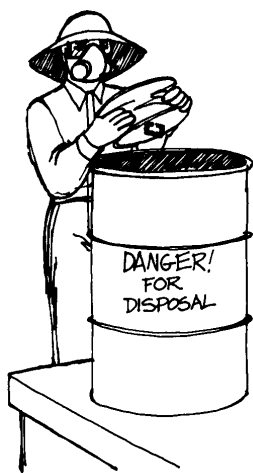
the location of the proper facility can be obtained by calling the appropriate County Solid Waste Management Office. Containers can also be turned over to a drum reconditioner or a legitimate recycler or reclaimer if the label on the product does not prohibit this.

Obviously, triple rinsing is not practical in the case of ULV, granular, dust, or bait formulation, pressurized containers, or bags. If containers or any of the above have held acutely hazardous waste, they must be disposed of in accordance with Hazardous Waste regulations. However, even if the pesticide waste qualifies as a hazardous or acutely hazardous waste the applicator may be eligible for reduced requirements as a “small quantity generator.” A small quantity generator is one who produces a total quantity of 1 kilogram (2.2 lbs.) or less of acutely hazardous waste in any one month or a total quantity of 100 kg. (220 lbs.) or less of hazardous waste per month. A small quantity generator is free from the requirements of manifesting the waste, using a registered hazardous waste hauler, disposing of the waste in a registered treatment, storage, and disposal facility and become registered as a hazardous waste generator.

A small quantity generator may dispose of pesticide waste in any facility licensed to manage New Jersey Waste Type #27 or exercise several other options. He may use other states’ facilities licensed to manage municipal or industrial waste or any facilities which reclaim or recycle the waste. For more details on disposal of pesticides containers and pesticide waste refer to the Pesticide Control Program’s “Guidelines for Disposal of Empty Pesticide Containers and Pesticide Waste.” You can also contact the Hazardous Waste Manifest & Information System at (609) 292-7081.

METHODS OF DISPOSING OF PESTICIDES AND PESTICIDE CONTAINERS

Disposal of pesticides and their containers can be a problem. They should be returned to the manufacturer whenever possible. Otherwise you must choose the method which is best for you and still protects others and the environment. Federal and state laws may require that you use certain methods when disposing of specific pesticides.



Incineration - Burning pesticides and containers in special high temperature pesticide incinerators is one safe method of disposal. These incinerators are specially designed so that the pesticides will be reduced to harmless gases and solid ashes. This method may not be used for pesticides or pesticide containers with mercury, lead, cadmium, arsenic or inorganic pesticides. Do not confuse this special incineration method with open burning or ordinary incineration which is illegal in New Jersey. To find out if a pesticide incinerator is near your operation, contact your state regulatory officials or your regional Environmental Protection Agency office.

Burial - Burying pesticides and containers can also be an effective method of disposal. Do not bury pesticides or their containers anywhere but in an appropriate landfill. Containers which contain liquids that are classified as acutely hazardous waste pesticides must be disposed of accordingly unless the containers are empty, free from any pesticide residue, and triple rinsed. After being triple rinsed, they can be crushed or punctured and legally disposed of in a Type 27 (dry industrial-waste) sanitary landfill.

Containers which have not held acutely hazardous pesticides can be disposed of in a Type 27 Landfill if they are empty. Containers which have held dry or pressurized acutely hazardous pesticides must be disposed of as hazardous wastes.

Do not bury pesticides or containers with mercury, lead, cadmium, arsenic or inorganic pesticides unless special precautions are taken. Encapsulation is one method of keeping these compounds from getting into the environment.

Chemical Degradation - Sometimes pesticides can be chemically degraded into non-toxic materials. These methods are specific for each chemical and cannot be described here. Check with the manufacturer or local Environmental Protection Agency officials for specific methods.

Soil Injection - Disposal of surplus pesticides through soil injection is a fairly new method. "Soil injection" means plowing the pesticide into the soil over a large area in normal tillage practices. The effect of this method on the environment is not fully known. Use soil injection methods only when recommended by state or federal regulatory officials.

Take the extra time and effort to dispose of surplus pesticides and empty containers safely. It's well worth your while!!

SELF STUDY QUESTIONS

1. The use of protective safety equipment by the applicator while working and handling pesticides in the pesticide storage area may be necessary.

T () F ()

2. The main reason for the requirement to have a lock on the door of a pesticide storage area is to:

- A) keep the door closed when the storage is not in use.
- B) decrease pesticide fumes.
- C) prevent unauthorized people and children from entering.

3. Most pesticides containers are so well made and sealed that no pesticide escapes until the seal is broken or the package is damaged.

T () F ()

4. A good spot for a pesticide storage is a low area so that spilled pesticides are contained and cannot be washed away by rain.

T () F ()

5. Activated charcoal, hydrated lime, and sodium hypochlorite are useful items to have on hand in or near a pesticide storage:

- A) to add to the spray mixture when needed.
- B) to reduce pesticide fumes and vapors to a minimum.
- C) to induce vomiting if ingestion occurs.
- D) to neutralize or absorb spilled pesticides.

6. When not in use a pesticide storage should be tightly closed and sealed to prevent any pesticide fumes or vapors from escaping.

T () F ()

7. In New Jersey the regulations in force for the disposal of pesticides are:

- A) federal.
- B) state.
- C) both federal and state.

8. The best way to dispose of pesticides in New Jersey is:

- A) burning.
- B) burial.
- C) chemical break down.
- D) use them according to current labeling.

9. Pesticides can now be disposed of by special incineration procedures.

T () F ()

10. Many of the "sanitary" landfills under state control in New Jersey are satisfactory for the disposal of pesticides in large amounts.

T () F ()

11. After proper rinsing of liquid pesticide containers they can be crushed and/or broken for disposal in New Jersey "sanitary" landfills.

T () F ()

12. The only satisfactory way for the disposal of empty paper containers of dry pesticide formulations in New Jersey is:

- A) burning.
- B) burying.
- C) returning to the manufacturer.

ANSWERKEY

- | | |
|------|-------|
| 1. T | 7. B |
| 2. C | 8. D |
| 2. F | 9. T |
| 4. F | 10. F |
| 5. D | 11. T |
| 6. F | 12. B |

CHAPTER EIGHTEEN

LIABILITY

Learning Objectives

- * Know which type of pesticide application most often results in claims for damages against applicators.
- * Describe what actions the applicator should take in the event of becoming involved in a legal problem.
- * Understand insurance requirements.
- * Explain how the Pesticide Control Program operates concerning the enforcement regulations.

Almost all pesticides are considered hazardous. Even the most careful applicators sometimes have claims for damages against them. The usual claims are for non-performance or for injury to crops being treated or to crops in nearby fields. It is important for all licensed applicators to be informed of the most common claims made against them.

DRIFT

Drifting pesticides are a major cause of environmental contamination and damage to non-target areas. In general, the courts have held the applicator and/or the applicator business liable in drift cases. The grower may also be liable when he/she hires or contracts for a “particularly dangerous operation” such as the application of pesticides. The manufacturer of the pesticide may be held liable in drift cases in certain instances. If the label doesn’t clearly warn about the possibility of drift, the manufacturer may share liability.

CROP INJURY

Claims of injury to the crop that was treated or claims that the pesticide had not performed as expected involve the dealer, the manufacturer, the applicator business, and the applicator. The courts must decide which of the four recommended or guaranteed the product for that specific use on that crop. The party in error must accept the blame and pay damages. Applicators must make sure that all the pesticides they use are recommended on the label for that purpose. Then the blame may be the manufacturer’s.

If the crop injury was not great or total, the grower must show how much damage was from the pesticide and how much was from other conditions such as weather, disease, etc. This breakdown is not necessary in cases with great or total injury.

PERSONAL INJURY

The application of pesticides is considered an especially dangerous or in legal terms, an “ultrahazardous” activity. As a result the pesticide applicator and/or applicator business is liable for any injury to a person from the pesticide. Usually the injured person can recover damages without proving negligence of the applicator. The injured party must only prove that he/she is free of any negligence and did not assume the risk of pesticide exposure. Pest control operators or exterminators are sometimes a special case. The liability in most cases involving personal injury or death depends on proving the applicator negligent

WRONG LOCATION OR SITE

If the pesticide is applied on a field, crop, or area other than the one it was intended for, serious problems can result. In the event that damage or over-tolerance occurs or that the owner just didn't want the area treated, the applicator may be charged with trespass. Defense is very difficult. Double check on addresses, field locations, and all landmarks before you treat an area. Applying pesticides to the wrong field can be costly.

BEEES

Honeybees are very important to the farmer who often has privately owned colonies or hives. Unfortunately, bees are insects and are very susceptible to many pesticides. If the bees in hives are killed as the result of drift from nearby fields, the applicator is usually held legally responsible. Often he/she must pay damages.

However, if the bees contacted the pesticides while in the sprayed fields, the applicator is not usually liable. The courts have ruled that the bee is trespassing, and that the land doesn't need to be safe to uninvited animals. Play it safe! Know where the beehives are located in your area. If the pesticide label notes that the product is toxic to bees, state law requires you to warn local beekeepers beforehand of when and where you will be spraying for specific crops.

ATTRACTIVE NUISANCE

The rulings on "attractive nuisance" usually involve cases when children are attracted to ground equipment or aircraft and injure themselves. The owner and/or applicator are held liable for leaving the "nuisance" where a child could be "attracted" to it. In one case, a young boy, seeing a small airplane parked in the corner of an airport, took his ax and chopped the plane into several pieces. Unfortunately at one point, the hatchet hit the plane, then slipped and cut his foot. The court under the "attractive nuisance" claim awarded the boy \$5,000 from the airplane's owner.

Therefore, beware! Do not leave ground equipment with exposed drive belts, drive wheels, gears, or any moving parts alone in areas where children can get to them. Aircraft should never be parked where curious children can find them. Empty containers and aerosol cans are also attractive and dangerous to children. Store or dispose of them properly!

NOISE

Recently claims have been brought against applicators for noise damage. Owners of mink, poultry, turkey and occasionally cattle ranches claim injury to their animals from fright caused by noise of aircraft and ground equipment operating above or near their ranch. They must prove direct loss of property due to noise from machinery operated carelessly or negligently. In some cases the ranch owner will claim that an applicator made an unlawful flight over privately owned property without permission. This is especially important in aerial applications when pullups over nearby property are necessary. Successful defense is possible when the applicator can show that the noise wasn't the cause of injury or that no injury occurred.

CROSS CONTAMINATION

Every year there are cases where a pesticide container has not only the pesticide named on the label but another pesticide also. The materials in the container may damage the crops being treated. There are three main ways this may occur:

1. The manufacturer may make a mistake in labeling or formulating the product.
2. The applicator may err in mixing or filling in the spray tank. Or all the pesticide left over from the last application may not have been removed from the tank.
3. Open containers of herbicides such as 2,4-D can vaporize (become a gas) and penetrate other pesticides which are stored nearby. When the other pesticides are applied the 2,4-D contamination can seriously injure the crops.

The applicator must know which container of pesticide was used on the crop so that laboratory tests can be made. The lab tests can show whether the contamination occurred during mixing and filling or earlier. In cases involving herbicide contamination, it is difficult to prove whether it is the result of vaporization during storage or manufacturer formulation error. The courts must decide who is to blame.

NOTE: All applicators should write on the label of each pesticide container the location and the date it was applied. They should also record the lot number in case of cross-contamination.

WHAT TO DO WHEN YOU ARE INVOLVED

If you become involved in any 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 at once. Do the following:

- * Examine your records to make sure that you were actually operating in the area at the time of the alleged injury.
- * Make sure that all of your records are up-to-date, particularly as to the identity of the equipment used, temperatures, wind direction and velocity, and all other pertinent data.
- * Proceed to the scene immediately and make notes of all essential information when you get there.
- * Record the presence of any adverse condition that you observed at the time of your investigation, particularly insect infestations, disease, water stress, late planting, carry-over effect from other materials or herbicides, and age of crop.
- * Photograph any adverse condition found with color film at a sufficiently close focal length so that the symptoms can be examined by an expert.

- * Save the container from which the product was removed that was used in the job. If it is not practical to save the whole container, use close-up color photography to record the label.
- * Notify your insurance company and do so immediately.
- * If you do not have insurance for the loss involved, request permission to have an expert examine the crop or the property, in order that you may have the benefit of a professional opinion.
- * If a chemical company is involved, notify them immediately. They will probably want to send their experts to the site too.
- * Obtain the names and addresses of all witnesses who might testify as to the nature of the operation, conditions of the crop before and after. In the event that the crop is perennial, examine aerial photographs to ascertain the condition of the orchard or other perennial planting in years prior to the year of alleged injury.

INSURANCE

A pesticide applicator should have insurance for possible pesticide mishaps. In New Jersey, insurance is mandatory for all pesticide applicator businesses. There are many different types of insurance plans ranging from bodily injury, property damage, restricted chemical liability and comprehensive chemical. The plan chosen should fit your needs. If you are in a relatively low risk position from a legal standpoint the minimum coverage may be enough. On the other hand, aerial applicators will probably need more insurance. Be sure to explore the costs, benefits, and drawbacks of insurance before you buy. You need to know exactly what you are covered for. An insurance agent who specializes in pesticide insurance is the best person to advise you on your individual (special) insurance needs. Also be certain any applicator business you hire has the required insurance coverage.

ENFORCEMENT ACTIONS

The Pesticide Control Program, Bureau of Pesticide Compliance (BPC) investigates the misuse of pesticides on the farms of New Jersey.

One of the ways the Pesticide Control Program determines compliance with New Jersey regulations is by collecting crops, primarily fruit and vegetables, at farm sites. The reason for this is to check for the use of pesticides on crops for which the pesticide is not labeled, and to monitor for pesticide levels above tolerances. Compliance monitoring for pesticide levels of products that are authorized for use under the provisions of the Federal Insecticide, Fungicide and Rodenticide Act Section 24(c) (Special Local Needs) and Section 18 (Emergency Exemptions) is also done.

The collection and analysis of these samples is a joint effort between the federal Food and Drug Administration (FDA) and the Pesticide Control Program. The investigators collect the samples at the farm and then transfer these samples to the FDA for analysis.

The Pesticide Control Program has the authority to make inspections of private applicators to determine compliance with New Jersey pesticide regulations. Refusal to allow access to perform **ANY** inspections is a violation of the regulations.

Enforcement violations of the Pesticide Control Regulations can range from an Administrative Order (warning notice) to penalty amounts up to \$3000 per violation. The amount of the penalty is based on a penalty guideline developed by the PCP.

Private applicators can be held responsible for misuse of pesticides by individuals under their direct supervision. Private applicators may also be required to retake the certification exam as a result of a pesticide misuse.

The registration of a private pesticide applicator may be denied, suspended, or revoked for violations of the regulations.

If you have any additional questions or need further clarification of the pesticide regulations, please contact the Pesticide Control Program at (609) 530-4070.

Remember no matter how careful you are, accidents will happen. You must be prepared for any emergency. Above all, keep calm.

SELF STUDY QUESTIONS

1. A major cause of pesticide environmental contamination and damage to non-target sites is caused by:
 - A) the label.
 - B) drift.
 - C) the target pests.
2. If a pesticide is labeled toxic to bees the applicators must:
 - A) warn local beekeepers.
 - B) not worry about it.
 - C) place a notice in the local newspaper.
3. In legal terms, the application of pesticides is considered:
 - A) not dangerous.
 - B) slightly dangerous.
 - C) an “ultra hazardous” activity.
4. Cross contamination is:
 - A) the combination of various chemicals.
 - B) when a fertilizer and herbicide are mixed.
 - C) when a pesticide container contains not only the pesticide named on The label, but another pesticide also.
5. In New Jersey, insurance is required by all pesticide:
 - A) applicator businesses.
 - B) applicators.
 - C) handlers.

ANSWERKEY

1. B
2. A
3. C
4. C
5. A

APPENDIX A

CALCULATIONS

Learning Objectives

- * Perform the calculations necessary to determine areas or volumes to be treated.
- * Understand label directions for quantity of pesticide required.
- * Calculate formulations required when diluting concentrations to meet label requirements.

CONVERSIONS AND CALCULATIONS

Effective application of pesticides and other agricultural chemicals is dependent on many factors. One of the more important is to correctly calculate the amount of material needed. Unless you have the correct amount of pesticide in your tank mix, even a correctly calibrated sprayer can apply the wrong rate.

Manufacturers provide application rate instructions on every pesticide label. Due to the variety of ways in which these recommendations are stated (such as lbs. of active ingredient (a.i.) per acre, lbs. of formulation per 100 gal. of spray, or ounces of a.i. per 1,000 sq. ft.) it is often necessary to adapt the recommendations to different areas and volumes, or even other units. Sometimes the amount of active ingredient must be converted to the amount of actual product. This process can be very confusing.

PESTICIDE CALCULATIONS

Formulations such as wettable and soluble powders, emulsifiable concentrates, and flowables are sold as concentrates and must be diluted in the spray tank with an appropriate carrier. Water is the most common carrier, but kerosene, oil, and other liquids are sometimes used. Below are examples of how to properly calculate the amount of pesticide that should be added to a spray tank.

Mixing Soluble and Wettable Powders

Pounds per 100 gallons. Directions for wettable or soluble powders may be given in pounds of pesticide formulation per 100 gallons of carrier. You must know the capacity in gallons of your spray tank (or the number of gallons you will be adding to your spray tank if the job requires only a partial tank load). Then use the following formula:

$$\frac{\text{Gallons in tank} \times \text{Pounds per 100 gallons recommended}}{100 \text{ gallons}}$$

= Pounds needed in tank

EXAMPLE:

Your spray tank holds 500 gallons. The label calls for 2 pounds of formulation per 100 gallons of water. How many pounds of formulation should you add to the tank?

$$\frac{500 \text{ gallons} \times \text{Pounds per 100 gallons (2)}}{100 \text{ gallons}}$$

= Pounds needed in tank (10)

$$500 \times 2 / 100 = 10$$

You should add 10 pounds to the tank.

EXAMPLE:

You need to spray only one acre and your equipment is calibrated to spray 60 gallons per acre. The label calls for 2 pounds of formulation per 100 gallons of water. How many pounds of formulation should you add to the tank to make 60 gallons of finished spray?

$$\frac{\text{Gallons in tank (60)} \times \text{Pounds per 100 Gallons (2)}}{100 \text{ gallons}}$$

$$= \text{Pounds needed in tank (1.2, or 19.2 oz.)}$$

$$60 \times 2 / 100 = 1.2$$

Number of pounds to add is 1.2, or 19.2 oz.

Pounds per acre. The label may list the recommended dosage as pounds per acre. If the job requires a full tank, you must know how many gallons your equipment applies per acre and the spray tank capacity. Use these formulas:

$$\frac{\text{Gallons in tank} = \text{Acres sprayed per tankful}}{\text{Gallons applied per acre}}$$

$$\frac{\text{Acres sprayed per tank} \times \text{lbs formulation per acre}}{= \text{Pounds formulation needed in tank}}$$

EXAMPLE:

Your sprayer applies 15 gallons per acre and your tank holds 400 gallons. The label rate is 3 pounds of formulation per acre.

$$\frac{\text{Gallons in tank (400)}}{\text{Gallons per acre (15)}} =$$

$$= \text{Acres sprayed per tankful (26.7)}$$

$$400 / 15 = 26.7$$

$$\frac{\text{Acres sprayed per tankful (26.7)} \times \text{lbs formulation per acre (3)}}{= \text{Pounds formulation needed in tank (80.1)}}$$

Add 80 pounds of pesticide formulation to the tank.

If the recommended dosage is given as pounds of active ingredient (a.i.) per acre, you must first convert that figure to pounds of formulation per acre. Use the following formula:

$$\frac{\text{lbs of a.i. per acre} \times 100}{\text{Percent of a.i. in formulation}} = \text{lbs formulation per acre}$$

Then follow the formulas listed above under “pounds per acre” to find the pounds of formulation to add to your tank.

EXAMPLE:

You wish to apply 2 pounds of active ingredient per acre. Your formulation is 80 percent WP.

$$\frac{\text{Pounds of a.i. per acre (2)} \times 100}{\text{Percent a.i. in formulation (80)}}$$

$$= \text{Pounds formulation per acre (2.5)}$$

$$2 \times 100 / 80 = 2.5$$

Mixing Liquid Formulations

Rates for liquid formulations (EC, F, etc.) are often listed as pints, quarts, or gallons per 100 gallons or per acre. Make these calculations as you did above for pounds per 100 gallons or pounds per acre, but in the formulas substitute the appropriate liquid measure for “pounds.”

EXAMPLE:

The label rate is 2 pints of pesticide formulation per 100 gallons of water. Your spray tank holds 300 gallons.

$$\frac{\text{Gallons per tank (300)} \times \text{Pints per 100 gallons (2)}}{100 \text{ gallons}}$$

$$= \text{Pints formulation needed in tank (6)}$$

EXAMPLE:

Your sprayer applies 22 gallons per acre and your tank holds 400 gallons. The label rate is 1.5 quarts per acre.

$$\frac{\text{Gallons in tank (400)} \times \text{Quarts per acre (1.5)}}{\text{Gallons per acre (22)}}$$

$$= \text{Quarts needed in tank (27.3)}$$

$$400 \times 1.5 / 22 = 27.3$$

If the recommendation for a liquid formulation is listed as pounds of active ingredient per acre, you must first convert that figure to gallons of formulation to apply per acre. The label of a liquid formulation always tells how many pounds of active ingredient are in one gallon of the concentrated formulation (4 EC has 4 pounds of active ingredient per gallon; 6 EC contains 6 pounds per gallon, etc.).

$$\frac{\text{Pounds of a.i. needed per acre}}{\text{Pounds of a.i. per gallon of formulation}}$$

$$= \text{Gallons of formulation per acre}$$

EXAMPLE:

The recommendation is for 1 pound of active ingredient per acre. You purchased an 8EC, which contains 8 pounds of active ingredient per gallon. Your tank holds 500 gallons and is calibrated to apply 25 gallons per acre.

$$\frac{\text{Pounds a.i. to apply per acre (1)}}{\text{Pounds a.i. per gallon (8)}}$$

$$= \text{Gallons per acre (1/8, or 1 pint)} \\ 1/8 = .125 (1/8)$$

$$\frac{\text{Gallons in tank (500)}}{\text{Gallons per acre (25)}} = \text{Acres per tankful (20)}$$

$$500 / 25 = 20$$

$$\text{Acres per tankful (20)} \times \text{Gallons per acre (1/8 or .125)}$$

$$20 \times .125 = 2.5$$

Square Feet vs. Acre Mixing

The label rate is sometimes given in pounds, pints, quarts, or gallons per 1,000 square feet. If you have calibrated your equipment in terms of 1,000 square feet, you must adjust the formulas above from an acre to 1,000 square feet. The following formulas may be used with either liquid or dry formulations:

$$\frac{\text{Gallons per tank}}{\text{Gallons applied per 1,000 sq feet by equipment}}$$

$$= \text{Number of 1,000 square feet by equipment}$$

Number of 1,000 square feet sections sprayed per tankful $\times$ pints, quarts, gallons, or pounds of formulation needed per 1,000 square feet = Amount of formulation to add to tank

However, if you have calculated the area you are to treat in acres, you must convert the 1,000-square-foot rate to a rate per acre as follows:

$$\frac{43,560 (\text{sq. ft. per acre})}{1,000 \text{ square feet}} = 43.5$$

Pint, quarts, gallons, or pounds per 1,000 square feet $\times$ 43.5 = Pints, quarts, gallons, or pounds of formulation to apply per acre

To convert from the rate per acre to a rate per 1,000 square feet (or 100 square feet):

$$\frac{\text{Pints, quarts, gallons}}{\text{or pounds of formulation recommended per acre}} \\ 43.5 (435 \text{ for } 100 \text{ sq. ft.})$$

$$= \text{Pints, quarts, gallons, or lbs of formulation per 1,000 square feet (or 100 sq. ft.)}$$

APPENDIX B

GLOSSARY OF PESTICIDE TERMS AS USED IN THIS MANUAL

ABRASION: A scrape, scratch, sore or cut which breaks the skin.

ABRASIVE: Something that grinds down or wears away an object. Example: wettable powders wear pumps and nozzles down quickly.

ABSORB: To take a pesticide into a plant, animal or the soil.

ABSORPTIVE CLAY: A special type of clay powder which can take up chemicals and hold them. It is sometimes used to clean up spills of pesticides.

ACARACIDE: Pesticide used to control mites and ticks. Same as miticide.

ACCUMULATE: Build up, pile up, store.

ACCUMULATIVE PESTICIDES: Those chemicals which tend to build up in animals or the environment.

ACID: A very sharp, sour liquid which is usually very dangerous in concentrated form.

ACRE: 43,560 square feet. An area of land about 209 feet long by 209 feet wide.

ACTIVATED CHARCOAL: Very finely ground, high quality charcoal which absorbs liquids and gasses easily.

ACTIVE INGREDIENT: The part of pesticide which will kill pests or prevent damage by them. Usually it is the same as the "technical" material in the formulated product.

ACTUAL DOSAGE: The amount of active ingredient (not formulated product) which is applied to an area or other target.

ACUTE POISONING: Severe poisoning which occurs after one exposure to a pesticide.

ACUTE TOXICITY: How poisonous a pesticide is to an animal (or man) after a single dose or exposure.

ADHESIVE: An adjuvant which helps the pesticide stick to the treated surface.

ADJUVANT/ADDITIVE: Something added to the pesticide mixture to help the active ingredient do a better job. Examples: wetting agent, spreader, adhesive, emulsifying agent, penetrant.

AEROSOL: Pesticide chemical stored in a container under pressure. The pesticide is driven through a fine opening by an inactive gas under pressure when the nozzle is triggered.

AGITATE: To keep a pesticide chemical mixed up; to keep it from settling or separating in the spray tank.

ALKALI: Opposite of an acid; it is usually dangerous in concentrated form.

ANNUAL: A plant that grows from seed, produces seed the same year, then dies.

ANTIDOTE: A treatment given by a doctor to reduce the effects of pesticide poisoning.

ANTI-SIPHONING DEVICE: A small piece of equipment attached to the filling hose to prevent fill water from draining back into the water source. Example: check valve.

APIARY: Place where colonies of bees are purposely kept.

APPLICATION: Putting a pesticide on or in plants, animals, buildings, soil, air, water or other target to kill pests or prevent damage by them.

AQUATIC WEEDS: Weeds that grow in water, either on top or under the surface.

ARTIFICIAL RESPIRATION: First aid for someone who has stopped breathing, by blowing air into his lungs or applying pressure to his back to start breathing again.

ATROPINE: An antidote for organophosphate and carbamate poisoning. Full name is atropine sulfate.

ATTRACTIVE NUISANCE: A legal term for any object which might attract children or other persons to it and then might injure or hurt them as a result. Examples: sprayers, empty pesticide containers.

BAIT: A food or other material which will attract a pest to a pesticide or to a trap where it will be destroyed.

BASE : Alkali; opposite of an acid.

BIOLOGICAL CONTROL: Pest control without the use of chemicals. Parasites, predators, diseases, etc. are used to control pests.

BOOM: Several nozzles joined together by sections of pipe or tubing to apply pesticides over a wider area at one time.

BROADLEAF PLANTS: Plants with wide, flat leaves and netted veins. Example: dandelion, rose.

BROAD SPECTRUM PESTICIDES: General purpose or wide range of uses. They are effective when several different pests are a problem.

CALCULATE: Do some arithmetic; work with numbers, determine, figure out.

CALIBRATE/CALIBRATION: To figure or measure how much pesticide will be applied by the equipment to the target.

CANCELLED: A pesticide use that is no longer registered as a legal use by the Environmental Protection Agency. Remaining stocks can be used by order of the Administrator, EPA.

CARBAMATE PESTICIDE: A family of pesticides which are chemically similar. They all attack a pest in the same way. Common ones are carbaryl (Sevin), carbofuran (Furadan) and methomyl (Lannate).

CARRIER (two meanings): The liquid or solid that is used to dilute the active ingredient in manufacturing a pesticide formulation, Example: talc, petroleum solvents

OR

The material used to carry the pesticide to the target. Examples: water in a hydraulic sprayer, air in a mist blower.

CARTRIDGE: The cylinder-shaped part of the respirator which absorbs the fumes and vapors from the air before you breathe them. It should be replaced often.

CAUTION: A signal word used on labels of pesticides to alert users that the pesticide is slightly toxic.

CHEMICAL: Often used here to mean “pesticide” chemical.

CHEMICAL NAME: Scientific name telling the contents or formula of the active ingredients of the poison.

CHEMICALLY INACTIVE: Will not easily react with any other chemical or object. Examples, talc, clay.

CHEMICAL REACTION: When two or more substances are combined and as a result undergo a complete change to make new substances or materials.

CHLORINATED HYDROCARBONS: A family of pesticides which are chemically similar - they all contain chlorine. They are generally very persistent as compared to carbamates or organophosphates. Examples include chlordane, lindane, methoxychlor.

CHRONIC POISONING: Poisoning which occurs as a result of small, repeated doses of pesticide over a long period of time.

CHRONIC TOXICITY: How poisonous a pesticide is to an animal (or man) after small, repeated doses over a period of time.

CIRCULATE: To move completely through something in a path that returns to the starting point.

COMMERCIAL: A job or business whose purpose is to make money or earn a profit.

COMMON NAME: A well-known, simple name of a pesticide accepted by the Pesticide Regulation Division of the Environmental Protection Agency. Examples: carbaryl, atrazine, benomyl.

COMPATIBILITY: When two or more pesticides can be mixed together without reducing their effectiveness or harming the target.

CONCENTRATE: A pesticide as it is sold, before diluting it. Usually contains a lot of the active ingredient.

CONCENTRATION: The amount of active ingredient of pesticide in a formulation or in a mixture.

CONDEMNATION: The act of removing a crop or product which does not meet legal standards for tolerances on foods and thus is not to be sold.

CONTACT: To touch or be touched by.

CONTAMINATE: Pollute; the addition of an unwanted material (often a pesticide) where it could do harm or damage.

CONTRACT: An agreement with someone to do a job or perform a service for him.

CONTROL: To reduce damage; to keep down the number of pests in an area.

CORROSION: The effect of being worn down or eaten away slowly.

CORROSIVE POISON: A type of poison containing a strong acid or base which will severely burn the skin, mouth, stomach, etc.

CROSS CONTAMINATION: When one pesticide gets into or mixes with another pesticide accidentally - usually occurs in pesticide container or in a poorly cleaned sprayer.

DAYS TO HARVEST: The least number of days between the last pesticide application and the harvest date, as set by law.

DAYS TO SLAUGHTER: The least number of days between the last pesticide application and the date the animal is slaughtered, as set by law.

DECONTAMINATE: To remove or break down the unwanted material (usually pesticide) so it cannot do any harm or damage.

DEFOLIANT: A type of pesticide which causes the leaves of a plant to drop off.

DEGRADE: Break down, decompose.

DEGREE OF EXPOSURE: The amount or extent to which a person has been in contact with a toxic pesticide.

DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP): The New Jersey state department responsible for pesticide rules and regulations.

DEPOSIT: The pesticide on the leaves or skin or other surface right after a pesticide application.

DERMAL TOXICITY: How poisonous a pesticide is to an animal when absorbed through the skin.

DESICCANT: A type of pesticide which draws moisture (liquids) from a plant or plant part causing it to wither and die.

DETERIORATE: To decay, to wear away, to break down.

DILUENT: A liquid or dust used to “water down” or weaken a concentrated pesticide.

DILUTE: To make a pesticide thinner or weaker by adding water, oil, or other material; to “water down”.

DISINFECTANT: A pesticide or other chemical that kills or inactivates a disease-producing microorganisms such as bacteria.

DISPOSAL: The act or process of discarding or throwing away a pesticide. Should be done carefully and safely.

DOMESTIC ANIMAL: Tame animal used for man’s benefit. Examples: cow, sheep, horse.

DORMANT SPRAY: Pesticide application made before trees and other plant life begin to leaf out in the spring.

DOSE-DOSAGE: The portion or amount of pesticide mixture which is applied to the target.

DOWNWIND: On the side which the prevailing wind is blowing towards.

DRIFT: The movement by wind and air currents of droplets or particles of a pesticide from the target area to an area not intended to be treated.

DUST: A finely ground, dry mixture containing a small amount of pesticide and an inert carrier such as talc or clay. The dust particles are of many different sizes.

ECOLOGY: Study of the relationship between a plant or animal and its surroundings.

EMULSIFIABLE CONCENTRATE: A pesticide formulation with a large amount of active ingredient dissolved in a liquid. An emulsifier is used, too, so that the pesticide can be diluted, usually with water.

EMULSIFIER: A chemical which helps one liquid form tiny droplets and thus remain mixed in another liquid. It is used to form a stable mixture between two liquids which usually would not mix. Example: oil in water.

ENCAPSULATION: Method of disposal of pesticides and pesticide containers by sealing them in a sturdy, waterproof container so the contents cannot possibly get out. Also a method of formulating pesticides.

ENVIRONMENT: Surroundings - usually water, air, soil, plants and wildlife.

ENVIRONMENTAL PROTECTION AGENCY - EPA: The federal agency responsible for pesticide rules and regulations.

EPA REGISTRATION NUMBER: A number assigned by EPA to a product when it is registered that must appear on all labels for that product. It will appear as “EPA Reg. No.” or “EPA Registration No.” followed by the company number and product number. Sometimes a state alphabetical designation and distributors number will also appear.

ERADICANT FUNGICIDE: Type of fungicide which kills the disease after it appears on or in a plant.

EVAPORATE: To form a gas and disappear into the air.

EXEMPTION: Exception

EXPOSE/EXPOSURE: Not shielded or protected; come in contact with the pesticide.

FACE SHIELD: A transparent piece of protective equipment used by a pesticide applicator to protect his face from exposure to pesticides.

FEED: Food used for the purpose of feeding livestock and domestic animals.

FILTER: To screen out the unwanted material; clean by straining out the undesirable parts, or a piece of equipment for doing this.

FINITE TOLERANCE: The maximum amount of pesticide which can remain on food or feed crops at harvest after the pesticide has been directly applied to the crops.

FLOWABLE: Very finely ground solid materials of pesticide which are mixed in a liquid carrier.

FLUID: Liquid.

FOAMING AGENT: Chemical substance which causes the pesticide mixture to form a thick foam. It is used to reduce drift.

FOGGER: Aerosol generator; a piece of pesticide equipment that breaks some pesticides into very fine droplets (aerosols or smoke) and blows or drifts the “fog” onto the target area.

FOLIAGE: Leaves, needles or blades of a plant.

FOLIAR SPRAYS: Pesticides which are applied on the stems, leaves, needles or blades of a plant.

FOOD CHAIN: A way of describing how all animals depend on each other for food. It is a link between plant-eaters, plant and meat-eaters, and meat-eaters.

FORMULA: A brief way of writing a complicated idea by using abbreviations and symbols.

FORMULATION: A mixture of one or more pesticides plus other materials such as carriers, diluents, etc. needed to make it safe and easy to store, dilute and apply. The formulation is the form the pesticide is bought in; does not include tank mixes, adjuvants, etc.

FUME: Unpleasant or irritating smoke, vapor or gas.

FUMIGATION: The use of a fumigant to destroy a pest.

FUNGI/FUNGUS: Group of small organisms which cause rots, molds and plant diseases.

FUNGICIDE: Pesticide used to control organisms which cause molds, rots, and plant diseases (fungi).

GASMASK: Type of respirator which covers the entire face and protects the eyes as well as the nose and mouth. They contain better filters and more absorbing material to cleanse the air than cartridge respirators and are less likely to leak around the edges.

GRANARY: A storage area for threshed grain.

GRANULES: Pellets; a pesticide formulation of dry, ready to use, low concentrate pesticide plus an inert carrier. The particles are all about the same size and are larger than those making up a dust.

GROWTHREGULATOR: A pesticide chemical which increases, decreases or changes the normal growth or reproduction of an organism.

HAZARD: The risk of danger; the chance that danger or harm will come to the applicator, bystanders, consumers, livestock, wildlife or crops, etc.

HERBICIDE: Pesticide that is used to control unwanted plants.

HYDRAULIC AGITATOR: A device which keeps the tank mix from settling out by means of water flow under pressure.

HYDRAULIC SPRAYER: A machine which applies pesticides by using water at high pressure and volume to deliver the pesticide to the target.

ILLEGAL RESIDUE: A quantity of pesticide remaining on the crop at harvest which is either above the set tolerance or which is not allowed on the crop at all.

INACTIVE: Will not react chemically with anything; not involved in the pesticide action.

INCINERATOR: A high heat furnace or burner which reduces everything to ashes and vapors or non-harmful residues.

INCOMPATIBLE: Not able to be mixed or used together.

INCORPORATE: To work or blend a pesticide into the soil completely.

INERT INGREDIENTS: Inactive part of a pesticide/formulation; any material in a pesticide mixture which would not prevent damage or destroy pests if used by itself.

INFESTATION: Any pests found in a area or place where they are not desirable.

INGEST: To eat or swallow.

INGREDIENT STATEMENT: The part of the label on a pesticide container which gives the name and amount of each pesticide chemical and the amount of inactive material in the mixture.

INHALATION: To take air into the lungs, to breathe in.

INHALATION TOXICITY: How poisonous a pesticide is to man or an animal when breathed in through the lungs.

INJECT: To force a pesticide chemical into a plant, animal, building, or the soil.

INSECTICIDE: A pesticide that is used to control or prevent damage caused by insects.

INTEGRATED CONTROL: A system in which two or more methods are used to control a pest. These methods may include cultural practices, natural enemies, and selective pesticides.

INTERVAL: Period of time. The time period between two pesticide applications or between the last pesticide application and harvest.

INVERT EMULSIFIER: An agent or additive which allows water to remain suspended in oil rather than settling out. The usual emulsifier allows suspension of oil in water.

IRRITATING: Annoying. Making an animal (or person) uncomfortable by burning, stinging, tickling, making the eyes water, etc.

JOINTLY LIABLE: Two or more persons or companies would share legal responsibility for negligence.

kg OR KILOGRAM: A unit of weight in the metric system equal to 2.2 pounds.

LABEL: The printed material attached to or part of a pesticide container.

LC₅₀: The concentration of a pesticide in air which would kill half of the test animals exposed to it. The lower the LC50 value, the more poisonous the pesticide. It is often used as the measure of acute inhalation toxicity.

LD₅₀: The dose or amount of a pesticide which would kill half of a large number of test animals if eaten or absorbed through the skin. The lower the LD50 value, the more poisonous the pesticide. LD50 values are the commonly used measure of acute oral and acute dermal toxicity.

LETHAL: Deadly, toxic.

LIABLE/LIABILITY: Legal responsibility for.

LIMITATION: Restriction, the most that is allowed.

LITER: A unit of volume in the metric system equal to a little more than one quart.

MARINE: Having to do with animals and plants which live in the ocean.

MATERIAL : A substance, often used to mean a pesticide chemical.

MAXIMUM DOSAGE: The largest amount of a pesticide chemical that is safe to use without resulting in excess residues or damage to whatever is being protected.

MECHANICAL AGITATOR: A device which keeps the pesticide and any additives thoroughly mixed in the spray tank by paddling, swirling or stirring.

METRIC: A system of measurement which is used by most of the world except the U.S. and Canada and which is used in scientific work. It uses meters, grams and liters as units.

mg OR MILLIGRAM: A unit of weight in the metric system; about 28,500 mg equals one ounce.

MISDIAGNOSE: To make a mistake in deciding what pest has caused the problem.

MITE: A tiny animal which is very similar to an insect but has eight legs rather than six. Its body is divided into two parts and it has no antennae (feelers).

MITICIDE: Acaricide, a pesticide used to control mites and ticks.

MOLD: A growth caused by a fungus which is often found in damp or decaying areas or on living things.

MOLLUSCICIDE: A pesticide used to control snails and slugs.

MONITORING SYSTEM: A regular system of keeping track of and checking up on whether pesticides are escaping into the environment.

MULTIPURPOSE: Doing more than one job, a pesticide which kills more than one pest.

NATURAL ENEMIES: The predators and parasites which exist in the environment and attack pest species.

NEGLIGENCE: Failure to do your job or duty, to be neglectful.

NEGLIGIBLE RESIDUE: A tolerance which is set on a food or feed crop which will have a very small amount of pesticide at harvest as a result of indirect contact with the chemical.

NEMATICIDE: A pesticide used to control nematodes.

NEMATODE: A tiny, hair-like worm that causes damage by feeding on roots or other plant parts.

NERVOUS SYSTEM: The brain, spinal cord and nerves of animals.

NEUTRALIZE: To destroy the effectiveness of, to counteract.

NON-ACCUMULATIVE: Will not build up in an animal's body or in the environment.

NON-LABELED: Use or method which is not written on the pesticide label and therefore is not legal.

NON-PERSISTENT: Only lasts a short time (a few weeks or less) after being applied, breaks down rapidly in the environment.

NON-SELECTIVE PESTICIDE: A pesticide chemical that will control a wide range of pests.

NON-TARGET: Any plant, animal or other organism that a pesticide application is not aimed at, but may accidentally be injured by the chemical.

NON-VOLATILE: A pesticide chemical that does not evaporate (turn into a gas or vapor) at normal temperatures.

OPERATING SPEED: The steady rate which your pesticide sprayer is moving along the ground—usually measured in miles per hour or feet per minute.

ORAL: Through the mouth.

ORGANISM: Any living thing; plant, animal, fungus, bacteria, insect, etc.

ORGANOPHOSPHATE PESTICIDES: A family of pesticides which are chemically similar—they all contain phosphorous. They are generally less persistent than the chlorinated hydrocarbon family. They act by inhibiting a blood chemical called cholinesterase. Examples include malathion, Diazinon, parathion.

ORIGINAL CONTAINER: The package (bag, can, bottle, etc.) which a pesticide is sold in. The package must have a label telling what the pesticide is, and how to use it correctly and safely.

ORNAMENTALS: Plants used to add beauty to homes, lawns, gardens, and parks. They include trees, shrubs and small colorful plants.

2-PAM OR PROTOPAM CHLORIDE: An antidote used for organophosphate poisoning, but not for carbamate poisoning.

PARASITE: A plant or animal that harms another living plant or animal (called the host) by living or feeding on or in it. Sometimes parasites are helpful to man by attacking and controlling pests which could injure crops or animals. These parasites are forms of biological control.

PARTS PER MILLION OR ppm: The amount of pesticide that remains on or in a plant, animal, food or feed crop after treatment (residue) is often measured in parts per million.

PENETRANT: A kind of additive or adjuvant which aids the pesticide to get through the outer surface (leaf, root, skin) and into the plant.

PERCENT BY WEIGHT: The amount of actual pesticide chemical in a mixture based on its weight compared to the weight of the whole mixture. Example: one pound of actual pesticide plus three pounds of other materials would give you a 25% pesticide by weight in the mixture.

PERENNIAL: A plant that normally lives for more than two years. Trees and shrubs are perennials.

PERSIST: To stay for a period of time; to remain.

PEST: An unwanted organism (animal, plant, bacteria, fungus, virus, etc.)

PESTICIDE: A chemical or other agent that will destroy a pest or protect something from a pest.

PESTICIDE CHEMICAL: Term used to describe a pesticide which is a chemical rather than a parasite, virus or some other type of pest killer.

PESTICIDE HANDLER: An employee who uses pesticides in the production of agricultural plants (on a farm, forest, nursery, or greenhouse) and performs the following tasks: (1) mixes, loads, transfers, or applies pesticides or assists in the application of pesticides; (2) handles open containers of pesticides; acts as a flagger; (3) adjusts or repairs pesticide application equipment; (4) enters enclosed areas while exposure level is above the specified safe level to operate ventilation equipment, remove coverings, or check concentration level or acts as a crop advisor under these conditions; (5) enters outdoor fumigant treated areas to remove coverings; (6) disposes of pesticides or pesticide containers.

PESTICIDE KILL: When careless or improper use of a pesticide results in death of a large number of non-target organisms.

PETROLEUM PRODUCTS: Anything which contains gasoline, kerosene, oil or similar products.

PHYTOTOXICITY: Injury to plant life caused by a chemical or other agent.

PLANT DISEASES: Sickesses which affect plant life and are usually caused by fungi or bacteria.

PLANT GROWTH REGULATOR (PGR): Growth regulator; a chemical which increases, decreases or changes the normal growth or reproduction of a plant.

POINT OF DRIP OR RUNOFF: When a spray is applied until it starts to run or drip off the ends of the leaves and down the stems of plants or off the hair or feathers of animals.

POISON: Any chemical or agent that can cause illness or death when eaten, absorbed through the skin, inhaled, or otherwise absorbed by man, animals, or plants.

POISON CONTROL CENTER: An agency (usually a hospital) in all the major cities which is informed of the proper first aid and antidotes for poisoning emergencies - including pesticide poisonings.

POLLINATORS: Bees, flies and other insects which visit flowers and carry pollen from flower to flower for many plants to produce fruit, vegetables, nuts, and seeds.

POLLUTE: To make unclean or unsafe through carelessness or misuse.

PORT OF ENTRY: Place where foreign goods (plants, animals, crops, etc.) enter the United States.

POST-EMERGENCE: After young plants push up through the soil.

POTENCY: The strength of something. Example: how deadly a poison is.

ppm: See parts per million.

PRECAUTIONS: Safeguards; safety measures; warnings.

PREDATOR: Any animal or insect that attacks, feeds on and destroys other animals or insects. Predators are important in the food chain and some help to reduce pests which cause disease, damage or harm.

PRE-EMERGENCE: The time period between planting seeds and seedlings pushing up through the soil.

PRE-HARVEST: The time period just before a crop is ready to be picked, cut or dug.

PRESSURE: The amount of force on a certain area. The pressure of a liquid pesticide forced out of a nozzle to form a spray is measured in pounds per square inch.

PRODUCT: A term used to describe the pesticide as it is sold - it usually contains the pesticide chemical plus a number of additives.

PROPERTIES: The characteristics or traits which describe a certain chemical or other thing.

PROTECTANT: A pesticide applied before pests are actually found but where they are expected. The pests are destroyed before they cause any disease, damage or harm.

PROTECTIVE GEAR: Clothes and equipment that guard a person against injury or death when using poisonous pesticides. They would include gloves, apron, shoes, coveralls, hat, cartridge, respirator and gas mask.

RATE: The amount of a material which is being delivered to a plant, animal or surface. Usually measured as per acre, per 1000 square feet or per hour.

RECOMMENDED DOSAGE: Advice from a County Agency, Extension Specialist or other authority or written on the label on how much of a pesticide to use for preventing damage by or destroying a pest. This amount is not always the maximum allowed by law.

REENTRY INTERVAL: Period of time between a pesticide application and when workers can safely go back into an area without protective clothing.

REGISTRATION: Approval by the Environmental Protection Agency of a pesticide for uses as stated on its label.

REGULATORY OFFICIALS: Those persons working for the federal or state government who enforce the rules and laws.

REPELLENT: A pesticide that keeps or drives insects or other pests away from the plant, animal or surface treated.

RESIDUAL PESTICIDE: A pesticide that can destroy pests or keep them from causing damage for long periods of time after it is applied (days, weeks, months).

RESIDUE: The amount of pesticide that remains on a crop, animal, or surface for a while after it has been treated. Not the same as deposit.

RESPIRATOR: A face mask which filters out poisonous gases and particles from the air so that a person can breathe and work safely.

RESTRICTIONS: Limitations.

RODENTICIDE: A pesticide use to control rats, mice, rabbits, and their relatives.

RUNAWAY PESTS: Insects, diseases, weeds or other pests which get into an area for the first time and therefore have no natural enemies - they often reproduce in large numbers and overrun an area.

SCIENTIFIC NAME: The one name used throughout the world by scientists for each plant and animal. The names are based on the Latin or Greek languages.

SEIZURE: To take or impound a crop or animal if it contains more than the allowable pesticide residue.

SELECTIVE PESTICIDE, SPECIFIC PESTICIDE: A pesticide which will control only a few pests species is not as poisonous to other plants and animals.

SENSITIVE AREAS: Places where pesticides could cause great harm if not used with special care and caution. Examples: houses, barns, parks, ponds, streams, etc.

SENSITIVE CROPS: Crops which are easily injured by pesticide chemicals - even slight drift could cause a lot of damage.

SHOCK: The severe reaction of the human body to a serious injury which can result in death if not treated, even if the injury itself would not.

SHORT TERM PESTICIDE: A pesticide which breaks down almost immediately after application into nontoxic by-products.

SIGNAL WORD: Word which must appear on pesticide labels to show how toxic the pesticide is. The signal words used are "Danger-Poison" or "Warning" or "Caution."

SOIL FUMIGANT: A pesticide which is added to the soil and takes the form of a gas or vapor to kill many pests. Often a tarpaulin, plastic sheet or layer of water is used to trap the gas in the soil until it does its job.

SOIL INJECTION: Placing a pesticide below the soil surface with little or no soil mixing. Example: Forcing a pesticide into the ground through a tube.

SOLUBLE POWDER: A finely ground, solid pesticide that will dissolve in water or another liquid to be applied.

SOLUTION: A mixture made by dissolving a solid, liquid or gas in a liquid. The mixture will not separate or settle out in normal use. Example: Sugar dissolved in water.

SOLVENT: A liquid such as water, kerosene, or alcohol that a pesticide or other substance will dissolve in and form a solution.

SPACE SPRAY: A pesticide which is applied in the form of tiny droplets which fill the air and destroy insects and other pests, either inside or out-of-doors.

SPRAY: A mixture of a pesticide with water or other liquid applied as tiny droplets.

SPRAY CONCENTRATE: A liquid formulation of pesticide that is diluted with another liquid (usually water or oil) before using.

SPECIES: A group of living organisms which are very nearly alike, are called by the same common name and can interbreed successfully. Examples: dogs or chickens or German cockroaches.

SPREADER-STICKER: A chemical added to a pesticide mixture to make the droplets of the spray spread out and stick better to the animal, plant or other treated surface.

STAGE OF DEVELOPMENT: Time period during the growth from newborn or egg to adulthood. Example: an insect goes through many changes from egg to adult - any one of these changes is a stage of development.

STERILIZE: Treat with a chemical or other agent to kill every living thing in a certain area.

STRUCTURAL PESTS: Insects, rodents and other pests which attack and harm barns, houses, and other buildings. Example: termites, carpenter ants.

SUCTION HOSES: The hose through which water is pulled from a pond or stream, or spray from the spray tank to the pump.

SURFACE SPRAY: A pesticide spray which is applied in order to completely cover the entire outside of the object to be protected.

SURFACE WATER: Rivers, lakes, ponds, streams, etc. which are located above ground.

SURFACTANT: A chemical or agent used in a pesticide formulation to make mixing easier and help the material to spread over and completely wet the surface to be sprayed. Examples: detergent, emulsifier, wetting agent.

SUSCEPTIBLE: Can be killed or injured by the pesticide at the rates used.

SUSPENDED: A pesticide use that is no longer legal and remaining stocks cannot be used. More severe than cancelled.

SUSPENSION: A mixture in which fine particles of a pesticide chemical are usually floating in a liquid.

SWATH: The width of the area covered by a sprayer making one sweep or one trip across the field or other treated area.

SYMPTOM: A warning that something is wrong. An outward signal of a disease or poisoning in a plant or animal or man.

SYSTEMIC: A pesticide that is taken up by one part of a plant or animal and moved to another section where it acts against a pest.

TARGET: The area, buildings, plants, animals, or pests intended to be treated with a pesticide application.

TECHNICAL MATERIAL OR PESTICIDE: The pesticide as it is first manufactured by the company before formulation. It is usually almost pure.

TEST ANIMALS: Laboratory animals, usually rats, fish, birds, mice or rabbits used to determine the toxicity and hazards of different pesticides.

THERMAL: Related to heat.

TICK: A small, eight legged, bloodsucking insect-like organism often found on dogs, cows or wild animals.

TOLERANCE: The amount of a pesticide that can remain on any food (plant or animal) that is to be eaten by livestock or humans. The tolerance is set by the Environmental Protection Agency.

TOLERANT: Not susceptible to (injured by) a pesticide application.

TOXIC: Poisonous, deadly,, injurious to plants, animals or humans.

TOXICANT: A poison. The chemical in a pesticide formulation that can injure or kill the pest as well as humans, animals or plants.

TOXICITY: “How poisonous” a pesticide is to a living organism.

TRADE NAME: A brand name. The name given to a pesticide by a manufacturing company to identify it as their product.

TRANSPORT: Carry from one place to another - usually in a car or truck.

TREATED AREA: A building, field, forest, garden or other place where a pesticide is applied.

ULTRA-HAZARDOUS: A job or activity that is very dangerous.

ULTRA-LOW VOLUME, ULV: The application of a pesticide that is almost pure toxicant or technical material by spraying it in extremely small amounts over a large area - usually only a few ounces per acre.

UNAUTHORIZED PERSONS: People who have no right doing something because they have not been told or trained to do so.

UNCONTAMINATED: Does not contain hazardous pesticide residues.

UNDERGROUND WATER: Waterways which are located beneath the soil surface which wells get their water from.

UNIFORMLY: Done exactly the same way each time or over each area. Done evenly.

UNINFORMED PERSONS: People who are not trained to use and handle pesticides safely.

UNINTENTIONALLY: Did not mean to do it, accidentally.

USDA: United States Department of Agriculture, no longer in charge of pesticide legislation and laws.

VAPOR: Gas, steam.

VAPORIZE: Evaporate, become a gas.

VERMIN: Pests, usually rats, mice or insects.

VICTIM: Someone who is injured, poisoned or hurt in any way.

VOLUME: The amount, mass or bulk.

VOMITUS: The matter which is vomited.

WEATHERING: The action of wind, snow, rain, ice and heat to wear away pesticides from the surfaces they are applied to.

WETTABLE POWDER: A pesticide formulation in the form of powder that is mixed with water to be applied. It does not dissolve in the water but forms a suspension.

WETTING AGENT: An additive which helps the pesticide spread out and coat a surface more evenly. It cuts down on the amount of spray that rolls off smooth surfaces or waxy leaves and helps sprays to spread evenly on hairy leaves.

WIDERANGE: Ability to kill many different types of pests.

APPENDIX C

A CHECKLIST FOR PREVENTING PESTICIDE ACCIDENTS

Everyone can improve their methods for safe handling of pesticides. Experienced pesticide applicators may become so familiar with the equipment and materials used that they become careless or take shortcuts. Then an accident can happen.

The following checklist of questions is drawn from data showing the common causes of pesticide accidents. Check it against your pesticide handling practices and see how many accidents are waiting to happen to you. Just one “No” may be the one that gets you in trouble!

YES	NO	Store Your Pesticides Safely
___	___	Do you have a separate space to store pesticides?
___	___	Do you keep it locked and are the windows tight, barred or boarded over?
___	___	Do you keep all your pesticides in this storage rather than in garage, feed room, basement, porch, kitchen or refrigerator?
___	___	Do you store herbicides separately from other pesticides?
___	___	Are there signs on your storage so firemen and others are warned?
___	___	Do you check periodically for leaking containers?

Keep in the Original Container So the Label Is There!

___	___	Do you always keep pesticides in the original container instead of old “coke” 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 remember what is in an unlabeled container?
___	___	Do you always remember the safety precautions, antidotes and directions for use, even though the container is not labeled?
___	___	Do you safely dispose of unlabeled pesticides, rather than take a chance with your memory?

YES

NO

Use the Recommended Clothing and Protective Equipment

- | | | |
|-----|-----|---|
| ___ | ___ | Do you read the label to see what protective clothing you should wear? |
| ___ | ___ | Do you start each spraying day with clean spray clothing? |
| ___ | ___ | Do you check the signal words and precautions for use 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 only tiny holes in them? |

Spills and Splashes of Concentrates Can Be Very Hazardous!

- | | | |
|-----|-----|---|
| ___ | ___ | Do you know what to do if you should 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 well maintained 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, by rinsing, etc., instead of blowing them out with your mouth? |

YES

NO

Poor Container Disposal May Cause Bad Accidents!

- | | | |
|-----|-----|---|
| ___ | ___ | Do you rinse each “empty” liquid container at least three times and dump the rinsate into the tank? |
| ___ | ___ | Do you keep your used containers in your storage area until disposed? |
| ___ | ___ | Do you collect every container 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 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!

- | | | |
|-----|-----|---|
| ___ | ___ | Do you keep your spray equipment where children cannot play on it? |
| ___ | ___ | Do you keep your spray equipment clean so that those touching 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

- | | | |
|-----|-----|---|
| ___ | ___ | 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 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? |

MANUAL EVALUATION FORM

It is our goal to provide you with an easy to understand category manual that helps you to become a competent pesticide applicator. We need your input in order to do our job better.

Please take a few minutes to complete the following evaluation of the Category 12AB manual, and return it to:

Pest Management Office

Rutgers University
93 Lipman Drive
New Brunswick, NJ 08903

DIRECTIONS: Circle the appropriate answer and write your comments in the spaces provided.

1. Did you find the manual easy to read and understand? **yes no**

If you answered no, please indicate which portions were difficult along with the page numbers.

2. Did you find any errors in the text? Please list any errors along with their page numbers.

3. Do you feel ready to take your exam after reviewing this manual and answering the self study questions?
yes no

If you answered no, please explain.

4. How would you suggest we could improve this manual? What, if anything, would you change?

NOTES

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