The Idaho Pesticide Core Training Manual for Applicators

PESTICIDE SAFETY EDUCATION PROGRAM

A guide for safe use and handling of pesticides for applicators, dealers, and consultants.

University of Idaho Extension

The Idaho Pesticide Core Training Manual for Applicators

PESTICIDE SAFETY EDUCATION PROGRAM

A guide for safe use and handling of pesticides for applicators, dealers, and consultants.

Authored/edited by Ronda Hirnyck, Sherman Takatori, and Marcelo Dimase

Published by **University of Idaho Extension Publishing** in cooperation with the **Idaho State Department of Agriculture** to promote the education and training of pesticide applicators, dealers, and consultants throughout the state. The Idaho State Department of Agriculture provides pesticide applicator certification and training programs, activities, and materials without regard to race, color, religion, national origin, sex, age, or disability in accordance with state and federal laws.

Authors

Ronda E. Hirnyck, Extension Educator Pesticide Programs (retired), University of Idaho Extension; **Sherman Takatori**, Program Manager, Pesticide Services, Idaho State Department of Agriculture; and **Marcelo Dimase**, Assistant Professor, Entomology and Pesticide Extension Specialist, University of Idaho Extension

Additional copies may be ordered from University of Idaho Extension Publishing, online at **www.uidaho.edu/extension/publications** or by calling **208-885-7982.**

Cover image adapted from a photo taken by Howard F. Schwartz, Colorado State University, Bugwood.org

Issued in furtherance of cooperative extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Barbara Petty, Director of University of Idaho Extension, University of Idaho, Moscow, Idaho 83844. The University of Idaho has a policy of nondiscrimination on the basis of race, color, religion, national origin, sex, sexual orientation, gender identity/expression, age, disability or status as a Vietnam-era veteran.

Published January 2026 |

TABLE OF CONTENTS

PREFACE

The *Idaho Pesticide Core Training Manual* will help you understand the federal and state pesticide laws and regulations, good environmental stewardship practices, sound pest management practices, and actions that are necessary for the safe and effective handling and application of pesticide products. In addition, laws and information relating to the sale and distribution of pesticide products are included for dealers.

Because of the complexities of pest control in the modern world, pesticide applicators must understand the environment that they attempt to control and the types of control options available. Sound pest management practices must consider human safety, human and animal health, and environmental impact. This manual does not attempt to provide all the information necessary for pest management decisions, but gives basic information critical for pesticide applicators, dealers, and consultants.

The Applicator Core Competency and Private Applicator examinations, administered by the Idaho State Department of Agriculture (ISDA), are based on information contained in this manual. In order to obtain a pesticide license, all applicators, dealers, and consultants must know specific information contained within this manual. All pesticide applicator examinations will contain questions specific to the information contained in this manual.

After reading each chapter, answer the review questions to test your knowledge of the chapter. Compare your answers with the correct answers shown at the end of the manual. The Pretest and Post-Test, included in this manual, will help you will help you prepare for the certification examinations and become familiar with the types of questions the actual examinations will ask. Please use the glossary to define words or terms you do not know prior to taking the examinations.

This manual is a valuable resource for all pesticide applicators. It contains useful information that will assist applicators in planning and managing a pest control program. Appendices B (common telephone numbers) and C (conversion table) contain additional information that is useful for all persons who handle or apply pesticides.

PRETEST

The following test is designed to provide the trainee with an introduction to some of the facts, concepts, and skills you will encounter in this manual.

Another practice exam, the Post-Test, is provided at the end of this manual. These tests and the end-of-chapter quizzes are designed to help assess your pesticide knowledge. They also introduce you to the types of questions and exam format you will encounter on the actual Applicator Core Competency or Private Applicator exam. If your performance on the Post-Test is not up to your expectations, re-study the parts of the manual and the questions you missed until you feel confident that you understand the concepts. To do well on the Applicator Core Competency or Private Applicator exam, you should be able to answer all of the questions on the pre- and post-tests and understand the concepts associated with the questions.

Read the entire question and answers and then choose the correct answer. See Pretest and Post-Test Answers sections in the back for the correct responses.

1. The key to minimizing the hazard of pesticide use to the applicator is to avoid exposure. (True or False)
2. The use of temperature or humidity manipulation is a _____ control method for pests.
   A. Cultural
   B. Biological
   C. Legal
   D. Physical
3. Pesticide drift problems can be reduced using
   A. Lower sprayer pressure and small- er nozzle orifices.
   B. Applying in very calm, stable air conditions.
   C. Spraying upwind of a sen- sitive area and leaving an untreated border.
   D. Using a nozzle that produces larger droplets.
4. Which is not a disadvantage of an emulsifiable concentrate pesticide?
   A. Higher phytotoxicity hazard.
   B. May be easily absorbed the skin.
   C. Needs constant agitation.
   D. Flammable.
5. The Environmental Protection Agency (EPA) and ISDA are the only federal and state agencies that regulate pesticides. (True or False)
6. Two or more pesticides that cannot be effectively mixed together are said to be _____.
7. All formulations with the same active ingredient carry the same signal word. (True or False)
8. The best way to dispose of a registered pesticide is to
   A. Pour it into the sewer system.
   B. Wrap it tightly in plastic and dispose with regular trash.
   C. Use it according to the label directions.
   D. Ship the rinsate to the EPA.
9. Wettable powder formulations pose little or no inhalation health risks during mixing or loading. (True or False)
10. The sand crossbones symbol must appear on every pesticide label. (True or False)
11. Which LD50 is representative of a highly toxic pesticide?
   A. 640 mg/kg
   B. 35 mg/kg
   C. 5,900 mg/kg
   D. 510 mg/kg
12. Pesticide-contaminated surface water can contaminate groundwater. (True or False)
13. Pesticide application records are required for a Restricted Use Pesticide application. (True or False)
14. A person can apply a Restricted Use Pesticide without an ISDA license if using hand equipment only. (True or False)
15. Dealers must keep records for seven years on the sale of general-use agricultural pesticides. (True or False)

CHAPTER 1:
Introduction to Pests and Pest Management

Learning Objectives

- Understand how pests have affected civilizations throughout time.
- Know the definition of a pest.
- Be able to define the words typed in *italics*.
- Identify some of the earliest used pesticides and what they were used to control.
- Identify some of the most significant synthetic chemical pesticides and what they were/are used to control.
- Know the contemporary issues concerning the application of pesticides in our society.
- Identify and recognize different pest control tactics.

Significant Pests

Civilizations have contended with pest organisms throughout history. Records contain many examples of how pests have had major impacts on humans. Probably the most infamous was the black plague of Europe in the fourteenth century, when millions of people died from the mysterious scourge. For many years, the cause of the plague and the reasons for its rapid and widespread devastation remained unknown. Centuries later, it was established that a bacterial disease spread to humans from fleas that fed on infected rats. When rats were killed, or were unavailable as a food source, the fleas sought other warm-blooded hosts, often humans. Today this problem, known as bubonic plague, can be treated if properly diagnosed. Controlling rats, other rodents, and fleas directly reduce the disease transmission.

One historical occurrence that directly influenced the population of the United States was caused by the destruction of Ireland's potato crop in the nineteenth century. A fungal disease, called late blight, essentially eliminated the staple food crop. The potatoes not destroyed in the field rotted in storage during the winter. As a result, thousands of Irish starved from the famine and more than a million immigrated to the United States. Late blight continues to be a major problem for potatoes, but today it is managed through the use of resistant varieties, proper sanitation practices, and pesticides.

The above examples illustrate the potential enormity and complexity of pest problems. But what is a pest? *Webster* defines a pest as "a plant or animal detrimental to man; one that pesters or annoys." Sound pest management recognizes many insects, disease-causing organisms, weeds, mollusks (slugs and snails), fish, birds, and a variety of mammals from rats to wolves as competitors for our livestock and crops. In addition, pests impact human health, destroy buildings and other structures, and reduce the aesthetic value of the landscape.

As competition between humans and pests evolved over time, so have the methods of control. Society attempts to alter their environment to suit their needs by growing food or feed, building houses in a desirable location, or creating desirable landscapes. In each case, the environment is altered from its natural state. These changes bring new challenges for controlling the naturally occurring pests. A single method of control rarely produces acceptable results over time. It is more effective to use a combination of control practices that produce the desired results without undue harm to humans, animals, or the environment.

History of Pest Control

Mystery surrounded the causes of crop failures and human and animal diseases for many centuries. Mystical beliefs often prevented their cures. The first pest-control measures were crude: weeds were pulled, rats clubbed, beetles plucked from foliage, and crop residues burned. The earliest use of chemicals as pesticides dates back to 2,500 BC, when early farmers burned sulfur to control insects and mites.

Through the years, experimentation and good fortune led to the recognition of additional chemicals with pesticidal activity. Early plant-derived insecticides included hellebore to control body lice, nicotine to control aphids, and pyrethrums to control a wide variety of insects. Later, the same experimentation led to the discovery that certain compounds containing mercury, arsenic, or other similar elements could be used for pest control. Lead arsenate was first used in 1892 as an orchard spray. While these substances and compounds controlled pests, they had also had their drawbacks. Pyrethrum was not effective against all pest insects and the heavy metal compounds had human and animal toxicity risks.

In France, during the late nineteenth century, a mixture of lime and copper sulfate was sprayed on grapevines to deter people from picking and eating the grapes. The farmer found the mixture also controlled downy mildew, a serious fungal disease of grapes. Later named bordeaux mixture, it remains one of the most widely used fungicides worldwide.

Development of Synthetic Pesticides

Until the 1940s, pest-control chemicals derived from plants and inorganic compounds. The synthetic organic chlorine pesticide, DDT, was developed prior to World War II and emerged as a very important factor in saving allied soldiers from insect-transmitted diseases. During that time, DDT was hailed as the insecticide to solve all insect pest problems. Countless other synthetic organic pesticides (2,4 D, aldrin, heptachlor) were developed and introduced

during this period, largely due to the success of DDT and advancements in the development of all chemicals. These synthetic products launched the modern-day chemical industry and began a new era in pest control. With significant success at relatively low costs, pesticides quickly became the primary method of pest control. They provided season-long crop protection against pests and complemented the benefits of fertilizers and other production practices. The success of modern pesticides, particularly in agriculture, encouraged widespread acceptance and eventual reliance upon them.

Contemporary Concerns

Pesticide use is significant in food and fiber production, forestry, and public health. Some drawbacks of heavy dependence upon pesticides have become increasingly apparent, with pesticide resistance issues being a significant issue. Since the *resistance* (decreased susceptibility of a pest to a chemical) of the San Jose scale to lime sulfur was recognized in 1908, many more species of insects have become resistant to one or more pesticides worldwide. Recent studies indicate that there are now over 600 species of insects and mites resistant to pesticides. Over 270 weed species, over 150 *plant pathogens*, and about a half-dozen species of rats are resistant to pesticides that once controlled them. A dramatic example is the Colorado potato beetle in the eastern United States, which has developed resistance to every major group of insecticides.

Increasing concerns about the environmental and health hazards associated with pesticides have also become significant factors challenging pesticide usage. In 1962, Rachel Carson published *Silent Spring*, a book that examined pesticides and their effects on the environment. Chlorinated hydrocarbons like DDT and others (aldrin, chlordane, dieldrin, heptachlor) were her primary concern because of their stability and persistence in the environment. Their long residual life was a major factor contributing to the effectiveness of these insecticides, but their ability to accumulate in the fatty tissues of some animals was a negative impact. Currently, most pesticides that accumulate in body tissue have been discontinued and are no longer used. The impact of *Silent Spring*, in regard to environmental awareness, was significant. Although the validity of many of the health and environmental claims stated in the work were later found to be inaccurate or nonscientifically based, the effect of her book was profound.

Since the publication of *Silent Spring*, the United States has experienced a level of environmental awareness and interest like no other period in history. The US Environmental Protection Agency (EPA) was created in 1970 with a mandate from Congress. The task was to implement, by regulation, the laws passed by Congress to protect the environment and the health of humans and other animals. Since its creation, the EPA has taken regulatory actions against many chemicals, including pesticides thought to pose significant environmental and health hazards. Public concern has led to stringent regulation of pesticides and shifts in the types of pesticides used.

More recently in 1996, the Food Quality Protection Act (FQPA) was signed into law. This act fundamentally changed how pesticide uses were approved by regulating pesticide residues on food and providing more realistic risk assessment and exposure.

In addition to regulating pesticide residues and pesticide risk assessment, the FQPA also required the EPA to

- Expedite approval of pesticides meeting the FQPA definition of reduced risk.
- Give special consideration to minor uses of pesticides (i.e., uses for which pesticide product sales produce small revenues; thus, the registrant might decide to not generate the data needed to support minor use).
- Provide a list of pests of significant public health importance.
- Expedite the review of applications to register antimicrobial pesticide products.
- Screen pesticides for disruption to the endocrine system.

The FQPA also requires the periodic review cycle for pesticide registrations. Changes in pesticide practices and new information concerning pesticide effects occur over time. These periodic review cycles make sure that as changes occur and new information is discovered, pesticide products can continue to be used safely. The Registration Review Program began in 2006 with the goal of reviewing each pesticide's registration every fifteen years to make sure that the pesticide still meets Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) standards for registration.

Development of Other Synthetic Pesticides

The banning of commonly used insecticides in the 1970s prompted the increased use of another group of insecticide compounds known as the *organophosphate* (OP) insecticides. Although OPs are generally more acutely toxic to mammals and more expensive than the chlorinated hydrocarbons, they are much less persistent in the environment. Other insecticide groups, such as the *carbamates*, showed increased use and increased development of other insecticides within the group. Broad-spectrum OPs and carbamates have provided the foundation for our chemical insect control from the early 1970s to the late 1990s. But just as concerns surfaced about the environmental hazards of DDT, OPs and carbamates were under increased scrutiny due to public health concerns and the mandates of the Food Quality Protection Act of 1996.

During the 1970s, the development of the *pyrethroid* insecticides contributed significantly as an alternative to predominant use of the OP/carbamate insecticides. Pyrethroids were developed from pyrethrum, a natural or botanical extract of certain chrysanthemum flowers known to have insecticidal properties since the 1850s. Pyrethrum had a number of limitations as a commercially viable insecticide; primary reasons were its rapid photo-degradation and relatively short paralysis effect. Permethrin was the first commercially available pyrethroid (synthetic pyrethrum) and was developed and marketed in the early 1970s. Compared to botanical pyrethrum, permethrin is much more photostable, is effective

against a wide range of insect pests, has low mammalian toxicity, and has low persistence in the environment. Many additional synthetic pyrethroid insecticides have since been developed with similar properties and have contributed greatly to controlling pest insects for both agricultural and general public (nonagricultural) applications. However, the pyrethroid insecticides, like the OPs and carbamates, are also broad-spectrum insecticides that have a high toxicity to aquatic organisms and many beneficial insects (pollinators). Although the positive contribution of synthetic pyrethroids to pest control is undeniable, their use must be balanced relative to their potential for harm the same as with the OPs and carbamates.

Future control of insects and other pests may include more emphasis on naturally occurring compounds, growth regulators, growth inhibitors, and biotechnology-based products such as RNA interference (RNAi) pesticides. These chemicals have the potential to be more selective in their spectrum of control, therefore posing fewer risks to the environment. It is also very possible that these new chemicals may have adverse effects within the environment that are as significant as their earlier synthetic chemical counterpart. They may not be economical to use or cannot be used in the same manner as the older synthetic chemicals (i.e., numbers of applications and timing) and retain the same level of effectiveness. It is probable that future pest management strategies will include refined nonchemical and chemical practices to provide the best balance for human health, environmental protection, and economic viability.

Pest Management Tactics

Today, pesticide applicators subscribe to a philosophy of pest control that involves the use of many tactics. The goal of such a philosophy is to prevent pest populations from developing into situations that cause economic losses. The principle is **pest management rather than pest eradication**. Development of a management strategy for any pest requires knowledge of what control tactics are available and how they can be effectively used while taking into consideration both the positive and negative aspects of their use.

Natural Controls

Natural controls are those measures that control or destroy pests without dependence upon humans for their continuance or success. In fact, humans cannot greatly influence these measures. Natural controls include climatic factors such as wind, temperature, sunshine, and rain. Topographic features, such as rivers, lakes, and mountains, can influence pest movement. Naturally occurring predators, parasites, parasitoids, and pathogens present in an area can regulate pest populations.

Applied Controls

Applied controls include those methods under the control of humans. Their use is necessary when harmful pests have not or cannot be controlled by natural controls. Methods of applied controls include mechanical control, physical control, cultural control, genetic control, biological control, legal control, and chemical control.

Mechanical Controls

Mechanical controls are methods that prevent the spread or reduce the infestation of pests, primarily weeds, insects, and vertebrate animals. Mechanical controls include hand destruction, traps, and mechanical exclusions (i.e., screens, nets, and fences). Screens are the most widely used mechanical means of controlling insects. Nets and fences are used to keep birds and mammals, such as deer, from depredating crops. Although used infrequently today, equipment to crush, drag, or grind insects was used in the earlier days of pest control.

Physical Controls

Physical controls are widely used in pest control and include manipulation of water, humidity or temperature, and the use of electric shock, light, or other radiant energy. These approaches are used primarily to control insects and diseases, but under certain conditions are used to control other types of pests. Physical control methods kill the pests, disrupt their life cycles, or make the environment unfavorable for pest survival.

Cultural Controls

Cultural controls are the routine management practices that prevent pests from developing. These practices include rotating crops, tilling the soil, varying the time of planting, destroying crop residues, pruning, thinning, and fertilizing plants. They 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. These control practices provide multiple tools for pest-control specialists. An important advantage is that many of these practices are carried out as part of normal operations.

Genetic Controls

Genetic controls involve the use of plants and animals that are resistant to attack by pests. Genetic control has been widely used in the past and offers great promise in the future. Traditional breeding techniques, coupled with contemporary gene manipulation, promise a new era on the horizon for host plant resistance. Scientists have experienced success in the development of plants resistant to insects and diseases and have developed animals resistant to certain diseases and ticks.

It must be noted that genetic controls are not a new concept. From the beginning of plant cultivation, humans used forms of genetic controls by selecting specific plants because they were hardier or produced higher yields, despite the presence of significant pests. Selecting a specific plant to use as a seed plant because of superior yield or hardiness was a common practice prior to the understanding of plant breeding and plant genetics.

Genetic manipulation of pest populations is also an effective method for pest control. For example, releasing large numbers of sterilized male screwworm flies (an important pest of cattle in some areas) or sterilized male Mediterranean fruit flies can effectively disrupt normal breeding and reproduction cycles in these insects. The sterile males mate with normal females who then lay sterile eggs. This practice effectively discontinues their life cycle.

For plants, it can also mean the manipulation of plant genes to benefit pest control. The term *Genetically Modified Organism* (GMO) is a type of genetic manipulation where desirable genes are inserted into the genetic makeup of a specific crop. Most of the modifications for crops have been for pest-control purposes, such as herbicide-resistant varieties of crops, but other desirable traits can be inserted into the genetic makeup of crops. For instance, plant nutritional value can be increased by using specific genes that produce specific nutrients in the crop. Genes can also be inserted into crops to increase their tolerance to environmental extremes such as cold temperatures or drought.

Biological Controls

Biological controls involve the introduction, encouragement, and artificial increase of plants, insects, and animals that are parasites or predators of a pest species. Biological control is only effective if the proper balance of predators and pests exists in the environment. Effective pest control is lost if the predator cannot be maintained in the environment. If a predator is introduced into an environment where they eliminate the pest, the remaining predators ultimately move to a different area or die due to lack of food. Biocontrol works on a dynamic balance between predator and pest: there must be a sufficient and continuous amount of pest to maintain the levels of predators or biological controls do not sustain themselves. Biological controls are best practiced in more stable, perennial environments, such as forests and ranges, and are less effective in rapidly changing environments, such as annual cropping systems. Biological controls are used mostly to control insects and weeds.

Legal Controls

Legal controls 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 laws establish a framework of inspections and quarantines to prevent the introduction of new pests into the United States or the spread of pests within the country. The laws are under the jurisdiction of the Animal and Plant Health Inspection Service (APHIS) at the federal level and the Idaho State Department of Agriculture (ISDA) at the state level.

Chemical Controls

Chemical controls involve the use of naturally derived or synthetic chemicals called pesticides that kill, attract, repel, or otherwise control the growth of pest plants, animals, and microorganisms. Pesticides include a wide assortment of chemicals with specialized names and functions:

AVICIDES—to control pest birds

BACTERICIDES—to control bacteria

FUNGICIDES—to control fungi

HERBICIDES—to kill weeds and other undesirable plants

INSECTICIDES—to destroy insects and related arthropods

MITICIDES (ACARICIDES)—to kill mites

MOLLUSCICIDES—to kill snails and slugs

NEMATICIDES—to kill nematodes

PREDACIDES—to control predatory vertebrate pests

PISCICIDES—to control pest fish

REPELLENTS—to repel insects, ticks, other invertebrates, birds, and mammals

RODENTICIDES—to destroy rodents

Although not considered pesticides by definition, the following three classes of chemicals are regulated and classified as pesticides under both federal and state pesticide laws:

DEFOLIANTS—chemicals that cause leaves or foliage to drop from a plant

DESICCANTS—chemicals that promote the drying or loss of moisture in plant tissues

GROWTH REGULATORS—substances (other than fertilizers or food) that alter the growth or development of a plant or animal

ADJUVANTS are substances added to pesticide formulations and tank mixtures to increase safety, effectiveness, or other desirable effects and are regulated as pesticides by the ISDA under the Pesticide and Chemigation Law.

Fertilizers and food (feed or feed additives) can regulate the growth of plants or animals, but are not regulated as pesticides in Idaho.

Mode of Action

Pesticides vary in their *selectivity*. Some pesticides, such as fumigants, are generally *nonselective*. These pesticides control a wide variety of pests—fungi, insects, weeds, nematodes, etc. Others kill only a limited number of pests or a certain stage of a pest's development. These pesticides are referred to as *selective pesticides*. Ovicides, for example, kill only the eggs of certain insects and related arthropods.

Pesticides also vary in their mobility upon contact with a host. *Systemic pesticides* (certain fungicides, herbicides, or insecticides) are absorbed through foliage or the roots and translocate through the vascular system of the treated plant. Similarly, systemic insecticides can be fed or injected into livestock to control certain livestock pests. In contrast, *contact pesticides* are neither absorbed by nor translocated within treated plants or animals. The pest must contact a treated area to be affected.

Some pesticides can be classified according to their route of entry into a pest. Insecticides and certain avicides are often categorized as either contact or stomach poisons or both. Some insecticides and rodenticides are inhalation poisons, meaning they are absorbed through the pest's respiratory system. Pests must ingest (eat or consume) stomach poisons (including rodenticides) to be effective. Contact poisons must physically contact the pest and inhalation poisons must be absorbed by the pest's respiratory system to be effective.

Regulation

The production, sale, use, storage, and disposal of all pesticides are regulated at the federal and state level. Federal pesticide law, as contained in the amended FIFRA (*Federal Insecticide, Fungicide, and Rodenticide Act*), is administered by the EPA (*United States Environmental Protection Agency*). The ISDA administers state pesticide and chemigation laws and associate administrative rules. These laws and rules were written to protect the general public, the user, and the environment from possible negative effects of pesticides. In addition, several other laws administered by other federal and state regulatory agencies regulate pesticide handling and use (transportation, disposal, and worker safety). For more information on these agencies, departments, laws, rules, and regulations, refer to the chapter, Pesticide Laws, Rules, and Regulations.

Integrated Pest Management

Integrated Pest Management (IPM) is an approach to pest control that combines physical, mechanical, biological, cultural, chemical, and other control methods to maintain pest levels below economically damaging levels. **The essence of integrated pest management is decision-making**. This means determining the IF, WHEN, WHERE, and WHAT mix of control methods that is needed to control a particular pest or number of pests. By definition, IPM deals with pests in the broadest sense: insects, mites, nematodes, pathogens, weeds, and vertebrates. In reality, this level of integration is somewhat difficult to achieve.

The IPM approach attempts to satisfy conflicting economic and environmental objectives. Thus, IPM provides cost-effective pest control that minimizes adverse impact on human health or the quality of environmental resources. As with any pest management strategy, politics inevitably become involved in balancing conflicting societal, economic, and ecological objectives. The sound approach of IPM permits a balance of sound pest management with environmental and social concerns.

The theory and practice of IPM was first advocated by entomologists during the 1950s and 60s in response to the problems of insecticide misuse, particularly the “pesticide treadmill.” The pesticide treadmill is the theory that pesticide use leads to an ever- increasing pesticide-use cycle due to pest resistance and resurgence. Drawing upon modern technology and techniques used to control pests before the wide use of pesticides, the IPM approach since the 1960s has been expanded to include all plant protection disciplines and today is an established philosophy of pest management.

The federal government has provided considerable funds for IPM research and demonstration since the late 1970s and university Extension IPM programs were in place nationally since the late 1980s. Nearly every economic evaluation of these programs has demonstrated increased profits to farmers through decreased production costs. This is done primarily by eliminating unnecessary (preventive) pesticide use and applying the most efficient pesticides when needed. In the urban environment, the benefits of reduced preventive pesticide use lead to a reduction in the potential for human, animal, and environmental exposure to pesticide residues.

Guidelines

There is no single recipe for IPM; guidelines for management of specific insects, plant pathogens, weeds, and other pests are different. However, the following principles broadly apply to IPM:

- **There is no magic bullet**. Exclusive use of any single control method can have unexpected and undesirable results. This has been documented for pesticides where overreliance can lead to the "3-R's" (resistance, resurgence, and replacement). The IPM philosophy considers all possible control actions, including taking no action at all, and fits tactics together into mutually beneficial strategies.
- **The cropping system or facility is the management unit**. Pest problems do not arise as independent, isolated events, but instead occur within crop systems or facilities governed by the same rules as natural systems. Attempts to control one pest without regard for the entire system can disrupt links and balances between plants, pests, beneficial species, and their physical environment. Action taken against one pest may intensify problems with another or may be incompatible with another control tactic.
- **Pest presence does not constitute a pest problem**. The objective of IPM is to reduce pest populations below levels (thresholds) that create damage (economical, medical, or aesthetic). Potentially harmful pests continue to exist, but at densities that do not represent damage risks, economically or otherwise. Eradication is not desirable, even if technically feasible, with the possible exception of invasive species. The IPM approach works on a concept of maintaining a dynamic balance between predators and pests to sustain beneficial species—in other words, supporting the basics of **biological control**. Exceptions include localized infestations of exotic pest species, or species that present an immediate medical injury potential, where eradication is the best IPM strategy.
- **When you kill natural enemies you inherit their work**. The IPM approach attempts to conserve or augment naturally occurring predators, parasites, pathogens, antagonists, and competitors that assist in reducing pest populations.
- **Use of a pesticide is no substitute for prevention**. The IPM approach begins from the premise that killing pests (direct mortality or eradication) is not the objective. The main objective of a good IPM program is protecting the commodity, facility, or site. Repelling the pest, avoiding the pest, and reducing the pest's rate of colonization or invasion reduce pest populations. This lowers the damage to the commodity, facility, or site in real and economic terms.

The principles and practices of IPM are combined to create IPM programs. Each situation is different, but six major components are common to all IPM programs:

1. Pest identification
2. Monitoring and assessing pest numbers and damage

3. Guidelines for when management action is needed
4. Preventing pest problems
5. Using a combination of biological, cultural, physical/mechanical, and chemical management tools
6. After action is taken, assessing the effect of pest management

Pest Management Practices

It is impossible to apply the principles of IPM unless you first know what pests there are and how many pests are present. To accurately determine the number of pests in a field or specific area, first *monitor* the area to determine the pest numbers. Pest monitoring may include *field scouting*, *sampling*, and trapping as practices to determine not only the numbers of pest organisms, but also attempts to determine the number of beneficial organisms present. No single monitoring program is appropriate for all situations, but the following rules generally apply to agricultural and urban situations:

Pest Monitoring (Field Scouting)

1. Monitoring (pest sampling) should be random. Nonrandom patterns run the risk that conclusions will be biased.
2. Monitoring should be representative of conditions across the entire field, the entire facility, or entire site. Never monitor solely at field borders, doorways, or landscape edges.
3. Always take adequate monitoring observations throughout the field, facility, or site. For instance, five observations (samples) per acre will obviously yield better and more accurate monitoring than a single observation.

Apply these principles by inspecting randomly selected sites while walking a "W" pattern across fields for agricultural sites or by conducting a room-to-room facility audit for urban sites.

Field scouting, monitoring, and pest management can be scheduled or anticipated by using the degree-day or heat-unit approach. A degree-day is a measure of environmental heat experienced by an organism (or pest species) during a twenty-four-hour period. Degree-days are computed as the daily average temperature minus the species-specific lower temperature at which development stops. The principle involved is that rates of crop and pest development primarily depend upon temperature.

Facilities monitoring presents additional considerations. Facilities with controlled environments present a challenge in that pest species may thrive indoors throughout the year with little or no thermal effect from the changing climate or conditions outdoors. Monitoring is the key to pest management decisions.

Pest development is most rapid when temperatures are warm and slows when temperatures are cool. If temperatures are too low, development will stop. If these limits are known, you

can predict the developmental stages of pests from daily temperatures and develop pest management plans. Knowledge of pest development and overall knowledge of pest species are keys to keeping pest populations below threshold levels.

Decision Guidelines

Economic injury level (EIL) and *economic threshold* (ET) are numerical guidelines that identify when pesticide use is and is not necessary. The EIL is the economic break-even point, where the number of pests that cause crop damage is equal to the cost of pest control. The ET (also called the action threshold) is the time to take control action to prevent the pest population from exceeding EIL. Put simply, the EIL is the level of pest infestation that, once reached, begins to lower the economic value of the crop or commodity more than the cost of pest control.

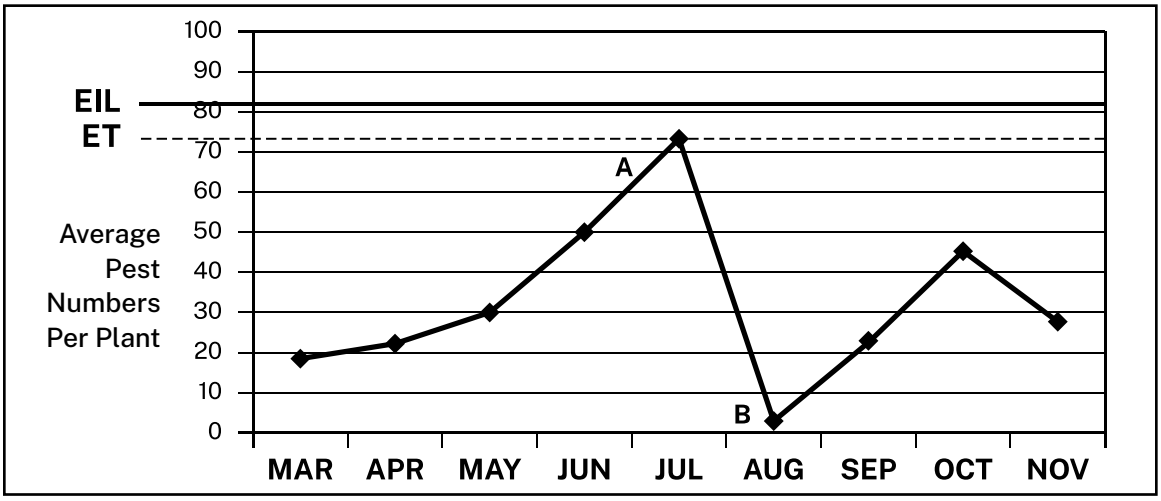
The IPM approach includes the use of pesticides, but only when field scouting shows that pest density meets or exceeds the ET. In theory, EILs and ETs fluctuate with changes in crop market value, pest control costs, control efficacy, and crop susceptibility to pest damage. In practice, EILs and ETs often are stated as simple static constants because we do not have the research base necessary to precisely compute their values and because pest-control prices (i.e., chemical and operating costs) are not constant amounts. However, it is far better to have an action plan based upon an established EIL and ET that reflects the most current information than to simply proceed with pest control as a preventive measure.

The EIL/ET Chart provides a simplistic chart that represents pest populations over a typical growing season. Both the EIL and ET were established for a certain pest. Periodic scouting reports and sampling data place the pest numbers below the ET until the pest population builds and the ET is reached during the month of July. Pest controls (pesticide application) are applied at the time that the detected pest population and the ET are equal (point A). In actual circumstances, the pest populations would probably be slightly higher at the time that the pesticide was applied because a certain amount of time is needed to interpret the sampling data and then to apply the pesticide. The application of the pesticide effectively reduces the pest population in August to a low number (point B). Although the pest population begins to rebound after the control is applied, it does not reach ET during the remainder of the season and, in fact, declines during November due to natural conditions.

EIL/ET Chart

Using this or similar charts provides additional management tools for growers, producers, or pest management professionals. By using these tools, pest populations may be specifically monitored relative to the damage they cause to a crop, commodity, or site. These charts indicate when controls should be applied or if they are necessary at all. There may be situations when the pest populations do not reach the EIL/ET level and therefore it is not economical to apply pesticides.

EIL/ET Chart



Human and Animal Health–Related IPM Issues

Human or animal health–injury levels tend to have very low action (tolerance) thresholds. The presence of species that represent immediate risk to human health, such as stinging insects, known vectors of diseases, and poisonous plants, should be dealt with in a proactive manner to reduce the potential threat to human or animal health. Preparation and organized pest management provides for a timely and effective reaction to most pest-control events. An example of this is a mosquito abatement district's preparation to address mosquito-borne diseases such as the West Nile virus and Zika virus.

Urban IPM Concerns

Aesthetic injury levels are very subjective in that each individual has a limit on the number or "weeds, bugs, or rodents" they tolerate. The IPM process, when applied to these situations, provides the individual or facility operator with more information on the pest, the benefits or risks of a "no-action" decision, and the least disruptive actions to take for short- and long-term control of the pests. An example of this type of injury is honeydew off a tree infested with aphids that spots an automobile finish. An IPM option is to park the car in a different location until the aphids are killed in the fall when the temperature falls and then apply dormant oil during the early spring to control the aphids the following year, provided that the aphid infestation is not significantly damaging the aesthetic value of the tree. The challenge that most urban pest-control businesses face is that the level of pest infestation is often dictated by the consumer or property owner. In these situations, urban pest-control professionals must educate their clientele on the benefits, economic and environmental, of following a structured IPM- based program. Otherwise, urban pest control becomes a practice of preventive chemical pest-control options without proper pest scouting and monitoring.

Management Strategies

Selection of control methods requires detailed knowledge of pest biology and ecology. The idea is to identify weak links in the pest life cycle or vulnerable life stages that selectively can be exploited with minimal disturbance to the rest of the system. Some tactics that are currently most useful to agriculture and urban situations include the following:

1. Protect naturally occurring insect predators and parasites with selective insecticides or selective use of broad-spectrum pesticides (e.g., altering application time, rate, and placement).
2. Use crop management or cultural practices that make the environment less favorable for pest colonization, establishment, and survival. This may be accomplished by manipulation of crop rotations, planting and harvest dates, site selection, cultivation, irrigation, and fertility regimes.
3. Use pest-resistant/tolerant plant varieties.

The exact mix of tactics depends upon the pest status. For subeconomic pests (pest that consistently remain below economic thresholds), the appropriate action is no control action. Regional monitoring of population levels is adequate to ensure that these pests do not pose a problem (economic problem). Occasional pests are those species that normally remain below the economic threshold, but sporadically exceed the threshold if conditions are correct. Here, an appropriate strategy is early detection and pest population prediction through field scouting and monitoring, with remedial or rescue use of pesticides when the threshold is reached.

The most difficult species to manage are classified as severe pests. These include many weeds and plant pathogens whose average densities are extremely high or pests that cause cosmetic damage to high-value fruits and vegetables. Pesticide use against a severe pest is usually not justified except as a short-term, stopgap measure because the frequent applications necessary for control inevitably result in environmental problems. Instead, long-term management requires combinations of methods that reduce the ability of the pest to grow and reproduce to damaging levels.

Pest managers must remember that the overall goal of a successful IPM program is **not** the reduction of pesticide use. The overall goal of a sound IPM program is to achieve an acceptable level of pest control using all available pest-control resources while reducing negative impacts on human health, the environment, and food safety. Properly executed, the adoption of IPM principles will have the effect of reducing pesticide use simply by reducing the number and amount of preventive pesticide applications and replacing preventive applications with the adoption of appropriate thresholds (ETs and EILs), proper scouting, pest monitoring, and utilization of all appropriate nonchemical pest-control methods when feasible. The primary goal of IPM must remain managing pest insect, weeds, and diseases.

Current Issues and the Future of IPM

The IPM approach has much greater acceptance since its beginnings in the 1970s. Initially envisioned as the best solution to the problem of environmental contamination by insecticides, IPM shifted its focus from environmental to economic concerns (competitiveness and profitability) during the 1980s. The 1990s was the decade of the environment, with a renewal of public scrutiny of agricultural and urban pesticides. During the 1990s and early in the twenty-first century, the promotion and acceptance of IPM was overshadowed by the increase and acceptance of the "Organic" or "Organically Produced" food items and the negative implications of "Cosmetic Landscape Pesticide Applications."

Concern is growing about pesticide residues on foods, groundwater contamination by agrichemicals, and farmworker safety. Food processors limit the types of pesticides that their growers can use, even when these uses are legal. Additional restrictions on the use of pesticides are inevitable as the products move through reregistration and evaluation under the Food Quality Protection Act. In the urban environment, concern is growing about pesticide exposure in parks and public areas and also possible contamination of surface waters such as rivers, streams, and lakes. The consequence of these concerns could be additional restrictions on the use of pesticides, including the cancellation of pesticide products or their uses.

The role of IPM must remain a decision-making strategy to provide farmers and urban pesticide users with alternative control strategies that create a sound and effective pest management program. Failure of agriculture and urban facility managers to voluntarily adopt IPM approaches may lead to legally mandated practices where effective pest control is not a primary concern. Indeed, some argue that it is already too late since there are some legislative initiatives and policy options now under consideration in the United States. Congressional opinions range from pesticide use by prescription only, to taxes on pesticide users, to crop insurance and tax credits for IPM users, and IPM-labeled fruits and vegetables.

In the future, IPM needs to become a dominant force in pest management in order to control our significant pest populations without excessive harm to the environment. Just as there are opinions concerning pest control and the role of pesticides in pest management, IPM needs to further define pest-control options and pest-control goals on the state, regional, and possibly national level in order to provide an acceptable level of sound pest management practices to the public. The development of new pest-control practices and pesticide chemistries provides the pesticide applicator with additional tools to provide safe and effective pest control only if there is adequate public education and information.

Review Questions

Select the correct answer or fill in the blank for each question. See answers in Chapter Review Answers.

1. One of the earliest uses of chemicals as pesticides was the burning of sulfur. (True or False)

2. One responsibility of the EPA is to protect humans and environmental health. (True or False)

3. Which of the following would not be considered a natural pest control method?
   A. Wind
   B. Rain
   C. Cultivation
   D. Sunshine

4. Which of the following is a cultural control method?
   A. Fertilization
   B. Planting time
   C. Pruning
   D. All of the above

5. All pesticides kill only the target pests. (True or False)

6. The use of temperature or humidity manipulation is a _____ control method for insects.
   A. Cultural
   B. Biological
   C. Legal
   D. Physical

7. The goal of any pest management program is to eradicate the pest. (True or False)

8. Which of the following is not classified and regulated as a pesticide in Idaho?
   A. Bactericide
   B. Fertilizer
   C. Desiccant
   D. Adjuvant

9. Which of the following pesticides can be absorbed by the plant and translocated within the plant?
   A. Systemic pesticide
   B. Contact pesticide
   C. Absorptive pesticide
   D. Volatile pesticide

10. Which of the following pesticides was not used before the 1900s?
    A. Bordeaux mixture
    B. Nicotine
    C. DDT
    D. Sulfur

11. DDT was banned because of its
    A. Acute mammalian toxicity
    B. Short residual action
    C. Stability and persistence
    D. Inability to accumulate in animals

12. Legal controls use
    A. Local volunteers
    B. Torts
    C. Quarantines
    D. Petitions

13. Piscicides are pesticides that control spiders. (True or False)

14. Herbicides and insecticides are both pesticides. (True or False)

15. Synthetic organic pesticides were introduced
    A. Pre-1900
    B. Early 1900
    C. Pre–World War II
    D. Post–World War II

16. Pulling weeds and trapping gophers are an example of what kind of control?
    A. Natural control
    B. Mechanical control
    C. Physical control
    D. Cultural control

CHAPTER 2:
Pesticide Laws, Rules, and Regulations

Learning Objectives

- Know the most prominent federal pesticide law.
- Be able to define the words typed in *italics*.
- Describe what is involved in pesticide registration and the practical importance of each.
- Know why products are classified Restricted Use and who may purchase and apply such products.
- Understand the roles that the University of Idaho Extension and Idaho State Department of Agriculture (ISDA) have in the Pesticide Safety Education Program (PSEP), certification, licensing, and recertification of pesticide applicators.
- Know what types and categories of licenses are available in Idaho for pesticide applicators.
- Know the conditions under which you qualify as a private applicator, professional applicator, pesticide dealer, or pesticide consultant.
- Know the certification requirements for private applicators, professional applicators, pesticide dealers, and pesticide consultants.
- Understand the recertification requirements needed to renew a pesticide license.
- Understand what is meant by prohibited pesticide and pesticide governed by a special rule.
- Understand the role of enforcement in pesticide application.
- Know the prohibited acts in regard to pesticide application.
- Know the types of records that are required for pesticide applications.
- Know if you are subject to the Worker Protection Standard (WPS) and for whom you must provide the appropriate protections.
- Describe the conditions under which you must be certified to apply pesticides to waters of the state.

Federal and State Pesticide Regulation

The United States Environmental Protection Agency (EPA) administers federal pesticide laws. Individual states must adopt the federal laws and may create their own to address their state-specific pest control issues. Therefore, all laws mentioned in this manual are requirements in Idaho, regardless of their origin.

In explaining regulations, we only paraphrase the actual wording found in the laws and rules. Also, this manual is revised every few years and the laws may have changed (or new laws enacted) in that time. Consult the laws and rules themselves to determine what you must do to comply with them.

Keep in mind that we do not mention all regulations affecting pesticide use in this chapter. Other chapters include additional legal requirements that are specific to those discussions (e.g., disposal and spills). Appendix B lists the addresses and phone numbers of regulatory agencies to contact when you have questions about the laws and rules mentioned in this manual.

Federal Insecticide, Fungicide, and Rodenticide Act

Both the US Congress and the Idaho legislature have enacted legislation that regulates the production, transportation, sale, use, and disposal of all pesticides. The most prominent pesticide law is the *Federal Insecticide, Fungicide, and Rodenticide Act* (FIFRA), which is overseen by the *United States Environmental Protection Agency* (EPA), Office of Pesticide Programs (OPP). The majority of the regulatory guidance concerning pesticide programs is found in Title 40, Subchapter E of the Code of Federal Regulations (CFR) and the specific regulations governing the certification of pesticide applicators is found in part 171 of that subchapter (also known as 40 CFR, Part 171).

Idaho Pesticide Statutes and Rules

The Idaho Pesticide Act of 1976, as amended, is the major state regulatory law and is administered by the ISDA. Rules relating to pesticide use and chemigation for Idaho originate from this act. The Idaho Pesticides and Chemigation Law (Chapter 34, Title 22, Idaho Code) and Rules Governing Pesticide and Chemigation Use and Application (IDAPA 02.03.03) are the current laws and rules that are derived from this act. All pesticide applicators must be familiar with the information contained within these documents.

Pesticide Product Registration

The EPA must *register* a pesticide before it can be sold or used in the United States. The EPA registers the use(s) of a product when test data, submitted by the manufacturer, meet all necessary criteria. Essentially, the data must show that the intended use(s) of the product will not create unreasonable risks. In the context of a pesticide *registration*, "unreasonable risks" means that the use of a pesticide will result in risks that exceed their benefits. In theory, registration is based on weighing benefits versus risks.

It is important to note that it is not merely the product that the EPA registers, but rather the use(s) of the product. Thus, even if the EPA registers the use of a product, it might not register it for all uses the manufacturer had intended.

In addition to the test data, the manufacturer must submit a label that includes special information on how to properly use the pesticide. If anything in the data suggests that the label does not contain proper information, the registrant (generally the pesticide or product

manufacturer) must change the label to be consistent with the pesticide's data. For example, toxicity tests may show that eye protection is required to safeguard a person who is applying the pesticide; therefore, the EPA would require the label to state those label requirements to register the pesticide.

Section 3 Registration

The EPA grants *Section 3 Registrations* to pesticide products after all data and tests fully satisfy the requirements for federal registration. This process is very meticulous and usually requires years to complete. The process of compiling data from research, testing, and other required elements may take more than seven years. It is not uncommon to take three years to complete the registration process after all data has been submitted. Once the EPA grants a Section 3 registration for a pesticide product, that product is available for use in the United States, provided it is properly registered with the state, territory, or other US entity where it will be used.

Special Local Needs Registration

Special Local Needs Registration (known as SLN or *24(c) Registrations*) allows a state or local area to further control how federally registered pesticides are used within its jurisdiction. The SLN registrations are typically used to add application sites, pests, or alternate control techniques to those listed on the federal label. Normally, the states require additional data to in order to determine if the pesticide product effectively controls the pest without unreasonable harm to the pesticide applicator or the environment. The state also requires that a supplemental label is produced that provides any pesticide restrictions, hazards, handling procedures, and use instructions to specifically address the local use of the pesticide.

In Idaho, you must have the applicable Section 3 pesticide label and the supplemental SLN labeling (available from your agrichemical dealer) in your possession to apply a pesticide for the purpose indicated by the registration. (Labeling discussed in more detail in chapter 5). The registration is valid only in the state or local area listed on the supplemental labeling.

Emergency Exemption Registration

Sometimes, an emergency pest situation arises for which no effective pesticide is registered. If obtaining federal or SLN registrations would take too long to allow timely control of the pest, a state may petition the EPA for an emergency exemption from registration (known as a *Section 18 Exemption*). The EPA grants the exemption only when certain carefully defined emergency, crisis, or quarantine conditions prevail.

The emergency exemption allows the sale and use of a pesticide for a nonregistered purpose for a specified time; the exemption may also be limited to a specified total number of acres within a state. The process for obtaining a Section 18 Registration for a pesticide product includes submitting information to the ISDA that justifies the product's use. The ISDA reviews the data required for registration under Section 18 and then forwards a recommendation for registration to the EPA for their approval. Like the Special Local Needs

Registration, a supplemental label must be produced and approved that accompanies the Section 3 label for all emergency uses of the pesticide. The user also is required to report the amount of pesticide used, as well as the total acres treated, to the ISDA registration section.

Pesticide Reregistration

Many pesticides had been registered before adequate safeguards were added to FIFRA for human health and environmental protection. Therefore, requirements were added to FIFRA that required these older products undergo *reregistration* to ensure that their use would not pose unreasonable risks.

The EPA must have the necessary human and environmental safety data of a pesticide product before it will reregister that product. The registrant (i.e., the pesticide manufacturer) is responsible for supplying any requested data and paying fees to support the reregistration program. Registrants could choose not to seek reregistration of specific products (often due to the cost involved), in which case the EPA cancels the registration for those products. Once the EPA has all the data it needs for a given pesticide, it determines under what conditions or situations the product may be registered for use.

General Use Pesticide

Pesticides are significant tools for pest control and when properly handled and applied and do not pose an unreasonable risk to human health and/or the environment. Pesticide products that represent a significantly lower risk of adverse effect are known as *General Use Pesticides*. General Use Pesticide (GUP) products may be purchased and applied by any adult and the user (applicator) is not required to have pesticide certification or licensing.

Restricted Use Pesticide

If the use of a pesticide might have the potential for unreasonable adverse effect on human health and/or the environment, but the potential harm is adequately lowered by application from trained, certified, and licensed persons, the EPA classifies the pesticide as *restricted use*. All pesticide classified as *Restricted Use* can only be applied by applicators that have the appropriate pesticide license for the product in Idaho. This classification statement (or a similar statement) must be printed on the pesticide label.

Example of a Restricted Use Statement on Pesticide Labels

Restricted Use Pesticide
Due to High Toxicity and potential for secondary damage. 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.

The restricted-use pesticide designation (see example above) is displayed on all pesticides that are designated as a *Restricted Use Pesticide* (RUP). The above example states the reason why the product is designated as an RUP and who is authorized to purchase and use the product.

Licensed Applicator

Only a *licensed applicator* may apply or direct and supervise the use of RUPs. Supervision requirements are covered later in this chapter. To become licensed, a person must exhibit a broad-based knowledge and competency in pesticide use. This is done by taking and passing certification examinations. In the case of professional applicators, additional requirements, such as financial responsibility (insurance), are also required prior to granting a license for application. Licensing provides an alternative to more stringent controls in the sales and use requirements for these pesticides.

Pesticide Safety Education Programs (PSEP) and Licensing

Pesticide Safety Education Programs

The *Pesticide Safety Education Program* (PSEP) of the University of Idaho Extension and the ISDA Pesticide Training Section provides necessary training to people who want to become certified to use pesticide products in Idaho. The principles of proper handling and use are the same for any pesticide regardless of whether the pesticide is classified *Restricted Use* or *General Use*. The pesticide applicator training is focused for all users of pesticides. The PSEP conducts training sessions in all certification categories and produces educational materials (including this manual) that help you better understand the many aspects of pest control.

There are two major categories of training that PSEP programs administer. *Certification training* is initial training to potential pesticide applicators. This type of training provides basic information to assist students in obtaining licenses in the type and categories they need. *Recertification training* is pesticide training specifically designed to enhance the knowledge of pesticide applicators that are currently licensed. Recertification training is sometimes referred to as "Continuing Education," as it is specifically designed to provide the most current information to applicators in all subjects pertaining to pesticide application.

The ISDA administers Chapter 32, Title 22, Idaho Code (Idaho Pesticide and Chemigation Law) and IDAPA 02.03.03 (Rules Governing Pesticide and Chemigation Use and Application). These documents comprise the primary regulations concerning pesticide use in Idaho.

As authorized by FIFRA, the ISDA administers a state program to certify and license pesticide applicators. The Pesticide Applicator Licensing and Training Section within the ISDA Agricultural Resources Division provides this program for Idaho.

There are three types of licenses that ISDA administers: *private applicators*, *professional applicators*, and *pesticide dealers*. Statewide consultants are persons who consult pesticide applicators and may recommend products for agricultural use. The Statewide consultant is a category under the professional applicator type of license, although statewide consultants do not apply pesticides.

Private Applicators

Private applicators are those applicators that apply restricted-use pesticides to **farms, nurseries, greenhouses, and forest commodities** on land they own, lease or rent, or are employed by a landowner, lease holder, or renter to apply restricted-use pesticides to agricultural or forest commodities. You may also apply to land you do not own, rent, or lease to agricultural or forest commodities as trade for other services, such as applying pesticide to a crop in trade for other fieldwork or harvesting. In addition to the basic Private Applicator license, there are specific categories that private applicators must obtain if they perform those pesticide applications:

- If the private applicator applies any fumigation pesticide for soil fumigation, they must obtain the Soil Fumigation (SF) applicator category.
- If the private applicator performs any Aerial Application of pesticide products with fixed or rotary winged aircrafts [to include Unmanned Aerial Vehicles (UAV)], they must obtain the Aerial Applicator (AA) category.
- If the private applicator applies any fumigation product as a space, commodity, or rodent burrow for area or space fumigation, they must obtain the Area Fumigation (AF) applicator category.
- If the private applicator applies any chemical (pesticide or fertilizer) through any irrigation system, they must obtain the Chemigation (CH) category.

You qualify as a private applicator if you meet the following criteria:

- Must be at least eighteen (18) years old.
- Pass the certification examination for restricted-use pesticides and any additionally required license categories.

Frequently, people who apply pesticides to their own property feel that they qualify as a private applicator. This is not necessarily the case. For example, an application of an RUP in the home is not considered a private application because it is not for the purpose of producing an agricultural or forest commodity. Likewise, pesticide applications to a person's business property, such as a restaurant or golf course, are not private applications.

Professional Applicators

Professional applicators are those applicators that apply general-use and restricted- use pesticides to land they do not own for monetary compensation or hold themselves (through advertising, marketing, etc.) as a professional applicator. The main differences between private and professional applicators are that private applicators receive no monetary compensation for pesticide applications and do not present themselves as professional applicators. Professional applicator categories cover a wide range of pesticide application situations. The Statewide Consultant category is included in the Professional applicator category, although people in this category do not apply pesticides with the exception of pesticide applications for Demonstration and Research. For a complete listing of professional categories, refer to the Idaho Pesticide and Chemigation Law and Rules.

You qualify as a professional applicator if you meet the following criteria:

- Must be at least eighteen (18) years old.
- Pass the certification examination in the professional category that you require plus the Core Competency (CO) license category.
- Show proof of minimum insurance for liability or financial responsibility.

Pesticide Dealers

Pesticide dealers are those persons who sell or distribute restricted-use pesticide products within the state. Unless they hold the appropriate pesticide applicator licenses, pesticide dealers cannot professionally apply any pesticide product.

You qualify as a Pesticide Dealer if you meet the following criteria:

- Must be at least eighteen (18) years old.
- Pass the certification examination for pesticide dealers for the type of restricted-use pesticide products that are sold or distributed plus the CO license category.

Pesticide Consultants

Statewide pesticide consultants are persons who may consult on and recommend agricultural pesticide products and/or brand names within the state. Although the license type is for professional applicators, they cannot apply any pesticide product professionally without first obtaining an applicator license.

You qualify as a statewide pesticide consultant if you meet the following criteria:

- Must be at least eighteen (18) years old.
- Pass the statewide consultants certification examination category and the CO license category.

Professional applicators may also consult in areas in which they are licensed in Idaho. For example, if an applicator is licensed in the Agricultural Herbicide category, he/she may legally consult on (or recommend) agricultural herbicide products and/or brand names within the state.

There are twenty-five different certification categories of pest control available for certification. Contact the ISDA if you need clarification on what type of certification you need for your operation. The following is a list of the current professional certification categories. Note that the aerial applicator, chemigation, soil fumigation, and area fumigation categories apply to **both** professional and private applicators.

License Categories

- Applicator Core Competency (CO)—Required category for all Idaho Professional Applicator Licenses. General knowledge of pesticides, including proper use and disposal, product characteristics, first aid, labeling, and laws.

- Agricultural Crop Pest Control (AC)— This category applies to professional applicators who use or supervise the use of pesticides in production of agricultural commodities, including grasslands and noncrop agricultural lands.
- Aerial Pest Control (AA)—Required for application of pesticides to all application sites by operating or flying fixed-wing or rotary aircraft. This category applies to both private and professional applicators.
- Anti-Fouling Coatings (FC)—Required for applicators who use or supervise the use of anti-fouling coatings to control fouling organisms on aquatic vessels, underwater structures, and other similar structures. This category applies to both private and professional applicators.
- Agricultural Livestock Pest Control (LP)—Required for applicators who apply or supervise the application of pesticides directly to animals or to areas where animals are housed or confined. This category applies to both private and professional applicators.
- Aquatic Weed and Pest Control (AP)—Required for professional applicators who use or supervise the use of any pesticide purposefully applied to standing or running water. This category excludes public health pest control (PH) and applies to professional applicators employed by irrigation districts, canal companies, contractors, or others performing aquatic pest control.
- Consultant and Research (CR)— Required for consultations or recommendations to supply technical advice concerning the use of agricultural pesticides and for the application or supervision of the use of restricted use pesticides (RUPs), for no compensation, to demonstrate the action of the pesticide or to conduct research with RUPs.
- General Vertebrate Control (GV)— Required for controlling vertebrate pests, such as large and small predators, rodents, and birds, by Wildlife Services (WS) personnel of the United States Department of Agriculture-Animal and Plant Health Inspection Service (APHIS). This category applies to professional applicators who use or supervise the use of sodium cyanide and sodium fluoroacetate to control regulated predators.
- Industrial, Institutional, and Structural Pest Control (Commodity) (CP)—Required for professional applicators who use or supervise the use of pesticides on manufactured products or commodities in the following: food-handling establishments, packinghouses, and food-processing facilities; and industrial establishments, including commodity storage facilities, grain elevators, and any other similar areas, public or private, for the protection of stored, processed, manufactured products, or commodities.
- Industrial, Institutional, and Structural Pest Control (Noncommodity) (IP)—Required for professional applicators who use or supervise the use of pesticides in, on, or around the following: food-handling establishments, packinghouses, and food-processing facilities; human dwellings; cooling towers; air washers; evaporative condensers; swimming pools; pulp and paper mills; sewer treatment; residential

and commercial building; institutions, such as schools, hospitals, and prisons; and industrial establishments, including manufacturing facilities, warehouses, and any other structures and adjacent areas, public or private, for the protection of health, dwellings, structures, and stored, processed, or manufactured products.

- Nonsoil Fumigation (NS)—Required for applicators who use or supervise the use of a pesticide to fumigate anything other than soil. This category applies to both private and professional applicators.
- Ornamental Pest (OP)—Required for professional applicators who use or supervise the use of pesticides to control pests in the maintenance and production of ornamental plants and turf.
- Public Health Pest (PH)—For state, tribal, federal, or other governmental employees and contractors who use or supervise the use of pesticides in government-sponsored public health programs for the management and control of pests having medical and public health importance.
- Regulatory Pest Control (RP)—For state, tribal, federal, or other local governmental employees and contractors who use or supervise the use of pesticides in government-sponsored programs for the control of regulated pests. Certification in this category does not authorize the purchase, use, or supervision of use of products for predator-control pesticides listed in the General Vertebrate Control (GV) category.
- Right-of-Way Herbicide (RW)—Required for professional applicators who use or supervise the use of pesticides in the maintenance of roadsides, powerlines, pipelines, and railway rights-of-way, and similar areas.
- Seed Treatment (ST)—Required for professional applicators using or supervising the use of pesticides on seeds in seed treatment facilities.
- Soil Fumigation (SF)—Required to apply any soil fumigant pesticide to agricultural fields, plant nurseries, and other similar growing media for the growing of agricultural commodities, excluding rodent control. This category applies to both private and professional applicators.
- Chemigation (CH)—Required to apply any pesticide and/or fertilizer through an irrigation system. This category is applicable to both private and professional applicators.
- Professional Commercial Apprentice License—For conducting General Use Pesticide (GUP) applications only in situations applicable to the CP, OP, AC, IP, and RW categories. To obtain a professional commercial apprentice license the applicant must pass the Applicator Core Competency exam with a minimum score of 70% or better and meet the requirements as outlined in section 100. Persons with this license may only perform pesticide applications under limited supervision of a properly certified professional applicator. Applicators with this license cannot supervise other

pesticide applicators. The professional commercial apprentice license may not be reciprocated with other participating agencies. The license expires one year from the date of issuance. The professional commercial apprentice license is nonrenewable.

Applicator Recertification

To maintain certification, the applicator must complete a specified amount of *recertification training* within the license period. The goal of the recertification program is to provide training for applicators that will continually increase their level of competency.

The applicator may recertify by attending ISDA-approved pesticide recertification training courses and accumulating credits. An applicator may also recertify by passing a recertification test in the category(s) that he/she needs recertification. Attending approved recertification classes and accumulating recertification credits is the preferred method of retaining applicator certification.

The requirement for recertification credits is sixteen (16) credit hours during the license period for professional applicators and seven (7) credit hours during the licensing period for private applicators.

Supervision

Idaho law allows unlicensed individuals to perform applications, which normally requires a license, if they are under the applicable supervision of a properly licensed person. The definition of supervision is dependent upon the license type required for the application.

Idaho Administrative Rule specifically defines two types of applicator supervision:

Limited Supervision: This is applicable for a pesticide applicator who holds the CA category and their professional applicator supervisor. The CA must be supervised by a professional applicator that has the appropriate license category for the application the CA is performing. The professional applicator is limited to supervising a maximum of two CA applicators at any one time and must maintain immediate communication (voice, radio, cellular telephone, or similar) for the duration of all pesticide applications.

On-Site Supervision: This is for the application of RUP: For any unlicensed pesticide applicator or an applicator who does not hold the appropriate license category for professional or for-hire applications, a supervising professional pesticide applicator must be physically at the site of application, must have visual contact with the pesticide applicator, and must be in a position to direct the actions of the pesticide applicator. The supervising professional applicator may not supervise more than two pesticide applicators.

Private applicators may supervise unlicensed pesticide applicators applying RUPs to their lands provided the unlicensed pesticide applicator has successfully completed the WPS Pesticide Handler Training or its equivalent. The unlicensed pesticide applicator must maintain immediate communication (voice, radio, cellular telephone, or similar) with the licensed private applicator for the duration of all RUP pesticide applications. The licensed private applicator is responsible for all applications made by the unlicensed applicator under his/her supervision regardless of whether the pesticide is a RUP or GUP.

Professional Applicator Requirements

Professional applicators are required to show proof of surety bonding or liability insurance in order to obtain and maintain a pesticide applicator license. All professional applicators must have adequate liability insurance. Check current Idaho Pesticide and Chemigation Law and rules or with the ISDA for the liability limits needed for professional pesticide applicators. A professional applicator's license is automatically suspended if the insurance lapses or is cancelled.

Professional and private applicators must inform the ISDA of any changes in their status as an applicator. These changes may include, but are not limited to

- Change in employer
- Change in home address
- Change in insurance status

It is the responsibility of the professional applicator, **not the employer**, to inform the ISDA of any changes. The professional applicator must be licensed in the category(s) that correspond to the sites, commodities, or situations they apply.

Dealer Requirements

No person (dealer) shall distribute any pesticide unless it is in the original, unbroken container and there is a registered pesticide label affixed to the container. The practice of "bulking out" (repackaging a product for distribution without obtaining registration for the repackaged product) is illegal.

Each dealer outlet that sells restricted-use pesticides must have a dealer license from the ISDA. Check with the ISDA for current exemptions.

Dealers are responsible for verifying that only ISDA-certified applicators purchase restricted-use pesticides. They must also verify that products used for chemigation, soil fumigation, and nonsoil fumigation are only sold to applicators who have the appropriate certification from the ISDA for these pesticides. It is illegal to sell an RUP to a person who is not certified to purchase these products. For example, a professional ornamental applicator may not purchase an agricultural RUP.

Prohibited Pesticides

The following active ingredients have been prohibited for use either because of their exceptionally hazardous nature or because of their environmental persistence.

aldrin	DDT (DDE or TDD)	heptachlor	cadmium
dieldrin	silvex	chlordane	dinoseb
TDE (DDD)	thallium sulfate	endrin	2,4,5-T

Other prohibited pesticides include any pesticide whose use has been prohibited by state statute or FIFRA.

Pesticides Covered by Special Rule

Some pesticides, because of their potential adverse effect on the environment or to human health, are regulated through *special rules*. These rules may seem similar in principle to the rules regarding RUPs; however, special rules go beyond limiting the use of the pesticide to licensed applicators. For example, Idaho has special rules regarding the use of sodium flouroacetate in the Livestock Protection Collar (LPC). The use of the LPC is limited to employees of USDA Wildlife Services.

Enforcement

The ISDA investigates and enforces the provisions of the state pesticide law and rules on state lands, federal lands, or private property with the exception of federal Indian reservations.

State Pesticide Investigators

The ISDA has a number of investigators throughout the state. Currently, ISDA's field investigators are located in major cities throughout Idaho. They provide assistance and education to pesticide applicators in their areas in addition to investigating pesticide-related complaints and performing routine inspections. They are assigned to ISDA's Division of Agricultural Resources.

Properly credentialed inspectors of the ISDA, EPA, or USDA may enter any public or private land at reasonable times for the following purposes:

- Observing the use and application of pesticides
- Inspecting pesticide application records
- Inspecting spraying equipment, storage facilities, and/or disposal areas
- Investigating complaints of injury
- Inspecting and sampling land or soil
- Inspecting and sampling pesticides being distributed, offered for sale, applied, or to be applied

There are different types of inspections that the ISDA performs. These inspections include education, compliance/assistance, and complaint/injury investigations.

Prohibited Acts

Under the Idaho Pesticide and Chemigation Law, the ISDA has the responsibility and authority to investigate pesticide incidents. This requires the determination of causes, remedies and whether regulatory action should be taken. The following is an excerpt from the Idaho Pesticide and Chemigation Law that specifies certain prohibited acts. Each is a violation of pesticide laws and could result in an enforcement action.

22 3420 — PROHIBITED ACTS. No person shall

- Use a pesticide in a manner inconsistent with its labeling except as provided for by rule.
- Make pesticide recommendations in a manner inconsistent with its labeling except as provided for by rule.
- Make false or misleading claims through any media relating to the effect of pesticides or application methods to be utilized.
- Operate a faulty or unsafe pesticide spray apparatus, aircraft, or other application device or equipment.
- Operate a faulty or unsafe chemigation system.
- Apply ineffective or improper pesticides.
- Make false, misleading, or fraudulent records, reports or application forms required by the provisions of this act.
- Apply pesticides in a faulty, careless, or negligent manner.
- Refuse or neglect to keep and maintain records required by the provisions of this act or to make reports when and as often as required.
- Distribute, sell, or offer for sale any pesticide or device that is misbranded.
- Formulate, distribute, sell, or offer for sale any pesticide that is adulterated.
- Distribute, sell, or offer for sale any pesticide except in the manufacturer's original unbroken container.
- Refuse or neglect to comply with any limitations or restrictions placed on a license or permit issued under the provisions of this act.
- Refuse or neglect to comply with any other provisions of this act or rule or any lawful order of the director.
- Aid or abet a licensed or an unlicensed person to evade the provisions of this act, conspire with such licensed or an unlicensed person to evade the provisions of this act, or allow one's license or permit to be used by another person.
- Make false or misleading statements during or after an inspection concerning any infestation or infection of pests found on land.
- Impersonate any federal, state, county, or city inspector or official.
- Use or supervise the use of any restricted-use pesticide or any state restricted- use pesticide without that person's first complying with the licensing requirements pursuant to this act and such other restrictions as had been determined by the director

as necessary to prevent unreasonable adverse effects on the environment, including injury to the applicator, persons, or land, provided that a person who is not a certified applicator but an employee of a licensed private applicator may use a restricted-use pesticide or a state restricted-use pesticide under the direct supervision of the licensed private applicator unless otherwise prescribed by the labeling of the pesticide.

- Use or supervise the use of a chemical in a chemigation system without having complied with the licensing requirements pursuant to this act and rules and such other restrictions as have been determined by the director. A person who is not a certified applicator but an employee of a licensed private applicator may use chemicals under the direct supervision of a licensed private applicator unless otherwise prescribed by the labeling of the chemical.
- Chemigate without installing the proper chemigation equipment to protect against surface or groundwater contamination.
- Fail to abide by the conditions of a stop sale, use or removal order, or chemigation stop work order.
- Offer for sale, hold for sale, sell, barter, ship, deliver for shipment or receive and, having so received, deliver or offer to deliver chemicals for chemigation to an unlicensed person.

Remember that it is the responsibility of the *pesticide applicator* to know and understand all applicable pesticide regulations. Failure to abide by federal, state, local laws, rules, and regulations could result in legal and financial liability. If you have any questions concerning these regulations or their interpretation, please contact the ISDA.

Additional State Rules

State rules forbid pesticide applications that will damage man, animals, or the environment. The ISDA administers several rules to protect bees and beneficial organisms, to reduce off-target applications (drift), and to reduce the potential for groundwater contamination. Some items subject to specific regulations include the following:

- Licensing and recertification procedures
- Windspeed restriction when not specified in the pesticide label
- Restrictions to protect pollinators in blooming crops
- Storage of pesticide containers
- Applications by aircraft

As new problems arise, the ISDA may find it necessary to implement application restrictions through additional rules. Applicators need to be aware of all special rules in areas where they use pesticides.

Chemigation

The Idaho Pesticide and Chemigation Law requires that persons who apply chemicals (pesticides and fertilizers) through an irrigation system must obtain the chemigation category. Passing the testing requirements of the chemigation category and certifying that any irrigation equipment used for chemigation purposes meets ISDA requirements for chemigation. Recertification is accomplished over a two-year period by attending approved recertification training or by taking the recertification examination.

Additional Information

Other sections of the manual also discuss matters that are regulated by ISDA:

- Disposal in chapter 7, Using Pesticides Safely
- Groundwater protection in chapter 8, Pesticides and the Environment
- Storage in chapter 7, Using Pesticides Safely
- Transportation in chapter 7, Using Pesticides Safely

Pesticide Recordkeeping

Pesticide application records are very important for many reasons. They provide a positive record of application and are important management tools. They also provide valuable information to medical or governmental officials for health and safety reasons. You are required to keep a record of pesticide applications if

- You make an application as a professional applicator.
- You make an application as a private applicator and the pesticide is an RUP.
- You make pesticide applications through an irrigation system (chemigation) as a professional applicator or private applicator using an RUP.

The actual requirements differ slightly for professional applicators (see subsection, Professional Applicator Records). Pesticide applicators are required to maintain accurate and complete application records for all applicable pesticide applications. Currently, pesticide records must be retained for a minimum of two (2) years for private applicators and a minimum of three (3) years for professional applicators.

Private Applicator Records

Eight items need to be recorded on application records for private applicators:

- Date of application
- Crop, animal, or commodity treated

- Product name of the pesticide applied
- *EPA registration number* of the pesticide applied
- The total amount of area, animals, bushels, linear feet, etc. to which the pesticide was applied
- Total amount of pesticide applied
- Location of the application
- Name and license number of the certified applicator

Professional Applicator Records

The professional applicator must keep the following information in his/her records:

- Date/time of application
- Crop, animal, or commodity treated
- Product name of the pesticide applied
- *EPA registration number* of the pesticide applied
- The total amount of area, animals, bushels, linear feet, etc. to which the pesticide was applied
- Total amount of pesticide applied
- Location of the application
- Name and license number of the certified applicator
- Name and address of the person for whom the pesticide was applied
- Wind speed and direction during application
- Worker protection information exchange (agricultural applicators, when applicable see subsection Worker Protection Standard)
- Person who recommended the pesticide application

The private and professional applicators must record the correct information for each application in their pesticide records. If you have any questions concerning the information necessary to comply with either the USDA or Idaho State Pesticide and Chemigation Law and rules, please contact the ISDA field representative in your area or contact the ISDA, Division of Agricultural Resources (see Appendix B).

The Worker Protection Standard

The federal *Worker Protection Standard* (WPS) for agricultural pesticides is designed to reduce the risk of employee exposure to pesticides. The agricultural employer (e.g., farm, forest, greenhouse, and nursery owner or labor contractor) is responsible for complying with and providing employees with the protections mandated by the WPS.

You are subject to the WPS if you have at least one (1) employee (excluding yourself or a member of your immediate family) who is involved in the production of agricultural plants in a nursery, greenhouse, forest, or farming operation. Professional applicators and their employees are subject to WPS if they mix, load, or apply agricultural-use pesticides.

As with FIFRA and Idaho State Pesticide and Chemigation Law and rules, WPS is a complex rule. Therefore, we will introduce it here and cover other aspects of it in appropriate chapters in this manual. We will not, however, be able to cover the entire WPS. For EPA publications that help you understand and comply with this rule, refer to the WPS materials found online at the Pesticide Environmental Resource Center website or contact the ISDA field representative in your area.

Affected Pesticide Uses

The WPS covers almost all pesticide applications for the production of agricultural plants in nurseries, forests, and greenhouses and on farms. Some pesticide uses not included in the above definition are applications to pastures and rangelands, for vertebrate pest control, of attractants and repellents, on animals or to their premises, and to harvested portions of plants.

Affected Employees

Any employee is subject to the WPS if they handle an agricultural plant pesticide or enter a treated site during an application, a *restricted-entry interval* (REI), or in the thirty days after an REI has expired.

- Agricultural workers include anyone who performs tasks relating to the production and harvesting of agricultural plants. Early entry workers are agricultural workers who enter a treated site during an REI. As discussed in other chapters, early entry is allowed only under certain circumstances and for workers who receive appropriate training and protection.
- Pesticide handlers include anyone who handles agricultural plant pesticides or assists in their application (e.g. mixers, loaders, applicators, flaggers) or cleans or repairs application equipment.

Exemptions

Note that these definitions include the farmer and his/her family members who perform the tasks described.

When performing the tasks of an agricultural worker or a pesticide handler, the owner of an agricultural establishment (under WPS, you are considered the “owner” of land you rent or lease) and his/her immediate family are exempt from many WPS requirements. For a complete explanation of owners and immediate family member exemptions, see the “How to Comply” manual to the WPS—published by the Pesticide Educational Resources Collaborative (PERC) found online at pesticideresources.com—or contact the ISDA.

Protection of State Waters

Water is one of the most important natural resources in Idaho and, as such, it is the responsibility of each pesticide applicator to ensure that all waters (including ground and surface sources) are protected from accidental or intentional discharge of pesticides and fertilizers. With proper use and prudent knowledge of pesticide interaction within the environment, pesticides do not pose unnecessary risks to state waters. However, certain pesticides applied in specific environments have contributed to the contamination of state waters.

It is important to remember that **any pesticide has the potential to contaminate water sources**. Pesticides have been detected in Idaho ground and surface waters and in most cases, the detections are below established tolerance levels. However, there is still the potential for substantial damage if proper pesticide application practices are not followed. Specific regulations contained within the Idaho Pesticide and Chemigation Law and rules are designed to protect Idaho's water. Federal regulations, such as the Clean Water Act, may provide significant penalties if proper use and application of pesticides (in regard to the protection of state water) is disregarded.

The most prevalent type of pesticide detected in Idaho's waters is herbicide, particularly those that are soil applied. Atrazine, prometon, diuron, and bromacil are examples of herbicides that have been detected in groundwater throughout Idaho.

Applicator Categories

Currently the Aquatic Pest license category allows applicators to apply pesticides to surface waters within the state of Idaho to control aquatic pests.

For some operations, it is desirable to add chemicals (fertilizers or pesticides) to irrigation water as a means of application. This application is known as *chemigation* and requires a chemigation category regardless of license type. In addition to the chemigation category, chemigation systems within Idaho must be inspected and registered with the ISDA to ensure that each system has the proper pollution-prevention devices.

These categories are specifically designed to train applicators to safely use chemicals and prevent water contamination. Other sources, such as the EPA, Idaho Fish and Game, Idaho Department of Environmental Quality, or other governmental agencies that have responsibility for water quality within Idaho may apply additional restrictions. It is the responsibility of all pesticide applicators to ensure that any application is performed in a manner that prevents the contamination of water.

Other Regulatory Agencies

In addition to the ISDA, the following state and federal agencies have regulatory powers in Idaho, in regard to pesticide distribution, use, safety, and disposal.

Federal Agencies

- United States Environmental Protection Agency—regulates pesticide and environmental issues at a federal level.
- Food and Drug Administration—monitors pesticide residues on the nation's food supply.
- Occupational Safety and Health Administration—regulates worker-safety issues.
- Federal Aviation Administration—regulates aerial application equipment.
- United States Department of Transportation—regulates interstate transportation issues.

State Agencies

- Idaho Office of Emergency Management—handles emergency crises, spills and leaks.
- Idaho Department of Environmental Quality—regulates environmental issues of pesticides, such as pesticide spills, contamination, hazardous wastes and proper disposals.
- Idaho Department of Labor—regulates employee safety issues.
- Idaho Department of Health and Welfare—handles health issues.
- Idaho Fish and Game—regulates wildlife and fish issues.
- Idaho State Police and Idaho Transportation Department (Ports of Entry)—handle intrastate transportation issues including responses to spills of hazardous materials.
- Idaho Public Utilities Commission—regulates the transportation of hazardous materials (placarding, shipping documents, etc.) assisted by the Idaho State Police and the Ports-of-Entry (Department of Transportation).
- Department of Transportation (Department of Motor Vehicles)—issues endorsements for both drivers and carriers to transport hazardous materials and/or wastes.

Review Questions

Select the correct answer or fill in the blank for each question. See answers in Chapter Review Answers.

1. The most prominent pesticide law in the United States is the Federal Insecticide, Fungicide, and Rodenticide Act. This act is overseen by what agency?
    A. USDA
    B. US Department of Commerce
    C. US Department of Transportation
    D. Division of Chemistry
    E. EPA

2. When a pesticide is registered by the EPA, it essentially means
    A. The pesticide is available for use for any purpose in the United States.
    B. The pesticide has undergone strict review that has determined its use(s) do not create undue risks.
    C. The pesticide company has paid administrative fees to allow testing of the product they wish to be approved.
    D. The pesticide has undergone strict review to determine what crops, commodities, location, sites, etc. it may be used on or in.
    E. B and D above.

3. Restricted-use pesticides are those pesticides that
    A. Can only be used under emergency circumstances, which must be approved by the EPA.
    B. Present a hazard to the applicator, environment, animals, or other persons and require special training for application.
    C. May only be purchased by research scientists for testing purposes.
    D. May only be purchased by professional applicators.
    E. May be purchased by any individual who exhibits the need for the pesticide.

4. A person who applies pesticides to lawns and ornamental plants in an urban setting as an integral part of their business is a
    A. Private applicator
    B. Commercial applicator
    C. Limited applicator
    D. Professional applicator

5. A person applies restricted-use pesticides to control bark beetles in trees that grow on land he owns. Which license does he need?
    A. Private applicator
    B. Commercial applicator
    C. Limited applicator
    D. Professional applicator

6. The Idaho State Department of Agriculture conducts several types of inspections which include
    A. Educational
    B. Compliance
    C. Assistance
    D. Complaint or injury investigations
    E. All of the above

7. The Worker Protection Standard for agricultural pesticides applies to any business that
    A. Has at least one employee.
    B. Has at least five employees.
    C. Has at least ten employees.
    D. Hasover ten employees.

8. As a professional pesticide applicator, you must keep accurate pesticide application records for
    A. Only the restricted-use pesticides that you apply.
    B. Only the pesticide applications that are made to private property.
    C. Only pesticide applications that have the potential for damage due to drift or runoff.
    D. All pesticide applications.

9. A farmer applies fertilizers and pesticides through his irrigation system. Which license does he need to be in compliance with ISDA Pesticide Laws and rules?
    A. Private applicator with Chemigation category
    B. Professional applicator with Aquatic Pest category
    C. Pesticide dealers for agriculture pesticides
    D. Statewide consultants
    E. None, since he is only applying fertilizers

CHAPTER 3:
Pesticides

Learning Objectives

- Define the terms that are in *italics*.
- Describe ways by which we can classify pesticides.
- Know the difference between inorganic, organic, and microbial pesticides.
- Be able to distinguish between the different types of pesticide names.
- Know the characteristics of the insecticide groups discussed in this chapter.
- Describe two ways in which pheromones are used in pest management.
- Describe the uses and limitations of contact and systemic herbicides.
- Distinguish between protectant and eradicant fungicides.
- Be familiar with the characteristics of inorganic and synthetic organic fungicides.
- Know when nematicides are typically applied and how they reach the target organisms.
- Distinguish anticoagulant and acute rodenticide with respect to lethal dose and list the advantages of each.
- Describe different ways avicides control pest birds.

What Is a Pesticide?

We will define a *pesticide* as any substance used to either directly control pest populations or to prevent or reduce pest damage. Not all pesticides actually kill the target organism; some may only inhibit growth or repel the organism.

We will discuss in the following sections how pesticides are classified and some of the major groups of pesticides in use today.

Classification of Pesticides

We classify pesticides in several ways, based on its own value for a given purpose:

- Their chemical nature (e.g., inorganic, organic).
- Their formulation (e.g., wettable powder, granular).

- The *site* on which they are used. The site is the crop, animal, area, or commodity that is treated (e.g., corn, poultry, barn, stored grain).
- Use pattern or purpose of treatment (e.g., preplant versus postemergence herbicide).
- The *target pest*, which is the pest you are trying to control (e.g., fly spray).
- The group of pests controlled (e.g., insecticides, herbicides, fungicides). The group of pests controlled is the most common form of classification.

Chemistry of Pesticides

Chemical pesticides can be divided into two main groups: inorganic and organic compounds. A third group of pesticides consists of natural disease-causing agents.

Inorganic Pesticides

The *inorganic pesticides* are those that do not contain carbon. They are of mineral origin and commonly contain arsenic, copper, boron, mercury, sulfur, tin, or zinc. The inorganic pesticides were the most important of the early pesticides. They are still used today, primarily for the control of plant diseases and as wood preservatives. They are usually toxic to a wide range of organisms, a characteristic that is often undesirable (except in the case of wood preservatives). They also are generally less effective than many of the organic compounds. Some have relatively low acute toxicity to humans, although compounds containing lead, mercury, and arsenic have generated widespread health and environmental concerns and their use has been either banned or severely curtailed.

Organic Pesticides

The *organic pesticides* contain carbon. They also contain hydrogen and often oxygen, nitrogen, phosphorus, sulfur, or other elements. Most pesticides used today are organic compounds. A few organic pesticides are either derived or extracted directly from plants. Most, however, are *synthetic* compounds. They are often extremely effective and easy to use, have been relatively low cost, and some are quite specific in their activities. They also have been the principal focus of health and environmental concerns and are the pesticides most commonly associated with problems of pesticide use and misuse.

Microbial Pesticides

A distinct group of pest-control agents are the so-called *microbial pesticides*. These are bacteria, viruses, and fungi that cause disease in a given species of pests. Although they occur naturally in certain areas, they are sometimes intentionally introduced in sufficient quantities that a relatively high level of control becomes possible. They tend to be highly specific in their activity and are often virtually harmless to nontarget species. There are, however, relatively few microbial pesticides registered for use at this time.

Insecticides

Insecticides enter insects in a number of ways. Some must be swallowed as the insect feeds; these are the *stomach poisons*. Others penetrate the insect's outer membrane or enter through its respiratory tubes (the spiracles); these are the contact poisons. Most synthetic organic insecticides work in both ways.

Some insecticides remain on the surface of treated plants or animals following application. Others are absorbed and subsequently *translocated* or moved throughout the plant or animal; these are the *systemic* insecticides. Plants absorb systemic pesticides either through the foliage or the roots. Systemic insecticides, which may act as either contact or stomach poisons, are particularly useful against insects with piercing-sucking mouthparts.

Selective insecticides, sometimes called *narrow-spectrum* insecticides, kill only a few, usually related kinds of insects without harming other insects. More common are the *broad-spectrum* insecticides; these are useful when several different kinds of insects are a problem. However, no single insecticide kills all insect pests.

Insecticides vary in the length of time they remain effective. Some break down almost immediately into nontoxic by-products; these are short-term or *nonresidual* insecticides. They are useful where greater persistence could harm nontarget organisms (treated animals) or could contaminate food. The *residual* insecticides, however, remain active for a relatively long time; they are valuable when particular insects are constant control problems and where adverse health and environmental effects are unlikely. Most insecticides with notably long residual activity have either been banned or their use has been severely curtailed.

Inorganic Insecticides

These types do not have carbon in their molecular structure. In general, they are stable chemicals, do not evaporate, and are usually water soluble. Although not extensively used, inorganic insecticides provide additional options for the control of insects. Examples of inorganic insecticides include the following:

- Borates or sodium borate compounds are used as a spot treatment to control insects that infest wood, such as joists and structural timbers.
- Sulfur, specifically sulfur dust, is helpful in controlling mites, chiggers, thrips, and newly hatched scale insects. In addition to its insecticidal properties, it is also an effective fungicide that is particularly effective on powdery mildews.
- Inorganic fluorides, such as sodium fluoride, barium fluosilicate, sodium silicofluoride, and cryolite are used for insect control. Cryolite is used in fruit and vegetable production due to its lower toxicity.
- Boric acid is a nonvolatile salt that is often used to control crawling insects in wall voids and other difficult to reach household or building spaces. It is effective as long as it is kept dry and in adequate concentration and acts as a stomach poison and insect cuticle wax absorber.

- Silica gels or silica aerogels (silica dusts) are often used for household insect control. The silica aerogels kill insects by absorbing waxes from the insect cuticle, permitting the continuous loss of water from the insect body and causing the insects to become desiccated and to die from dehydration. Often, other types of insecticides are used with the silica gels to increase their effectiveness.

Synthetic Organic Insecticides

This is unquestionably the most important group of insecticides and includes the organophosphates, carbamates, chlorinated hydrocarbons, synthetic pyrethroids, and a number of other chemical classes.

Organophosphates

Organophosphates are some of the oldest synthetic pesticides. While they were widely used in the past, they have come under increased scrutiny due to human exposure and environmental risks and are not used as frequently as they were even 10–20 years ago. They are highly effective against a wide range of pests, though some specific products may be rather selective. Similarly, many organophosphates are relatively nonpersistent while others have residual activity. Most are contact poisons and are often effective against mites.

Carbamates

Carbamates are an important group of insecticides. They are quite variable in toxicity and persistence and some are systemic. They are similar to the organophosphates in that they both affect the insect's nervous systems. Some carbamates also act as a juvenile hormone mimic or an insect repellent. Like the organophosphates, carbamates also have troubling toxic effects and have come under scrutiny.

Chlorinated Hydrocarbons

Chlorinated hydrocarbons were the first synthetic organic insecticides developed and are still used today. However, many of them had a long residual life and persisted in the environment. They tend to accumulate in wildlife, particularly in fat tissue, and can have adverse effects. Thus, the use of many of these compounds has been prohibited or subjected to special restrictions. Modern-day chlorinated hydrocarbons have very few, strictly regulated industrial uses, and this class of chemistry is no longer registered for agricultural or residential pesticide use in Idaho.

Pyrethroids

Synthetic chemicals related to the pyrethrums differ substantially from the natural pyrethrums in activity, toxicity, and uses. The pyrethrums are unstable in sunlight. However, numerous synthetic pyrethrums (pyrethroids) have been developed that overcame this problem.

The pyrethroids, which often contain the synergist piperonyl butoxide, almost instantaneously knock down flying insects, but generally exhibit low toxicity to mammals. They also are noted for their extended residual activity and effectiveness at lower temperatures.

One problem with pyrethroids when used on fruit crops is their tendency to cause outbreaks of spider mites. While this is still a concern, some newer pyrethroids also have miticidal activity. Because pyrethroids are highly toxic to aquatic organisms, the EPA now requires the use of buffer zones and runoff mitigation measures to minimize environmental contamination.

Nicotinoids

Just as synthetic pyrethroids are similar to and modeled after natural pyrethrins, nicotinoids are also similar to and modeled after natural nicotine. As a relatively new class of insecticide, the nicotinoids (also called neonicotinoids, neonicotinyls, and chloronicotinyls) were first registered in the United States in 1992. Nicotinoids are a nerve poison that damages the central nervous systems of insects. They are effective against a wide range of insects and particularly useful for controlling sucking pests due to their systemic activity. The insecticide is also used as a seed treatment pesticide. Imidacloprid, thiamethoxam, clothianidin, and acetamiprid are common examples of nicotinoids.

Spinosyns

Another important class of insecticides is the spinosyns, a group of naturally derived compounds that act on the insect nervous system. Products such as spinosad and spinetoram provide effective control of many chewing and sucking pests and are considered reduced-risk materials. Some formulations are approved for use in organic systems.

Diamides

The diamides are a newer class of insecticides that target insect muscle, resulting in paralysis and death. These insecticides have long residual activity, low toxicity to mammals, and are important tools for resistance management. Common active ingredients in this group include chlorantraniliprole, cyantraniliprole, and cyclaniliprole. These insecticides are widely used in both field and specialty crops due to their high efficacy and favorable environmental profile.

Chitin Synthesis Inhibitors

Compounds such as diflubenzuron inhibit the development of chitin, which is an essential part of an arthropod's exoskeleton. Thus, they are specifically toxic to invertebrates that normally produce chitin.

Repellents

Insect *repellents* have been used effectively for many years against mosquitoes, flies, fleas, ticks, and chiggers that attack people and animals. Butoxypolypropylene glycol and dipropyl isocinchomeronate are common repellents; some repellents contain pyrethroids.

Insect Hormones

Hormones are chemical messengers that regulate the development and certain behaviors of insects. Naturally occurring hormones or synthetic chemicals that mimic their activity can be used to control and/or monitor insects.

Insect Growth Regulators (IGRs)

The *insect growth regulators* control the development of an insect. For example, methoprene controls flies in poultry houses and causes developmental changes in maggots that prevent them from emerging from the pupal stage.

The IGRs normally have a high degree of specificity and appear to present minimal risk to nontarget species. The potential for insects to develop resistance to these chemicals also appears less than with conventional insecticides. One exception is cyromazine, registered as a feed additive for laying hens; resistance among fly populations has been common in some parts of the country.

RNA Interference (RNAi) Products

Recent advances in biotechnology have led to the development of RNA interference (RNAi)-based insecticides, which silence specific genes essential to insect survival. These products are highly selective and represent a promising tool for integrated pest management. Ledprona is a recently registered RNAi insecticide that provides highly specific control of Colorado potato beetle, representing a new generation of biotechnology-based pest management tools.

Attractants

Attractants lure insects to traps or to poison bait stations. They may be used to control or monitor insect populations. An attractant may be a food source, such as molasses or sugar, or a substance as sophisticated as a sex *pheromone*. While attractants have been used only to a limited extent for control purposes, they are often quite specific, thus providing a highly selective weapon against the target species.

Insects produce pheromones to communicate with other members of the same species. The sex attractants are the most important pheromones in insect pest management; they attract members of the opposite sex for mating. Pheromones of many insects have been identified and synthesized but are used to monitor pest populations more often than to control them. Traps are baited with pheromones; when a certain level of the particular pest is found in the traps, a pesticide is applied.

One use of sex pheromones for controlling insects is called *mating disruption*. Sufficient pheromone is applied to the crop so that male pest insects cannot find females. Therefore, mating is not accomplished and females cannot produce offspring. The pheromone for codling moth has been registered for use in apples and pears.

Acaricides

Acaricides are used to control mites and spiders. Most of the previous discussions on insecticides apply equally well to acaricides. Many of the same chemicals are registered for use against both insects and mites. Moreover, there are products designed specifically for use as acaricides for crop, livestock, and urban applications.

Herbicides

Herbicides are a *phytotoxic* chemical, which means they are toxic to plants. With the exception of bactericides and disinfectant pesticides used for water purification and general cleaning, herbicides are the most used category of pesticide. The herbicides used to control certain weeds without injuring the crop are called *selective herbicides* because they only harm select plants. Crops usually tolerate selective herbicides because the crop plant metabolizes or detoxifies the herbicide before it causes significant damage. However, selective herbicides can damage crop plants if you misapply them or if stressful weather conditions exist. *Nonselective herbicides* are toxic to most or all plants and are often used before crop emergence, after harvest, or general weed-control applications.

A sequence of events is necessary for a herbicide to kill a plant:

- It must contact (sprayed/placed) on the plant.
- It must be absorbed into the plant, either through the leaves or roots.
- If necessary, it must be moved (translocated) to the sensitive part of the plant.
- It must block a sensitive or critical process in the plant (e.g., photosynthesis).

The specific process that a herbicide inhibits is called its *mode of action*. We can group herbicides accordingly (e.g., growth regulators such as 2,4-D and photosynthetic inhibitors such as atrazine).

Contact Herbicides

Herbicides that only kill the parts of a plant that they actually come in contact with are called *contact herbicides*. Uniform and complete spray coverage is important with contact herbicides. Other herbicides are translocated throughout the plant and are called *systemic herbicides*; usually, they kill the entire plant even if all of the leaves are not treated.

Contact herbicides are not translocated within a plant. Paraquat is an example of a contact herbicide that causes rapid burning and browning of treated leaves. Contact herbicides are most effective when applied to actively growing weed seedlings.

In general, contact herbicides are nonselective. They kill susceptible annual weeds, but generally do not provide residual control; thus, a new flush of weeds may germinate from seed after a contact herbicide application. Contact herbicides also burn off the aboveground growth of perennial weeds, but these weeds usually resprout from underground parts.

Systemic Herbicides

Systemic herbicides absorbed through the roots move with the flow of water to expanded leaves; systemic herbicides absorbed through the leaves move along with the sugars from photosynthesis to growing points. Systemic herbicides need to be used when controlling established perennial weeds. Many herbicides used in crop production are systemic herbicides.

The correct application rate is especially critical with systemic herbicides. The rate must be high enough to be effective, but not so high that contact activity would occur. If plant tissue is killed at the point of contact, the herbicide will not translocate throughout the plant.

Fungicides

Fungicides either kill or inhibit the growth of fungi. They may be broad- or narrow-spectrum pesticides.

Protectant Fungicides

Because a fungal pathogen normally lives in close association with its host, it is difficult to find chemicals that kill the fungus without harming the plant. For this reason, most fungicides are applied as *protectants*; in other words, they are applied before disease develops to protect the plant from would-be invaders. They usually prevent the fungal spores from germinating or the fungus from penetrating the plant. You may need to apply protectants repeatedly during the growing season in order to protect new plant growth.

Sometimes, protectants may stop or slow the spread of a disease that has just begun and is still limited, but they are generally less effective once infection is established. Some protectants are systemic.

Eradicant (Systemic) Fungicides

Eradicants, sometimes called *systemic fungicides*, kill or stop the spread of a fungus after the fungus has become established in or on the plant. They are usually used when protectants aren't available, aren't applied in time, or are too expensive or not practical to use. Eradicants that remain active only on plant surfaces are of limited value because most fungi grow within the tissues of the host. Most eradicant fungicides, therefore, are systemic.

Inorganic Fungicides

Inorganic fungicides have been successfully used for disease control for over a century. Bordeaux mixture and sulfur are perhaps the foremost examples. Sulfur is still used today to control certain foliage and fruit diseases, particularly powdery mildew. Bordeaux mixture consists of soluble copper sulfate mixed with hydrated lime in water. The "fixed" or "insoluble" copper compounds have largely replaced Bordeaux mixture for disease control.

The inorganics are generally broad-spectrum fungicides and have low acute toxicity to humans. Many of the inorganics cause considerable injury to plants, which explains in part why synthetic organic fungicides have largely replaced them.

Synthetic Organic Fungicides

Many synthetic organic fungicides are highly selective, have residual properties, are effective at relatively low rates, and are generally less toxic to crops and less harmful to the environment than the inorganics.

Bactericides

Chemical control of bacterial disease has been largely unsuccessful. However, some fungicides, such as Bordeaux mixture, "fixed" coppers and the carbamates, have been somewhat effective in controlling bacterial leaf spots and blights.

Antibiotics

Some fungi and bacteria produce chemical compounds that are toxic to other microorganisms; these compounds are called *antibiotics*. Some antibiotics that are commonly used to treat infections in people and animals (e.g., streptomycin) also show promise for controlling bacterial plant pathogens. However, antibiotics are currently used to control only a few plant diseases (e.g., fire blight on apples).

Nematicides

A *nematicide* is generally used as a preventive measure; thus, nematicides are most often applied at or before planting. However, fenamiphos is available for use in established plantings of some fruit crops.

There are two general types of chemicals used to treat soil for nematodes: *fumigants* and nonfumigants. Professional applicators must be certified in the Soil Fumigation category to use soil fumigants. A separate manual for soil fumigation is available for this category.

Fumigant Nematicides

A *fumigant* is a pesticide that is active as a gas, although it may be initially formulated as either a solid or liquid. Most nematodes live in the soil, so the fumigants are either injected (gas or liquid) or incorporated (solids) into the soil at the appropriate depth for control. Once injected or incorporated, the soil surface must be either covered with a tarp or prepared so that the gases cannot readily escape by compacting the soil surface or wetting the surface with water.

Nonfumigant Nematicides

Nonfumigant nematicides are often referred to as contact nematicides. They must be incorporated into the soil and/or carried by water so that they are brought into contact with the nematodes. If you use the products correctly, they should not injure the young plants.

Nonfumigant nematicides are generally either organophosphates or carbamates. They are normally effective against certain insects as well as nematodes and some are systemic. Examples are terbufos and ethoprop.

Rodenticides

Rodenticides are classified as either *anticoagulants* or acute compounds.

Anticoagulants

These types are bait formulations that are ingested by the pest rodent, which damages capillaries and reduces the ability of the blood to clot; ultimately, it causes internal bleeding that kills the rodent. Early rodenticides, known as multiple-feed or first-generation rodenticides, need the rodent to ingest the bait repeatedly over a period of several days to reach a lethal level. The active ingredients bromadiolone and brodifacoum rodenticide baits are examples of acute or second-generation anticoagulants. These types of rodenticides can kill rodents after a single feeding.

As a group, anticoagulants are considered safer than the acute rodenticides. They are available as baits in several forms: grain baits (either meal or pelleted), extruded baits (pellets or blocks), paraffinized blocks used in damp areas, and soluble sodium salts used to make lethal water baits.

Acute Compounds

The acute rodenticides, prepared with active ingredients such as strychnine or zinc phosphide, provide a quick knockdown of a rodent population. Often, these types of baits are restricted as to where they may be used and who may be able to purchase and use them.

Avicides

Avicides control bird species. The number of available avicides is much smaller than that of most other pesticide groups. Toxicants are usually mixed with specific food baits and placed where only targeted pest birds eat them. The use of avicide baits is generally restricted to government animal control officials in Idaho.

Some avicides have repellent as well as *lethal* properties. When consumed, they cause birds to exhibit distress symptoms. Exposure to this erratic behavior scares the rest of the flock out of the area.

Plant Growth Regulators, Defoliants, and Desiccants

Although legally defined as pesticides, *plant growth regulators*, *defoliants*, and *desiccants* are not normally used as pest-control agents (except for plant growth regulator herbicides such as 2,4-D). These chemicals are used to alter, in some manner, the crop itself.

Plant growth regulators increase, decrease, or change the normal growth and/or reproduction of a plant in some manner. Their use on field and vegetable crops is limited (e.g., to prevent or delay sprouting of tubers following harvest); however, they are used extensively in fruit crops.

Defoliants and desiccants are usually referred to as “harvest-aid” chemicals. A defoliant causes the leaves of a plant to drop off prematurely; a desiccant draws moisture from a plant, causing it to wither and die. In either case, the harvesting of the crop becomes easier. Desiccants are used in Idaho on potatoes and certain seed crops (such as alfalfa).

Wood Preservatives

Wood preservatives are pesticides that poison wood so it will not be used as a food source by fungi and insects. Pentachlorophenol (penta) and inorganic arsenicals (e.g., CCA) are commonly used to pressure treat wood products. Many wood preservatives are also available for brush-on or spray-on treatment.

Penta, creosote, and the inorganic arsenicals are highly toxic and their use has been restricted. Take precautions whenever you handle a wood preservative or pressure-treated wood:

- Wear the appropriate protective equipment when handling preservatives or treated wood; note that rubber gloves do not protect your hands from creosote.
- Saw or sand treated wood outdoors and wear goggles and a dust mask.
- Avoid exposure to penta if you are pregnant because it has caused birth defects in laboratory animals.
- Ask for a Consumer Information sheet when purchasing wood treated with penta, creosote, or inorganic arsenicals; these sheets provide further handling instructions, as well as information about where you can use treated wood.
- Do not burn treated wood; doing so releases toxic fumes. Dispose of treated wood in a sanitary landfill.

For more information on the use of wood preservatives and treated wood around the farm, contact your University of Idaho County Extension Educator, your local library, or the ISDA.

Review Questions

Select the correct answer or fill in the blank for each question. See answers in Chapter Review Answers.

1. Although these pesticides are not normally used in pest control specifically, they do assist in the harvesting of certain crops:
   A. Rodenticides and Eradicants
   B. Dessicants and Defoliants
   C. Eradicants and Organics
   D. Systemics and Selectives
   E. Insecticides and Fungicides
2. Wood-preservative chemicals are often practically nontoxic and therefore applicators need very little protective clothing or regulation. (True or False)
3. Coverage and rate are not important when applying a systemic-type pesticide. (True or False)
4. Coverage is important in a contact-type herbicide because
   A. The pesticide must contact the target pest in sufficient quantity to be effective.
   B. Small amounts of pesticides that contact the target pest may not be sufficient to control the pest.
   C. Contact herbicides do not translocate.
   D. All of the above.
5. Systemic insecticides work well on insect and insect-like pests that have
   A. Chewing mouthparts
   B. Pinching mouthparts
   C. Grasping mouthparts
   D. Piercing/Sucking mouthparts
6. Microbial pesticides are those chemicals that control microbes in the plant or soil. (True or False)
7. Nematicides are
   A. Generally used as a preventive measure
   B. Are fumigant pesticides
   C. Are nonfumigant pesticides
   D. All of the above
8. Protectant fungicides often must be applied repeatedly during a fungal disease period because
   A. They rapidly lose their effectiveness when exposed to sunlight.
   B. They rapidly degrade in the presence of oxygen.
   C. They only protect the portions of the plant that were sprayed, not the new growth.
   D. All of the above.
9. Organophosphates, carbamates, and chlorinated hydrocarbons are examples of
   A. Inorganic pesticides
   B. Microbial pesticides
   C. Herbicides
   D. Synthetic organic pesticides
10. Anticoagulant pesticides kill by causing nervous system failure in rodents. (True or False)
11. Because they are highly specific, insect growth regulator pesticides are generally _____ susceptible to the development of resistance.
   A. More
   B. Less
   C. The same
12. In the early years of pesticide development, which class of pesticide was the most important?
   A. Organic pesticides
   B. Inorganic pesticides
   C. Biological pesticides
   D. None of the above
13. An eradicant fungicide is generally systemic. (True or False)
14. Synthetic organic insecticides include what types of chemicals?
   A. Chlorinated hydrocarbons
   B. Pentachlorophenol
   C. Hydrated lime compounds
   D. CCA

CHAPTER 4:
Pesticide Formulations

Learning Objectives

- Define words typed in *italics*.
- Know what an inert or other ingredient is and why it is added to pesticides.
- Name the types of pesticide formulations and the advantages and disadvantages of each type.
- Understand specific precautions for handling or applying each type of formulation.
- Understand what adjuvants are and how they are used.
- Know what compatibility in pesticide mixture is and why it is important.
- Understand which pesticide formulations are particularly conducive to dermal absorption and inhalation exposure.

Active and Inert Ingredients

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 or Other Ingredients (nonpesticidal). Inert Ingredients are added so that the pesticide may be handled and applied easily, safely, and effectively. 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.

Pesticide 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 (EC)
- Solutions (S)
- Soluble Powders (SP)
- Wettable Powders (WP)

- Flowables (F)
- Water Dispersable Granules (WDG)
- Microencapsulates (ME)
- Dusts (D)
- Baits (B)
- Granules (G)
- Ultra-Low Volumes (ULV)
- Aerosols (A)
- Fumigants
- Impregnated Materials

Formulations vary in their

- Safety to the user
- Potential hazard to the environment
- Application methods and equipment
- Likelihood of causing phytotoxicity
- Cost
- Efficacy of pest control

Choose the best formulation for a particular job. This requires the applicator to know the characteristics of each type of formulation and the type of pest they are attempting to control. For instance, it would not be advisable to use a formulation that is sensitive to pesticide drift (such as a dust) during a period of the year that has high winds. Some pesticides are manufactured with different formulations although the active ingredient(s) are the same. The greater variety of formulations allows the pesticide applicator to more specifically match the pesticide to the conditions. The following section describes the most common formulations and some of their advantages and disadvantages.

Types of Pesticide Formulations

Emulsifiable Concentrates (EC or E)

Emulsifiable Concentrates are liquid formulations with the active ingredient dissolved in one (1) or more petroleum solvents. An emulsifier is added so the formulation will mix readily with water for application. The ECs usually contain between two (2) and eight (8) pounds of active ingredient per gallon and when added to water usually form a milky white emulsion (liquid in another liquid).

The EC formulations 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 to keep the pesticide from separating.
- Nonabrasive to equipment.
- Does not plug screens and nozzles.

Disadvantages:

- High concentrations of active ingredient reduce the margin for error when mixing or applying.
- May have a high phytotoxicity hazard.
- May be easily absorbed through the skin of humans or animals (due to solvents).
- Solvents in the formulation may cause equipment deterioration.
- May be corrosive, causing pitting or discoloration of painted surfaces.
- May be flammable.

Solutions (S)

Solutions are formulations with a water-soluble active ingredient dissolved in one or more liquid solvents. They may be ready to use or they may require further dilution. The advantages and disadvantages of solutions vary dramatically depending upon 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% active ingredient(s). Soluble powders dissolve readily in water.

Advantages:

- Easy to store, transport, and handle.
- Has a lower phytotoxicity than some liquid formulations, especially ECs.
- Has slower skin and eye absorption than ECs.

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% active ingredient. Unlike the soluble powders, wettable powders do not dissolve in water.

The active ingredient is combined with a dry, inert carrier (clay, talc) and mixed with an emulsifier. Wettable powders are mixed with water and applied as suspensions (dry particles in a liquid).

Wettable powders share all the advantages and disadvantages of soluble powders. In addition to the inhalation hazard, other disadvantages of wettable powders include the following:

- Constant agitation of the tank mix to avoid settling of the particles in the tank.
- Wear to nozzles and pumps from abrasive spray mix.
- A higher tendency for sprayer screens and nozzles to clog.
- Difficulty mixing in very hard or alkaline water.
- Visible residues on treated surfaces.

Flowables (F)

Flowable formulations are finely ground, solid particles combined with active ingredient(s) and 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 four (4) or more pounds of active ingredient per gallon of formulation, they should be handled with the same care as ECs 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, thus dustless. The granules disperse or break apart when mixed with water. 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%–10.0%) 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.
- Easily applied in hard-to-reach areas (cracks, under leaves).

Disadvantages:

- Easily drifts 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 the user.

Granules (G) and Pellets (P)

Granular and *pellet* formulations are dry, ready-to-use materials usually containing from 2% (2) to 15% 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 corncobs.

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.

The Ps or SPs are very similar to granules and the terms are often used interchangeably. In a pellet formulation, however, all the particles are the same weight and shape. This uniformity allows a more precise application.

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.
- Can be applied with inexpensive application equipment.

Disadvantages:

- More expensive than WPs or ECs relative to the amount of active ingredient in the formulation.
- Does not stick to foliage.
- May need soil incorporation or moisture to activate pesticide.
- May be hazardous to nontarget species.

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. Usually, the pest must eat the bait to be affected.

Baits may be used to control certain insects, snails and slugs, birds, rodents, and other pest mammals. Most bait formulations contain a low percentage of active ingredient(s) (less than 5%). 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 either by direct consumption or secondary poisoning (consuming affected animals or animal parts).
- Baits may not control the target pest because other available sources of food are more attractive.
- Application costs are high relative to the amount of active ingredient in the formulation.
- Dead pest may cause an odor or sanitation problem.

Ultra-Low Volume (ULV)

An *Ultra-Low Volume* application is a spray application of undiluted formulation at a rate of no more than one-half of a gallon (2 quarts) per acre. The formulation may contain only the active ingredient or the active ingredient in a small amount of solvent. Always apply ULV formulations without further dilution.

The principal advantage of a ULV application is that you can spray a large area with a small volume of liquid. These formulations often require specialized application equipment and are limited principally to a small number of insecticides and a few uses.

Advantages:

- Ready-to-use: Pour into tank or lock container and spray.
- Requires little agitation in the spray tank.
- Does not plug hoses and screens.
- Nonabrasive to equipment.

Disadvantages:

- Can cause rubber or plastic hoses, gaskets, pump parts, and surfaces to deteriorate.
- Can present a significant drift hazard.
- Easily absorbed through the skin. Protective clothing is necessary.

You may not make a ULV application unless it is specifically designated on the label or is based on an official written or published recommendation of the EPA.

Microencapsulate (M) or (ME)

The active ingredient (liquid or dry) in *encapsulated pesticides* is encased in extremely small, coated capsules, which are then suspended in a liquid. The pesticide is released gradually over a period of time as the coating deteriorates. This principle is similar to that used for time-released cold medicines.

Advantages:

- Relatively easy to transport, handle, and store.
- Can be applied with conventional spray equipment.
- Is effective when the pesticide is needed for a time-release situation: Single application that is effective over a longer period of time.

Disadvantages:

- Constant agitation is necessary to suspend the pesticide in the liquid carrier.
- Presents a significant hazard to bees (pollinators) because the capsules may be carried back to the hive with the pollen.
- Since they remain effective longer than other formulations of the same active ingredient, they may have much longer reentry periods (Reentry Interval or REI).

Aerosols (A)

Aerosols are those formulations containing an active ingredient in solution (usually a petroleum distillate) and packaged in a pressurized container or sprayed under high pressure to create small, suspended droplets. “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. The pesticides are sprayed under pressure to create very fine droplets that get increasingly smaller due to the evaporation of the petroleum distillate in the droplet. The goal of the spray application is to create a very small droplet that does not have sufficient mass to drop out of the air. The resulting small, suspended droplets are ideal for delivering pesticides to control flying insects, such as flies, gnats, and mosquitoes.

Aerosols may also be applied by very specialized equipment that uses high pressures and small nozzles to produce the extremely small droplets required for aerosols. These machines are also called foggers or misters and are capable of creating plumes of suspended droplets wider than 100 yards to apply to large areas.

Advantages:

- Ready-to-use products are small and easy to use.
- Very good coverage due to extremely small droplet size.
- Droplets suspend in the air, having similar properties as a fumigant gas.
- Can penetrate thick foliage.
- Commercial applications can cover very large areas. Swath widths are often over 100 yards wide.

Disadvantages:

- Ready-to-use products are relatively high cost.
- Risk of inhalation injury.
- Difficulty in confining the pesticide to the target site or pest.
- Product is highly flammable.
- Large area coverage requires specialized equipment.

Fumigants

Fumigants are pesticides that are active as gases. Some fumigants are formulated as liquids, either volatile liquids, or pressurized liquids that become gases when released to normal atmospheric pressures. Others are solids that release gases when exposed to moisture (humidity) and the correct temperature range.

Because of their toxicity and the hazards associated with application, the EPA placed additional restrictions on the sale and use of fumigation products. Additional training and/or license category is required prior to using these products.

Fumigants are generally nonselective in their action. Most fumigants can kill insects, weed seeds, nematodes, rodents, fungi, and other pests. Because they are a gas, fumigant use is generally limited to soil and closed structures, such as warehouses, containers, ship's holds, granaries, and greenhouses.

Advantages:

- Toxic to a wide range of pests.
- Penetrates cracks, crevices, wood, and tightly packed areas, such as soil or grain.
- If performed correctly, a single application is sufficient.
- Little or no pesticide residue.

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 (warning) gas may dissipate faster than the fumigant, leaving a toxic situation without warning.
- Treatment area must be enclosed or covered to prevent the gas from escaping during application and for a specific period after application.
- Additional training and/or certification is needed prior to using fumigation products.

Pesticide-Impregnated Materials

Pesticide-impregnated materials include ear tags, collars, and gaskets. They are usually plastic or rubber materials that have been impregnated with an insecticide (generally an

acaricide) or herbicide. These materials are designed to release the pesticide slowly into the immediate area that comes in contact with the material. Insecticidal tags or collars have relatively low toxicity, but the consistent release of insecticide may cause irritation to the area around the tag. They are most commonly used for livestock and domestic animals/pets (e.g., ear tags and flea collars). Some rubber gaskets are impregnated with herbicides for root control in underground pipes (sewer lines). These are very effective in reducing or eliminating root growth in pipe joints.

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 formulated as premixes for applicator convenience, but they are more often purchased separately and mixed by the applicator. Pesticides can be tank mixed unless tank mixing is not allowed by label instructions. Even though tank mixing is allowed under federal and state pesticide regulations, the applicator is responsible for any damage that results from the application of the pesticide mixture.

When you mix two or more pesticide formulations to form a single sprayable mixture, always follow the "WALES method" (Wettable powders, Agitation, Liquid formulations, Emulsifiable concentrates, and Surfactants) of pesticide mixing. This will ensure that all of the pesticide formulations used are mixed thoroughly.

- Add the *diluent* to the spray tank to one-half the tank capacity.
- While the tank is under agitation, add **W**ettable powders, water-dispersible granules, soluble powders, and other powder or granular formulations.
- Thoroughly **A**gitate the tank to mix the powders and granules.
- Add any **L**iquid formulations and adjuvants to your spray tank and continue to agitate.
- Add the **E**mulsifiable concentrates last and continue to agitate.
- Fill the remainder of the tank with *diluent*.

The WALES method of mixing pesticides is a guide when the pesticide label does not have specific tank-mixing instructions. If one or more of the pesticides you are tank mixing has specific instructions on how to tank mix the products, follow the label directions.

Pesticide Incompatibility

Not all pesticides work well in combination. Two or more pesticides that can be mixed together are said to be compatible. Pesticides that cannot be effectively combined to form a sprayable mix are *incompatible*. Chemical or physical separation of ingredients into layers, globules, clumps, precipitates, or gels indicates that 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

Compatibility Test

Before mixing two or more pesticides, or pesticide(s) and fertilizer to apply as a liquid tank mix, read the label. Although tank mixing is a common and legal practice, the compatibility of all possible pesticide combinations is unknown. Unless the combination of pesticides is known to be compatible, perform compatibility testing prior to tank mixing. This can be done by conducting this simple jar test:

1. Wear the label-required personal protective equipment.
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 the same proportion, in the same sequence, and at the same temperature you would if you were tank mixing. Unless labels specify otherwise, use the WALES method for mixing pesticides (see subsection, Pesticide Mixtures). **If the pesticide label calls for using a compatibility agent, add it to the test mixture**!
5. Shake the jar vigorously and let it stand for approximately 15 minutes. If scum, clumps, or any precipitates (solids) 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 have changed drastically.
7. Test the mix on the plant species to which it will be applied (under similar conditions, if possible) to check for any phytotoxic effects (plant damage).

Adjuvants

An *adjuvant* or additive is a chemical added to a pesticide to modify the product's physical properties, change the properties of the spray tank mixture, and/or enhance pesticide performance. Adjuvants themselves generally have little or no pesticidal effect. Adjuvants are used most extensively in products designed for foliar applications. Most pesticide formulations contain certain adjuvants to obtain the results the manufacturer needs for pest control.

Surfactants

Surfactants (surface active agents) are adjuvants 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 and 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 to get proper coverage.

Other Adjuvants

Stickers, *penetrants*, and *safeners* are additional adjuvants that influence the adherence, ab- sorption, or safety of a pesticide mixture on a treated surface. *Buffers* or *buffering agents*, *compatibility agents*, *emulsifiers*, and *antifoaming agents* affect the mixing, handling, and longevity of a pesticide mixture. For example, *buffering agents* are used to adjust the pH of a tank mix solution. *Foaming agents*, *drift retardants*, and *thickeners* reduce drift during application.

Formulations often contain all necessary adjuvants in appropriate amounts for all or most uses. Sometimes, however, it may be desirable to add adjuvants at application. Wetting agents and spreader-stickers are the adjuvants added most frequently by the applicator. *Crop oil concentrates* and liquid fertilizers (28-0-0, 10-34-0) are often added to increase the activity of foliar-applied herbicides. *Compatibility agents* are being added with increasing frequency to allow the effective mixing of two or more pesticides or a pesticide with a fertilizer. *Thickening agents*, also call drift reduction agents, are being used more extensively as drift continues to be of increasing concern.

The need for an adjuvant, and the best type to use, depends on pesticide, crop, pest, and environmental conditions. Use adjuvants as recommended on the pesticide label for optimum pesticide performance. Do not use them indiscriminately; misuse may lead to crop injury, compatibility problems, or reduced pest control. Some pesticide labels very clearly prohibit their addition, while other labels are quite specific to the type of adjuvant that can be used and when it should be added to a spray mixture.

Choosing an adjuvant is difficult because of confusing terminology and the large number of adjuvants on the market. The ingredients of a particular adjuvant product may change from year to year. If you have questions about what adjuvant you should add to your spray mix or if you should add an adjuvant, consult your pesticide dealer, University of Idaho County Extension, or the ISDA.

Review Questions

Select the correct answer or fill in the blank for each question. See answers in Chapter Review Answers.

1. The component of a pesticide formulation that controls the pest is the _____ ingredient.

2. Careful pesticide selection is important because pesticide formulations vary in their safety to the user, the environment and the crop to be treated; their efficacy; and their cost. (True or False)

3. Which of the following concerning an emulsifiable concentrate pesticide formulation is false?
   A. Higher phytotoxicity hazard
   B. May be easily absorbed through human and animal skin
   C. Flammable
   D. Easily clogs nozzles and screens

4. Which of the following formulations dissolves in water?
   A. Wettable powders
   B. Flowables
   C. Water dispersible granules
   D. Soluble powders

5. Breathing the dust is a potential hazard associated with the mixing of wettable powders and soluble powders. (True or False)

6. Which of the following pesticide formulations must be mixed with water before being used by the applicator?
   A. Flowables
   B. Aerosols
   C. Granules
   D. Dusts

7. When added to water, emulsifiable concentrates form
   A. Suspensions
   B. Separates
   C. Solutions
   D. Emulsions

8. Most bait formulations have 50% or more active ingredients. (True or False)

9. Extreme care must be exercised when placing baits to make them inaccessible to children, pets, and other nontarget species. (True or False)

10. Incineration is recommended for disposal of empty aerosol containers because the heat completely destroys any pesticide in the container. (True or False)

11. Which of the following is a true statement about fumigant formulations?
    A. The use of fumigants is limited to soil, enclosed structures, and containers.
    B. Fumigants are only toxic to soil insect pests.
    C. Fumigants are the most hazardous of all pesticide formulations.
    D. Answers A and C above.

12. Two or more pesticides that cannot be effectively mixed together are said to be _____.

13. When adding two or more pesticides into a spray tank, always add the liquid formulations first. (True or False)

14. Tank mixtures of pesticide formulations often require the addition of a(n) _____ to aid in safety and effectiveness.

15. Adjuvants can be added to any pesticide spray mixture. (True or False)

16. Which of the following formulations are less likely to cause wear on pumps and nozzles?
    A. Granules and dusts
    B. Water dispersible granules and soluble powders
    C. Baits and repellants
    D. Emulsifiable concentrates and soluble powders

17. You do not need to check the hoses or other plastic and rubber parts of a sprayer when using emulsifiable concentrates because they do not cause wear. (True or False)

18. When using baits, you do not need to be concerned about other food sources because the bait is an attractant and the pest will eat the bait before it eats anything else. (True or False)

CHAPTER 5:
The Pesticide Label

Learning Objectives

- Understand the background of the pesticide label and its importance to the pesticide applicator.
- Define the words typed in *italics*.
- Understand the different tests that pesticides must undergo in determining their effectiveness and safety.
- Understand what tolerance is and how it applies to pesticides.
- Learn the parts of a pesticide label and understand the information contained in each part.
- Understand the differences between the brand, product, or trade name; chemical name; and the common name.
- Understand what is included in the ingredients statement.
- Know the pesticide label signal words and symbols and what they represent.
- Be able to distinguish the EPA Registration Number from an EPA Establishment Number or other registration number.
- Understand what precautionary statements are and why they are included on the pesticide label.

One of the most important tools for the safe and effective use of pesticides is the product label. Pesticide manufacturers are required by law to put certain information on the label. When pesticide label information is not followed, accidents can occur that may result in legal action against the violator. Labels are legal documents providing directions to handle, mix, apply, store, and dispose of a pesticide product.

Before purchasing, mixing, or applying a pesticide, read and fully understand label instructions!

History of the Pesticide Label

Early pesticide labels usually contained nothing more than the name of the product and what pests the product was supposed to control. The early pesticide labels also did not provide much safety and use information. Very little product information was offered and

many times the users needed to guess as to how the product was to be used. In addition, safety and safe-handling information was practically nonexistent. Pesticide labels have evolved from those early labels to very formidable documents that contain important safety, use, and legal information. Indeed, the pesticide label is an enforceable document; the information contained in it can be enforced by a pesticide control official or authorized ISDA field investigator. As an applicator, you must do what the pesticide label instructs and cannot do what the pesticide label prohibits.

To appreciate the value of the information on a modern-day label, consider the time, effort, and money spent in gathering it. The label on a pesticide product is the result of years of research by scientists in both laboratory and field tests. The information on the label normally takes a minimum of six (6) years to obtain and costs chemical companies millions of dollars in research and testing.

Chemical companies continually make new compounds and screen them in laboratories for possible pesticide use. For each material that finally meets the standards of a potential pesticide, thousands of other compounds are screened and discarded for various reasons. When a promising pesticide is discovered, its potential use is evaluated. If the company believes it has a worthwhile product and there is a possibility for reasonable sales volume, they initiate wide-scale testing and label-registration procedures. In the development and labeling of a pesticide, scientists and registration specialists are interested in proving that the chemical is safe when used as directed and that it controls pests.

Many carefully controlled tests must be conducted to determine the effectiveness and safety of each pesticide under a wide range of environmental conditions.

Toxicity or Toxicological Tests

Toxicity and toxicological tests determine how poisonous or dangerous a pesticide is to humans, wildlife, and other nontarget organisms. To determine this, the pesticide is administered at different dosages to test animals, usually rats and mice. In addition, various species of wildlife are tested to determine the effect of a pesticide on wild animal species.

Efficacy or Performance Tests

The company must have performance data to show that the pesticide will control a particular pest or group of pests on one or more hosts or sites, including plants, animals, soil, and structures. The data is gathered as the result of *efficacy* or *performance tests*. Data must show that the pesticide, when used for its intended purpose and according to directions, is a useful product.

These tests provide information about plant/crop varieties, soil types, application methods and rates, and number of required applications. They must show that the pests are controlled; plants, crops, or animals are not injured; yield and/or quality have been improved; and the pesticide definitely provides a worthwhile benefit.

Degradation, Mobility, and Residue Tests

A series of studies is needed to show how long it takes for the compound to break down (degrade) into harmless materials under various conditions. These tests also determine the mobility of the pesticide in the soil and the ability of plants to absorb the pesticide through their roots.

Residue studies are conducted about each method of application for crops or animals. These tests determine how much of the pesticide remains on/in the crop or animal. From these data, the number of days from the last pesticide application until harvest or slaughter is determined. A residue *tolerance* is the maximum amount of a pesticide residue that may legally remain on or in food or feed at harvest or slaughter. The EPA establishes the residue tolerance. The residue tolerance for a pesticide on a crop is a value higher than any residue that has been found in experimental trials or would be expected under the specified use conditions outlined by the manufacturers and approved by the EPA.

Pesticide Residues and Tolerance

A residue tolerance is set for a pesticide on each crop or commodity. Tolerances are expressed in *"parts per million"* (ppm).

Pesticide residues on or in food or feed must not exceed the residue tolerance limits when the crop or animal (including meat, milk, and eggs) is ready for market or livestock feeding. If a residue is over the tolerance limit, the commodity can be condemned and destroyed.

The Food Quality Protection Act of 1996 established specific guidelines for potentially harmful substances that may be in our food supply. Because of this act, tolerances of pesticide residues were established that provided a standard for crop production or pest-control products and also provided for additional safety factors for children. Integral to this process was the attempt to look at all uses of a pesticide or class of pesticide to ensure that there would not be overexposure to the product by either food residues or other pest-control uses. The act provided a much more comprehensive evaluation of possible human pesticide exposure to assist in establishing pesticide residue levels in foods.

Effect on Wildlife and the Environment

A chemical company must determine the effects of pesticide applications on wildlife and the environment. Any potentially harmful effects on wildlife and the environment that are recognized during these studies must be included in the environmental impact statement submitted to the EPA.

EPA Label Review

After the above effects have been evaluated, a chemical company is ready to propose a label for the pesticide product and take the data to the EPA for review. The chemical company asks for pesticide "use registrations" on as many plants, crops, animals, or other application sites as it has pest management test data to support its claims. The EPA reviews the available data and determines if the pesticide meets all of the requirements for registration or if more data is needed from the chemical company to satisfy the registration requirements.

The approval of a pesticide label that specifies what the product may be used on, where it may be used, and under what conditions is integral to the registration process. After all requirements for information are addressed and there are no additional concerns with the pesticide or the pesticide label, the EPA grants registration to the pesticide.

Parts of the Label

Some labels are very easy to understand, while others are more complicated. It is the user's (applicator, mixer, or loader) responsibility to read and understand the label before buying, using, storing, or disposing of a pesticide. To help you better understand labels, important label components are discussed in this section. Appendix A of this manual has example pesticide labels to refer to throughout this section to become more familiar with how pesticide label information is presented in modern-day labels.

Trade, Brand, or Product Name

Every manufacturer has trade, brand, or product names for its products. For simplicity, the ISDA refers to the registered name of the pesticide product as the product name, even though the manufacturer may have a specific trade or brand name. Most companies register each product name as a trademark and will not allow any other company to use that name without permission. Product names may differ on products even though the active ingredient(s) is the same. The product name of a pesticide product is clearly visible on the front panel of the label and is the name used in advertisements and by company salespersons. In general, it is what the manufacturer names a specific pesticide product.

The product name often indicates the type of formulation and the percentage of active ingredient. For example, Sevin 50WP is the registered product name and the formulation is a wettable powder containing 50% active ingredient (50WP means 50% active ingredient in a wettable powder formulation).

Ingredients Statement

Every pesticide label must list each active ingredient and its percentage in the container. Inert or other ingredients are not usually named, but the label must show what percentage of the total contents they comprise. The ingredient statement must list the official chemical names and/or common names of the active ingredients. An example:

Sevin 50WP

Active ingredient:

Carbaryl (l naphthyl N methyl carbamate)	50%
Inert ingredients	50%
Total	100%

In the above example, **Sevin 50WP** is the product name of the pesticide product; it has one active ingredient (Carbaryl [1-naphthyl N-methyl carbamate]). The ingredients statement shows that there is 50% of the active ingredient and 50% inert ingredients in this product.

Active Ingredient

The *active ingredient* is that part of a pesticide product that does the actual controlling of the pest organism. A pesticide product may have one or more active ingredients depending upon how the pesticide manufacturer formulates the product and what pest or pests the manufacturer wants the product to target. The active ingredient is always listed on the pesticide label and the ingredient statement has the percentage of it in the formulated pesticide product.

Chemical Name

The *chemical name* is the complex name that identifies the chemical components and structure of the pesticide. This name is sometimes listed in the ingredient statement on the label, but more recent labels omit the chemical name because listing its common name is adequate. For example, the chemical name of the active ingredient in Sevin 50WP is 1-naphthyl N-methyl carbamate.

Common Name

Because chemical names are usually complex, many are given a shorter *common name*. Only those common names officially accepted by the EPA may be used in the ingredient statement on the pesticide label. The official common name is sometimes followed by the chemical name in the list of active ingredients; however, most modern-day labels only list the common name. For instance, the common name for the above example is carbaryl. By purchasing pesticides according to the common names, you will be certain of getting the correct active ingredient, no matter the brand name or formulation.

Inert Ingredients

Other ingredients are added to a pesticide product for various reasons. The additional ingredient may be there to simply dilute the active ingredient to make it safer to handle or store. Some pesticide manufacturers add ingredients that make the pesticide product easier to spray or apply, stick to the target pest better, or increase the pesticide's effectiveness. These other ingredients are referred to as the *inert ingredient*s or sometimes called *other ingredients* when they appear in the ingredient statement of a pesticide label. These ingredients are normally not listed by name on the pesticide label.

Use Classification Statement

The EPA classifies every pesticide product as either a Restricted Use Product (RUP) or an unclassified/General Use Product (GUP). The GUPs can be purchased and used by anyone provided they follow the label instructions; RUPs can only be purchased and used by applicators that have a valid pesticide license.

General Use Pesticide (GUP) products are designated because the product does not have a large potential for harm to humans, animals, wildlife, and the environment. This does not mean that the product cannot or will not cause harm to humans, animals, or the environment. It simply means that the pesticide product is less likely to cause extensive harm. This is the reason that GUP products are sold to the general public for pest control. People purchasing and using these products do not need special training or a pesticide license.

Restricted Use Pesticide (RUP) products have a high potential to harm humans, animals, wildlife, and/or the environment. Because of the potential for damage from the product, the EPA and ISDA require that anyone who purchases or uses any RUP must have the proper training or must have a valid pesticide applicators license. Every pesticide product classified as restricted use by the EPA must carry a restricted-use statement in a prominent place at the top of the front panel of the pesticide label. For example:

Example of Restricted Use Designation

> **Restricted Use Pesticide**
> **Highly Toxic to Humans and Animals**. For retail sale to and use only by certified applicators or persons under their direct supervision and only for those uses covered by certified applicator certification.

In the above example, the pesticide is restricted in its sale and use because it has a high potential to harm humans and animals because of its toxicity. Do not confuse any other designation, such as "For Professional or Commercial Use Only" or "Licensed Applicator Use Only," as evidence that the pesticide product is an RUP. Only pesticides that bear the "Restricted Use Pesticide" designation are restricted by federal and state pesticide regulations. The other designations, if present on a pesticide label, are added to the label by the manufacturer as a vendor or retail seller restriction and are not enforceable by ISDA investigators.

If the ISDA classifies an EPA general-use product as restricted use, the label will not bear a restricted-use statement. Pesticides declared as "state restricted use" are identified by active ingredient by the ISDA.

Type of Pesticide

The type of pesticide is usually listed on the front panel of the pesticide label. This short statement indicates, in general terms, what the product will control. For example:

- Insecticide for control of certain insects on fruits, nuts, and ornamentals
- Herbicide for the control of woody brush and weeds
- Fungicide for control of downy mildew

Type of Formulation

The type of formulation (wettable powder, bait) may be identified on the label. If it is not identified, it should be possible to determine by reading "Directions for Use."

Net Contents

The front panel of the pesticide label shows the amount of product in the container. This is expressed as pounds or ounces for dry formulations and as gallons, quarts, or pints for liquids. Liquid formulations may also list the pounds of active ingredient per gallon of product.

Name and Address of Manufacturer

The law requires that the manufacturer or formulator of a product put the name and address of the company on the label. This is so you will know what company or manufacturer made or sold the product.

Registration Numbers

An EPA registration number (for example, EPA Reg. No. 312 280) must appear on all pesticide labels with the exception of spray adjuvants, which are included in the definition of a pesticide by the state of Idaho. The EPA Registration Number indicates that the pesticide product has been registered and its label approved by the EPA. In cases of Special Local Need (SLN) registrations, pesticide products may be approved for use in a specific state. These registrations are designated, for example, as EPA SLN No. ID860009. In this case, SLN indicates "special local need" with ID meaning that the product is registered for a specific use in Idaho.

Establishment Number

An EPA Establishment Number (for example, EPA Est: No. 5840 AZ l) must also appear on the pesticide label. It identifies the facility that produced the product. The EPA Establishment Number is important in case a problem arises with the product, such as an unlawful adulteration.

Every pesticide label must include a signal word. This important designation gives the user an indication of the relative toxicity of the product to humans and animals.

Signal Words

The signal word must appear in large letters on the front panel of the pesticide label along with the statement, "Keep Out of Reach of Children." The following signal words are found on pesticide labels:

- ***DANGER-POISON*** (with skull and crossbones symbol). These words and symbol must appear on all products that are highly toxic by any route of entry into the body. **Peligro**, the Spanish word for danger, must also appear on the label.
- ***WARNING***. This word signals that the product is moderately toxic orally, dermally, or through inhalation or causes moderate eye or skin irritation. **Aviso**, the Spanish word for warning, must also appear on the label.
- ***CAUTION***. This word signals that the product is slightly toxic orally, dermally, or through inhalation or causes slight eye or skin irritation.
- ***DANGER***. Danger is sometimes used without the signal word "POISON" to identify products that have hazards other than the toxicity of the active ingredient. These have significant irritant or caustic properties that may harm the user.

Choose the least toxic chemical that will give the desired level of pest control. For further description of signal words, refer to chapter 6, Pesticide Hazards and Health.

Precautionary Statements

All pesticide labels contain additional statements to help applicators decide the precautions to take to protect themselves, their employees, and other persons (or animals) that could be exposed. Precautionary statements may be composed of several sections and include the Route of Entry Statements, Specific Action Statements, and Protective Clothing and Equipment Statements.

Routes of Entry Statements

Routes of entry statements are statements that immediately follow the signal word either on the front or side panels of the pesticide label, which indicate the route or routes of entry (mouth, skin, eyes, and lungs) that are particularly hazardous and need protection. 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 followed by "Corrosive—causes eye damage and severe skin burns."

These statements are not uniform on all labels; many variations may be found. More than one or even all of the following precautions may be stated on a label.

Typical DANGER label statements include

- Fatal if swallowed
- Fatal if inhaled
- Fatal by skin contact—rapidly absorbed through skin
- Corrosive—causes eye damage and severe skin burns

Typical WARNING label statements include

- Harmful or fatal if swallowed
- Harmful or fatal if inhaled
- Harmful or fatal if absorbed through the skin
- Causes skin and eye irritation

Typical CAUTION label statements include

- Harmful if swallowed
- May be harmful if inhaled
- May irritate eyes, nose, throat, and skin

Specific Action Statements

Specific action statements usually follow immediately after the route-of-entry statements. The specific action statements help prevent pesticide poisoning by recommending necessary precautions and correct protective clothing and equipment. These statements are directly related to the toxicity of the pesticide product (signal word) and the routes of entry.

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

Typical WARNING labels combine specific action statements from DANGER and CAUTION labels.

CAUTION labels generally contain specific action statements that are less severe than those on the DANGER label, indicating that the toxicity hazard is not as great. For example:

- Avoid contact with skin or clothing
- Avoid breathing dust, vapors, or spray mists
- Avoid contact with eyes

Protective Clothing and Equipment Statements

Pesticide labels vary in the types of protective clothing and equipment statements they contain. Many labels carry no statement at all. The best way to determine the correct type of protective clothing and equipment is to consider the signal word, the route of entry statements, and the specific action statements, along with the basic guidelines listed in chapter 6, Pesticide Hazards and Health, and chapter 7, Using Pesticides Safely.

Some pesticide labels fully describe appropriate protective clothing and equipment. A few list the kinds of respirators that should be worn when handling and applying the product.

Follow all advice on protective clothing or equipment that 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.

Other Precautionary Statements

Labels often list other precautions that should always be followed when 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, drinking, or smoking.
- Wear clean clothes daily.
- Not for use or storage in and around a house.
- Do not allow children or domestic animals into the treated area.

Statement of Practical Treatment

These are commonsense guidelines. Because they are guidelines, they are not necessarily enforceable by state investigators; however, all of the guidelines represent important safety or environmental information. Just because the guideline is not enforceable by a state inspector **DOES NOT** indicate that they should be ignored.

This section lists 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, induce vomiting.

All DANGER labels and some WARNING and CAUTION labels contain a note to physicians describing the appropriate medical procedures for poisoning emergencies and may identify an antidote. The label should always be available in emergencies.

Environmental Hazards

Pesticides can be harmful to the environment. Some products are classified restricted use because of environmental hazards alone. Watch for special warning statements on the label concerning hazards to the environment.

Special Toxicity Statements

Special toxicity statements on the label indicate that a particular pesticide is especially hazardous to wildlife. For example:

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

General Environmental Statements

Some of these statements appear on virtually every pesticide label. They are reminders to follow certain commonsense or specific actions to avoid contaminating the environment. The absence of any or all of these statements does not indicate that you do not need 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 the following:

- 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 improperly disposing of pesticide wastes or rinse water.
- Do not apply when bees are likely to be in the area.

Physical or Chemical Hazards

This section of the label describes any special fire, explosion, or chemical hazards the product may pose. For example:

- 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.

Hazard statements (hazards to humans and domestic animals, environmental hazards, and physical or chemical hazards) are not located in the same place on all pesticide labels. Some labels group them 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." Before use, examine the label for these statements to ensure knowledgeable and safe handling.

Reentry Statement

Some pesticide labels contain a *reentry interval precaution*. This statement tells how much time must pass before people or workers may reenter a treated area without the protective clothing and equipment required by the label. Both the EPA and some states set reentry intervals. Reentry intervals set by states are not always listed on the label; it is your responsibility to determine if one has been set. Contact the ISDA to determine whether any state reentry intervals have been established for the pesticide that you intend to use. It is illegal to ignore them.

For nonagricultural uses, the reentry statement may be printed in a box under the heading "Reentry" or in a section with a title such as "Important," "Directions For Use," "Worker Safety," "Note," or "General Information." **For agricultural pesticides, the REI will always be listed in the "Agricultural Use Requirements" portion of the label along with minimum required PPE for early entry.**

Minimum Reentry Interval

If no reentry statement appears on the label or none has been set by your state, **all unprotected persons must wait at least until sprays have dried or dusts have settled before reentering without protective equipment**. That is the minimum legal reentry interval.

Worker Protection Standard (WPS) statements may also be included in the Agricultural Use Requirements section to provide safety precautions and information to agricultural, nursery, or greenhouse workers who will be working near or in treated areas. This section may require written and/or oral information and posting of treated areas.

Storage and Disposal

All pesticide labels contain general instructions for the appropriate storage and disposal of a pesticide and its container. State and local laws vary considerably; specific instructions usually are not included. One or more statements may appear in a special section of the label titled "Storage and Disposal" or under headings such as "Important," "Note," or "General Instructions" and may include the following:

- Store herbicides away from fertilizers, insecticides, fungicides, and seeds.
- Store at temperatures above 32°F (0°C).
- Do not reuse container. Render unusable and properly dispose, according to state and local law.
- Do not contaminate water, food, or feed by storage or disposal.
- Triple-rinse and offer this container for recycling or reconditioning or properly dispose according to state and local law.

It's important to note that the most significant storage and/or disposal requirements are usually ones that are state or local (municipal or county) regulations. Because they are state or local, they will not appear on the label and applicators must know these specific regulations regarding the storage of pesticides or the disposal of the pesticide, containers, or rinsate.

Seek sound advice to determine the best storage and disposal procedures for your operation and location.

Endangered Species Restrictions

Endangered species protection is covered by the Endangered Species Act (ESA) of 1973, designed to protect animal and plant species in danger of becoming extinct, and is administered by the US Fish and Wildlife Service (FWS). It is unlawful to kill any threatened or endangered species by any means (pesticide, car, firearms). New label restrictions are in the process of being implemented by the EPA. These restrictions address the use of certain pesticides that pose a threat to species or their habitats that have been listed by the FWS as endangered or threatened in specified states and counties. The new pesticide labels require that you obtain additional material (bulletins or maps) to determine if your application is within the area of restriction and if, or how, that application can be made. Currently, ESA bulletins may be found on the internet in the EPA's "Bulletins Online" area of their webpage.

Product Restrictions

The Product Restrictions section of a pesticide label tells applicators what they cannot do with the pesticide. This may be an application, equipment, carrier, tank mixing, or other restriction specific to the pesticide. For instance, if an applicator is using a pesticide that is highly leachable and may get into groundwater, the label may state that the product cannot

be used in areas that have a sandy-type soil. Applicators must remember to read this section of the label prior to any application to ensure that any of their actions is not restricted by the pesticide label.

Typical information included in the restrictions section of the label may include

- Temperature or humidity restrictions
- Application equipment restrictions
- Restrictions in the types or kinds of adjuvants that can be used
- Tank-mixing restrictions
- Application restrictions around water sources
- Application restrictions to protect certain organisms (i.e., pollinators)
- Plant-back restrictions
- Type or kind of spray-nozzle restrictions
- Minimum gallons-per-acre requirements

Note: Restrictions listed in this section apply to all application methods for the pesticide you are using. Failure to read this section could result in an illegal action or off-label application.

Directions For Use

These instructions include directions for applying the product. The use instructions tell you

- The pests that the manufacturer claims the product will control
- The plant, crop, animal, or site the product is intended to protect
- The proper equipment to be used and mixing instructions
- How much to use (rate) and how often to apply
- Compatibility with other frequently used products
- Phytotoxicity and other possible injury
- Where and when the material should be applied
- If it is labeled for use by chemigation

The Directions for Use section is usually the most extensive portion of the pesticide label and has the most information of any section. This is because this portion must contain all of the information for use of the product and more importantly, the sites, location, crops, or plants for which the pesticide can be used. Specific use information is included in this section regarding each crop or situation for which the pesticide may be used. For pesticides that are used extensively for multiple purposes (agricultural, nonagricultural, and urban) the labels can be very extensive. An example of an extensive label is any herbicide that contains the active ingredient glyphosate that may contain sixty or more pages in the pesticide label.

Exceptions

It is a violation of federal and state pesticide law to use a pesticide product in a manner inconsistent with its labeling. However, Section 2(ee) of FIFRA allows the following exceptions:

- A pesticide may be applied to control a target pest not specified on the label, provided the pesticide is applied to a plant, crop, animal, or site specifically listed on the label.
- Any method of application may be used that is not prohibited by the label, except for chemigation.
- A pesticide may be applied at a dosage, concentration, or frequency less than that specified on the label, unless the label restricts lower dosage applications.
- A pesticide fertilizer or pesticide mixture may be used if the mixture is not prohibited by the label.

Preharvest/Preslaughter Intervals

Labels for agricultural pesticides often list the minimum numbers of days which must pass between the last pesticide application and the harvest of crops or the slaughter or grazing of livestock. These preharvest intervals (days to harvest) or preslaughter intervals are set by the EPA to allow time for the pesticide to break down on or in the crop, in the livestock (meat), or in the systems of lactating dairy animals. Adhering to these intervals prevents the poisoning of grazing animals and prevents pesticide residues greater than the tolerance on food, feed, or animal products. For further information, read chapter 6, Pesticide Hazards and Health.

Additional Information

Many terms are used on labels to describe when and how to use pesticides. Many technical terms are also found in leaflets and bulletins that you may get from your Cooperative Extension office, the University of Idaho, or other agencies. Your understanding of these terms (e.g., preplant versus postemergence; band versus broadcast) helps you obtain maximum results from pesticides. Refer to the glossary. If you do not understand the directions on a label, check with the ISDA, your pesticide dealer or salesperson, your Cooperative Extension office, or a vocational agriculture instructor. The label provides a wealth of information. Failure to follow the instructions on a pesticide label can result in a serious pesticide accident and constitutes a legal violation subject to civil or criminal prosecution. The label is a legal document. The user is liable for personal injury, plant/crop damage, or pollution incurred through the misuse of a pesticide.

When to Read 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
- Whether you have the necessary protective equipment
- How much pesticide is needed

Before you apply the pesticide, read the label to determine

- What safety measures you should follow
- Where the pesticide can be used (livestock, plant, crop, structures)
- When to apply the pesticide (including the preharvest/preslaughter period) and how to apply the pesticide
- Whether there are any restrictions for use of that 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 dispose of the pesticide container
- Where and how to dispose of surplus pesticide

In addition to the pesticide label, manufacturers often provide supplemental information. These materials (pamphlets, brochures, information sheets, and advertising) complement the product label, but do not legally substitute for the label.

Review Questions

Select the correct answer or fill in the blank to answer each question. To answer questions 9–16, refer to the CARBOM 4L label found in Appendix A. For answers, see Chapter Review Answers.

1. Before purchasing a pesticide, read the container label to determine
   A. If the product can be used to treat your plant, crop, animal, or site.
   B. If the product will control the problem pest.
   C. How much of the product will be needed.
   D. All of the above.

2. Regardless of the signal words they bear, all pesticide labels must carry the words "KEEP OUT OF REACH OF CHILDREN." (True or False)

3. All formulations of the same active ingredient carry the same signal word. (True or False)

4. The skull-and-crossbones symbol must appear on every pesticide label. (True or False)

5. Which signal word(s) on a pesticide label indicate that a product is highly toxic to humans?
   A. Warning
   B. Caution
   C. Danger-Poison
   D. Beware

6. Labels should be removed from pesticide containers and kept in a notebook so they may remain clean and legible. (True or False)

7. A certain active ingredient has a chemical compound name and one accepted common chemical name, but may be in products with several different trade/brand names. (True or False)

8. You are storing a pesticide and notice that the label is partially missing. You should
   A. Get another pesticide label from where you purchased the original product.
   B. Make sure that the pesticide is stored with another container that has the same label.
   C. Don't worry about it if it has the "Directions for Use" portion of the label intact.
   D. A and B.

The remaining questions refer to the pesticide label **CARBOM 4L** (Appendix A):

9. CARBOM 4L can be sprayed directly to blooming crops since it is not toxic to bees. (True or False)

10. You should wear a respirator when mixing and loading CARBOM 4L. (True or False)

11. If a person filling a spray tank accidentally swallows some CARBOM 4L, induce vomiting. (True or False)

12. You wish to use to use the stalks of your popcorn field for forage after you harvest crop. How long must you wait after the last application of CARBOM 4L to use the stalks for forage?
   A. 7 days
   B. 10 days
   C. 15 days
   D. 21 days

13. The empty containers of CARBOM 4L should be
   A. Triple-rinsed and burned
   B. Disposed of by burying
   C. Triple-rinsed and recycled
   D. Triple-rinsed and reused

14. Containers of CARBOM 4L may be kept in the house if
   A. The storage area is locked and ventilated
   B. The storage area is properly placarded
   C. The storage area has adequate fire-suppression equipment available
   D. None of the above. You cannot store the chemical in a house or dwelling.

15. If an applicator is accidentally exposed to CARBOM 4L and is poisoned, the antidote the physician should administer is
   A. morphine
   B. tranquilizers
   C. antibiotics
   D. atropine sulfate

16. CARBOM 4L can be used in a chemigation operation. (True or False)

CHAPTER 6:
Pesticide Hazards and Health

Learning Objectives

- Define the words typed in *italics*.
- Understand the ways pesticides can enter the body and which pesticides present hazards to specific routes of entry.
- Know the difference between acute and chronic toxicity.
- Understand the concept of LD50 and how it relates to signal words and symbols.
- Identify the early, moderate, and advanced symptoms of pesticide poisoning.
- Understand what actions to take in the event of a pesticide poisoning.
- Understand how organophosphate and carbamate pesticides affect organisms.
- Know what antidotes are needed for organophosphate and carbamate poisoning.
- Know what information must be provided to workers handling pesticides.

Toxicity and Hazard

Many pesticide accidents can be traced to applicator carelessness or misuse. These accidents can damage plants, injure livestock or wildlife, and, more importantly, endanger the health of the applicator and other humans. All pesticides are designed to be toxic to target organisms; however, the chemicals are quite variable in the hazards they represent to humans. *Toxicity* is a measure of the capacity of a pesticide to cause injury. It is a property of the chemical itself, its concentration, and its formulation. *Hazard* (risk) however, is the potential for injury or the degree of danger involved in using a pesticide under a given set of circumstances. The toxicity of a pesticide is a function of the pesticide itself, regardless of its origin. Whether a pesticide is an inorganic, synthetic organic, botanical, or microbial pesticide has no bearing on its toxicity to humans or *nontarget* organisms. This is important to remember when assessing the hazard associated with using a particular pesticide. Hazard depends upon both the toxicity of the pesticide and the chance of exposure to harmful amounts of the chemical.

Because many people mistakenly use the terms *toxicity* and *hazard* interchangeably, let's look at two examples that illustrate the differences between them. Gasoline is extremely toxic, especially if taken orally. Every day, however, millions of people fill their gas tanks

without incident. The toxicity is high, but gas pumps are designed to virtually eliminate exposure; thus, the hazard associated with filling your car's tank is very low. But aspirin is not very toxic at all. Still, if a bottle is left where a toddler can reach it, the child could eat all the pills and get very sick. In this example, the toxicity is low, but the potential exposure is high and, therefore, so is the hazard. Manufacturers routinely put childproof caps on aspirin and other medications to lower the hazard by reducing the chance of exposure.

The best way to avoid or minimize the hazards of pesticide use is to know what you are using and how to use it. This means **you must read the label carefully and follow its instructions**. The attitude of the user is of utmost importance. If applicators mistakenly think they know exactly how to use a pesticide or do not care what precautions should be taken, accidents are more likely to occur. Applicators must realize their legal and moral obligations when using pesticides. By taking adequate precautions and practicing good management with safety in mind, there should be few accidents from pesticide use.

In this chapter, we review the many facets of pesticide hazards and health, such as how pesticides enter our bodies, the symptoms they induce, and the treatments if an accident should occur. Pesticide injuries involving humans occur because the body can absorb pesticides in excessive amounts. Pesticides also cause skin or eye damage (topical effects) and can induce allergic responses. Any chemical can be poisonous or toxic if absorbed in excessive amounts. For example, common table salt is toxic to the human body if too much is consumed. **The toxic effect of a pesticide thus depends upon the toxicity of the chemical and the amount the body absorbs.**

Exposure: How Pesticides Enter the Body

Four routes of entry or ways a pesticide can enter the human body are through (1) the skin (*dermal*), (2) the lungs (*inhalation*), (3) the mouth (*oral*), and (4) the eyes.

Dermal Exposure

In most exposure situations, the skin is the most common route of pesticide entry into the body. Evidence indicates that about 97% of all body exposure to pesticides during a spraying operation is by skin contact. Dermal absorption may occur as the result of a splash, spill, or drift when mixing, loading, applying, or disposing of pesticides. It may also result from exposure to pesticide residues or when cleaning or repairing contaminated equipment.

If only a small amount of chemical is allowed to remain on the skin and be absorbed into the body, a person can be poisoned. Different parts of the body vary in their abilities to absorb pesticides. The scrotal area and the head tend to be more absorptive, although cuts, abrasions, and skin rashes enhance absorption in other parts of the body. Pesticide formulations vary in their absorbency through skin. In general, wettable powders, dusts, and granular pesticides are not as readily absorbed, whereas oil or solvent-based liquid formulations, such as emulsifiable concentrates, are readily absorbed.

Inhalation Exposure

Protection of the lungs is especially important when pesticide powders, dusts, gases, vapors, or very small spray droplets can be inhaled during mixing, loading, or application or when pesticides are applied in confined areas. Once breathed into the lungs, pesticides enter the bloodstream rapidly and completely. If inhaled in sufficient amounts, pesticides cause damage to nose, throat, and lung tissue. Inhalation is the quickest and most direct route into the body for pesticides.

Ingestion

Accidental ingestion occurs most frequently when pesticides have been taken from the original labeled container and put into an unlabeled bottle or food container. Unfortunately, children are the most common victims.

Ingestion also occurs when liquid concentrates splash into the mouth during mixing or when cleaning equipment. The mouth should never be used to clear a spray line or to begin siphoning a pesticide. Chemicals can also be swallowed when eating, drinking, or smoking or even licking one's lips. Since the intestinal tract rapidly and completely absorbs many pesticides, it is sound advice to wash your hands and face thoroughly before eating, drinking, or smoking.

Ocular (Eye) Exposure

Under certain conditions and with certain pesticides, absorption through the eyes can be significant and particularly hazardous. Considering their size, eyes can absorb surprisingly large amounts of chemicals. Serious eye exposure can result from a splash or spill, drift, or eyes rubbed with contaminated hands, gloves, or clothing. This is why wearing protective eyewear, such as safety glasses or goggles, is always a good safety practice when applying pesticides for an extended period of time.

Preventing exposure is the key to safe pesticide use. Wearing the proper protective equipment and clothing (described in chapter 7, Using Pesticides Safely) helps avoid exposure.

Toxicity and the Potential Health Effects of Pesticides

Toxicity of a particular pesticide is estimated by subjecting test animals (usually rats, mice, rabbits, and dogs) to different dosages of the active ingredient and to each of its formulated products.

Acute Toxicity and Acute Affects

Acute toxicity is based on a single dosage and is determined by at least three methods:

- Dermal toxicity is determined by exposing the skin to the chemical.
- Inhalation toxicity is determined by permitting the test animals to breathe vapors of the chemical.
- Oral toxicity is determined by feeding the chemical to test animals.

The harmful effects that occur from a single exposure by any route of entry are termed acute effects. In addition, the effect of the chemical as an irritant to the eyes and skin is examined under laboratory conditions.

LD_{50} and LC_{50}

Acute toxicity is usually expressed as *LD_{50}* (lethal dose 50) and *LC_{50}* (lethal concentration 50). This is the amount or concentration of a toxicant required to kill 50% of a test population of animals under a standard set of conditions. The LD_{50} values of pesticides are recorded in milligrams of toxicant per kilogram of body weight of the test animal (mg/kg). The LC_{50} values of pesticides are recorded in milligrams of pesticide per volume of air or water (ppm). To put these units into perspective, 1 ppm is analogous to 1 inch in 16 miles, 1 minute in 2 years, or 1 tablespoon in 4,000 gallons.

The LD_{50} and LC_{50} values are useful in comparing the toxicity of different active ingredients, as well as different formulations of the same active ingredient. **The lower the LD_{50} value of a pesticide, the less it takes to kill 50% of the population and, therefore, the greater the acute toxicity of the chemical.** Pesticides with high LD_{50} values are considered the least acutely toxic to humans when used according to the directions on the product label.

Some pesticides may produce acute toxic effects, due to corrosiveness causing burns or eye damage. These are not lethal effects, but they are quite damaging. Chemicals with these properties need to be used with extra care.

Signal Words and Symbols

Acute toxicity and acute toxic effects are the basis for selecting the appropriate signal word (toxicity categories) to be used on a product label. The toxicity category is assigned on the basis of the highest measured toxicity, whether oral, dermal, or inhalation toxicity; effects on the eyes; or external injury to the skin.

Signal Words and Hazards

Signal Word	Approx. Oral Lethal Toxicity	Oral LD_{50} (mg/kg)	Dose (150-lb person)
Danger-Poison	Highly Toxic	0–50	A few drops to 1 teaspoon
Warning	Moderately Toxic	50–500	1 teaspoon to 1 ounce
Caution	Slightly Toxic	Over 500	1 ounce to 1 pint or pound

Danger-Poison

Pesticides that are classified as "highly toxic" on the basis of either acute oral, dermal, or inhalation toxicity must have the signal words DANGER and POISON (in red letters) and the skull-and-crossbones symbol prominently displayed on the package label. *Peligro*, the Spanish word for Danger, must also appear on the labels of highly toxic chemicals. Acute oral LD_{50} values for pesticide products in this group range from a trace to 50 mg/kg. As little as a few drops of such a material taken orally could be fatal to a 150-pound person.

Some pesticide products carry the signal word DANGER without the skull-and-crossbones symbol. This is done because possible skin irritation or eye effects are more severe than suggested by the acute toxicity (LD_{50}) of the product.

Warning and Caution

Pesticide products considered "Moderately Toxic" must have the signal words WARNING and *Aviso* (Spanish) displayed on the product label. Acute oral LD_{50} values range from 50 to 500 mg/kg. From 1 teaspoon to 1 ounce (2 tablespoons) of this material could be fatal to a 150-pound person. Pesticide products classified "Slightly Toxic" must have the signal word CAUTION on the pesticide label. Acute oral LD_{50} values are greater than 500 mg/kg.

Chronic Toxicity and Chronic Effects

The *chronic toxicity* of a pesticide is determined by subjecting test animals to long-term exposure of an active ingredient. The harmful effects that occur from small doses repeated over a period of time are termed chronic effects. Some of the suspected chronic effects from exposure to certain pesticides include the following:

- Birth defects—*Teratogenesis*
- Toxicity to a fetus—*Fetotoxic effects*
- Production of tumors—*Oncogenesis*
  - » Benign tumors—*Noncancerous*
  - » Malignant tumors—*Cancerous* or *Carcinogenesis*
- Genetic changes—*Mutagenesis*
- Blood disorders—*Hemotoxic effects*
- Nerve disorders—*Neurotoxic effects*
- Reproductive disorders

Some pesticides are required to include chronic toxicity warning statements on the product label. The chronic toxicity of a pesticide is more difficult to determine through laboratory analysis than the acute toxicity.

Pesticide Poisoning

The most serious pesticide poisonings usually result from acute exposure to nervous system poisons. Organophosphate and carbamate insecticides are two such classes of pesticides that affect the nervous system. The symptoms of poisoning from these types of pesticides may vary in their onset and severity. It is very important to recognize symptoms associated with pesticide poisoning, especially if you frequently apply or are exposed to these pesticides.

Early Symptoms

Early symptoms of a systemic poisoning begin as

- Fatigue
- Headache
- Giddiness
- Sweating
- Dizziness or blurred vision
- Cramps
- Nausea, vomiting, and diarrhea

Moderate Symptoms

Moderate symptoms that may develop include

- Numbness
- Changes in heart rate
- General muscular weakness
- Difficulty in breathing and walking
- Pinpoint pupils
- Excessive salivation
- Increase in the severity of earlier symptoms

Advanced Symptoms

In advanced poisoning cases there may be convulsions and coma or other situations that may ultimately lead to death.

These symptoms of pesticide poisoning, especially the early ones, could be very similar to a cold, flu, or heat exhaustion. Additionally, affects from both acute and chronic pesticide poisoning can be delayed from pesticide exposure, making it more difficult to diagnose. For further discussion on how organophosphates and carbamates cause poisoning and a program to monitor the effects of these insecticides, refer to the last section of this chapter, How Organophosphate or Carbamate Insecticides Affect Organisms.

Dermal or Eye Effects

Topical effects from pesticide poisoning are a result of either the irritant properties of a chemical in a pesticide formulation (active or inert ingredient) or an allergic response by the victim. *Dermatitis*, or inflammation of the skin generally is accepted as the most commonly reported topical effect associated with pesticide exposure. Symptoms of dermatitis range from reddening of the skin to blisters or rashes. Some persons may be allergic to pesticide chemicals. Symptoms of an allergic reaction can range from reddening and itching of the eyes and skin to respiratory discomfort that often resembles an asthmatic condition.

Be alert for the early symptoms of pesticide poisoning in yourself and others. Early recognition of symptoms and an immediate appropriate response may save a life. The development of certain symptoms, however, is not always the result of pesticide exposure. Common illness, such as the flu, heat exhaustion or heat stroke, pneumonia, asthma, respiratory and intestinal infection, or even a hangover from drinking alcohol, produces similar symptoms. But when symptoms appear after contact with pesticides, seek medical attention immediately. **Take the label with you to the hospital or doctor**. The doctor needs to know the pesticide ingredients to determine the proper course of treatment. If you cannot get the pesticide label off the container, take the container with you, but make sure that it is not carried in the passenger compartment of your vehicle.

If you use pesticides or reside near areas where pesticides are used, have the name and number of the nearest poison control center readily available. The number of the nearest poison control center is located in your local telephone book. **Identify the number of your local poison control center and post the number throughout the workplace or near the telephone**. It is also a good idea to post the number in any vehicle that transporting chemicals.

First Aid for Pesticide Poisoning

Immediate action may be necessary to prevent serious injury to a victim of pesticide poisoning. It could indeed be a life-or-death matter. Someone may need to administer first aid to the victim. The product label should be a first source of information in a pesticide exposure emergency. Call your poison control center or a physician. First aid is only the first response and is not a substitute for professional medical help.

General First Aid Instructions

The following is a list of immediate actions that may be taken in case of pesticide poisoning. This list is not given to replace medical care; always seek medical attention if pesticide poisoning is suspected.

- Call 911.
- Read the pesticide label for immediate actions for dermal exposure or ingested pesticides.
- If inhalation exposure occurs, get the victim to fresh air immediately.

- Always have a source of clean water available. In an extreme emergency, even water from a farm pond, irrigation system, or watering trough can be used to dilute the pesticide.
- Never try to give anything by mouth to an unconscious person.
- Become familiar with the proper techniques of artificial respiration; it may be necessary if a person's breathing has stopped or become impaired.
- If it is likely that you will be directly exposed to a pesticide while administering first aid or removing the victim from an enclosed area, wear appropriate protective equipment.

Specific First-Aid Instructions

The pesticide has been spilled on the skin or clothing:

Remove clothing immediately and thoroughly wash the skin with soap and water. Avoid harsh scrubbing since this enhances pesticide absorption. Rinse the affected area with water; wash again and rinse. Gently dry the affected area and wrap it in a loose cloth or a blanket, if necessary. If chemical burns of the skin have occurred, cover the area loosely with a clean, soft cloth. Avoid the use of ointments, greases, powders, and other medications, unless instructed by a medical authority.

If the affected person is unable (either trapped or unconscious) to exit a contaminated area to decontaminate him/herself, do not assist the person unless you are wearing the appropriate protective clothing.

It may be best to dispose of contaminated clothing, especially if the clothing is saturated with the pesticide. If the clothing is not heavily contaminated, store and wash it separately from the family laundry.

The pesticide has gotten into the eye:

Hold the eyelid open and immediately begin gently washing the eye with clean running water. Do not use chemicals or drugs in the wash water unless instructed by a physician or the poison control center. Continue washing for 15 minutes. Avoid contamination of the other eye if only one eye is involved. Flush under the eyelids with water to remove debris. Cover the eye with a clean piece of cloth and seek medical attention immediately.

The pesticide has been inhaled:

Get the victim to fresh air immediately; carry the victim (do not allow the victim to walk). Have the victim lie down and loosen clothing. Keep the victim warm and quiet. If the victim is convulsing, watch their breathing and protect the victim's head. Keep their chin up to keep air passages free for breathing. If breathing stops or is irregular, give artificial respiration. **Do not attempt to rescue someone who is in a closed contaminated area, unless you are wearing appropriate protective equipment**.

The pesticide has been swallowed:

The most important decision one must make is whether to induce vomiting. The decision must be made quickly and accurately; the victim's life may depend upon it. Where specific instructions are given, always follow the label directions. If the pesticide has gotten into the mouth, but has not been swallowed, the mouth should be rinsed with large amounts of water. If the pesticide has been swallowed, it should usually be voided fast, but NEVER induce vomiting if the victim is unconscious or convulsing. The victim could choke to death on the vomit.

NEVER induce vomiting if the victim has swallowed petroleum products (kerosene, gasoline, and oil) unless directed by the label, a physician, or a poison control center. Pesticides that are formulated as emulsifiable concentrates have petroleum products as a part of their ingredients. The letters EC or words "Emulsifiable Concentrate" on the pesticide label are signals NOT to induce vomiting of a concentrated material without first consulting the product label or a physician. Petroleum products aspirated (inhaled) into the lungs can cause serious respiratory disorders.

NEVER induce vomiting if the victim has swallowed a corrosive poison—a strong acid or alkali (base). A corrosive poison will burn the throat and mouth as severely coming up as it did going down. Determine what poison the person has ingested. The victim may experience severe pain and have extensive mouth and throat burns. Some household disinfectants and germicides fall into this category, but fortunately, most pesticides are not corrosive. The best first aid is to dilute the poison as quickly as possible. For acids or alkalis, give the victim water if the patient is able to swallow and drink. It is very important that the victim get to a hospital without delay.

The actions discussed in this section are only first-aid procedures. Obtain the assistance of a poison control center and get the victim to a doctor or hospital. If you have the pesticide label, take it with you to the doctor or hospital.

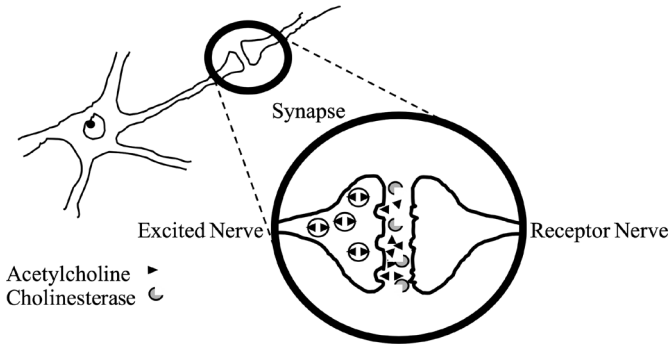
How Organophosphate and Carbamate Insecticides Affect Organisms

Cholinesterase Inhibitors

The organophosphate (OP) and carbamate classes of insecticides cause by far the greatest number of pesticide poisonings in the United States. Organophosphate insecticides include such chemicals (active ingredients) as chlorpyrifos, diazinon, terbufos, ethoprop, malathion, and dimethoate. The carbamate compounds include oxamyl, temik, carbaryl, and methomyl.

Organophosphates and carbamates inhibit or inactivate the enzyme *cholinesterase* (ChE), thus interfering with the normal function of the nervous system. These chemicals can poison all living mammals with cholinesterase in the nervous system, such as insects, fish, birds, humans, and other mammals.

To understand how the organophosphate and carbamate insecticides affect the nervous system, you need to understand how the nervous system actually works. The nervous system, which includes the brain, is the most complex system in the body. It consists of millions of cells that make up a communications system throughout the organism. The messages or electrical impulses (stimuli) travel along this complex network of cells. Nerve cells (neurons) do not physically touch each other; rather there is a gap or synapse between cells. The impulses must therefore cross or "bridge" the synapse between nerve cells in order to keep the message moving along the entire network.

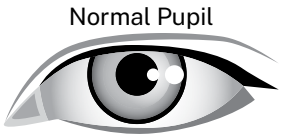


When an impulse reaches the synapse, *acetylcholine* is released to carry the message on to the next cell. Acetylcholine is the primary chemical responsible for the transmission of nerve stimuli across the synapse of two neurons. After the impulse is transmitted across the synapse, the acetylcholine is broken down by cholinesterase. Now the synapse is "cleared" and ready to receive a new transmission.

Organophosphate and carbamate insecticides inhibit or halt the activity of cholinesterase (hence the name, *cholinesterase inhibitors*), resulting in a buildup of acetylcholine in the body. An increase in acetylcholine, for whatever reason, results in the uncontrolled flow of nerve transmissions between nerve cells. The nervous system is therefore "poisoned" by the accumulation of acetylcholine, which results in the continual transmission of impulses across the synapses.

Symptoms

The effects of organophosphate or carbamate poisoning can affect the entire body or may only affect a specific area of exposure (such as the hands).



Direct exposure to the eye can cause symptoms, such as constricted or pinpoint pupils, blurred vision, an eyebrow headache, and severe irritation and reddening of the eyes. Symptoms and signs of systemic poisonings are almost entirely due to the accumulation of acetylcholine at the nerve endings. Early symptoms depend upon the route of absorption and the severity of the exposure. Gastric symptoms, such as stomach cramps, nausea, vomiting, and diarrhea, appear early if the material has been ingested. Similarly, salivation, headache, dizziness, excessive secretions, and 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 thirty days from the most recent exposure. Establishing a baseline value often requires two tests performed at least seventy-two hours but not more than fourteen days apart. If these two tests differ by as much as 20%, a third test is often recommended.

Establishing a Baseline

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% below the established baseline, the worker should retest 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 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. It is ineffective for carbamate poisoning.

Review Questions

Select the correct answer or fill in the blank for each question. Answers available in Chapter Review Answers.

1. The hazard associated with a pesticide product depends entirely upon the toxicity of the active ingredient. (True or False)

2. The most common route of pesticide exposure leading to poisoning is inhalation. (True or False)

3. Because of the protective nature of eye tissues, very little pesticide that contacts the eyes is actually absorbed. (True or False)

4. Select the incorrect statement. Symptoms of pesticide poisoning
   A. Always occur immediately after exposure.
   B. Can appear almost immediately or be delayed several hours, depending on the chemical and the amount of exposure.
   C. May mimic heat stroke, pneumonia, or intestinal infections.
   D. Often occur as skin reactions.

5. Toxicity 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

6. The signal word on a pesticide label indicates the pesticide's
   A. Effectiveness
   B. Toxicity
   C. Compatibility
   D. Formulation

7. Which LD_{50} is representative of a highly toxic pesticide?
   A. 640 mg/kg
   B. 5,800 mg/kg
   C. 12,840 mg/kg
   D. 46 mg/kg

8. The potential adverse health effects of pesticides are studied on laboratory test animals. (True or False)

9. Which signal word(s) indicates a product that is least toxic to an applicator?
   A. Danger-Poison
   B. Caution
   C. Warning
   D. Hazardous

10. Applicators who regularly use organophosphate and carbamate insecticides are advised to have a preseason blood test to establish their normal (baseline) level of
    A. Carcinogens
    B. Cholinesterase
    C. Random antibodies
    D. Acetylcholine

11. The key to minimizing the hazard of pesticide use to the applicator is to avoid exposure. (True or False)

12. If pesticides are spilled on the skin or clothing, the first reaction should be to
    A. Remove contaminated clothing and put on clean clothing.
    B. Call a doctor immediately.
    C. Find the label.
    D. Remove contaminated clothing and wash affected area with soap and water.

13. A person who has swallowed a pesticide must be made to vomit regardless of their condition or the pesticide in question. (True or False)

14. Pesticide labels contain information for the treatment of poisonings and should always be available, especially if medical attention is sought. (True or False)

15. The quickest and most direct route of pesticide exposure is through the skin. (True or False)

CHAPTER 7:
Using Pesticides Safely

Learning Objectives

- Know and understand various methods for effective and safe use of pesticides.
- Understand the importance of personal protective clothing and be able to describe its function.
- Understand the hazards during the mixing and loading operation and why you must take special precautions.
- Know what precautions must be taken before, during, and after a pesticide application.
- Understand how to store pesticides safely.
- Understand how to dispose of pesticides and pesticide containers legally and safely.
- Know the three C's of pesticide spills.
- Understand what precautions must be taken to prevent pesticide fire hazards.

Pesticide Safety Practices

There are many reasons for properly using pesticides. Pesticides are expensive and improper use is costly. A misapplication can result in wasted material, plant/crop damage, and failure to control the pest. In addition, pesticides have the potential to cause immediate as well as long-term harmful effects to humans, pets, livestock, property, and other components of the environment.

The safe and proper use of pesticides is essential if we expect to be assured of an abundant and varied supply of products in the future. Every time a misuse or accident involving pesticides occurs, we jeopardize the future availability of these chemicals. Prudent and safe use helps to minimize regulatory action.

This chapter describes methods for the effective and safe use of pesticides. Some of the commonsense safety practices include the following:

- Use pesticides only when necessary and as a part of an Integrated Pest Management (IPM) program.
- Familiarize yourself with the current federal, state, and local pesticide laws, rules, and regulations.
- Always read the label to ensure you are treating a listed site at the proper time and application rate.

- Do not allow children to play around sprayers and other pesticide application equipment or mixing, storage, and disposal areas.
- Lock pesticides (in originally labeled containers) in a properly marked cabinet or storeroom, away from food and feed. Note the Storage section in this chapter.
- Work in pairs when applying highly toxic pesticides.
- Wear appropriate protective clothing and equipment. See the section, Protecting Yourself from Pesticide Exposure.
- Never eat, drink, or smoke while handling pesticides.
- Avoid drift into nontarget areas. Dust formulations drift more than sprays and air blast sprayers usually create more drift than boom sprayers.
- Avoid spilling materials on skin or clothing. Should such an accident occur, wash immediately with soap and water. Note first-aid procedures in chapter 6, Pesticide Hazards and Health. Have ready access to a clean water source and first-aid supplies.
- If pesticide poisoning is suspected, contact your nearest poison control center, hospital emergency room, or physician. Take the label with you.
- Observe reentry intervals specified on the label.
- Dispose of empty containers according to the label and in a manner that does not endanger humans, animals, or the environment. Note the section, Pesticide Disposal.
- Bathe after handling pesticides or pesticide-contaminated equipment. Wash clothing after applying pesticides. Until laundered, such clothing must be handled with the same caution as the pesticides themselves. Keep pesticide-contaminated clothing separate from the family wash.

Protecting Yourself from Pesticide Exposure

Pesticides pose a hazard to humans. The greatest risks to the user are in handling and applying highly toxic materials and in mixing and loading pesticide concentrates. Although applications of diluted material are usually less hazardous, the hazard increases when there is significant drift or when appropriate safety and application procedures are not followed. The danger of exposure also exists when cleaning up pesticide spills, making equipment repairs, and entering treated areas prematurely.

Protective Clothing

Wearing protective clothing and/or equipment offers protection against exposure. Although protective clothing and equipment are sometimes uncomfortable and cumbersome to wear, do everything possible to protect yourself and your employees from exposure to pesticides.

The type of protective clothing and equipment needed depends upon the job being done and the type of chemical being used. Many highly toxic pesticides require full protection, including a respirator and during mixing, application, and disposal of the pesticide. Some fumigants may require special equipment, such as a self-contained breathing system. Read the label on the pesticide container carefully and follow all directions concerning the necessary protective clothing and equipment. The general instructions on a label may include the following:

- Avoid skin contact
- Avoid breathing dust of fumes
- Keep out of eyes

These cautions do not mention specific clothing or equipment, but imply that protection is needed to reduce the risk of chemical contact. The lack of any statement or the mention of only one piece of safety equipment does not rule out the need for additional protection.

Protective clothing should always provide minimum protection to the body. A long-sleeved shirt and long pants that are clean and made of a tightly woven fabric or a water-repellent material should always be worn regardless of the pesticide applied. Cotton T-shirts and shorts do not provide adequate protection when applying pesticides. Shoes and socks provide far more protection against pesticides than sandals or bare feet.

Protective clothing and equipment and some important considerations for their selection including the following:

Coveralls, Aprons, and Rain Suits

Coveralls, whether disposable or reusable, vary in their comfort, durability, and the degree of protection they provide. They are generally adequate when handling most pesticides. Wear a liquid-proof apron or raincoat (or rainsuit) when pouring and mixing concentrates and when using highly toxic pesticides. Coveralls usually do not provide adequate protection against the spills and splashes from these chemicals. Wear a raincoat whenever mist or spray drift is likely to substantially wet your work clothes or coveralls and when applying highly toxic pesticides unless the potential for exposure is minimal. Liquid-proof aprons and rainsuits should be made of rubber or a synthetic material resistant to the solvents in pesticide formulations. The apron should cover the body from your chest to your boots.

Gloves

Wear unlined, waterproof gloves when handling or applying pesticides. Gloves should cover the wrist and should not have a fabric wristband. Fill the gloves with water and squeeze them carefully to check for leaks. Water will visibly leak out of any holes or punctures in the gloves. Use gloves that are approved for use with chemicals. Some rubber products react with certain solvents and become sticky as the rubber dissolves. If this occurs, dispose of these gloves and use gloves approved for use with pesticides.

For most jobs, shirtsleeves should be worn outside the gloves to keep pesticides from running down the sleeves into the gloves. But, if you will be working with your hands and arms overhead, put the gloves outside the sleeves and turn up the cuffs of the gloves to catch material that might run down your arms. Wash chemicals off the gloves with soap and water before removing them. This avoids contamination of your hands when removing the gloves.

Hats

Although most pesticide applications do not require hats, wear a head covering when handling pesticides. It should be liquid proof and have a wide brim to protect the face. Hats should also be either disposable or easy to clean with soap and water and not made of absorbent materials such as leather, straw, or cloth. Always wear a protective hat if the label instructs.

Shoes and Boots

Boots should be unlined and made of rubber. Because of their absorbency, boots of leather, canvas, or cloth should never be worn when handling pesticides. Wear pantlegs outside the boots to prevent pesticides from running down the leg and into the boot.

Eyes easily absorb pesticides. Protective eyewear includes safety glasses, goggles, and face shields. Wear tightly fitting, nonfogging goggles (approved for use with pesticides) or a full face shield when there is any chance of getting pesticide in your eyes. This is especially important when pouring or mixing concentrates or handling dusts or toxic sprays. Those who wear contact lenses may want to consult an eye doctor or physician before using pesticides.

Protective Eyewear

Goggles and face shields should be kept clean at all times. Wash goggles and face shield plastic/glass parts in soap and water. Sanitize the plastic, glass, or rubber parts by soaking equipment for two (2) minutes in a mixture of two (2) tablespoons chlorine bleach in one (1) gallon of water. Rinse thoroughly with clean water to remove soap and sanitizer. Wipe with a clean cloth and allow to air dry. In particular, pay attention to the goggle headbands. They are often made of absorbent material that requires regular replacement.

Respirators

The respiratory (breathing) system is the quickest and most direct route of entry for pesticides into the circulatory system. From the blood capillaries of the lungs, toxic substances are rapidly transported throughout the body.

Respiratory protective devices vary in design, use, and protective capability. In selecting a respiratory protective device, the user must first consider the degree of hazard associated with breathing the toxic substance and then understand the specific uses and limitations of the available equipment. Select a respirator that is designed for the intended use and

always follow the manufacturer's instructions concerning the use and maintenance of your respirator. An applicator may need different respirators for different chemicals or groups of chemicals. Select only equipment approved by the National Institute for Occupational Safety and Health (NIOSH). Refer to the pesticide label for the appropriate level of respiratory protection (i.e. cartridges).

Types of Respirators

Respiratory protective devices can be categorized into three classes: air purifying, supplied air, and self-contained. Most pesticide contaminants can be removed from the atmosphere by air-purifying devices. For complete information on respirators, go to the *WPS Respiratory Protection Guide*, available through PERC online at pesticideresources.org.

When using any respirator, make sure that you have the proper training and certification to use it, if required by federal or state safety regulations. Generally, chemical cartridge or canister-type respirators and Self-Contained Breathing Apparatus (SCBA) respirators have additional requirements before you can safely use them for pesticide application or other operations involving pesticides.

Air-purifying devices include mechanical filters, chemical cartridge respirators, and gas masks (also referred to as canister filter respirators). They can be used only in atmospheres containing sufficient oxygen to sustain life.

Mechanical filter respirators (*particulate respirators*) provide respiratory protection against particulate matter such as mists, smokes, metal fumes, and nonvolatile dusts. They cover the nose and mouth (e.g., N95 respirators). Do not confuse them with *dust masks* that people commonly use when working around the house (e.g., when sanding joint compound or sawing lumber). Dust masks are not a substitute for a respirator. Never use dust masks when mixing or applying liquids. If the pesticide splashes, spills, or volatilizes, the pesticide can be absorbed by the mask. Once absorbed, the chemical is kept close to the skin and breathing passages, increasing absorption into the body.

Particulate Respirators

Particulate respirators become more efficient as they trap particles because air passages become smaller and thus trap smaller particles; however, this also makes breathing more difficult. Replace your particulate respirator or filter whenever one of the following conditions applies:

- Breathing becomes too difficult
- The filter is damaged or torn
- You are required to by the pesticide label or respirator manufacturer
- You have any concern with the condition of the mask or filters

Chemical Cartridge Respirator

Note: All respirators must be NIOSH-approved.

Chemical Cartridge Respirators

Chemical cartridge respirators provide respiratory protection against certain gases and vapors in concentrations not greater than one-tenth (0.1%) percent by volume. Use them only when exposure to high continual concentrations of pesticides is unlikely, such as when mixing pesticides outdoors. They are available either as half masks, covering only the nose and mouth, or as masks with a full face shield for eye protection.

Many cartridge respirators have a combination of chemical and mechanical filters. These can provide respiratory protection against both gases and particulate matter.

Cartridge-type respirators provide respiratory protection against particulate matter and against specific gases and vapors in concentrations of up to two (2%) percent by volume. Exceeding this concentration is immediately dangerous to life and health. Gas masks cover the eyes, nose, and mouth and can be worn when continuously exposed to some pesticides. However, a gas mask will provide only limited protection in structural fumigation or when the oxygen supply is low. Special fumigant masks with a self-contained oxygen supply are required in certain situations.

Various chemical filters (cartridges, canisters, or gas masks) are used to purify inhaled air. A different type of chemical cartridge or canister must be used for different contaminants. For example, cartridges and canisters that protect against certain organic vapors differ chemically from those that protect against ammonia fumes. Use the cartridge or canister that is approved for the pesticide you intend to use.

The length of time a cartridge or canister will provide protection depends upon the conditions of use, such as the type and concentration of the contaminants, the user's breathing rate, and the humidity. Cartridge longevity is dependent upon its gas and vapor-absorption capacity. When the chemical cartridge becomes saturated, the contaminant starts to pass through the cartridge, usually allowing the user to smell the pesticide. At this point, the cartridge must be changed immediately.

You will need to replace filters and cartridges regularly. Replace them when any one of the following conditions applies:

- You detect any odor, taste, or irritation when wearing the respirator
- You are required to by the pesticide label or respirator manufacturer
- You have any concerns about the effectiveness or age of the cartridge

Do not use chemical cartridge respirators for protection against extremely toxic gases such as hydrogen cyanide, methyl bromide, or other fumigants. Special fumigant masks are available for these purposes from several manufacturers.

Positive-Pressure Powered Air-Purifying Respirator (PAPR)

Both dust/mist respirators and canister-type respirators are examples of *Air-Purifying Respirators*. These respirators pass air through the filters and/or vapor-removing materials in one of two ways. Negative-pressure respirators depend upon your lung power to draw air

through the purifying materials with each breath. Most air-purifying respirators are of this type. *Positive-pressure powered air-purifying respirators* (PAPR) assist you by using a blower to force air through the purifying material. Do not confuse PAPRs with SCBAs, which use a source of uncontaminated air rather than purifying contaminated air.

Self-Contained Breathing Apparatus

The *Self-Contained Breathing Apparatus* (SCBA) is the highest level of respiratory protection that is available for pesticide applicators. As the name implies, the SCBA supplies all of the breathable air to the applicator. Since it is self-contained, there is little chance for external air (and therefore toxic fumes or gasses) to enter the wearer's lungs unless the unit is defective or is not fitted properly. All breathable air is supplied via a separate source, such as a pressurized air tank.

There are very few circumstances that call for the use of an SCBA. These situations are generally applications that present very high gas or vapor concentrations or low oxygen situations, such as a closed-structure fumigation operation. Although it is not advisable to enter closed structures that have a high level of pesticides, there may be situations where entering a structure or application area while the application (or fumigation) is in progress is necessary. An SCBA would be a logical choice in these situations.

Because the SCBA utilizes a regulator to control the amount of air supplied to the person wearing the respirator, check and service it frequently to ensure proper operation. A qualified technician should perform any service to an SCBA.

Respirator Use and Care

Respirators are worn as needed for protection when handling certain pesticides. Before using a respirator, read and understand the instructions on the cartridge or canister and all supplemental information about its proper use and care. Be sure the filter will provide protection against the pesticide you intend to use. Respirators labeled only for protection against particulates should not be used for gases/vapors. Similarly, respirators labeled for protection against gases/vapors should not be used for particulates. **Cartridges and filters do not supply oxygen**. Do not use them where oxygen may be limited.

Make sure all valves, mechanical filters, and chemical filters (cartridges or canisters) are properly positioned and sealed. Fit the respirator on your face to ensure a tight but comfortable seal. A beard or large sideburns may prevent a good face seal. The following two fit tests help to determine the quality of most chemical cartridge respirators.

The first test is to place your hand tightly over the outside exhaust valves. If there is a good seal, exhalation should cause slight pressure inside the facepiece. If air escapes, readjust the headbands until a tight seal is obtained. The second test is to cover the inhalation valve(s) by placing your hand over the cartridge(s). If there is a good seal, inhalation should cause the facepiece to bend inward. If air enters, readjust the headbands.

Get to fresh air immediately if you sense any of the following danger signals that may indicate your cartridges or filters may be used up (breakthrough or other abnormal conditions that exceed the capacity of the respirator).

- You begin to smell or taste contaminants or your eyes, nose, or throat become irritated.
- Your breathing becomes difficult.
- The air you are breathing becomes uncomfortably warm.
- You become nauseous or dizzy.

After each use of the respirator, remove all mechanical and chemical filters. Wash and sanitize the facepiece using the same procedure recommended for goggles. Store the respirator facepiece, cartridges, canisters, and mechanical filters in a clean, dry place, preferably in a tightly sealed plastic bag.

Washing Pesticide-Contaminated Clothing

Wash all protective clothing and equipment at the end of each day of use. Store and wash pesticide-contaminated clothing separately from family laundry. Wear gloves during handling and laundering and always check the label for any specific instructions. **Note: Clothing that has become saturated with a pesticide concentrate should be discarded**.

Some residues may be removed by hosing the contaminated clothing with water or presoaking it in an appropriate container. Washing in hot water removes more pesticide from the clothing than washing in other water temperatures. Cold water might save energy, but it is relatively ineffective in removing pesticides from clothing.

Phosphate, carbonate, or heavy-duty liquid laundry detergents are effective in removing most pesticides from fabric. However, heavy-duty liquid detergents typically have better oil-removing ability and are more effective than other detergents in removing emulsifiable concentrates. The ease of pesticide removal through laundering does not depend upon toxicity, but on the formulation of the pesticide. Bleach or ammonia may possibly help in the removal or breakdown of certain pesticides, but **never mix bleach and ammonia because they react to form chlorine gas that can be fatal**.

Wash clothes at the full water level. Afterward, rinse the washing machine with an “empty load,” using hot water and the same detergent. Line drying of clothing is recommended for two reasons. First, it eliminates the possibility of residue collecting in the dryer. Second, residues of many pesticides break down when exposed to sunlight.

Wash your hands and arms after the laundering procedure. Keep protective clothing separate from the pesticide storage area.

Mixing and Loading Pesticides

Most people agree that **the most hazardous activities involving pesticides are mixing and loading concentrates**. This section reviews some safety guidelines for mixing and loading pesticides.

Always follow certain procedures when mixing and/or loading pesticides. These include but are not limited to

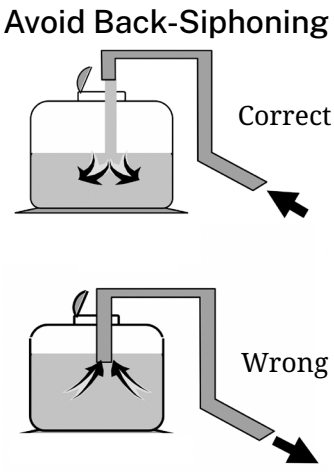
- **Reviewing the label before opening the container so you are familiar with current mixing and usage directions.**
- **Always wearing adequate protective clothing and equipment**. Put them on before handling or opening a pesticide container. Wear a respirator or appropriate form of eye protection if there is any chance of pesticide inhalation or eye exposure. Never eat, drink, or smoke while handling pesticides.
- **Carefully choosing the pesticide-mixing and -loading area**. Set up one outside, away from other people, livestock, and pets. Do not mix pesticides in areas where a spill or overflow could get into a water supply. Often, handling areas must be near a pond or stream bank. If this is the case, grade the area to slope away from the water. If you must work indoors or at night be sure there is adequate ventilation and light. Have a supply of clean water and soap available and, if possible, do not work alone.
- **No tearing of paper containers to open them; use a sharp knife or scissors**. When pouring from a container, keep the container at or below eye level and avoid splashing or spilling on your face or protective clothing. Do not use your mouth to siphon a pesticide from a container. Always stand upwind so the wind does not blow the pesticide toward your body. If an accident occurs, attend to it immediately. Remove any contaminated clothing and wash yourself thoroughly with soap and water. Spills on the floor or ground need special attention and will be discussed later in this chapter.
- **Measuring accurately, following label instructions, and mixing only the amount you plan to immediately use**. Newer measuring devices such as “tip and pours” are a great help in handling small amounts of concentrate. Keep all measuring devices (spoons, cups, and scales) in the pesticide storage area and never use them for other purposes. Use glass or plastic measuring utensils, since some pesticides may react with metal. Rinse measuring cups and put the rinsewater into the spray tank. Also, triple-rinse pesticide containers as soon as they are emptied because residues can become dried and difficult to remove later. Pour the rinsewater into the spray tank to avoid disposal problems and waste. Replace the container caps, close the bags, and return them to the pesticide storage area.

Never Leave a Sprayer Unattended While It Is Being Filled!

- **Calibrating equipment and making sure they are operational before filling and using them**. The spray tank must also be clean; oil, grease, and chemical residues cause incompatibility problems. The agitation system should be running and the spray tank should be approximately half-filled with water before adding any pesticide. Always keep your head above the fill hole and do not allow the pesticide to spill or splash when putting it into the tank.
- **If two or more pesticides are to be mixed, making sure that they are compatible and mixed in the proper order:**
    1. Wettable powders
    2. Flowables
    3. Water-soluble (powders or solutions)
    4. Emulsifiable concentrates

    Compatibility is discussed further in chapter 4, Pesticide Formulations. Also see the section, Pesticide Mixtures in chapter 4.

    Wettable powders often mix easier if you first mix the dry wettable powder with a small amount of water to form a slurry, then add the slurry to the spray tank under agitation.
- **When adding the additional water to a spray mixture, keeping the position of the water pipe or hose at least two pipe diameters above the level of the container**. This prevents contamination of the hose and avoids the possibility of back-siphoning the pesticide into the water source.



- **Keeping in mind that water characteristics influence the effectiveness of some pesticides**. Alkaline spray water, for example, leads to the chemical breakdown of many organophosphates and carbamates. The recommended water pH for mixing most pesticides is between five (5.0) and seven (7.0). Use buffers and acidifying agents to adjust the pH of the water.
- **Knowing that closed handling systems can reduce user exposure to pesticide concentrates**. A closed handling system has interconnected equipment that allows the applicator to remove a pesticide concentrate from its original container, to rinse the empty container, and to transfer the pesticide and rinse water to the spray tank without contacting the pesticide.

Consider these general procedures prior to and during any mixing/ loading operation. The main concern is always safety.

Pesticide Application

The safety and effectiveness of a pesticide application depend largely upon using the proper amount of pesticide and using an appropriate application method.

Before Application

Before making a pesticide application, review the product label. Never let irresponsible or untrained people apply pesticides. Some employees cannot read label instructions while others may simply choose not to read the label. These employees should not apply pesticides.

As with other pesticide-handling procedures, clean clothing and the proper protective equipment should be worn. Respiratory protection may be essential if the application is made indoors or if the applicator rides in an enclosed cab without air filters. Never eat, smoke, or drink while applying pesticides; do not even carry food or smoking items with you. Fresh water, soap, and paper towels should be carried in a protected container to allow quick removal of pesticide contaminants from the body following exposure to a spill or spray drift. A first-aid kit and plastic eyewash bottle that has a flushing action are also good precautions, particularly in service vehicles. Applicators should work in pairs when applying highly toxic pesticides.

To avoid pesticide-disposal issues, mix only the amount needed for your application. This will reduce or eliminate the potential for pesticide-disposal problems or the risk of over-application in an effort to empty the spray tank.

Cover or remove livestock, pets, farm equipment, and other nonessential items from the area to be treated. Any persons not involved in the application should leave the area to be treated. The posting of placards may be required to keep unauthorized or unprotected persons from entering the area.

Check application equipment carefully, particularly for leaking hoses and connections and plugged or worn nozzles.

During Application

The applicator's primary considerations during application are personal and environmental protection. Periodically check the application equipment for proper function. Personal and environmental safety is most seriously compromised when making spray applications with nozzles having small orifices and operating under high pressure (over 30 psi). This combination produces many small droplets that tend to remain airborne long enough to drift onto the operator or away from the target area. When spraying in a light breeze, conduct the application so the wind carries the pesticide away from the applicator and susceptible plants and animals. If the pesticide label requires use of a respiratory device during application, be sure that the respirator is functioning properly. If pesticide can be smelled through the respirator, it is not working properly. Application equipment is highly contaminated and definitely a source of pesticide exposure, so take appropriate precautions

if the application equipment must be fixed or adjusted while making an application. If a nozzle becomes clogged while spraying, stop spraying and move to an untreated area to correct it. Don't remove any of your protective equipment while working on it. Use an old toothbrush or comparable soft brush to clean the plugged nozzles; avoid wire or metal that can damage the nozzle orifice. Do not remove materials clogging a nozzle or pump part by blowing it out with your mouth.

Pesticide Drift

One of the major concerns about environmental safety during pesticide applications is off- target pesticide movement. Of the many ways pesticides can move off target, spray drift is the most common and potentially the most devastating. Every applicator must understand the factors that contribute to pesticide drift and how to minimize this problem. A comprehensive discussion of pesticide drift is included in chapter 8, Pesticides and the Environment.

After Application

After the pesticide application, clean all equipment. Pesticide residues can corrode metal, damage pumps, and are much harder to remove when dry. Never leave equipment unattended at the application site. Follow any cleaning recommendations on the label. Clean in a designated area away from water supplies. Wear the appropriate protective equipment and clothing, keeping in mind that all equipment parts exposed to the pesticide (pumps, tanks, hoses) are likely to bear some residue. Exercise extreme caution if a sprayer once used for herbicides is to be used to apply any other type of pesticide or agricultural chemical. If the tank, pump, or hoses are not cleaned and flushed properly, herbicide can carry over to the next application and damage plants.

Most pesticide labels list reentry intervals. These intervals are the length of time following a pesticide application when a person is required to wear protective clothing and equipment in a treated area or site. These intervals must be strictly observed, unless applicators or field personnel are properly protected from the pesticide residues. If there is no other time listed on the label, the minimum reentry interval is when sprays have dried or dusts have settled. It may be necessary (or required) to post fields, sites, or structures with appropriate warning signs to reduce the possibility of someone accidentally walking into a treated area.

To maximize pest control, follow any postapplication procedures listed on the label. Irrigation, for example, is required to move some soil insecticides into the target area.

After cleaning the application equipment, clean your PPE. A previous section in this chapter provides some guidelines for cleaning equipment and laundering clothing. Do not continue to wear contaminated clothing or footwear. Make sure that you include personal cleaning with equipment and PPE cleaning. In particular, wash your hands and face thoroughly with soap and water before eating, drinking, or smoking. Shower and change clothing as soon as possible after any application. Scrub your scalp, neck, behind your ears, and under your nails.

Storage

Proper pesticide storage helps prolong chemical shelf life while protecting the health of people, animals, and the environment. Several conditions are essential for safe pesticide storage. Consult the pesticide product label for storage information. **Consult the ISDA for specific storage requirements for professional applicators and pesticide dealers.**

The ISDA's laws and rules list minimum standards for pesticide storage. These standards are based on the hazard category of each chemical and the type of applicator license you maintain. The ISDA defines four categories of hazard:

- Category I: Pesticides that are highly toxic, with the signal word "Danger" or "Danger/Poison."
- Category II: Pesticides that are moderately toxic, with the signal word "Warning."
- Categories III and IV: Pesticides that are slightly or practically nontoxic, with the signal word "Caution."

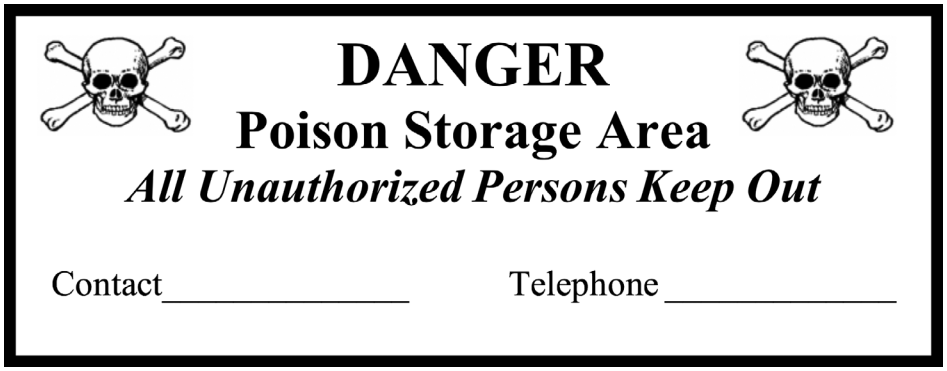
Storage Area

Store all pesticides in a secure location, out of the reach of children, pets, livestock, and irresponsible people. Do not store pesticides in or around the home. Store them in a locked and posted enclosure, such as a separate building or storage room.

Locate a storage area where potential damage or contamination to ground and surface water is unlikely. In certain situations, dikes or other barriers (containment) may be warranted. For pesticide storage outdoors, erect a fence to prevent unauthorized entry and to reduce the chances of theft and vandalism. The fence should be a minimum of six (6) feet in height. In addition,

- Post highly visible warning signs on walls, doors, and/ or windows to indicate to anyone attempting to enter the facility that pesticides are stored there. Post "No Smoking" signs and other warning signs around all storage areas with the following information:

Example of a Pesticide Storage Area Placard



- Store pesticides away from food, feed, potable water supplies, veterinary supplies, seeds, and protective equipment. This prevents contamination from fumes and dusts or spills and reduces the likelihood of accidental human or animal exposure.
- Ventilate the storage area and keep it relatively free from temperature extremes. Very high or low temperatures cause pesticide deterioration. Exhaust fans directed to the outside reduce the temperature and dust or fume concentrations. Fireproof construction with a sealed concrete floor.
- Keep pesticides cool, dry, and out of direct sunlight.
- Keep plenty of soap and water available in or close to the storage area. A fire extinguisher approved for chemical fires, first-aid equipment, and emergency telephone numbers should all be readily available.
- Store pesticides in their original containers rather than using soft drink bottles, fruit jars, or other types of nonpesticide containers. Serious poisonings could result because small children, as well as most adults, associate the shape of a container with its contents.
- Keep the original label attached to the container. To keep a label legible, protect it with transparent tape or lacquer. Note that the label is the most important safety factor in the use of pesticides. Do not let it become damaged or destroyed.
- Never lend a pesticide in an unmarked or unlabeled container. Those who use the pesticide should not rely on verbal directions.
- Close containers securely when not in use. Dry formulations tend to cake when wet or subjected to high humidity. Place opened bags of wettable and soluble powders, dusts, and granules into sealable plastic bags or other suitable containers. This reduces moisture absorption by the material and prevents a spill, should a tear or break occur.
- Store liquid formulations and small containers of dry formulations on metal shelving. Metal shelving will not absorb spilled pesticides and is easier to clean than other surfaces.

Pesticide Kills Cows

Joe (the neighbor) was helping Sam plant his corn. When Joe finished planting, he had a little corn rootworm insecticide left in the hopper. So Joe looked for a container to dump the granules into. There was an empty feed mineral bag blowing around the barnyard and Joe poured the unused pesticide into the bag. Joe set the bag over by the shed and left to do another job.

In the meantime, Frank, a hired hand, saw the bag by the shed and since it was a feed mineral bag, he carried it over and put it in the feed shed. He had no reason to suspect the bag did not contain feed minerals. Later, when another farm-hand went to the feed shed, he noticed that it was time to mix some more feed. Logic told him to use the opened bag before opening another, so he unknowingly poured the pesticide granules into the feed mixer. The granules and mineral feed supplement were so similar in appearance that he didn't notice anything peculiar. Also, pesticides are "never" stored in the feed shed. The result was several dead dairy cows. ***Keep pesticides in their original containers.***

- Store pesticides in glass bottles under cool conditions on lower shelves. Too much heat can cause the container to break or explode. Containers should not extend beyond shelving where they could be bumped or knocked off.
- Place larger metal drums and nonmetallic containers on pallets.
- Check containers regularly for leaks, breaks, rust, and corrosion. If a leak or break occurs, place the container inside another container or transfer the contents to an empty container that originally held the same material and has the same label attached.

Safety when handling pesticides cannot be overly stressed. Most injuries or poisonings that are related to pesticides are the result of carelessness or failure to follow simple safety procedures. The following is provided as general guidelines for safety when handling any pesticide product.

- Wear the appropriate protective clothing when handling pesticide containers.
- Label all items used for handling pesticides (measuring utensils, protective equipment, etc.) to prevent their use for other purposes.
- Keep clay, kitty litter, activated charcoal, sawdust, or a similar material available to soak up spills or leaks. Hydrated lime and bleach should be available to decontaminate spill surfaces.
- Seed that is intentionally treated with a pesticide presents a potential hazard if not stored properly. Such seed is usually treated with a brightly colored dye to serve as a warning that the seed has been treated with a pesticide. Unfortunately, the bright colors may be attractive to children. Treated seed should never be used for feed or mixed with untreated seed. It should be handled with the same care as the pesticide itself and stored in a locked storage facility away from feed, veterinary supplies, pesticides, other farm chemicals, farm equipment, pets, and children.
- Store volatile herbicides separately to avoid possible cross contamination with other pesticides, fertilizers, and seeds.

Pesticide Shelf Life

Keep an inventory of all pesticides in storage and mark each container with the purchase date. If a product has an effective shelf life recorded on the label, you will know how long the product should remain usable. Contact the dealer or manufacturer if there are doubts concerning the shelf life of a pesticide. Pesticide deterioration may be apparent when mixing a batch: excessive clumping, poor suspension, layering, or abnormal coloration. Sometimes pesticide deterioration from age or poor storage conditions is apparent only after application. Poor pest control and/or damage to the treated plant, crop, or surface can occur.

To minimize storage problems, avoid storing unnecessarily large quantities of pesticides for long periods. Keep records of previous usage requirements to make good estimates of future

needs. Buy only as much as you anticipate needing for the season; recommendations may change by next season. Remember, rotate your supplies, “first in, first out,” when storing chemicals to avoid forgotten, old chemicals.

Reporting Requirements

Title III of the federal Superfund Amendments and Reauthorization Act of 1986 (SARA) is also called the Emergency Planning and Community Right-to-Know Act. The act requires reporting certain pesticide inventories if the stored amount is greater than a “threshold planning quantity.” In Idaho, the Bureau of Hazardous Materials in the governor’s office administers this law.

It is good policy to inform your local fire department if you store agricultural chemicals (including fertilizers). Chemical fires cannot usually be extinguished by ordinary means and the smoke from the fire can be extremely hazardous to firefighters. The fire department must be properly prepared in the event of an agricultural chemical fire.

Pesticide Disposal

It is the responsibility of the pesticide user to see that pesticide wastes, such as unused chemicals and empty pesticide containers, are disposed of properly. In recent years, there has been growing concern that improper disposal of pesticide wastes can create serious hazards for both humans and the environment. Empty pesticide containers are hazardous to curious children and animals. Improperly disposed of pesticides can result in groundwater contamination and plant or crop damage.

It makes good business sense to deal with pesticide wastes properly and safely. Plan carefully and observe the following guidelines.

- Avoid disposal problems associated with excess pesticide by purchasing only the amount you need for one growing season. Do not stockpile materials. Recommendations may change and new chemicals may be better than older ones. The storage period may also exceed the effective shelf life of the product.
- Always read the label for special disposal instructions.
- Clothing and protective equipment to be discarded should be considered pesticide waste and handled as such.
- Federal and state laws regulate the disposal of containers and other pesticide wastes. Anyone requiring assistance with any question or problem relating to pesticide disposal should contact the Idaho Department of Environmental Quality (IDEQ) or the ISDA.

Containers

Triple-rinsing or pressure rinsing allows glass, metal, plastic, and even some heavy paper containers to be considered nonhazardous waste. It is recommended to use rinsate in future pesticide mixes. This effectively disposes of the rinsate within established state and

federal guidelines. It also saves money because each rinse captures pesticide residues from the sides and bottom of the container and includes it in the spray mix. Although pesticide labels require proper rinsing of empty pesticide containers, the greatest benefit is that these containers are no longer considered hazardous waste. As simple solid wastes, they can be disposed of along with other solid waste in landfills if the local authority will accept them. However, the best solution is to offer the empty containers for recycling.

Contact the ISDA for information concerning pesticide container recycling.

Triple-Rinsing

To triple-rinse:

1. Allow the concentrate to drain from the empty pesticide container for thirty seconds.
2. Fill approximately 20% of the container volume with water, replace the lid, and rotate the container so all the interior surfaces are rinsed.
3. Dump the rinse water into the spray tank, allowing it to drain for **at least thirty seconds**.
4. Repeat the procedure two more times.

To power-rinse:

1. Empty the container into the spray tank. Tilt the jug so any product trapped in the hollow handle flows out. Once the flow is down to a drip, let it drip for an extra thirty seconds.
2. Immediately start to rinse the container.
3. Hold the container upside down so rinse water will flow into the spray tank. Plunge the tip of the spray nozzle through the side above the handle.
4. Using water pressure of at least 40 psi, spray the inside of the jug, changing the nozzle angle to spray all surfaces inside the container.
5. Spray-rinse for thirty seconds; drain all rinse water into the spray tank.
6. Do not replace the cap on the jug; this allows the container to dry thoroughly.

Triple-rinsed or power-rinsed containers held for disposal at a later time should be marked to indicate triple rinsing has been done with the date of the rinsing. Pesticide containers not be recycled through a recycling facility should be rendered unusable by breaking, puncturing, or crushing them. Never reuse pesticide containers unless specifically allowed by the manufacturer. Keep all containers in the locked storage area until disposal and keep them away from all possible contact with children and animals.

Disposal of triple-rinsed or power-rinsed containers in a sanitary landfill is permissible; check with your local solid waste authority before discarding them. There may be local ordinances in place that could prohibit the disposal of pesticide containers.

Depending on their previous contents, pesticide containers that have not been properly rinsed may be regulated as hazardous waste and are generally not accepted by landfills. They may require disposal as a hazardous waste. **Burning pesticide containers is prohibited in Idaho**.

Whenever feasible, recycle triple-rinsed or pressure-rinsed containers. For information on plastic pesticide container recycling, contact the ISDA or contact one of the ISDA field offices in your area. This is by far the most desirable method of disposing of plastic pesticide containers.

Spray Mixes and Rinse Water

To minimize waste and thus disposal problems estimate job needs carefully so you will mix only as much pesticide as needed for a particular application. If you mix too much, it is best to apply the material in the recommended manner to another site listed on the label.

If possible, use the rinse water from your spray tank in a future spray mix. Be extra careful with herbicide-contaminated rinse water on sensitive plants. Caution must also be exercised with food or feed crops to avoid illegal residues. Never dispose of pesticide-contaminated rinse water in a manner that contaminates public or private water sources or sewage treatment facilities.

Follow the disposal instructions on the label and seek assistance with disposal problems.

Pesticide Concentrates

The safest means of "disposal" for pesticide concentrates is to use the product in a manner consistent with its label. If this is not possible, try to return it to the dealer or manufacturer or offer it to another qualified applicator. If no disposal option is available, then check with the ISDA's Pesticide Disposal Program. Certain pesticides may be disposed of through a municipal refuse collection service; others may require more stringent and costly disposal procedures, such as shipment to a hazardous waste facility.

Applicators should be aware of the current hazardous waste guidelines established under the Resource Conservation and Recovery Act (RCRA) as well as all comparable state hazardous waste statutes before disposing of pesticide wastes. Pesticide wastes classified as hazardous require special disposal and recordkeeping practices. The IDEQ or ISDA provide more information on the RCRA and your specific disposal responsibilities under the law.

Most agricultural or commercial pesticide formulations are designated hazardous, though this depends on their toxicity, environmental persistence, carcinogenic effects, flammability, and corrosiveness. Therefore, most agricultural wastes, along with the commercial pesticides, will be classified as hazardous and require special recordkeeping, packaging, shipping, and acceptance at a hazardous waste disposal facility.

Transportation

Once a pesticide is in your possession, you are responsible for its safe transport. Accidents can occur even when transporting materials a short distance. Do all you can to prevent a transport problem, but be prepared in case of an emergency.

Transport Vehicle

The safest way to carry pesticides is in the back of a truck with all pesticide containers firmly secured to prevent damage. Flatbed trucks should have side and tail racks. Steel beds are preferable, since they can be more easily decontaminated if a spill occurs.

Never carry pesticides should in the passenger compartment of a vehicle. If a pesticide container breaks or spills, the pesticide may cause injury and be impossible to remove from seats or upholstery. If pesticides are transported in a van, open the windows and don't permit anyone to ride near the pesticides. Never carry pesticides in the same compartment as clothes, fertilizers, seed, food, or feed; the risk of contamination is too high should a spill occur. In particular, separate herbicides from fertilizers and other pesticides.

The Idaho State Police and the Idaho Public Utilities Commission regulate intrastate transportation of pesticides. The US Department of Transportation (DOT) regulates interstate transport.

A commercial driver's license endorsement is required on your driver's license if you will be transporting placarded, hazardous materials. An endorsement is also required for the carrier. This endorsement can be obtained from the Motor Vehicle Bureau of the Idaho Department of Transportation. Farmers are exempt from the regulations if they are transporting placarded, hazardous materials within 150 miles of the farm. Contact the Idaho Motor Vehicles Bureau for further clarification.

Inspect containers before loading to be sure all caps and plugs are tightly closed and legible labels attached. Handle containers carefully to avoid rips or punctures. Ensure that the outsides of containers are not contaminated with pesticide.

Secure containers to safeguard against spills or leaks that may result if the containers roll or slide. Packing or shipping containers provide extra protection. Protect all containers from moisture that would saturate paper and cardboard packages or rust metal.

Protect pesticides from temperature extremes during transport. In hot weather, for instance, the temperature inside the trunk of a car is always considerably higher than outside.

Never leave your vehicle unattended when transporting pesticides in an unlocked trunk compartment or open bed truck. You are legally responsible if curious children or careless adults are accidentally poisoned from pesticides left unattended and exposed in your vehicle. Whenever possible, transport pesticides in a locked compartment.

Transport of Hazardous Substances

Some pesticides are federally regulated as hazardous substances and have specific requirements when being transported, such as proper labeling, manifests, and placarding.

Any hazardous substance must be properly labeled before shipping. Manifests must be issued with each delivery of a hazardous substance; thus, dealers must furnish customers with a manifest when distributing pesticides classified as hazardous substances.

It is the responsibility of the transporter to know the specific requirements for transporting hazardous materials. In general, most applicators will not be transporting any large amounts of pesticides that require specific DOT requirements such as manifests and placarding of transportation equipment. Contact the DOT state office for more information concerning pesticide transportation.

Fire Safety

Pesticide products vary significantly in their flammability and as a storage hazard. Those requiring extra precautions bear the label statement, “Do not use or store near heat or open flame.” Pesticides containing oils or petroleum solvents are the ones most likely to have these warnings, although certain dry formulations also present fire and explosion hazards.

To reduce fire hazards,

- Locate storage areas as far away as possible from where people and animals live.
- Keep storage area locked at all times.
- Post signs on all exterior walls and entrances that indicate combustible or hazardous materials are stored in the facility.
- Store combustible materials away from steam lines and other heating systems.
- Do not store glass containers in sunlight where they can concentrate heat rays and possibly explode or ignite.
- Install fire detection systems in large storage areas.
- Keep a fire extinguisher approved for chemical fires in all storage areas.
- Notify the servicing fire department as to the location and contents of the storage area. It may save their lives and the lives of others a fire start.

Pesticide Fire

In the event of a pesticide fire,

- Clear all personnel from the area and move to a safe distance upwind from the smoke and fumes.
- Call the fire department and inform the firefighters of the nature of the pesticides involved. The label and Material Safety Data Sheets provide technical and emergency information.

- Firefighting personnel must bring to the scene and wear the proper protective clothing and equipment (especially respirators). Assume all protective gear worn at the fire scene is contaminated and hazardous until it is washed.
- Be aware of the potential for explosion of overheated pesticide containers. Nearby Move the containers or keep them cool.
- The principal objective is to contain the fire and prevent contamination of surrounding areas. For small fires, avoid the use of water in favor of fog, foam, or dry powders. For large fires, use only as much water as absolutely necessary. Avoid heavy hose streams and build any necessary dikes to prevent the flow of contaminated runoff into lakes, ponds, streams, wells, or sewers.

Pesticide Spills

As careful as people try to be, pesticide spills happen. The spill may be minor, involving only a leaking container, or major, if the contents of a fully loaded spray tank are suddenly released because of equipment malfunction. It is very important that all users of pesticides be familiar with the laws and guidelines governing chemical spills. Your failure to respond properly to such an emergency, no matter how minor the problem appears, could seriously endanger public health and environmental quality.

The suggested guidelines in the event of a pesticide spill or, for that matter, a spill of any hazardous chemical, are included under the "Three C's" program. You must ***CONTROL*** the spill; ***CONTAIN*** the spill; and ***CLEAN UP*** the spill.

Control the Spill

Take immediate steps to control the flow of the material being spilled, regardless of the source. If a sprayer has tipped over or if a metal pesticide container on a storage shelf has rusted through and is leaking, do everything possible to stop the leak or spill. Smaller containers, up to 55 gallons, can be put into larger containers to prevent further release of the chemical. Place torn bags into larger plastic bags or tape them shut so dust, powders, and granules cannot leak out.

Do not expose yourself unnecessarily to the leaking chemical. Wear the appropriate protective equipment when attempting to control the leak.

Isolate the area—Keep people at least 30 feet away from the spill. Rope off the contaminated area if necessary. Avoid coming in contact with any drift or fumes that may be released. Do not use road flares if you suspect the leaking material is flammable. At times it may be necessary to evacuate people downwind from the spill.

Do not leave the spill site until someone relieves you. Someone should be present at the spill site continuously until the chemical is cleaned up.

Get help—Unfortunately, stopping large leaks or spills is not often simple. If you encounter a pesticide accident or spill that you cannot handle or if problems occur during the cleanup

phase, contact the **Idaho Office of Emergency Management** by calling (800) 632-8000. The commission is staffed twenty-four hours a day to respond to incidents involving hazardous materials. Another available resource for emergency information about spills, leaks, or fires is the Chemical Transportation Emergency Center (CHEMTREC) in Washington, DC. You can contact CHEMTREC by calling (800) 262-8200.

If you need emergency assistance, have the product label available. Additional and important emergency telephone numbers are found on many labels. The manufacturers staff these emergency lines twenty-four hours a day with qualified persons prepared to handle pesticide emergencies involving their products.

Have someone alert the state and local police if the spill occurs on a public highway. In certain cases, it may be necessary to alert the fire department, but caution them not to wash down the spill until advised to do so. At times it may be necessary to contact public health officials and a hospital emergency room.

Contain the Spill

At the same time the leak is being controlled, contain the spilled material in as small of an area as possible. Do everything possible to keep it from spreading or getting worse. Use a hand tool, such as a shovel or rake, or power equipment to construct a dam of soil or sod. If the spilled material flows into a ditch or depression, block the flow on all sides to reduce further movement. Do not allow the spilled material to enter any body of water, including storm sewers, no matter how small the spill!

Protect Water

If the chemical contaminates a stream, pond, or any other waterway, contact a regional office of the IDEQ. Authorities should notify downstream users as soon as possible. Prompt precautionary actions could prevent accidental poisoning of livestock and avoid contamination of plants, crops, and soil receiving irrigation water from the stream. Bring the pesticide-contaminated well to the attention of a county or state health official.

Liquid pesticide spills can be further contained and absorbed by covering the entire spill area with absorbent materials, such as fine sand, vermiculite, sawdust, clay kitty litter, or absorbent pads. However, avoid using sawdust or sweeping compounds on a spill material that is a strong oxidizer because these materials create a fire hazard. Some examples of oxidizers are chlorites used in some herbicides and desiccants, calcium hypochlorite, often used as a sanitizer, and ammonium nitrate fertilizers.

If dust, wettable powder, or granules spill, further reduce their spread by lightly misting the material with water or covering the spill with some type of plastic cover. Be careful when cleaning or disposing of all materials (clothes, equipment, and soil) used in containing or cleaning up a pesticide spill.

Clean Up the Spill

If you have not already done so, spread absorbent material over the contaminated area, sweep it up, and place it in a heavy-duty plastic bag. Keep adding the absorbent until it soaks up the spilled liquid. Absorbent materials are not used for dry spills. Sweep up dry spills for reuse if possible. If dry materials have become wet or contaminated with soil and other debris, sweep them up and place them in a heavy-duty plastic bag.

Once the spill has been cleaned up, it may be necessary to decontaminate or neutralize the area, especially if a carbamate or organophosphate insecticide was involved. A solution of three parts household bleach to seven parts water, prepared commercial decontaminant, or hydrated lime may be used. **But do not use bleach and lime together!** Wearing protective equipment if needed, work this preparation into the spill area with a coarse broom. Then add fresh, absorbent material to soak up the now-contaminated cleaning solution. Sweep up hte material and place it in a plastic bag or drum for disposal. If necessary, repeat this procedure several times to ensure that the area has been thoroughly decontaminated. **Do not hose down the area with water**. Although this may dilute the concentrated pesticide, it does not remove the pesticide from the area of the spill and may spread the contaminated area further.

Soil Contamination

Depending on the pesticide in the soil, it may be possible to incorporate the saturated soil with uncontaminated soil and allow soil microbes to degrade the pesticides. Contact the ISDA for assistance with spills in soils. The only effective way to decontaminate soil saturated with a pesticide is to remove the contaminated soil and two to three inches of uncontaminated soil around the zone of contamination. Cover the area with at least two inches of lime, then cover the lime with fresh topsoil. Dispose of the contaminated soil properly.

Applying activated charcoal to the contaminated surface immediately after the spill or misapplication sometimes amends the result of application errors or minor spills. The charcoal can adsorb or tie up enough chemicals to avoid significant plant injury and long-term contamination. However, application of activated charcoal to areas where large spills have occurred is unlikely to reduce soil contamination and may hamper cleanup operations.

If the soil has been saturated in a small area, simply dig up the saturated soil and place it into a leak-proof container. Make sure that you take the soil at least two inches around the edge of the saturated area and at least three inches below the zone of saturation. That will ensure that all of the pesticide spilled on the soil is collected. Contact the ISDA for information about how to dispose of the pesticide-saturated soil.

Clean Equipment and Vehicles

Clean up any vehicles or equipment that were contaminated either as a result of the original spill or during the cleanup procedure. Before you begin, properly clothe and protect yourself to avoid contact with the chemical. Use household bleach and water or an alkaline detergent (dishwasher soap) solution to clean the equipment, but do not mix the bleach with alkaline detergent. Porous material and equipment, such as brooms, leather shoes, and cloth hats, cannot be effectively decontaminated and should be discarded or destroyed. Also, do not try to save disposable garments and gloves or any clothing that is badly contaminated. You should properly dispose of them immediately after you are finished.

Dispose of Spill Materials

You generally have two options in dealing with spill material (pesticide and absorbent material). First, apply the spill material at or below a labeled rate on a labeled site. If the spill was major, this application will need to be approved by the IDEQ and ISDA. If application of the spill material is not possible, dispose of the material in accordance to the state rules for hazardous waste disposal.

Follow-Up

For legal protection, keep records of your activities and conversations with regulatory authorities, emergency personnel, and the general public when dealing with a pesticide spill. Photographs help to document any damages, as well as help with the cleanup process. Be sure the spill has been reported to the appropriate agencies (e.g., IDEQ).

Title III of SARA, discussed earlier in the section, Storage, also requires the reporting of certain pesticide spills if the amount spilled is greater than the “reportable quantity” for that chemical.

Discharge of chemical substances into waterways must also be reported to the EPA under the authority of the Clean Water Act.

Spill Prevention and Preparation

A key to preventing pesticide spills is to properly maintain all vehicles and application equipment. Leaks and drips from cracks or loose fittings in equipment are indications of potential trouble. An understanding of how spray equipment works, especially a pumping system, is often essential to controlling the flow of a product and minimizing equipment damage should a problem occur. Safe driving and other operating habits further reduce the likelihood of a spill.

Knowing how to safely handle pesticide spills and leaks is as important as knowing how to correctly apply the material. All facilities in which pesticides are handled should have the abovementioned telephone numbers as well as other emergency phone numbers (fire, police, doctor, poison control center) readily available. Always have the label with you! A Material Safety Data Sheet for every pesticide on the premises is also recommended. In

case of a spill or emergency, the proper equipment is essential (absorbent materials, broom and dustpan, neutralizers, a shovel, protective clothing and/ or equipment, first-aid supplies, clean water, soap, and disposable towels).

All persons using or transporting pesticides and other hazardous chemicals have a responsibility to protect the public and the environment. Doing everything possible to avoid spills and adhering to a few basic guidelines when handling spills and leaks can go a long way toward meeting that responsibility.

Review Questions

Select the correct answer or fill in the blank for each question. Answers available in Chapter Review Answers.

1. Pesticide respirators should be approved for use by the
   A. National Institute for Occupational Safety and Health (NIOSH)
   B. Mine Safety and Health Administration (MSHA)
   C. Environmental Protection Agency (EPA)
   D. Both A and B
2. The life of the cartridge in a chemical respirator depends only upon the concentration of the pesticide. (True or False)
3. Gloves and boots worn when handling pesticides should be made of what material?
   A. Leather
   B. Cotton cloth or canvas
   C. Unlined rubber
   D. None of the above
4. Clean protective equipment and clothing should be kept with pesticides in the locked pesticide storage area. (True or False)
5. Pesticide-contaminated clothing should be washed separately from the family laundry in hot water with laundry detergent. (True or False)
6. When filling a spray tank with water, back-siphoning is prevented by
   A. Attaching an antibackflow valve to the hose.
   B. Keeping the hose above the level of the water in the spray tank.
   C. Observing the tank as it fills.
   D. All of the above.
7. You may dispose of waste rinse water (rinsate) by
   A. Using the rinsate in future spray applications.
   B. Dumping the rinsate in a vacant lot.
   C. Diluting the rinsate with additional water and spraying the mixture on the same crop.
   D. Both A and C.
8. If a nozzle becomes clogged while spraying
   A. Carefully use your mouth to blow out what is plugging the nozzle.
   B. Continue to spray until the tank is empty, then correct the problem.
   C. Stop spraying, move to an untreated area, and use a soft brush to clean the plugged nozzle.
   D. None of the above.
9. Which is an undesirable characteristic of a pesticide storage area?
   A. Dry.
   B. Well lighted by direct sunlight.
   C. Locked and away from children, pets, food, feed, and water sources.
   D. Well placarded with warning signs.
10. Pesticides should be stored in
    A. Any container as long as the container is labeled.
    B. Only in their original container.
    C. In containers too heavy for children to handle.
    D. In any container that is childproof.
11. The best way to dispose of a registered pesticide is to
    A. Carefully pour it into a sewer system.
    B. Apply it to a vacant lot.
    C. Use it as directed on the label.
    D. Ship the pesticide to the EPA.
12. An acceptable way to clean empty pesticide containers is to
    A. Rinse the container once with water while collecting the rinsewater.
    B. Rinse the container twice with water while collecting the rinsewater.
    C. Rinse the container three times with water while collecting the rinsewater.
    D. Rinse the container until the residue appears to be gone.
13. Pesticides should not be transported in the passenger compartment of a vehicle. (True or False)
14. Select the incorrect statement regarding pesticide spill cleanup:
    A. A spill should never be left unattended.
    B. No matter how small the spill, it must be kept out of water sources.
    C. Materials used to absorb a liquid pesticide spill must be treated as pesticide waste.
    D. Immediately hose the area down with plenty of water.
15. Pesticide application records are
    A. Kept for one year and then disposed.
    B. Are maintained for not less than two years.

CHAPTER 8:
Pesticides and the Environment

Learning Objectives

- Understand the types of damage that can occur to plants, animals (wildlife), soil, water, and air.
- Understand the typical ways that pesticides are broken down or move within the environment.
- Understand the definition of the words printed in *italics*.
- Understand what pesticide drift is and what factors contribute to pesticide drift.
- Understand why it is important to protect water sources and the recommended practices that are necessary to protect water sources.
- Understand the importance of protecting crop pollinators and what laws and regulations are in place to protect them.
- Understand what management practices may be used to lower any negative impact to fish and wildlife.

As our population increases, so do our demands for clean water and air and an environment that is not threatening to our health and safety. Society has become increasingly concerned about the state of our environment. We worry that the Earth's natural resources are becoming polluted and unfit for human use. As a result, many of the activities that we have taken for granted are now being carefully examined for potential damage to the environment. Pesticides are only one group of chemicals being blamed for environmental abuse.

Pesticide misuse can cause environmental damage through injury to wildlife and contamination of water, soil, and air. If properly handled, pesticides can control pests with minimal environmental impact.

This chapter examines the fate of pesticides in the environment, groundwater contamination, and the effect of these chemicals on nontarget organisms. A greater awareness of these issues by pesticide applicators should help them make environmentally responsible decisions regarding pesticide use.

Pesticide Fate

We can accomplish our pest-control objectives by applying pesticides directly to plants, animals, or structures or by mixing them with soil, water, or even air. Various processes affect pesticides as soon as they are released into the environment. Sometimes these processes are beneficial and enhance pest control. For example, root leaching absorbs herbicide into the root zone, which can enhance weed control. The degradation of pesticides removes nonessential pesticide residues from the environment. Often, however, these processes are detrimental. Drift or runoff moves a herbicide away from target weeds, wasting pesticide and reducing weed control. In any situation where the pesticide stays where it is intended, the possibility of damage to nontarget plants, human health hazards, and nearby soil and water pollution increases.

In this section, we examine the fate of pesticides and the various processes that affect their stability and persistence following an application, disposal, or spill. The processes can be divided into two basic types: those that transfer chemicals or influence their movement and those that degrade or break down chemicals. The primary transfer processes are spray drift, volatilization, adsorption, absorption, runoff, leaching, and plant removal from a treated area. The degradation processes are *microbial*, *chemical*, and *photodegradation*.

Pesticide Drift

The Idaho Pesticide and Chemigation Law dictates that pesticide applications cannot damage or endanger humans, property, or the environment; therefore, off-target drift is one of the most important considerations when applying pesticides. Drift is the movement of airborne pesticides (particles, spray droplets, or gases) beyond the intended target area.

Drift is most commonly due to off-target movement of pesticide spray droplets. It is essential to understand the factors that contribute to spray drift and to make a conscious effort to minimize drift for every spray application.

Three primary factors contribute to pesticide spray drift:

1. Weather conditions
2. Equipment configuration and operation
3. Applicator attitude

Equipment configuration and operation determine spray droplet size. Small droplets are most likely to drift off target and are produced in greatest volume when using small nozzle orifices and high pressure. Select the correct nozzle type and use a spray pressure low enough to produce the largest droplets that provide sufficient penetration and coverage of the intended target. Drift potential is also increased as the distance between the nozzle and the target increases, so applications should always be made as close to the target as possible.

Many pesticide labels include directions that prohibit spray application of the pesticide “under conditions that favor drift.” Complying with these directions requires an understanding of weather conditions that enhance drift.

Obviously, excessive winds are often the cause of downwind drift problems. Such drift can be reduced by leaving an untreated border around the target area and by spraying downwind from sensitive areas, such as residential properties or beehives. The maximum wind speed allowed by the Idaho Pesticide and Chemigation Law/Rule is ten mph. Certain pesticides may have a lower allowable wind speed listed on their label. If you are using a pesticide that has a lower wind-speed restriction, you must follow the label directions.

Most applicators are not aware of the potential dangers associated with applications made under no wind or low wind conditions. These are often considered ideal application conditions; however, applications made under these conditions can result in more extensive and devastating drift than those caused by excessive winds. Long distance drift (over a mile) is most often associated with applications made under highly stable or temperature inversion conditions.

A *temperature inversion* exists when the air at ground level is cooler than the temperature of the air above it. Under these conditions, there is little or no vertical air movement. Almost all air movement is horizontal. High concentrations of small spray droplets suspended in the layer of cool air near the ground carry very long distances. Inversions occur at any time, but they most often develop during the early evening hours, intensify during the night, and often persist until midmorning. Consequently, applications made during the early evening or morning hours under what appear to be ideal conditions can result in highly damaging, long-distance drift, especially if humidity is high.

Observing dust or smoke movement can recognize stable air conditions (inversions). If dust or smoke rises little from its source and tends to hang in the air, an inversion is present or developing. A prudent applicator knows that this is not the time to make a pesticide spray application.

The most important factor in drift minimization is applicator attitude. Small droplets and high equipment operating pressures can provide better spray coverage, but also produce large amounts of very small spray droplets that are susceptible to drift. Spraying when it is convenient and disregarding existing weather conditions will often result in off-target pesticide application, leading to inconsistent pest control and possible damage to adjacent crops or properties. It is too late to start worrying about drift if and when complaints are voiced or legal action is initiated. Pesticides remain viable pest-control alternatives only if these chemicals can be applied accurately and responsibly. The applicator is legally responsible for any pesticide that moves off target and is responsible for the damage that the pesticide may cause. Present public perceptions about pesticides strongly suggest that it is time for all applicators to make every effort to minimize pesticide drift.

Volatilization

Volatilization occurs when a solid or liquid changes its state and turns into a gas. Volatilization of pesticides increases with higher temperature and air movement, higher temperature at the treated surface (soil, plant, etc.), low relative humidity, and small spray droplets. Pesticides also volatilize more readily from coarse-textured soils and from medium to fine texture soils with high moisture content.

A pesticide in a gaseous state can be carried away from a treated area by air currents; the movement of pesticide vapors in the atmosphere is called *vapor drift*. Unlike the drift of sprays and dusts that sometimes are seen during an application, vapor drift is not visible. Some herbicides volatilize and move from the treated area, reducing the control of the target weeds and increasing the likelihood of injuring nontarget plants.

Avoid application of a volatile pesticide when conditions favor volatilization, such as high temperatures combined with low humidity. The vapor pressure rating of the pesticide may help indicate the volatility of the material. A higher vapor pressure means that the pesticide is more volatile. Volatilization can be reduced through the use of low volatile formulations and soil incorporation of the pesticide. Precautionary statements on labels indicate pesticides that have a potential for vapor drift.

Adsorption

Adsorption is the binding of one type of molecule (e.g., solute or liquid) to another molecule (e.g., soil). Pesticides adsorb to soil particles. The amount and persistence of pesticide adsorption vary with pesticide properties, soil moisture content, soil pH, and soil texture. Soils high in organic matter or clay are the most adsorptive; coarse, sandy soils that lack organic matter or clay are much less so. The increased adsorption of soils high in clay and organic matter is due to an increase in soil surface area, thus accounting for the number of binding sites for chemicals.

Knowing the adsorptive nature of your soil is important because adsorption influences the other processes that determine the ultimate fate of a pesticide. A soil-adsorbed pesticide is less likely to volatilize, leach, or be degraded by microorganisms. When pesticides are tightly held by soil particles, they are less available for adsorption by plants. For this reason, certain pesticides used on highly adsorptive soils often require higher rates or more frequent applications to compensate for the pesticide bound to soil particles. Pesticides can, however, be readily moved when bound to soil particles eroded by wind or water.

Plant Absorption

Absorption by plants and microorganisms is another process that can transfer pesticides in the environment. Once absorbed, most pesticides are degraded within plants. These residues may persist inside the plant or be released back into the environment as the plant tissue decays.

Some pesticides are persistent enough in the soil to be absorbed by plants grown in a field one or more years after the application. Recognizing that absorption can occur is important in order to avoid damage to sensitive plants and the development of illegal residues in a food or feed crop.

Runoff

Runoff is a process that moves pesticides in water. Runoff occurs as water moves over a sloping surface-carrying pesticide, either mixed in the water or bound to eroding soil. The amount of pesticide runoff depends upon the grade or slope of an area, the characteristics

and texture of the soil, the soil moisture content, the amount and timing of irrigation or rainfall, and pesticide properties. For example, a pesticide application made to a heavy clay soil already saturated with water is highly susceptible to runoff. Established vegetation or plant residues also influences runoff because of their ability to retain soil and moisture.

Runoff from farms, residential and recreational areas, and industrial sites can be a factor in pesticide pollution of surface waters (streams, ponds, and lakes). Pesticide residues in surface water cause injuries to plants and animals in aquatic systems, contaminate groundwater, and result in livestock and plant/crop losses to downstream users. Herbicide runoff into nontarget areas damages sensitive plants.

Pesticide losses from runoff are greatest when heavy rainfall occurs shortly after a pesticide application. Pesticide runoff can be reduced by careful observation of current and predicted weather conditions. If heavy rain is expected, delay application of pesticides. Irrigate in accordance with labeled instructions and monitor it to avoid runoff and accumulation of excess surface water.

Some no-tillage and minimum-tillage cropping systems reduce pesticide runoff, as do soil incorporation application methods. In addition, adjuvants that promote pesticide retention on treated surfaces reduce the pesticide content in runoff water. Finally, surface grading, drainage ditches and dikes, and the use of border vegetation helps reduce the amount and controls the movement of runoff waters.

Leaching

Leaching is another process that moves pesticides in water. In contrast to runoff that occurs as water moves on the surface of the soil, leaching occurs as water moves through the soil. Several factors influence the leaching of pesticides, such as water solubility of the pesticide, soil texture, and adsorption. A pesticide that dissolves in water moves readily with the water as it seeps through the soil. Soil structure and texture influence soil permeability (how fast the water moves through soil) as well as the amount and persistence of pesticide adsorption to soil particles. Adsorption is probably the most important factor influencing pesticide leaching. If a pesticide strongly adsorbs to soil particles, it is less likely to leach regardless of its solubility, unless the soil particles themselves move with the waterflow.

In addition, the amount and timing of rainfall or irrigation and the pesticide application method affect whether and how much pesticide leaching occurs. The greater the amount of pesticide used and the closer the time of application to a heavy rainfall or irrigation, the great- er likelihood some pesticide will be lost to leaching. If a pesticide leaches beyond the target area, absorption of the pesticide by the target reduces. This results in reduced pest control and increases the likelihood that the pesticide continues to leach. Soil injection or incorporation may make a pesticide more available for leaching by reducing pesticide losses from sunlight, surface runoff, and volatilization. Leaching occurs with lateral or vertical movement of water, so take precautions if sensitive plants are nearby.

Groundwater contamination is a major concern associated with the leaching of pesticides from treated fields, mixing and rinsing sites, waste disposal areas, and manufacturing facilities. Refer to the next section in this chapter, Groundwater Contamination, for information about preventing contamination.

Plant Removal

Plant or crop removal is the final pesticide-transfer process. When treated crops are harvested or plant parts removed (i.e., grass clippings), the pesticide residues are removed with them and transferred to a new location. After harvest, many agricultural commodities are washed and/or processed, which removes or degrades much of the remaining residue.

Microbial Degradation

Microbial degradation occurs when microorganisms, such as fungi and bacteria, use a pesticide as a food substrate. Microbial degradation can be rapid and thorough under soil conditions favoring microbial growth. Those conditions include warm temperatures, favorable pH levels, adequate soil moisture, aeration (oxygen), and fertility. The amount of adsorption also influences microbial degradation. Adsorbed pesticides, because they are less available to some microorganisms, more slowly degrade.

Microbial degradation is one of the more important means by which pesticides are destroyed in soils. Certain pesticides require higher application rates to compensate for the microbial degradation. In extreme cases, accelerated microbial degradation causes pesticides that were once effective for weeks to suddenly lose their effectiveness in a matter of days. Prior applications of these chemicals had stimulated the buildup of certain microorganisms that were effective in rapidly degrading the pesticides.

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 all influence the rate and type of chemical reactions that occur. Many pesticides, especially the organophosphate insecticides, are susceptible to degradation by hydrolysis in high pH (alkaline) soils or spray mixes. The addition of buffers to the spray mix can help slow hydrolysis reactions.

The product(s) of chemical reactions are usually nontoxic or nonpesticidal. As a result, the amount of pesticide is reduced, as is the degree of pest control.

Photodegradation

Photodegradation is the breakdown of pesticides by the action of sunlight. Pesticides applied to the foliage, soil surfaces, or structures vary considerably in their stability when exposed to natural light. Similar to other degradation processes, photodegradation reduces the amount of chemical present, which subsequently reduces the pest-control level. Soil incorporation by mechanical means during or after application or by irrigation water or rainfall following application reduces pesticide exposure to sunlight.

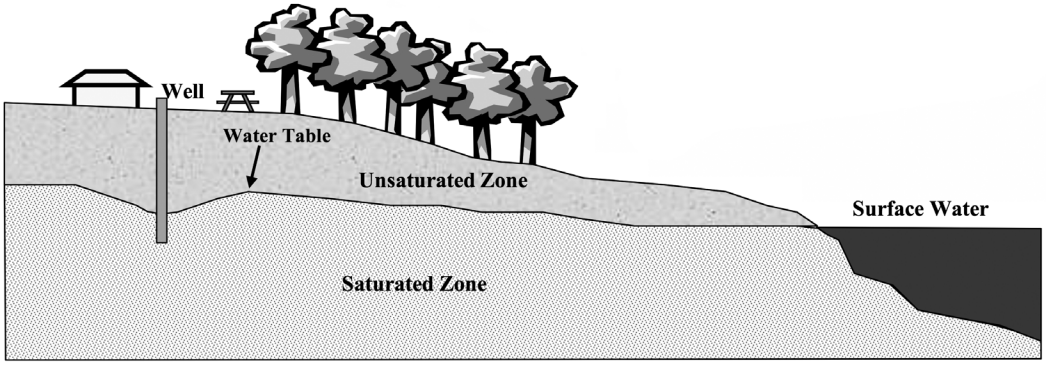
Groundwater Contamination

Groundwater is a crucial natural resource. One half of the people in Idaho—up to 100% of the people in some rural areas—must rely on it as a source of drinking water. Groundwater is also essential to Idaho industry and agriculture.

Groundwater is found below the surface of the Earth. Most groundwater occurs in aquifers that are permeable zones of rock, sand, gravel, or limestone saturated with water. It moves through aquifers and can be obtained at points of natural discharge, such as springs or streams, or by drilling a well into the aquifer.

The upper level of the water-saturated zone in the ground is called the *water table*. The depth of the water table below the soil surface fluctuates throughout the year, depending upon the amount of water removed from the ground and the amount of water added by recharge and connected surface waters. Recharge is water that seeps through the soil from rain, melting snow, or irrigation sources. *Surface waters* are bodies of water we see, such as lakes, rivers, and oceans. Both surface water and groundwater are subject to contamination by human activities. A major concern is waste disposal. Problems result from domestic waste (septic systems, landfills, and waste treatment plants), industrial waste (landfills, brine and mine wastes, and deep-well disposal), and government-generated waste (radioactive wastes). Another concern is agriculture. Through the maintenance of livestock waste storage facilities and the application of manures, fertilizers, and pesticides to farmland, agriculture is a potential contributor to groundwater contamination. Pesticides in particular receive considerable national notoriety. This section presents how pesticides contaminate groundwater and how pesticide users help prevent contamination.

Earlier in this chapter, we discussed pesticide fate and the numerous transfer and breakdown processes that occur in the environment. Those processes help determine whether pesticides reach groundwater or degrade before reaching these underground waters. Geological characteristics, such as the depth of the water table and the presence of sinkholes, are also critical. If the water table is close to the soil surface, few opportunities for adsorption and degradation reactions may occur.



On the soil surface, and within the first few inches of soil, pesticides can be volatilized, adsorbed to soil particles, and/or taken up by plants. They can also be broken down by the action of sunlight, soil microorganisms, and/or chemical reactions. Leaching may remove pesticides from the soil. The pesticide properties and the soil properties (as discussed in the previous section of this chapter) determine the extent of pesticide leaching.

Weather conditions and management practices also affect pesticide leaching through the soil. Too much rain or irrigation water leaches pesticides beyond the treatment area. A pesticide that is not volatilized, absorbed by plants, bound to the soil, or broken down potentially moves through the soil to the groundwater.

After pesticides reach groundwater, they may continue to break down, but at a much slower rate because of less available light, heat, and oxygen. The movement of groundwater is often slow and difficult to predict. Substances that enter the groundwater in one location can turn up years later in other locations. The major difficulty in dealing with groundwater contaminants is that pollution sources are not easily recognizable. The problem is occurring underground, out of sight.

Protecting Groundwater

It is very difficult to purify or clean groundwater that has become contaminated. Treatment is complicated, time consuming, expensive, and often not feasible. The best solution to groundwater contamination is to prevent the problem in the first place. Use the following management and pesticide application practices to reduce the potential for surface and groundwater contamination.

- **Integrated Pest Management (IPM) programs**—Combining chemical control with other pest-management practices minimizes pesticide use.
- **Consider the geology of your area**—Consult with your Soil Conservation District and the Natural Resources Conservation Service (NRCS) to learn about the groundwater and soil in your area. When planning pesticide applications, be aware of the water table depth and the permeability of the geological layers between the soil and groundwater. Sinkholes can be especially troublesome because they allow surface water to quickly reach groundwater. Characteristics that are particularly vulnerable are sandy and/or mineral soil textures combined with a shallow bedrock depth.
- **Consider soil characteristics**—The susceptibility of your soil to leaching should be determined. In particular, soil texture and organic matter content influence the movements of chemicals into groundwater.
- **Select pesticides carefully**—Pesticides that are highly soluble, relatively stable, and not readily adsorbed to soil tend to be the most likely to leach. Choose pesticides with the least potential for leaching into groundwater. Read labels carefully and consult a UI Extension specialist or your chemical dealer if necessary.

- **Follow label directions**—The label carries crucial information about the proper rate, timing, and placement of the pesticide in that container.
- **Calibrate accurately**—Calibrate equipment carefully and often. During the calibration procedures, check the equipment for leaks and malfunctions.
- **Measure accurately**—Carefully measure concentrates before they are placed into the spray tank. Do not "add a little extra" to make sure the pesticide does a better job. Such practices only increase the cost of pest control, the likelihood of injury to the treated plants or animals, and the chance of groundwater contamination.
- **Avoid back-siphoning**—The end of the fill hose should remain two pipe diameters (1" minimum) above the spray tank at all times to prevent back-siphoning of chemical into the water supply. Use an antibackflow device when siphoning water directly from a well, pond, or stream. These practices also reduce the likelihood of the hose becoming contaminated with pesticides.
- **Consider weather and irrigation**—If you suspect heavy or sustained rain, delay the application of pesticides. Control the quantity of irrigation to minimize the potential for pesticide leaching and runoff.
- **Clean up spills**—Avoid spills. But when they occur, contain and clean them up quickly. Chemicals spilled near wells and sinkholes move directly and rapidly into groundwater.
- **Dispose of wastes properly**—All pesticide wastes must be disposed of in accordance with local, state, and federal laws. Triple-rinse or power-rinse containers. Pour the rinse water into the spray tank for use in treating the site.
- **Store pesticides away from water sources**—Situate pesticide storage facilities away from wells, cisterns, springs, and other water sources.

Idaho's aquifers currently provide a vast supply of clean water for use in agriculture, homes, and industry. They can ensure a source of high-quality groundwater for future needs if they are protected now. Understand how your activities, including the use of pesticides, impact them.

Effects on Nontarget Organisms

Throughout the earlier sections of this chapter we examined the fate of pesticides in our environment. We have seen that groundwater contamination can occur. Injury and death of nontarget organisms can also occur. In this section, we examine the effects of pesticides on some nontarget organisms, emphasizing plants, bees, and other beneficial insects, fish, and other wildlife.

Plants

All kinds of pesticides injure or kill plants. However, because herbicides are used to control plants, they are the primary cause of nontarget plant injury. Herbicides move from treated areas and from mixing, disposal, and storage sites.

A chemical that causes injury to plants is *phytotoxic*. The symptoms of herbicide phytotoxicity are frequently difficult to diagnose. Symptoms often do not appear for several days or sometimes weeks and even then are often confused with pest damage, nutritional deficiencies, cultural practices, or adverse weather conditions.

Improper pesticide use may damage the marketability of a crop or commodity, even if no symptoms occur. The crop or commodity may be held, or prohibited from sale, due to illegal pesticide residues.

Accurate diagnosis of herbicide injury is aided by having access to the following: good application records, weather data, knowledge of how the herbicide works (mode of action), fresh plant specimens, and knowledge of the planting area and its proximity to other potential sources of pollution. When necessary, get professional help by contacting UI Extension or a manufacturer's representative. If it is determined that a herbicide caused the injury, take adequate precautions to ensure that it does not happen again.

Bees and Other Pollinators

Bees and other pollinating insects are essential for the successful production of many crops, such as deciduous tree fruits, small fruits, most seed crops, and certain vegetables. Many pesticides, particularly insecticides, are highly toxic to pollinating honeybees and wild bees. Pesticide applicators should be aware of how bee poisonings occur and how to prevent them.

Most poisonings occur when blooming plants are treated with insecticides. Pollinators attracted to the flowers of treated plants may come into direct contact with a pesticide spray or dust. Hives contaminated by pesticides can kill broods, young adult bees, and field bees.

The residual activity of a chemical is a key factor in determining the safety to bees. An insecticide that becomes inaccessible to bees (i.e., tightly adhered to the foliage) within a few hours after application can probably be used with reasonable safety, as long as bees are not actively foraging during the actual application or before it dries.

With certain exceptions, ISDA's Pesticide Rules Governing Pesticide and Chemigation Use and Application (IDAPA 02.03.03) restricts the application of pesticides that are toxic to bees on agricultural crops and adjacent weeds when they are in bloom. During the times crops and/or weeds are in bloom, **pesticide applications that are toxic to bees may only be made from three hours before sunset until three hours after sunrise** (IDAPA 02.03.03).

Reducing Pollinator Damage

Pollinators are very important to our environment. From a food standpoint, about one-third of the food we eat requires pollination. In addition, there are a number of seed crops that require pollination in order to produce viable seed. If you add to that the number of plant species that live in the wild that add to the diversity of the environment, you can see that pollination is not just a food-crop issue.

Although the most prominent species used for pollination are the European honeybee and the leaf-cutter bee, by no means are these the only pollinators that are available. There are about four thousand species of bees that are native to the United States and all of these are important for pollinating the crops, forages, nuts, fruits, and other agricultural commodities we grow in Idaho.

Other insects, such as butterflies and beetles, also have the ability to pollinate plants, although they are normally not as effective as bees. Other organisms, such as birds and bats, also pollinate plants.

Because of their importance to food crops and the environment, Idaho adopted practices that encourage growers, landscape maintenances workers, and other pesticide applicators to protect native and non-native pollinators. While these practices focus on bees, they are applicable to all pollinators and pertain to all pesticide applicators, regardless of their application type or location. Idaho adopted a *Managed Pollinator Protection Plan* (MP3) that provides specific guidance to protect pollinators in the state. The plan specifies required and recommended actions for all Idaho pesticide applicators to maintain a healthy pollinator population. It also recommends practices for beekeepers and bee handlers to maintain healthy bee populations.

Specific to pesticide applications, the following precautions reduce the chances of bee poisoning:

- Do not apply pesticides that are toxic to bees during bloom. Even shade trees and weeds should not be sprayed when blooming. Mow cover crops and weeds to remove the blooms before spraying.
- Select the pesticide least harmful to foraging bees. Check product labels for specific bee hazards.
- Select the safest formulation. In general, dusts are more hazardous to bees than sprays; wettable powders are more hazardous to bees than either emulsifiable concentrates or water-soluble formulations. Granular insecticide formulations are generally the least hazardous, although microencapsulated formulations can be quite

hazardous. The hazard to the bees increases when the material is carried back to the hive. Since microencapsulated and dust formulations are picked up with pollen, they are the most dangerous because they can affect the brood as well as other adults fed by the contaminated pollen.

- Reduce drift during application. Applications made by aircraft usually are more hazardous to bees than ground applications.
- Try to time the pesticide application carefully. Evening applications are less hazardous than early morning ones. Both are safer than midday applications.
- Do not treat near hives. Bees need to be moved or covered before using insecticides near colonies.
- Cooperate with beekeepers. Fostering cooperation among beekeepers, growers, and pesticide applicators reduce bee poisonings.

Beekeepers that manage honeybees must identify their hives, according to Idaho law. Identify the hives with the business name, or the name, address, and telephone number of the beekeeper. This information is necessary for growers to contact the beekeeper prior to a pesticide application and to minimize damage to the bees. Remember that some bees are native and build living colonies in natural areas (i.e., alkali bees).

Be aware of all naturally occurring pollinators in your area and take steps to protect those areas when you apply pesticides.

Other Beneficial Insects and Microorganisms

In addition to pollinators, there are many beneficial insects and other arthropods that are either parasites or predators of pests. Unfortunately, controlling a target pest, often reduces populations of beneficial organisms.

Pesticides can alter populations of beneficial bacteria, fungi, and other microorganisms in the soil. Many of these microorganisms are important in the degradation of organic matter to basic nutrients used by plants and other organisms. Others are involved in the natural control of soil-borne pests. Any negative impact on beneficial soil microbes by a pesticide is undesirable. Fortunately, the effect on soil microbes from the use of soil-applied chemicals is usually minimal or short lived. As previously mentioned, there are instances where soil-applied pesticides have stimulated the selection of certain microorganisms.

The best way to avoid injury to beneficial insects and microorganisms is to make appropriate pesticide selections, follow pesticide application directions, and minimize pesticide usage. Selective pesticides should be used whenever possible and applied only when necessary as part of a total pest-management program.

Fish and Other Wildlife

Pesticides can be harmful to all kinds of vertebrates. Most recognizable are the direct effects from acute poisoning. Fish kills often are a direct result of water pollution by a pesticide. Pesticides can enter water via drift, surface runoff, soil erosion, leaching, and in some cases, deliberate or careless release of the pesticide directly into the water. Fish kills are most often caused by insecticide contamination of small ponds or streams with low water volume or turnover.

Bird kills from pesticides occur in many ways. Birds ingest the toxicant in granules, baits, or treated seed; they may be exposed directly to the spray; they may consume a treated food source; they may drink or use contaminated water; or they may feed on pesticide-contaminated prey. Animals often mistake granules or pellets for food. Pets, birds, and other wildlife are killed when baits are left unattended or improperly placed. Granule pesticides are particularly attractive to birds, since they are often mistaken for food.

The subtle and less recognizable effects of long-term pesticide exposure are a major concern. In general, most pesticides that have a very long residual in the environment are no longer available for pest control.

The following practices can minimize negative effects to wildlife caused by improper or unnecessary pesticide application:

- Use pesticides only when necessary. Select the least toxic and least persistent pesticide to do the job.
- Observe environmental precautions on a label.
- Treat only the area needed. Avoid aquatic areas whenever possible. Leave a buffer zone between bodies of water and the treated area.
- Avoid spraying trees that overhang streams or ponds.
- Exercise caution when placing baits or granules. Clean up any spilled granules or completely cover them with soil.

Be aware of the legal considerations when using pesticides. Very strict laws have been enacted to protect wildlife, especially endangered species.

Environmental damage can be avoided when pesticides are used carefully, wisely, and according to the instructions on the product label. When misused, all the benefits associated with pesticides are quickly outweighed by the risks they present and the harm they cause. Be especially sensitive to these concerns by doing your part to preserve our environment.

Review Questions

Select the correct answer or fill in the blank for each question Answers available in Chapter Review Answers.

1. The airborne movement of pesticide particles from a target area occurs only during application and is clearly visible when it occurs. (True or False)

2. Select the condition that could help reduce pesticide volatilization:
   A. High air temperatures
   B. Low relative humidity
   C. Incorporation
   D. Smaller droplets

3. Pesticide adsorption is greatest in coarse, sandy soil. (True or False)

4. Runoff is usually more likely from a water-saturated soil than from an unsaturated soil. (True or False)

5. Pesticide degradation processes can be beneficial because they reduce the amount of pesticide residue in the environment. (True or False)

6. The upper level of the water-saturated zone in the soil is called the
   A. Surface water
   B. Groundwater
   C. Aquifer level
   D. Water table

7. Pesticides can reach groundwater through
   A. Microbial activity
   B. Leaching
   C. Photodegradation
   D. Absorption

8. Pesticide properties have little if any effect on whether a chemical will reach groundwater. (True or False)

9. Pesticide-contaminated surface water can contaminate groundwater. (True or False)

10. To reduce the potential for groundwater contamination
    A. Do not dispose of leftover spray mix near wells or sinkholes.
    B. Prevent back-siphoning into water sources.
    C. Delay application of pesticides if a heavy rain is expected.
    D. Do all the above.

11. Minimize drift by taking precautionary measures (monitor weather, alter spray systems). (True or False)

12. Select the incorrect statement. To reduce the chances of bee poisoning from pesticides
    A. Select dust formulations whenever possible.
    B. Do not apply pesticides toxic to bees during bloom.
    C. Reduce drift during application.
    D. Do not treat areas near beehives.

13. Fish kills most commonly result from pollution of water by
    A. Herbicides
    B. Fungicides
    C. Insecticides
    D. Rodenticides

14. Drift problems can be reduced by
    A. Raising pressure and decreasing nozzle orifice size.
    B. Applying in very calm, stable air conditions.
    C. Spraying downwind of a sensitive area and leaving an untreated border.
    D. Spraying volatile spray mixtures during high temperature conditions.

15. Accidental or intentional environmental damage caused by a pesticide can result in financial losses to the responsible party. (True or False)

CHAPTER 9:
Pesticide Application Principles

Learning Objectives

- Learn the different methods of pesticide application and under which situation each is applicable.
- Learn what equipment is appropriate for pesticide application for both dry and liquid pesticide formulations.
- Understand the definitions of the words printed in *italics*.
- Be able to identify the various liquid pesticide sprayers and the characteristics of each.
- Be able to identify the various components of liquid spray equipment, their function, and their characteristics.
- Know the recommended management and operator practices for pesticide spray equipment operation (before, during, and after spraying operations).
- Understand the importance of proper sprayer calibration.
- Know what equipment is necessary to properly calibrate pesticide spray equipment.
- Know how to properly calculate basic sprayer calibration problems for various situations.

Management and Applicator Considerations

Successful pest management relies on the selection of the best pest-control strategy. Proper pest control requires planning for known probable pests due to weather, environmental conditions, or scouting (forecasting). When this strategy includes using pesticides, plan the proper methods, equipment, technology, formulation, and timing to derive the most benefit from your application.

Select a method of application that ensures proper placement of the pesticide so it can work upon the target pest with minimum effects to the environment. For example, if you have a soil-borne insect infestation, the pesticide should be placed in the soil where the insect lives.

Select the application equipment that delivers the pesticide to the target area. Equipment must be kept in good working order to ensure application accuracy. A substantial investment in equipment requires that the choice be based on a thorough familiarity with all alternatives.

Recent developments in application technology greatly improves the effectiveness of pesticide applications. Drift-reduction nozzles, precision application equipment, and computer-enhanced application are a few technology products that greatly enhance the effectiveness and lower the hazards of pesticide applications.

Calibration is essential for proper chemical pest control. Calibrate your equipment so it delivers the proper amount of pesticide to the target area. Calculate the amount of pesticide and carrier (if needed) that is specified on the pesticide label. Improper calibration or calculations lead to poor pest control by either applying too little or too much pesticide. These errors can be detrimental both economically and environmentally.

Time your pesticide application to control the pests at the time of year they are most vulnerable. This requires knowledge of the pest or pests that you wish to control. Know the life cycles and characteristics of the pests and apply chemical controls at the time they are the most susceptible.

Methods of Application

The particular application method chosen depends upon different factors that include the following:

- The nature and habits of the target pest
- The crop or plant
- The pesticide itself
- Available application equipment
- The relative cost and efficiency of alternative methods

One or more of the above factors often predetermines the method of application, although there is frequently a choice between methods. The principal objective with any chemical application is to effectively bring the pesticide into contact with the target organism(s).

There are many methods of chemical application. Common methods of application include the following:

- *Foliar application*. The spray solution is sprayed on the leaves alone or leaves and stems. Plants should not be under moisture or heat stress when treated because it greatly affects pesticide absorption. Take care to avoid drift to nearby sensitive vegetation with foliar applications.
- *Soil application* is the application of a pesticide directly to the soil rather than to a growing plant.
- *Broadcast treatment* is the uniform application of a pesticide to an entire field or area. It can be made either pre- or postemergence (before or after the crop, plant, or weed has emerged).

- *Band treatment* is the placement of a pesticide in a strip either over or along the crop row. It may be made pre-or postemergence.
- *Furrow treatment* is the placement of a pesticide in a strip directly over the seed at planting time.
- *Spot treatment* is the application of a pesticide to small, discrete areas.
- *Directed-spray treatment* directs a pesticide at target pests in an effort to minimize contact with other organisms, plant or animal.
- *Soil incorporation* is the use of tillage equipment to mix the pesticide with the soil.
- *Soil injection* is the placement of the pesticide beneath the soil surface.
- *Basal sprays* are directed at the lower 18 inches of the stems and trunks of brush and trees.
- *Cut-stump treatments* are made to the freshly cut stump surfaces.
- *Frill and hatchet injection* methods cut the bark around the trunk base and then herbicide is either applied as a separate step or injected simultaneously in the cambium area.
- *Chemigation* is the application of pesticides or fertilizers through an irrigation system by injecting the chemical into water flowing through the system (e.g., sprinkler, surface, or drip).

Application Equipment

Most pesticide application equipment can be used for several purposes. Selecting the equipment best suited for the type of work improves efficiencies and reduces costs. The appropriate choice depends on several factors, including the working conditions, pesticide formulation, type of area to be treated, and anticipating potential application challenges. While large power equipment may be desirable for some operations, smaller portable or hand equipment may be more practical for other situations. Most application equipment systems can be categorized into two main groups:

1. Dry pesticide formulation applicators
2. Liquid pesticide formulation applicators

Equipment for Dry Applications

Dusters blow fine particles of pesticide dusts onto the target surface. Often the package containing the pesticide dust—such as a plastic squeeze bottle or a telescoping tube with a spout—acts as the duster. Dusters are used mostly for individual spot treatment of plants or small areas. In some situations, dusts are still applied with large, powered models, including aerial application equipment.

Granule applicator equipment is designed to apply coarse, dry particles of uniform size to soil, water, and in some cases, foliage. Spreaders may work in different ways, including pneumatic whirling disks (seeders, fertilizer spreaders), multiple gravity feed outlets (lawn spreaders, grain drills), soil injectors (furrow treatments), and ram-air (aircraft).

Shaker cans and hand distribution of pellets or gridball formulations are techniques that also may be used on occasion. Although there are substantial variations in design, granule applicators normally consist of a hopper for the pesticide, a mechanical-type agitator at the base of the hopper to provide efficient and continuous feeding, and some type of metering device, usually a slit-type gate, to regulate the flow of the granules.

Equipment for Liquid Applications

More pesticides are applied with sprayers than with any other equipment; nearly 90% of all pesticides are formulated for spraying. There are many different types and sizes of sprayers, varying from hand-operated units to machines weighing several tons. Some apply diluted pesticide mixtures while others apply concentrates. Some use low-pressure and low-flow rate (low volume) and usually have simple *roller pumps*. Others are high pressure and/or high volume, usually supplied by high-pressure *piston pumps*. Some apply spray through single outlets or nozzles, while others use multiple nozzles linked by sections of pipe or tubing to form a boom. The principal types are discussed include the following, but there may be several variations or combinations of these types:

Hydraulic (liquid) *sprayers* use water to dilute the pesticide concentrate. The water acts as a carrier for the pesticide. Pesticides are mixed with sufficient water to obtain the desired application rate at a specified pressure and equipment travel speed. The spray solution is then pumped through the spraying system under pressure from either a pump or compressed gas and released on the target area through the nozzles. The exception is in Ultra-Low Volume (ULV) spraying, where the pesticide is applied directly as an undiluted formulation. In ULV spraying operations, the undiluted formulation is either sprayed through small nozzles at very high pressures or the formulation is metered onto a spinning disk or plate that shatters the liquid formulation into very small droplets and propels them toward the target at a high velocity.

Hydraulic sprayers are used for spot, band, and broadcast spraying. The sprayer may have one or several nozzles on a boom or in a cluster. The nozzles may be permanently mounted or handheld. 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 or knapsack (backpack) sprayer is often used.

Low-pressure hydraulic sprayers are normally designed to deliver low to moderate volumes at 15–80 pounds of pressure per square inch (psi). Low-pressure sprayers do not deliver sufficient volume to provide adequate coverage for some insecticides and fungicides. The spray cannot penetrate dense foliage because of low operating pressures. These are usually mounted on tractors, trucks, or trailers.

High-pressure hydraulic sprayers are designed to deliver large volumes at high pressure. They can deliver up to 50 gallons of spray per minute and operate at pressures up to 800 psi. Application rates of 200–600 gallons per acre are delivered by means of a boom or handgun. High-pressure sprayers provide thorough coverage and penetrate dense foliage; however, these sprayers produce large numbers of small spray droplets that are susceptible to drift. Proper maintenance provides a long-lived system, even with the use of more abrasive tank mixes, such as wettable powders. These sprayers can provide low- pressure flow when proper pressure regulators are used.

Small-capacity sprayers (hand or backpack sprayers) are well suited to treat individual plants, small areas, or hard-to-get-to areas. Hand sprayers use carbon dioxide or compressed air to force the spray liquid through the nozzles. These sprayers are available for use with single or multiple nozzle systems. The capacity of hand sprayers generally ranges from one-half to five gallons.

Air-blast sprayers use air and water to deliver pesticide to target surfaces. A high-performance fan (blower) creates an air blast that blows the pesticide away from the spraying nozzle. The rushing air shatters the liquid into tiny droplets that are carried to the target by the air blast. Air-blast sprayers provide good coverage and penetration, but produce a spray that is difficult to confine to target areas and may be subject to significant drift.

Mist blowers are special air-blast sprayers that use air velocities of 120–200 miles per hour. A fine spray is produced which allows for lower water volumes than standard air-blast sprayers. Low-volume mist blowers use a diluted pesticide mixture, but ULV mist blowers use undiluted concentrates. Low-volume and ULV sprays are more susceptible to drift and may provide less complete coverage as a result. Use them with caution.

Miscellaneous Equipment

- *Tree injectors*. These implements offer a precise way of introducing the pesticide into the trunks of well-developed brush or trees.
- *Wiper-type applicators*. Roller or rope-wick applicators apply pesticides at a set height, thus targeting the weeds that are taller than the crop or nontarget plants.
- *Recirculating sprayers*. The pesticide is directed at the target plants by a horizontal spray and the excess solution is collected in a catch basin or trough and returned to the tank.
- *Electrostatic sprayers*. The target and the spray droplets are electrically charged so they are attracted to each other.
- *Injection spraying systems*. The pesticide is injected after the pump, eliminating the need to premix a tank solution.

Sprayer Monitors

A number of spray monitors are available. Modern sprayer monitors are very accurate and aid in the detection of system errors or failure. Nozzle monitors sense the flow at each nozzle. System monitors sense the operating conditions of the total spraying system and warn the operator of any problems. Sensors and a microcomputer provide information, such as travel speed, pressure, line flow, application rates, acres, and gallons to empty. An audible and/or visual alarm alerts the applicator of any system problems.

Sprayer Components

Sprayers consist of components that, when working properly, deliver the pesticide to the target pest at the correct rate. Each of these components is essential for proper pesticide application. A malfunction of one of these components could result in the pesticide being misapplied. Applicators must frequently check the condition of the sprayer to ensure that all components are in good condition and are working properly.

Tanks

Sprayer tanks must be built to allow easy use and maintenance. They must be made of material that is resistant to corrosion from various pesticide formulations. Suitable tank materials include polyethylene, fiberglass, and stainless steel. Some pesticides cause corrosion on aluminum, galvanized, and steel tanks. Precautions for each type of tank materials are

- Polyethylene. Do not use with ammonium phosphate solutions and complete-analysis fertilizers. Ultraviolet light causes polyethylene to break down.
- Fiberglass. Some solvents may affect fiberglass.

Tanks hold the spray mix of the pesticide being applied. Regardless of material, they should be in good condition, free from leaks, weak spots, or corrosion. Additionally, tanks should have the following characteristics:

- Large openings for easy filling and cleaning.
- Filters or screens to allow straining during a filling operation.
- Hydraulic or mechanical agitation devices that completely agitate the contents of the tank mix.
- Large drain openings for easy draining.
- Active gauge to show the liquid level of the tank that is protected from breakage.
- Cut-off valve for storing liquid pesticide temporarily while other parts are being serviced.

Pumps

Sprayer pumps must have sufficient capacity to supply the needed volume to the nozzles and hydraulic agitator (if necessary). The pump must be sufficient to maintain the desired pressure. Pump parts should be resistant to corrosion and abrasion since many

formulations contain corrosive and abrasive materials. Select gaskets, plunger caps, and impellers resistant to the swelling and deterioration caused by many liquid pesticides. A wide range of options for pumps is available; consult a knowledgeable dealer for the best information.

Never operate a sprayer pump at speeds or pressures above those recommended by the manufacturer. Pumps will be damaged if run dry or have restricted inlets or outlets. Pumps depend upon the spray liquid for lubrication and removal of friction heat.

Pumps commonly used on pesticide sprayers are roller, centrifugal, piston, and diaphragm. Each has unique characteristics making it well adapted for a particular situation.

Agitators

An agitator is required to mix the components of the spray mixture uniformly and to keep the material in some formulations in suspension. If agitation is inadequate, the actual application rate of the pesticide may vary as the tank is emptied. The two common types of agitators are hydraulic and mechanical:

- Hydraulic agitators use either a return hose(s) directed from the main pump into the tank to agitate the contents or have a separate pump specifically designed to recirculate and agitate the tank contents. These agitators generally create less foaming in the tank because the return hoses are normally toward the bottom of the tank.
- Mechanical agitators are a series of circulating paddles inside the tank that agitate the contents. They are normally powered by the power takeoff (PTO) of the application equipment or may have a separate power source on a larger tank. Because the paddles will be exposed as the tank contents lower, mechanical agitators create more froth or foam in the tank.

Filters and Strainers

Proper filtering of the spray mixture protects the working parts of the spraying system. They also prevent misapplication due to nozzle tip clogging. As the mixture moves through the system, strainer openings should be progressively smaller. The number of openings per linear inch describes strainer mesh. Therefore, a high number indicates a small opening or finer mesh. Place strainers on the filler opening, on the suction or supply line to the pump, between the pressure relief valve and the boom, and on the nozzle body. Clean the strainers after each use and replace them if damaged or deteriorated.

Hoses

Many hoses are available that are made of a variety of materials. Choose one that is best suited to your application equipment and your application method. The characteristics of a good hose are

- Made of synthetic rubber or plastic
- Have a burst strength greater than peak operating pressures
- Weather, oil, and solvent resistant

Keep hoses from twisting or being rubbed. Rinse them often, both inside and outside, to prolong their life. Because UV light deteriorates plastics and rubbers, store them out of the sunlight. Replace any hose that shows any signs of deterioration.

Pressure Regulators

Pressure regulators control the pressure and, indirectly, the quantity of spray material delivered by the nozzles. It protects pump seals, hoses, and other sprayer parts from damage due to excessive pressure. Check pressure regulators periodically for proper operation. Replace them at the first sign of malfunction.

Pressure Gauges

Pressure gauges monitor the function of your spraying system. They must be accurate and have a range needed for your work. For example, a 0–100 psi gauge with 2 lb gradations are adequate for most low-pressure sprayers. Check frequently for accuracy. If the gauge does not zero properly or shows any other signs of malfunction, replace it immediately.

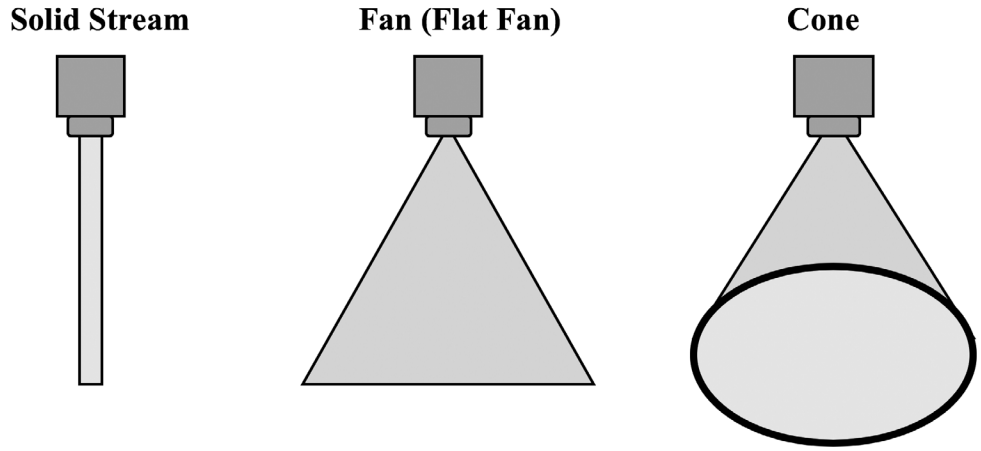
Control Valves

Locate quick-acting cutoff valves between the pressure regulator and the nozzles to provide positive on-off action. Cut-off valves should be in easy reach of the sprayer operator to stop all flow or flow in any section of the sprayer.

Nozzles

Nozzle tips break the liquid into droplets. They also distribute the spray in a predetermined pattern and are the principal elements controlling the rate of application. Nozzle performance depends upon

- Nozzle design or type
- Operating pressure
- Size of the opening (orifice size)
- Tip or orifice plate



They may also include a separate spinner plate. Successful spraying depends on the correct selection, assembly, and maintenance.

There are three basic types of nozzle patterns:

- Solid Stream
- Fan
- Cone

Some special purpose nozzle tips or devices produce special patterns. These include raindrops, flooding, and others that produce a wide-angle fan or cone-shaped patterns. Some special purpose nozzles are manufactured for a specific purpose, such as drift reduction or air-induction nozzles.

Nozzles are available in several materials. Tungsten carbide nozzles and ceramic nozzles are the most resistant to abrasion and corrosion. They are also the most expensive to purchase. Stainless steel nozzles have good corrosion resistance and resist abrasion, especially if they are "hardened stainless steel." These tips are normally less expensive than the tungsten carbide or ceramic nozzles. Plastic nozzles will not corrode, resist abrasion better than brass, and are moderately priced. They swell when exposed to organic solvents found in some formulations. Brass nozzles resist corrosion (except from fertilizers), but not abrasion. Aluminum nozzles are inexpensive and are resistant to some corrosive materials.

Proper operation and maintenance of spray equipment is essential for safe and effective pest control. Operating the equipment correctly and following a good maintenance program will significantly reduce repair costs and prolong the life of the sprayer.

Sprayer Operation and Maintenance

At the beginning of each spraying season, the sprayer thoroughly rinse the sprayer with clean water. All nozzles should be the same type, size, and fan angle. Color-coded nozzle caps and colored, plastic covered stainless steel nozzles are available to prevent errors due to mismatched or improper nozzles. They provide a reliable and quick way of ensuring that all nozzles on the sprayer are the same type and size. These caps are also designed to attach quickly and give proper nozzle alignment. Check valves prevent dripping when flow to the nozzles drops below a certain pressure. If your sprayer system uses check valves, make sure that the nozzles do not drip after the shutting off the flow to the boom.

Before Spraying

Check the spraying system for leaks in all critical areas. Also, check the nozzle height by measuring the distance between the nozzle tip and target and adjust the boom accordingly. Nozzle height is essential in broadcast applications because it affects the uniformity of the spray pattern.

Always make sure the tank is level when filling it so that the tank gauge registers correctly.

During Spraying

Frequently check the pressure gauge and tachometer while spraying to ensure that the sprayer is operating at the same pressure and speed as it was originally calibrated. Speed should be reasonable, so that sprayer booms are not bouncing or swaying excessively. Periodically check the hoses and fittings for leaks and check the nozzles for unusual patterns (signs of wear). If emergency repairs or adjustments are required in the field, be sure you wear adequate protective clothing, particularly rubber gloves. Use an old toothbrush to unclog nozzles. Never use metal wire or a knife tip to unclog a nozzle because it may distort the nozzle opening and change the spray pattern.

After Spraying

Always flush the spray system with water after each use. Clean the inside and outside of the sprayer thoroughly before switching to another pesticide and before doing any maintenance or repair work. Remember that all equipment and equipment parts exposed to a pesticide normally have some residue, including sprayer pumps, tanks, hoses, and boom ends. Pesticide residue on application equipment causes pesticide poisoning, particularly through the skin.

Cleaning Spray Equipment

The following are guidelines for cleaning spray equipment. Clean on a wash pad and the apply rinsate to labeled sites.

- Flush the sprayer tank, lines, and booms thoroughly with clean water and apply the pesticide-contaminated rinsate to labeled sites.
- Fill the sprayer to capacity with water, adding 1 cup of trisodium phosphate or household ammonia for each 10 gallons of water. If neither is available, use a strong detergent or soap. Phenoxy-type or growth-regulator herbicides, such as 2,4-D, are only removed with ammonia or manufacturer-recommended cleaning solutions.
- Wash the tank and pump parts thoroughly by running the sprayer for about five minutes with the nozzles closed.
- If possible, let the cleaning solution stand in the sprayer overnight. Take care with ammonia, as it corrodes aluminum sprayer parts.
- Discharge the liquid from the tank, spraying some through the nozzles.
- Drain the sprayer completely and remove nozzles, screens, and strainers.
- Scrub all accessible parts with a stiff bristle brush.
- Rinse the sprayer thoroughly with clean water and reassemble.

Sprayer Storage

Before storing at the end of the season, clean the sprayer thoroughly and add 1–5 gallons of lightweight emulsifiable oil (depending upon the size of the tank) to an equal volume of clean water. Flush the entire system with the oil/water mixture. As the mixture pumps out from the sprayer, the oil leaves a protective coating on the inside of the tank, pump, and plumbing.

All nozzles and screens should be removed, cleaned, and placed in a dry place to prevent corrosion. Cover the nozzle openings in the sprayer boom with tape to prevent dirt from entering. As an added precaution to protect pumps, pour 1 tablespoon of radiator rust-inhibitor antifreeze into the pump inlet. Turn the pump several revolutions to coat the internal surfaces.

Equipment Calibration

The effectiveness of any pesticide depends upon the proper application and placement of the chemical. The purpose of calibration is to ensure that chemical application equipment uniformly applies the correct amount of material over a given area. Although you may have the correct chemical mixture, it is still possible to apply the wrong amount. Too little pesticide results in uncontrolled pest problems and fosters pesticide resistance. Too much applied pesticide may result in pollution, may cause environmental and human health problems, and always results in monetary loss. Pesticide delivery rate changes with equipment wear, gauge error, nozzle error, wheel slippage, speedometer error, and friction loss.

Preapplication Considerations

Several decisions must be made before every pesticide application:

- The amount of product (amount per area) to control the pests.
- Determination and possible adjustment of the equipment's delivery rate (calibration).
- Determination of how much area a single tank covers.
- How much pesticide formulation to add to the spray tank or hopper.

The label, calibration, and calculations answer all these questions.

Application equipment suppliers often provide charts and tables to help the applicator determine equipment configurations and to obtain desired delivery rates. These sources of information will provide only an approximation of delivery rates. Charts and tables cannot account for equipment wear, inaccurate gauges, or inaccurate speed estimates. Consequently, more reliable determinations of equipment delivery rates are usually accomplished by calibrating the equipment.

Calibration Tools

To properly calibrate, you need a few basic tools. For any type of equipment you need, at a minimum, the following:

- A measuring container to measure the amount of liquid sprayed from each nozzle or dropped from the outlet.
- A stopwatch to accurately measure time.
- Measuring tape to measure distances or calculate the area.
- Flags or stakes for marking.
- A pocket calculator for calculations.

Additionally, always wear a pair of chemical-resistant rubber gloves while performing any adjustments to your sprayer, especially if it is not new.

Calibration is simply the determination of the equipment's delivery rate or the measure of the amount of pesticide delivered (applied) from the application equipment over a known area.

Granular Application Calibration

Calibration of granular application equipment requires you to measure the amount of granules spread over a known area. You must calibrate using the pesticide granule to be applied because each granule flows differently. You must recalibrate each time you switch the type of granular pesticide.

Variables that determine granular applicator output—Two variables that affect the amount of granules applied per unit area include the following:

1. The size of the gate opening. The rate that the granules flow out of the applicator depends upon the size of the gate opening. A larger opening allows for more granules to flow and thus a higher delivery rate at any given speed. Making changes to the size of the gate opening significantly increases or decreases the delivery rate.
2. Ground speed of the applicator. The speed at which the granular applicator travels is a key factor in determining the total output per unit area. When travel speed increases, less material is applied per unit area. When the speed reduces, more material applies per unit area. Making adjustments to the speed of travel can be used when small changes to the delivery rate are necessary.

The effects of each variable of delivery rates must be understood to properly calibrate your application equipment. If the equipment is hand powered, the challenge is to calibrate the *applicator*, given that the equipment provides a constant output. Making adjustments to the gate opening and/or the travel speed is a method for fine-tuning your application equipment to deliver the proper amount of pesticide. It may take multiple adjustments before calibrating the application equipment or applicator correctly.

Conduct the calibration test over a known area where the granules can be collected (tarped area, driveway) or use a collection device to collect the granules. The catch container must not interfere with the delivery of chemical. Calibration may be conducted using the following steps:

1. Measure a known area.
2. Make an application and weigh the amount of chemical "spread" over the measured area.

The application rate is the weight of material (or quantity) collected for the area covered.

Calibration Math Practice

Example 1

You wish to apply an herbicide to turf for weed control using a broadcast spreader. Measure a 400-square foot area on concrete (20 feet × 20 feet) and cover with a tarp. Add chemical to the spreader and spread it over the measured area. Collect the material from the tarp and determine that 12 ounces of chemical was delivered. The label bases applications on 1,000 square feet. (Use Conversion Table in Appendix C.)

What is the application rate in pounds per 1,000 square feet?

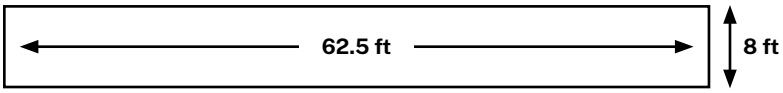
- Application rate is the amount applied per unit area, 12 ounces over 400 square feet.
- Convert 400 square feet to 1,000 square feet by dividing 1,000 by 400 (1,000 ÷ 400) to get the conversion. The 2.5 units of 400 are in 1,000; therefore, apply the conversion (2.5) to 12 ounces (12 × 2.5) to get the amount needed to cover 1,000 square feet (30 ounces).
- Convert the ounces to pounds. There are 16 ounces in a pound, so 30 ounces divided by 16 (30 ÷ 16) result in the amount in pounds per 1,000 square feet: **1.9 pounds/1,000 square feet**.

Example 2

You wish to apply a herbicide to turf for weed control using a broadcast spreader with an 8-foot application swath. You want to calibrate on the basis of 500 square feet.

What is the length of a single run going to be to make 500 square feet?

- Calibration distance = desired area ÷ swath width, so 500 ÷ 8 = 62.5 feet.
  62.5 feet × 8 feet = 500 square feet



  Your calibration determined the rate of application was 21 ounces per 500 square feet.

What is the application rate in pounds per 1,000 square feet?

- Convert 21 ounces per 500 square feet to ounces per 1,000 square feet. Divide 1,000 by 500 (1,000 ÷ 500) to get the conversion unit (2). Apply the conversion unit to the rate of application per 500 square feet (21 ounces × 2) to get the application amount for 1,000 square feet: 42 ounces needed to cover 1,000 square feet.
- Convert ounces to pounds: 42 ounces ÷ 16 ounces/pound = **2.6 pounds/1,000 square feet**.

Example 3

You are applying an insecticide from a chemical box on a seeder, using an 8-inch band (swath). A bag is placed under the drop tube to collect the granules. The planter is driven a total of 1,000 feet. One ounce of insecticide was collected in the bag.

What was the rate of application?

Determine application area in square feet: band width × area traveled. First convert the band width to feet (12 inches per foot): 8 inches divided by 12 inches/foot (8 ÷ 12) equals 0.67 feet. Application area of 0.67-foot band multiplied by 1,000 feet (0.67 × 1,000) equals 670 square feet. Therefore, the application rate is **1 ounce per 670 square feet**.

What is the application rate in pounds per acre?

- Convert 1 ounce to 1 pound (1 × 16) to get the conversion unit (16).
- Apply the conversion unit (16) to the area to get the amount of area covered for a 1-pound application (16 × 670 = 10,720 square feet/pound of granules).
- Convert the square feet/pound of granules (10,720) to acres by dividing the square feet per acre (43,560) by the square feet per pound of granules (10,720) to get the pounds of granules per acre: 43,560 ÷ 10,720 = 4.06 or **4.1 pounds per acre**.

Example 4

Another way to calculate granular applications is using time and known speed to determine the output of the spreader. In order to determine the application rate, find out the speed of the spreader, the output of the spreader over time, and the application width of the spreader.

You are applying a granular herbicide from your spreader that applies to a 60-foot boom width and operates at 7 miles per hour. The label directs you to apply 35 pounds of herbicides per acre.

At what output rate per minute must you adjust your spreader to apply at the label-directed rate?

- Determine the area applied per acre: Using the conversion sheet, you travel 88 feet every 1 mile per hour each minute, so 88 × 7 = 616 feet traveled in one minute. Your spreader applies to a 60-foot width so, 616 feet (distance traveled) × 60 feet (spreader boom width) = 36,960 square feet.
- Determine the conversion for rate: 43.560 (square feet per acre) ÷ 36,960 = 1.18.
- Determine the output rate of the spreader per minute:
  35 (pounds per acre) × 1.18 = **41.3 or 41 pounds, five (5) ounces output per minute**.

Changes in Application Conditions

Changes in application conditions change the amount of material the application equipment discharges. Therefore, repeat calibration for any changes in conditions or product. These include the following:

- Temperature
- Humidity
- Lot number of granules
- Different chemicals/formulations
- Different application speed
- Different agitation speed

Applicator delivery rates are easily adjusted if more or less pesticide is needed. For small changes, you may alter the speed of travel. For larger changes, you need to adjust the size of the opening to allow or restrict the amount of flow.

Sprayer Calibration

Proper sprayer function is essential for accurate sprayer calibration. The following procedures are recommended before calibration is performed:

- Be sure the sprayer nozzle tips are appropriate for the kind of spray application to be made.
- Thoroughly clean all nozzles, nozzle tips, and screens to ensure proper operations. Use a soft brush, not wire or any hard materials.
- Add water to the spray tank and visually check nozzle output during sprayer operations. Discard and replace nozzle tips that produce distorted or irregular spray patterns.
- If possible, check the spray volume delivery of all nozzles and replace nozzle tips whose delivery deviates more than 10% from the delivery rates indicated in the equipment catalogs.
- Check the sprayer pressure gauge for serviceability and accuracy. Replace the gauge if it is rusty or inaccurate. This is especially important if delivery rates are taken from spray charts or tables.

Variables That Determine Sprayer Output

Two variables essentially affect the amount of spray solution applied per acre:

1. The nozzle flow rate
2. The ground speed of the sprayer

Nozzle Flow Rate

Rates of flow through a nozzle varies with the pressure and the size of the nozzle tip. Raising the pressure or using a nozzle tip with a larger orifice (opening) increases the flow rate.

Increasing pressure does not proportionally increase the flow rate. For example, doubling the pressure does not double the flow rate; you must increase the pressure four-fold.

Comparison of output as a fuction of sprayer pressure.

Sprayer Pressure (Speed Constant)	Sprayer Output (gal/acre)
10 psi	10
40 psi	20
160 psi	40

Pressure cannot be used to make major changes in the spray rate, but it can be used to make minor changes. Keep in mind that operating pressures must be maintained within the recommended range for each nozzle type to obtain a uniform pattern and to minimize drift.

The easiest and most effective method to make a large change in the flow rate is to change the size of the nozzle tips. Small changes in nozzle size significantly changes the sprayer output or rate. The amount of change depends on the operating pressure, the sprayer speed, and the nozzle spacing. Nozzle manufacturer catalogs give information for the selection of proper tip size for any given application.

Ground Speed of the Sprayer

For most sprayers, delivery rate is inversely proportional to the ground speed of the sprayer. As the speed increases, the amount of spray applied per unit area decreases at an equivalent rate. If spray pressure remains constant, doubling the ground speed of a sprayer reduces the amount of spray by one-half. In contrast, spray pressure in wheel- driven sprayers varies with the speed of travel. In these types of sprayers, as the speed increases, the pressure increases and therefore the output also increases.

Comparison of output as a fuction of sprayer speed.

Sprayer Speed (Pressure Constant)	Sprayer Output (gal/acre)
1 mph	40.0
2 mph	20.0
3 mph	13.3
4 mph	10.0

When spraying, keep the travel speed within certain limits to keep the nozzle pressure within the recommended range.

Sprayer calibration is designed to determine the amount of spray the equipment delivers per unit area. Most labels direct the user to apply a specified amount of the pesticide per acre, but some label instructions include specifications for an amount of pesticide to be applied per 1,000 square feet or some other area measure.

Boom Sprayer Calibration

The following calibration method is only one of many used for boom sprayers. This "Spray an Acre" method is one of the most accurate. To apply this method, the applicator should do the following (use Conversion Table in Appendix C):

- Select a reasonable operating travel speed for the terrain and relative durability of the spray equipment (usually 3–5 mph). Record the tachometer or speedometer reading and the gear setting used to maintain the selected speed.
- Select and record the spray pressure at which the system will operate (check label and nozzle guides for guidelines). Adjust pressure to the desired psi while the pump operates at normal speed and water actually flows through the nozzles. It is good practice to operate at the lower end of a nozzle's pressure range to minimize drift potential.
- Measure the total boom swath width to the nearest whole foot by spraying on a dry, flat surface, such as a parking lot or road.
- Determine the spray distance necessary to cover an acre (43,560 square feet). Example: If the swath width is 20 feet wide, then 43,560 square feet/acre ÷ 20 feet = 2,178 feet. The sprayer must travel 2,178 feet to cover an acre.
- Using only water, fill the tank to a known level, mark that level, and mark the exact place on the ground where the sprayer is situated.
- With a running start, spray the measured distance.
- Return to the exact site where the tank was originally filled and measure that amount of water required to refill the tank to the original level. This normally involves the use of a pail of known capacity.
- The number of gallons necessary to refill the tank is the sprayer delivery rate in gallons per acre (GPA). If you applied 13.2 gallons to cover that acre, then your sprayer delivery rate is 13.2 GPA.

If you choose, alter this by making an application to any known area; but there is more room for error when using smaller areas.

Example Calibration Problem for Boom Sprayer

You make a calibration test over 100 feet. Your sprayer has a swath width of 60 feet. The sprayer delivered 2.4 gallons over that area.

What is the sprayer delivery rate per acre?

- Determine the area covered: 100 feet traveled multiplied by the swath width of the sprayer (60 feet) or 100 × 60 = 6,000 square feet.
- Determine how many 6,000 square feet units are in an acre. Divide the square feet per acre (43,560) by your area sprayed (6,000) to get the conversion unit, 43,560 ÷ 6,000 = 7.3 units.
- Use the conversion unit to determine gallons per acre. Multiply the conversion unit to the output of the sprayer (2.4 gallons) to get the output per acre, 7.3 × 2.4 gallons = **17.5 gallons per acre (GPA)**.

Sprayer calibration results are valid only for the speed, nozzles, pressure, and spray width (swath) used during the calibration. Changes in any of these factors require another calibration check. It is often necessary to calibrate numerous times per season as your sprayer setup or conditions change.

Compressed Air Sprayer Calibration

Most compressed air sprayers are small, hand-operated units carried by the operator. Application factors such as speed, spray width, and pressure are quite variable. In short, calibrating this kind of sprayer provides a rather rough estimate of sprayer GPA, but this is certainly preferable to no estimate at all.

The following is just one of the several possible methods used to calibrate hand-pressurized sprayers:

- Measure and mark a square area on a surface that will readily demonstrate the spray pattern width. A parking lot is an ideal location for this purpose.
- Using a clean, empty tank, add enough water to fill the tank to one-half. Mark the waterline on the tank.
- Pressurize the sprayer and spray the predetermined area that you marked. Maintain uniform operator walking speed, nozzle height, and tank pressurization.
- Depressurize the spray tank by opening the filler cap and determine the amount sprayed by adding water to the tank from a measured container up to the original fill line.
- Use the amount sprayed over the area to determine any number of conversions, such as GPA, ounces per 100 square feet, and ounces per 1,000 square feet, etc.
- If you mark your area 18’6” × 18’6” to do your calibration, the amount of ounces sprayed on this area roughly equals the gallons per acre of the sprayer.

These are only estimates for a hand-sprayer operation. Realize that when you are calibrating a hand sprayer, you are actually calibrating the operator of the spraying equipment more than the sprayer itself. If you use a tank mix of a given concentration, the most effective way to make small adjustments to the rate of application is to vary the speed of the application (speed the operator applies). Larger adjustments need a change in nozzle size.

Example Calibration Problem for Compressed Air Sprayer

With your 3-gallon compressed air sprayer, you measure out an area 10' × 50' (500 square feet). You perform a test spray of the area and find that you used 35 fluid ounces of water. (Use Conversion Table in Appendix C.)

What is the sprayer delivery rate based on 1,000 square feet?

- Determine the conversion unit for 1,000 square feet. Divide 1,000 by 500 (1,000 square feet ÷ 500 square feet actually sprayed) to get the conversion unit (2).
- Multiply the amount sprayed (35 fluid ounces) times the conversion unit to get the rate of application per 1,000 square feet: 35 × 2 = **70 fluid ounces per 1,000 square feet**.
- Convert the application rate if necessary.
  70 fluid ounces is equal to 2.2 quarts (70 ounces ÷ 32 ounces per quart) or
  2 quarts, 6 ounces (¾ cup) or
  4 pints, 6 ounces or
  8 ¾ cups
  0.546 gallon

Changing Sprayer Delivery Rate

Sprayer delivery rates are easily adjusted. If your sprayer delivers less than or more than enough spray to the desired area, change the rate by using one of the following three methods:

1. Change the pump pressure. Lower pressure means less spray delivered. This is usually not a good method because a change in pressure changes the nozzle pattern. To double output, you must increase pressure four-fold.
2. Change the speed of application. Slower speed means more spray is delivered and faster speed means less spray is delivered. Doubling the ground speed of the application reduces the sprayer delivery rate by one-half. Speed changes may be practical for small changes in the number of gallons, but not for large changes.
3. Change the nozzle orifice or nozzle size. The larger the hole in the nozzle tip, the more spray delivered. This is usually the preferred method when making any significant change to the sprayer output.

Application Considerations

There are many factors that an applicator must take into consideration before performing a pesticide application. Any one of these factors may contribute to poor pest control or improper application. It is vital that the applicator understands these considerations and takes the proper precautions to ensure a safe and effective pesticide application.

Many considerations have been previously discussed, such as the condition of application equipment, nozzles, operating pressure, speed, etc. The following are some additional considerations for all pesticide applicators:

Weather Conditions

Wind speed, inversions, humidity, precipitation, temperature, and other weather conditions often dictate whether an applicator may apply a pesticide or wait for more favorable conditions. Wind speed and inversions affect pesticide drift or off- target application. Humidity, precipitation, and temperature may affect how the pesticide application controls the target pests. The label often indicates any weather restrictions the pesticide may have. Under no circumstance should a pesticide be applied when the weather conditions are conducive to drift—it renders the application ineffective.

Application Timing

Certain pesticides must be applied within a specific time period to prevent damage to the crop, animal, site, or commodity. Many pesticides are effective against pests at certain stages in their life cycle. For example, certain herbicides are very effective against broadleaf weeds while they are in their seedling stage, but are almost ineffective once the plant reaches later stages of growth. Knowing when to apply the correct pesticide for the situation provides better control of the target pest. This requires not only knowledge of the pesticide, but also of the pest and its life cycle. Often the pesticide label has information specific to application timing that is essential for proper pest control.

Formulations

Certain formulations may not be used in some application equipment. For instance, wettable powders require constant agitation for the solids to be kept in suspension. Do not use these types of formulations in any application equipment that cannot provide agitation (such as a pressurized hand sprayer). The pesticide label indicates if there is any restriction on the type of application equipment.

Chemigation Applications

A pesticide cannot be used for chemigation (injecting a pesticide or fertilizer into an irrigation system) if the product label specifically states that chemigation is not allowed. The pesticide label states what type of irrigation systems through which the pesticide can be chemigated. Replace the irrigation system nozzles if there is excessive wear.

Special Restrictions

Certain pesticides have special restrictions that prohibit their use under specific conditions. These may include restrictions against applications near surface or groundwater areas, restrictions for use due to endangered species, or time of day restrictions to protect crop pollinators. Special restrictions are listed on the pesticide label and must be followed to ensure protection to water sources, wildlife, pollinators, or the environment.

Pesticide labels are very comprehensive documents. They contain valuable information needed for safe and effective pesticide application to crops, ornamental plants, turf, lawns, livestock, and other locations or commodities. If you need clarification of pesticide label directions or you need additional information, contact the pesticide manufacturer.

Mixing and Calculations

Proper calculations and mixing are imperative for safe, effective, and legal applications. Directions for mixing are given on the pesticide label and calculations are generally necessary to ensure proper rates. Mixing and calculations vary, depending on the type of pesticide used.

Pesticide Mixing Problems

The following mixing problems involve calculations to determine rate, tankloads per acre, or other necessary information needed for proper application. Similar problems appear on ISDA licensing examinations. It is necessary to convert common measurements to units or amounts that are required for each problem. The conversion table in Appendix C is of great help when calculating the conversions.

Example 1

You are working with a boom sprayer that has been calibrated to deliver 15 gallons of spray per acre at 20 psi with a travel speed of 5 mph. The spray tank holds 400 gallons. The pesticide label directs you to apply 3 pints of the product per acre.

- **How many acres does one tankload cover?**
  400 gallons ÷ 15 GPA = 26.7 acres per tankload
- **How many gallons of product should be added to each tankload for a proper application rate?**
  A tank covers 26.7 acres, thus apply 3 pints per acre, then
  26.7 × 3 = 80 pints per tankload. There are 8 pints in a gallon, so
  80 pints ÷ 8 pints/gallon = 10 gallons of product per tankload.

Example 2

Your boom sprayer is calibrated to deliver 12 gallons per acre (GPA) at 25 psi at 4 mph travel speed. The sprayer tank has a capacity of 800 gallons. The pesticide you want to apply directs you to apply a maximum of ½ ounce of the product per acre. The field you want to spray is 25 acres.

- **How much water should be added to the tank to cover 25 acres?**
  The sprayer delivers 12 GPA and you want to cover 25 acres, so
  12 GPA × 25 acres = 300 gallons.
- **How many ounces of product should you add to the water in the spray tank?**
  You are spraying 25 acres, so if you apply ½ ounce per acre, then
  25 acres × 0.5 ounces/acre = 12.5 ounces.

Example 3

The herbicide you want to use directs you to apply 8–12 liquid ounces of product per acre. The field you want to spray is 168 acres. The product is sold in 1-gallon containers only.

- **How many gallons of product must you purchase to cover the field at the minimum sprayer delivery rate?**
  The minimum rate for application is 8 ounces per acres for 168 acres, so
  168 acres × 8 ounces/acre = 1,344 ounces.
  There are 128 ounces in one gallon, so 1,344 ounces ÷ 128 ounces/gallon = 10.5 gallons.
  You must purchase 11 gallons of the product to cover the field.

Example 4

Because of the diversity of weeds infesting a 320-acre field, you have determined that two herbicides must be applied to achieve proper control. The label on herbicide "X" directs you to apply a maximum of ⅔ of an ounce (dry) per acre and the label on herbicide "Y" directs you to apply 1–1.5 pints of product per acre. Your sprayer is calibrated to deliver 8 gallons per acre and the spray tank capacity is 400 gallons.

- **How many acres will a tankload cover?**
  400 gallons ÷ 8 GPA = 50 acres.
- **How many pounds of herbicide "X" should be added per tankload?**
  You must apply ⅔ ounce/acre and your sprayer covers 50 acres/tankload, so
  ⅔ (.67) × 50 acres = 33.5 ounces. There are 16 dry ounces in a pound, so
  33.5 ounces ÷ 16 ounces/pound = 2.1 pounds.
- **How many gallons of herbicide "Y" should be added per tankload if you apply at the maximum rate?**
  Maximum rate = 1.5 pints per acre. One tankload covers 50 acres, so
  1.5 pints × 50 acres = 75 pints. There are 8 pints in a gallon, so
  75 pints ÷ 8 pints per/gallon = 9.4 gallons.

- **How many pounds of active ingredient are contained in a 20-pound bag of 20% wettable powder** (20% active ingredient and 80% other ingredients)?
  The decimal equivalent of 20% is 0.2, therefore 0.2 × 20 pounds = 4 pounds.

Ornamental Pesticide Mixing Problems

Example 1

You are to spray a turf area with a pesticide whose label directs you to apply 12 ounces of the liquid product per acre. The yard area to be sprayed is 50 feet wide and 120 feet long.

- **The area you are to spray represents what part of an acre** (acre = 43,560 square feet)?
  Determine the square feet in the yard. Multiply its width times its length to determine the total area: 50 feet wide × 120 feet long = 6,000 square feet.
  Divide the total square feet in the yard by the amount of square feet in an acre to get the acreage represented by the yard: 6,000 square feet ÷ 43,560 square feet = 0.14 acres.
- **Your sprayer is calibrated to deliver 30 GPA and the spray tank has a capacity of 50 gallons. To avoid leaving any spray mix in the tank when you finish, how many gallons of spray mix should you prepare to cover the yard?**
  The sprayer delivers 30 GPA and the yard is 0.14 acres. Multiply the amount of delivery per acre by the actual acreage to get the amount for the yard:
  30 GPA × 0.14 acres = 4.2 gallons.
- **How much pesticide (liquid product) is required to cover the yard?**
  The label directs 12 ounces/acre and the yard is 0.14 acres, so multiply the directed rate by the actual acreage of the yard to determine the amount needed for the yard:
  12 ounces/acre × 0.14 acres = 1.7 ounces for the yard.

Example 2

You are working with a 5-gallon capacity backpack (hand-pressurized sprayer) and have calibrated the sprayer to deliver 40 gallons per acre. You must apply an insecticide whose label directs you to apply 1 pint of the product per acre. The area you must spray is approximately ¼ acre.

- **How much of an acre will a tankload of spray mix cover?**
  The sprayer holds 5 gallons and delivers 40 GPA. Divide the capacity of the sprayer (5 gallons) by the delivery rate (40 GPA) to determine the amount sprayed by one tankload: 5 gallons ÷ 40 GPA = 0.125 acres sprayed with one tank.
- **How many tankloads is needed to cover the area you need to spray?**
  The area to be sprayed is ¼ acre or 0.25 acres. Divide the area (0.25) by the amount sprayed by one tankload (0.125) to determine the number of tanks needed to spray the area: 0.25 acres ÷ 0.125 acres sprayed by one tank = 2 tankloads.

- **How much of the product should you add to each tankload to apply the label-directed rate?**
  Each tank covers 0.125 acres and you apply a total of 1 pint (16 ounces) of product per acre. Multiply the number of ounces per acre (16) times the amount covered by each tank (0.125) to determine the amount in ounces needed for each tankload:
  16 ounces/acre × 0.125 acres = 2 ounces per tankload.

Example 3

You must apply a fungicide to a lawn. The product label directs an application of 2 ounces of product per 1,000 square feet in sufficient water to provide good coverage.

- **You calibrated your backpack sprayer and determined that it delivers 60 GPA. How many gallons deliver per 1,000 square feet?**
  Determine the conversion unit for 1,000 square feet. Divide 1,000 square feet by the square feet in an acre (43,560) to get the conversion unit (1,000 ÷ 43,560 = 0.02). Determine the amount sprayed on 1,000 square feet. Multiply the conversion unit (0.02) times the sprayer delivery rate (60 GPA) to determine the amount sprayed on 1,000square feet: 0.02 × 60 = 1.2 gallons/1,000 square feet.
- **How much product should be added to each tankload, according to the label-directed rate?**
  Determine the area sprayed with one tankload. Divide the capacity of the sprayer (5 gallons) by the amount of spray mix needed to cover 1000 square feet (1.2 gallons) to get the area covered by one tankload:
  5 gallons ÷ 1.2 gallons/1,000 square feet = 4,167 square feet per tankload. Determine the amount of product needed per tankload. Divide the area covered by one tankload by 1,000 square feet to get the conversion unit: 4,167 ÷ 1,000 = 4.17.
  Multiply the conversion unit by the amount of product per 1,000 square feet (2 ounces) to determine the amount needed for one tankload:
  4.17 × 2 ounces/1,000 square feet = 8.33 ounces per tankload.
- **How many pounds of active ingredient are contained in a 5-gallon jug of 16% emulsifiable concentrate with 2 pounds of active ingredient (a.i.) per gallon?**
  Liquid formulation has 2 pounds a.i. per gallon; you have 5 gallons of product. Multiply the gallons times the amount of a.i. per gallon to determine the amount of a.i. per container:
  5 gallons × 2 pounds/gallon a.i. = 10 pounds of a.i. per container.

Review Questions

Select the correct answer or fill in the blank for each question. Answers available in Chapter Review Answers.

1. Foliar applications are applications in which spray solutions are injected into the ground and then translocated to the foliage. (True or False)

2. Directed-spray treatments are treatments that
   A. Spray solutions horizontally rather than vertically.
   B. Spray solutions from multiple nozzles to achieve greater coverage.
   C. Spray solutions to obtain the best coverage of both the target organism and the protected plant or animal.
   D. Spray solutions to maximize the coverage of the target organism and minimize coverage to the protected plant or animal.

3. Cut-stump treatments refer to
   A. Treatments made to old tree stumps.
   B. Treatments made to freshly cut tree stumps.
   C. Treatments made to trees before they are cut.
   D. None of the above.

4. Band treatments usually require less actual pesticide applied per acre when compared to broadcast treatments. (True or False)

5. Chemigation is the application of fertilizer or pesticide through
   A. Sprinkler irrigation systems.
   B. Surface or gravity irrigation systems.
   C. Irrigation systems through which the water is supplied via a well.
   D. A and B above.
   E. All of the above.

6. Which application is well suited for a low-pressure hydraulic sprayer?
   A. Early season weed control in a row crop field.
   B. Summer insecticide application in an orchard.

7. Which application is well-suited for a high-pressure hydraulic sprayer?
   A. Midseason weed control on turf.
   B. Spot insecticide application on shade trees.

8. Which application is well suited for an air-blast sprayer?
   A. Fungicide sprays to a fruit orchard.
   B. Insecticide sprays to a late-season corn field.

9. It is always a good idea to operate a pump dry for a few minutes to completely drain any liquid out of the sprayer system. (True or False)

10. Choose the **incorrect** statement:
    A. Tungsten carbide and ceramic nozzles are the most resistant to abrasion and corrosion.
    B. Plastic nozzles work well with all solvents.
    C. Brass nozzles should not be used with fertilizers.
    D. Aluminum nozzles are usually the least expensive of all nozzle materials.

11. You are making a broadcast application of a granular pesticide on turf. You perform a test run of your equipment over an area of 20’ x 50’ and find that you spread 3 pounds of the pesticide. What is the application rate per acre of the pesticide?
    A. 13 pounds per acre
    B. 43.56 pounds per acre
    C. 131 pounds per acre
    D. 234 pounds per acre

12. You are making an application of herbicide to a row crop field. Your sprayer’s output is 22 GPA and your spray tank holds 450 gallons. Your pesticide rate is 2 quarts per acre. How much pesticide must be added to each tank for proper application?
    A. 10 gallons, 1 quart
    B. 20 gallons, 2 quarts
    C. 40 gallons, 3 quarts
    D. 45 gallons, 2 quarts

POST-TEST

This exam is offered as a means of assessing your progress and to provide an example of the kinds of questions you will encounter on the Laws and Safety and Private Applicator Exams, administered by the ISDA. To pass the actual ISDA examination, answer at least 70% of all questions correctly. Passing this post-test does not mean that you will pass the state certification. If you do well on this test, you should do equally well on the state certification.

One of the most important skills that you will be tested on in the certification exam is your ability to understand pesticide labels. Consequently, some of this practice exam is based on labels for fictitious chemicals: CARBOM 4L, CAVERN 68 and Radiant 40F (Appendix A). Note: These labels are not fictitious—they are for educational purposes only.

Read all the questions carefully and also the answers. Choose the correct answer. It is advisable to read labels before answering the label questions. See Pre- and Post-Test Answers to score.

1. The most common way for pesticides to enter your body is
   A. Respiratory inhalation
   B. Oral ingestion
   C. Absorption through the eyes
   D. Dermal absorption

2. When using an emulsifiable concentrate formulation, what do you need to remember?
   A. This formulation may have a high phytotoxicity hazard.
   B. It may be relatively expensive for the small amount of active ingredient.
   C. It needs constant agitation during application.
   D. The dust is hazardous if inhaled.

3. Which one of the following is not registered as a pesticide under Idaho Pesticide and Chemigation Law?
   A. Drift retardants
   B. Plant growth regulator
   C. Nematicides
   D. Ammonium nitrate fertilizer

4. Which one of the following is not a prohibited act as defined by Idaho State Pesticide Law?
   A. Use of pesticide inconsistent with the label.
   B. Misleading statements as to pesticide effectiveness.
   C. Applying a pesticide at the recommended rate.
   D. Making misleading statements to investigators.

5. Select the correct statement concerning RUPs:
   A. They are used only on animals and humans.
   B. They are more expensive to use.
   C. They can only be used by a certified applicator.
   D. They are restricted for use only on insects.

6. Which one of the following does not have to be on the application records for professional applicators?
   A. Location of the application
   B. Relative humidity
   C. Wind speed
   D. Month, year, and day of the application

7. Organophosphate and carbamate insecticides have the most direct effect on what major body system?
   A. Circulatory system
   B. Respiratory system
   C. Reproductive system
   D. Nervous system

8. Which one of the following pesticide characteristics contributes to an increased potential for groundwater contamination?
   A. High solubility
   B. High adsorption to soil colloids
   C. Relatively quick degradation properties
   D. High volatility

9. If you have a pesticide spill at your mix and load site that doesn't pose a threat to the environment or humans, you should
   A. Call the Department of Emergency Management hotline.
   B. Call the local police.
   C. Control, confine, and clean up the spill.
   D. Wash the spill with plenty of water.

10. Preharvest intervals stated on a pesticide label are designed to
    A. Protect produce from residues over tolerances.
    B. Protect workers from exposure.
    C. Prevent drift damage.
    D. Prevent environmental damage.

11. For which of the following pesticides can 2-PAM be used as an antidote?
    A. Organophosphates
    B. Carbamate insecticides
    C. Organic chlorine insecticides
    D. Growth-regulator herbicides

12. If the product you choose to use has an Endangered Species Restriction listed, you should
    A. Not worry about it, since no specific restriction is stated on the label.
    B. Obtain the necessary information to determine what the restriction entails.
    C. Apply early in the morning, to avoid contact with the threatened species.
    D. Call the Department of Wildlife for a permit.

13. You are storing a pesticide. Select the correct statement.
    A. Store pesticides in a warm, dry place such as a well house.
    B. Store pesticides in an open area for ventilation.
    C. Store pesticide pesticides with your PPE.
    D. Store pesticides in original container.

14. Which of the following conditions contributes most to pesticide spray drift?
    A. Large orifice, low pressure
    B. Large orifice, high pressure
    C. Small orifice, high pressure
    D. Small orifice, low pressure

*Questions **15–22** are based on the fictitious pesticide label, CARBOM 4L (Appendix A). Read the label first. Read all questions carefully and completely before answering them.*

15. For CARBOM 4L, Carbaryl is known as the
    A. Brand name C. Common name
    B. Product name D. Chemical name

16. What is the toxicity category of the CARBOM 4L product?
    A. Highly Toxic
    B. Moderately Toxic
    C. Slightly Toxic
    D. Practically Nontoxic

17. Which of the following beneficial organisms is the most at risk when apply CARBOM 4L?
    A. Worms
    B. Bees
    C. Fish
    D. Dogs

18. The best way to dispose of the excess CARBOM 4L is to
    A. Take it to your local landfill.
    B. Take it to a hazardous waste disposal facility.
    C. Bury it on your own property.
    D. Use the product consistent with the label.

19. CARBOM 4L can legally be used on tomatoes to control which of the following insects?
    A. Aphids
    B. Wasps
    C. Japanese beetles
    D. Applications onto tomatoes for any of the above insects are illegal

20. Determining the hazard involved in using CARBOM 4L is dependent upon its toxicity and your exposure to the product. (True or False)

21. Which of the following are symptoms of severe CARBOM 4L poisoning in a child?
    A. Headache
    B. Skin rash
    C. Blisters on the skin
    D. Convulsions

22. You have treated your field corn with CARBOM 4L. How long must you wait before entering the field without protective clothing?
    A. When the spray dries
    B. 12 hours
    C. 24 hours
    D. There is no REI requirement for CARBOM 4L

*Questions **23–35** are based on the fictitious pesticide label, CAVERN 68 (Appendix A).*

23. How soon can agricultural workers enter the field without protective clothing after a CAVERN 68 application?
    A. No earlier than 48 hours after application.
    B. No earlier than 7 days after application.
    C. When the dust has settled.
    D. When the spray has dried.

24. Other than acute toxicity, CAVERN 68 poses a hazard from
    A. Volatility
    B. Photodecomposition
    C. Secondary damage
    D. Buffering

25. When applying CAVERN 68, how many gallons of spray mix should you apply for aerial applications?
    A. At least 2 gallons per acre
    B. At least 5 gallons per acre
    C. At least 10 gallons per acre
    D. At least 15 gallons per acre

26. You work for an agricultural spray company and a customer has 20 acres of growing mint that has several weeds listed on the CAVERN 68 label. If you used CAVERN 68 to control these weeds, the application is
    A. Legal.
    B. Illegal.
    C. Legal, if you obtained approval from the manufacturer for that specific use.
    D. Legal if you obtained approval from the dealer for that specific use.

27. When using CAVERN 68 for weed control in fallow land and crop stubble, how long must you wait until you can plant any crop?
    A. 3 months
    B. 6 months
    C. 8 months
    D. 10 months

28. The CAVERN 68 formulation
    A. Is a liquid formulation.
    B. Contains clay particles and emulsifier.
    C. Contains petroleum solvents and an emulsifier.
    D. Causes abrasion damage to equipment.

29. If you swallowed CAVERN 68,
    A. Induce vomiting.
    B. Immediately administer atropine pills.
    C. Drink two glasses of milk.
    D. A and C above.

30. CAVERN 68 cannot be applied by
    A. Chemigation
    B. Broadcast application
    C. Spot application
    D. Band application

31. When applying CAVERN 68 for weed control on orchard floors, how long must you wait before you can irrigate after the application?
    A. Immediately after application
    B. 1 day
    C. 2 days
    D. 3 days

32. You have a damaging aphid problem and potential weed problem in your wheat field.
    A. You wouldn't want to apply CAVERN 68 in that situation.
    B. You could tank mix CAVERN 68 with your insecticide after jar testing the mixture.
    C. CAVERN 68 is effective against aphids in that situation.
    D. Apply CAVERN 68 at a low rate of 1 pint per acre.

33. CAVERN 68 is a federally restricted-use pesticide and can be purchased only by certified applicators. (True or False)

34. Aerial application of CAVERN 68 is
    A. Prohibited by the label.
    B. The preferred method of application.
    C. Allowed.
    D. Not recommended by the label.

35. How many pounds of active ingredient are in a quart of CAVERN 68?
    A. 6.4
    B. 0.4
    C. 1.2
    D. 0.1

36. You are applying a pesticide to a row crop field. Your sprayer output is 15 GPA at 5 mph. If you want to double your output, what must you do?
    A. Increase the pressure to the nozzles to twice the normal operating pressure.
    B. Increase the speed of travel to 8 mph.
    C. Decrease the speed of travel to 2.5 mph.
    D. None of the above.

37. In general, high-pressure hydraulic sprayers provide better coverage in thick foliage. (True or False)

38. Because of the low amounts of material sprayed, ultra-low volume (ULV) sprayers have no problems with drift. (True or False)

39. You need to spray your field for insects. Sweet clover grows along the borders of your field and attracts a significant number of bees. The insecticide you have is highly toxic to bees. Before you spray, what actions should you take?
    A. No action, since you will not be spraying the sweet clover.
    B. Spray during midday so that the pesticide can dry faster.
    C. Contact the beekeeper and inform him when you will spray.
    D. Mow the sweet clover, wait unit the bees have left the area, and then spray.
    E. None of the above.
    F. C and D above.

*Questions **40–44** are based on the fictitious pesticide label, Radiant 40F (Appendix A).*

40. When you add Radiant 40F to your tank,
    A. Fill the tank with water and then add Radiant 40F under agitation.
    B. Fill the tank half full with water, add Radiant 40F, and then fill the tank with water.
    C. Slowly add Radiant 40F to the tank while it is being filled under agitation.
    D. Add Radiant 40F to the tank and slowly fill with water.

41. You need to control Swiss needlecast in your Christmas tree orchard and used Radiant 40F as the fungicide. How long must you wait until workers can enter the orchard without protective clothing?
    A. When the sprays dry.
    B. 12 hours.
    C. 24 hours.
    D. 48 hours.

42. You apply Radiant 40F to control brown patch and dollar spot in your golf course fairways. What is the recommended output for your sprayer?
    A. 15–20 gallons per acre
    B. 20–30 gallons per acre
    C. 30–40 gallons per acre
    D. 40–50 gallons per acre

43. You also want to protect your golf course tees from dollar spot and currently your sprayer is set at an output of 50 gallons per acre. What adjustments do you need to make to your sprayer to spray at the required tank- mix volume when using Radiant 40F?
    A. Raise the tank mix output of the sprayer to at least 90 gallons per acre.
    B. Lower the tank mix output of the sprayer to 20–30 gallons per acre.
    C. No change is needed.
    D. You cannot spray tees with Radiant 40F.

44. In addition to the minimum amount of protective clothing applicators must wear, what additional PPE must applicators wear when applying Radiant 40F?
    A. Protective headgear (hat) and waterproof gloves.
    B. Waterproof gloves and protective eyewear.
    C. Waterproof gloves and a respirator with an organic-vapor-removing cartridge.
    D. No additional PPE is required.

PRE-AND POST-TEST ANSWERS

The following are the answers to the pretest and post-test for this manual. Knowing the answers to the questions presented in these tests do not guarantee a passing grade on the actual Private Applicators or Law and Safety Examinations, but are of great assistance because the subject emphasis and question types are similar. If you miss questions on these examinations, re-review the manual and revisit the information for those questions.

Pretest Answers

1. True
2. D
3. D
4. C
5. False
6. Incompatible
7. False
8. C
9. False
10. False
11. B
12. True
13. True
14. False
15. False

Post-Test Answers

1. D
2. A
3. D
4. C
5. C
6. B
7. D
8. A
9. C
10. A
11. A
12. B
13. D
14. C
15. C
16. C
17. B
18. D
19. D
20. True
21. D
22. B
23. A
24. C
25. A
26. B
27. A
28. A
29. D
30. A
31. D
32. B
33. True
34. C
35. C
36. C
37. True
38. False
39. F
40. C
41. D
42. C
43. A
44. B

CHAPTER REVIEW ANSWERS

The following are the answers to section review questions for this manual. If you miss questions on these examinations, re-review the manual and revisit the information for those questions.

Chapter 1

1. True
2. True
3. C
4. D
5. False
6. D
7. False
8. B
9. A
10. C
11. C
12. C
13. False
14. True
15. C
16. B

Chapter 2

1. E
2. E
3. B
4. D
5. A
6. E
7. A
8. D
9. A

Chapter 3

1. B
2. False
3. False
4. D
5. D
6. False
7. D
8. C
9. D
10. False
11. Less
12. B
13. True
14. A

Chapter 4

1. Active
2. True
3. D
4. D
5. True
6. A
7. D
8. False
9. True
10. False
11. D
12. Incompatible
13. False
14. Adjuvant
15. False
16. D
17. False
18. False

Chapter 5

1. D
2. True
3. False
4. False
5. C
6. False
7. True
8. A
9. False
10. True
11. True
12. C
13. C
14. D
15. D
16. False

Chapter 6

1. False
2. False
3. False
4. A
5. D
6. B
7. D
8. True
9. B
10. B
11. True
12. D
13. False
14. True
15. False

Chapter 7

1. D
2. False
3. C
4. False
5. True
6. D
7. D
8. C
9. B
10. B
11. C
12. C
13. True
14. D
15. B

Chapter 8

1. False
2. C
3. False
4. True
5. True
6. D
7. B
8. False
9. True
10. D
11. True
12. A
13. C
14. C
15. True

Chapter 9

1. False
2. D
3. B
4. True
5. E
6. A
7. B
8. A
9. False
10. B
11. C
12. A

GLOSSARY

absorption. The movement of a chemical into plants, animals (including humans), microorganisms, or soil.

acaricide. A pesticide used to control mites and ticks. A miticide is a type of acaricide.

activated charcoal. Charcoal, which, when finely ground, adsorbs liquids and gases.

activator. An adjuvant added to a pesticide to increase its toxicity.

active ingredient. The chemical or chemicals in a product responsible for pesticidal activity.

acute toxicity. The capacity of a pesticide to cause injury from a single exposure. LD50 and LC50 are common indicators of the degree of acute toxicity.

adherence. The property of a substance to stick (adhere) to a given surface.

adjuvant. A substance added to a pesticide to improve its effectiveness or safety; also called an additive. Examples: Penetrants, spreader stickers, and wetting agents.

adsorption. The process by which chemicals are held or bound to a surface by physical or chemical attraction. Clay and high organic soils tend to adsorb pesticides.

adulterated pesticide. A pesticide that does not conform to the professed standard or quality documented on its label or labeling.

aerosol. A pesticide that is contained under pressure and sprayed in very fine to extremely fine droplets. This is intended to keep the pesticide suspended in the air. Mainly used for flying insect control.

agitation. The process of stirring or mixing products in a sprayer.

air-blast sprayer. A specialized liquid sprayer that uses air to create very fine, high-velocity spray droplets directed toward the target. Often used in orchards and vineyards.

air-purifying respirator. A respirator that removes harmful materials and/or vapors through a filter or series of filters prior to breathing. Negative pressure respirators rely on the user's lungs to pull air through the filters. Positive pressure respirators use a blower to force air through filters prior to breathing.

algae. Simple aquatic plants that contain chlorophyll and are photosynthetic.

algaecide (algicide). A pesticide used to kill or inhibit algae.

annual. A plant that completes its life cycle in one year.

antagonism. The reduction of pesticide activity when two or more different pesticides are mixed together.

antibiotic. A chemical produced by a microorganism that is toxic to other microorganisms. Examples: streptomycin, cycloheximide, and penicillin.

anticoagulant. A chemical that prevents normal blood clotting; the active ingredient in some rodenticides.

antidote. A practical treatment used to counteract the effects of pesticide poisoning or some other poison in the body.

antifoaming agents. Adjuvant that is added to a tank mix to prevent the spray mix from foaming in the tank.

antisiphoning device. An attachment designed to prevent backflow of a pesticide mix from a spray tank into a water source.

antitranspirant. A chemical applied to a plant to reduce its rate of transpiration or water loss.

arachnid. A wingless arthropod with two body regions and four pairs of jointed legs. Spiders, ticks, and mites are arachnids.

arthropod. An invertebrate animal characterized by a jointed body and limbs and usually a hard body covering that is molted at intervals. Insects, mites, and crayfish are arthropods.

atropine (atropine sulfate). An antidote used to treat organophosphate and carbamate poisoning.

attractant. A substance or device used to lure insects or other pests to a trap or poison bait.

avicide. A chemical used to kill or repel birds.

bacteria. Microscopic organisms, some of which are capable of producing diseases in plants and animals.

bactericide. A chemical used to control bacteria.

bait. A food or other substance used to attract a pest to a pesticide or to a trap where it will be destroyed.

band application. Application of a pesticide or other material in or beside a crop row rather than over the entire field area.

basal application. Application to plant stems or trunks at or just above the ground line.

beneficial insect. An insect that is useful or helpful to humans. Examples are pollinators and parasites/predators of pests.

biennial. A plant that completes its life cycle within two years.

biological control. Controlling pests using predators, parasites, and disease-causing organisms. May be naturally occurring or introduced into the pest environment. See also **chemical control; cultural control; legal control; mechanical control; natural control;** and **physical control.**

biomagnification. The process whereby some organisms accumulate chemical residues in higher concentrations than concentrations found in the organisms they consume.

botanical pesticide. A pesticide produced from chemicals found in plants. Examples are nicotine, pyrethrum, and strychnine.

brand name. The registered or trade name, number, or designation of a specific pesticide product or device by the manufacturer or formulator. Also called the product name. For example: Roundup is Monsanto's brand name or product name for glyphosate.

broadcast application. The uniform application of a pesticide or other material over an entire field or area.

broadleaf plants. Plants with broad, rounded, or flattened leaves with netted veins (for example, dandelion and rose). Broadleaf plants have branching leaf veins; different from the narrow blade-like leaves with parallel veins of grasses, sedges, rushes, and onions.

broad-spectrum pesticide. A pesticide that is effective against a wide range of pests. Usually refers to insecticides and fungicides.

buffers. Adjuvants used to slow down the chemical degradation of some pesticides by lowering the pH of alkaline water.

calibrate/calibration. To properly adjust equipment to determine the amount of material applied to the target area.

carbamates. A group of pesticides commonly used to control insects and mites. They are cholinesterase inhibitors. Carbamate chemistry also includes fungicides and some herbicides.

carcinogenic. The ability of a substance or agent to induce malignant tumors (cancer).

carrier. An inert liquid, solid, or gas added to an active ingredient to make a pesticide formulation. A carrier is also the material, usually water or oil, used to dilute the formulated product for application.

causal organism. The organism that produces a given disease. See **pathogen**.

caution. The signal word assigned to pesticide products that are classified as slightly toxic: The oral LD50 is greater than 500 ppm/kg.

certified (applicator). An applicator who has obtained the necessary training, certifications, or licenses required by state and/or federal law to apply pesticide products.

chemical control. The use of naturally derived or synthetically manufactured chemicals called pesticides to kill, attract, repel, or otherwise control the growth of pest plants, animals, and microorganisms. See also **biological control**; **cultural control**; **legal control**; **mechanical control**; **natural control**; and **physical control**.

chemical name. The technical name of the active ingredient(s) found in a formulated product. This complex name is derived from the chemical structure of the active ingredient.

chemigation. The application of fertilizers or pesticides to soil or plants by inclusion in an irrigation system.

chemosterilant. A chemical compound used to sterilize insects or vertebrate pests.

ChemTrec. Chemical Transportation Emergency Center, a service of the American Chemistry Council. Toll-free number for members to provide 24-hour information for chemical emergencies such as a spill, leak, fire, or accident. https://www.chemtrec.com/.

chlorinated hydrocarbon. The first synthetic insecticide developed, also called organochlorines. Contains chlorine, carbon, and hydrogen in its molecular structure. Many are persistent in the environment. Examples: chlordane, DDT, methoxychlor.

chlorosis. The yellowing of a plant's normally green tissue.

cholinesterase. A chemical catalyst (enzyme) found in humans and many other animals that regulates the activity of nerve impulses.

chronic toxicity. The ability of a material to cause injury from repeated, prolonged exposure to small amounts. See also **acute toxicity**.

common name. A name given to a pesticide active ingredient by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of brand names, but an active ingredient has only one recognized common name. For example, the common name for Roundup is glyphosate.

compatibility agents. Adjuvants used to enhance the mixing of two or more different pesticide products and/or fertilizers.

compatible. Chemicals that can be mixed without reducing the effectiveness of any of the individual chemicals.

concentration. The amount of active ingredient in a given volume or weight of formulated product.

consultant, statewide pesticide. Persons who may consult on and recommend agricultural pesticide products (including brand names) within the state.

contact pesticide. A pesticide that kills primarily by contact with a pest with little or no translocation (movement within the pest). Contact insecticides do not need to be ingested to be toxic to the insect. See also **systemic pesticide**.

contamination. The presence of an unwanted substance in or on a plant, animal, soil, water, air, or structure. See also **residue**.

corrosive poison. A substance containing a strong acid or base that severely burns the skin, mouth, stomach, or respiratory tract.

crack-and-crevice application. Small amounts of pesticide placed into cracks and crevices in buildings, such as along baseboards and in cabinets.

crop oil concentrate. Plant-based oils that increase the activity of some pesticides.

cultural control. Routine management practices that disrupt a pest life cycle. Includes crop rotation, tilling, destroying crop residues, pruning, thinning, and fertilization. See also **biological control**; **cultural control**; **legal control**; **mechanical control**; **natural control**; and **physical control**.

curative pesticide. A pesticide (fungicide) that inhibits or kills a disease-causing organism after it is established in a plant or animal.

cut-stump treatment. Application of herbicides to freshly cut stump surfaces to inhibit or stop new growth from the stump.

danger. The signal word associated with pesticide products classified as highly toxic by at least one route of entry.

danger–poison. The signal rod associated with pesticide products classified as highly toxic, corrosive, or highly irritating to skin and eyes.

days to harvest. The minimum number of days permitted by law between the last pesticide application and the harvest date. Same as **preharvest interval**.

days to slaughter. The minimum number of days permitted by law between the last pesticide application and the date the treated animal is slaughtered. Same as **preslaughter interval**.

dealers, pesticide. Persons who sell or distribute restricted-use pesticide products within the state of Idaho.

decontaminate. To remove or break down a pesticide chemical from a surface or substance.

defoliant. A chemical that initiates the premature drop of leaves. See **harvest aid chemical**.

degradation. The process by which a chemical compound is broken down to a simpler compound(s) by the action of microorganisms, water, air, sunlight, or other agents. Degradation products are usually, but not always, less toxic than the original compound.

deposit. The amount of pesticide on a treated surface after application.

dermal toxicity. The ability of a pesticide to cause injury to a human or animal when absorbed through the skin.

desiccant. A chemical that promotes drying or loss of moisture from a leaf or other plant part.

detoxify. To render a pesticide's active ingredient or other poisonous chemical harmless.

diagnosis. The positive identification of a problem and its cause.

diluent. Any liquid or solid material used to dilute or carry an active ingredient. In spray-tank mixtures, the most common diluent is water.

dip. Complete or partial immersion of a plant, animal, or object into a pesticide.

directed-spray treatment. A pesticide treatment that directs the pesticide application specifically onto the pest organism with minimal or no contact with nonpest organisms.

disinfectant. A chemical or other agent that kills or inactivates disease-producing microorganisms in animals, seeds, or other plant parts. Also, commonly refers to chemicals used to clean or surface-sterilize inanimate objects.

dispersing agent. An adjuvant that facilitates the mixing and suspension of a pesticide formulation in water.

DLI. Idaho Department of Labor and Industries.

dormant spray. A pesticide application made in late winter or early spring before the resumption of active growth by plants.

dose, dosage. Quantity of a pesticide applied to a given area or target. See **rate of application**.

drift. The airborne movement of a pesticide spray or dust beyond the intended contact area.

drift retardant. An adjuvant added to a spray mixture to reduce drift.

dust. A finely ground, dry pesticide formulation containing a small amount of active ingredient and a large amount of inert carrier or diluent, such as clay or talc.

dusters. Equipment specifically designed to apply dust formulations. They usually have blowers or a mechanism that forces air with the dust to the target.

economic injury level (EIL). The economic break-even point. When the number of pests that cause crop damage exactly equal the cost of pest control.

economic threshold (ET). Also called action threshold. The designated time to initiate control options (actions) to prevent a pest population from exceeding the EIL. Generally, the ET precedes EIL.

efficacy or performance tests. Tests performed on pests to determine the effectiveness of a pesticide.

emulsifiable concentrate (EC). A pesticide formulation produced by mixing the active ingredient and an emulsifying agent in a suitable solvent, usually petroleum-based. When this formulation is added to water, a milky emulsion forms.

emulsifying agent (emulsifier). A chemical that aids in the suspension of one liquid in another that normally would not mix together.

emulsion. A mixture of two liquids each of which is not soluble in the other. One suspends as very small droplets in the other with the aid of an emulsifying agent. Example: Oil in water.

encapsulated pesticide. A pesticide formulation with its active ingredient enclosed in capsules of polyvinyl or other synthetic materials; principally used for slow release.

endangered species. A species of plant or animal whose population has been reduced to the extent that extinction of that species is possible.

environment. All the features, either natural or man-made, that surround and affect an organism or group of organisms.

Environmental Protection Agency (EPA). The federal agency responsible for implementing pesticide regulations and registering pesticide products across the United States.

EPA Establishment Number. A number assigned to each pesticide production facility by the EPA. The number indicates the facility at which the pesticide product was produced and must appear on all labels of that product.

EPA Registration Number. A number assigned by the EPA to a pesticide product when the manufacturer or the designated agent registers the product. The number must appear on all labels for the particular product.

eradicant. A chemical or other agent (such as steam, heat, etc.) used to eliminate an established pest from a plant, animal, or specific area (such as soil, water, buildings, etc.).

eradication. The complete elimination of a pest from a site.

fetotoxic. The ability of a substance to cause harm to a developing fetus, but not necessarily cause deformities. See also **teratogenic**.

field scout. A person who samples fields for pest infestations.

field scouting. The act of sampling a field for pest infestation. Also called pest sampling or monitoring.

FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act). A federal law dealing with pesticide regulations and use.

flowable. A pesticide formulation in which a very finely ground solid particle suspends (not dissolves) in a liquid carrier.

foaming agent. An adjuvant designed to reduce drift by causing a pesticide mix to form a thick foam.

foam retardant. An adjuvant used to reduce the foaming of a spray mixture under agitation.

fog treatment. A pesticide application where the spray droplets are extremely fine (small) so the application appears as a fine mist or fog.

foliar application. Pesticide application that is applied to the foliage or aboveground portions of the plant (leaves and stems).

food chain. Sequence of species within a community, each member of which serves as a food source for the next higher species in the chain.

forecasting. The prediction of pest incidence using weather and host and pathogen characteristics.

formulation. The pesticide product as purchased, containing a mixture of one or more active ingredients, carriers (inert or other ingredients), and other additives, diluted for safety and ease of application.

frill and hatchet application. Application of herbicides made to a pest tree after a tree has been cut or frilled by a hatchet. This application applies herbicide directly to the cambium to kill the pest tree.

fumigant. A pesticide that forms gases that are toxic to plants and animals when absorbed or inhaled.

fungi (singular: fungus). Non-chlorophyll-bearing organisms, living as saprophytes or parasites. Some infect and cause diseases in plants, animals, and humans or destroy wood and fiber products. Others are beneficial (e.g., decomposers and human food sources). Examples include rusts, mildews, molds, and smuts.

fungicide. A chemical used to control fungi.

fungistatic agent. A chemical that prevents the germination of fungus spores or the growth of mycelium, but does not kill the fungus.

furrow treatment. Application of a pesticide in a strip directly over the row of seeds. Usually done at the time of planting.

genetic control. The use of plants and animals that are resistant to attack by pests or the manipulation of plant genes for pest-control purposes.

germination. Refers to the sprouting of a seed or the production of a germ tube (the mycelium from a fungus spore).

GPA. Gallons per acre.

GPM. Gallons per minute.

granular applicator. Also called a granular spreader; application equipment specifically designed to apply granular formulations. They are also used for seed and fertilizer applications.

granule. A dry pesticide formulation. The active ingredient is either mixed with or coated onto an inert carrier to form a small, ready-to-use, low-concentrate particle that does not normally present a drift hazard. Pellets differ from granules only in their precise uniformity, size, and shape.

groundwater. Water sources located in aquifers beneath the soil surface from which well water is obtained or surface springs are formed.

growth regulator. A chemical that alters the growth processes of a plant or animal.

GUP (general-use pesticide). A pesticide that can be purchased and used by the general public. General-use pesticides are considered to have a lower hazard or risk to the user and the environment. They do not require a pesticide license to purchase and use.

harvest aid chemical. Materials applied to a plant before harvest to reduce the amount of plant foliage. See **defoliant**.

hemotoxic. The ability of a substance or agent to cause blood disorders.

herbaceous plants. Plants that do not develop woody tissues.

herbicide. A pesticide used to kill plants or inhibit plant growth.

hormones, insect. Internal chemical messengers that regulate the development and certain behaviors of pest insects.

host. A plant or animal on or in which a pest lives.

hydraulic sprayer. Spray equipment specifically designed to apply liquid pesticides.

hydraulic sprayer, high-pressure. Spray equipment more suited to insecticide and fungicide applications where thorough coverage and sufficient volume of application is necessary for good pest control.

hydraulic sprayer, low-pressure. Spray equipment more suited to foliar herbicide applications or similar applications where high-volume application and complete coverage is not necessary.

hydrolysis. Breakdown of a chemical in the presence of water.

IDHW. Idaho Department of Hazardous Waste.

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. Also pertains to residues in livestock.

incompatible. Two or more materials that cannot be mixed or used together.

inert ingredient(s). The inactive material(s) in a pesticide formulation that does not have pesticidal activity.

ingredient statement. The portion of a pesticide label that provides the name and amount of each active ingredient. Also includes the total amount of inert or other ingredients in the formulation.

inhalation. When a pesticide is breathed in through the nose and mouth into the lungs.

inhalation toxicity. The property of a pesticide to be poisonous to humans or animals when breathed into the lungs.

inoculum. The part of a pathogen that can cause disease in a host.

inorganic pesticide. Pesticide products that do not contain carbon. They are mineral-based, containing arsenic, copper, boron, mercury, sulfur, tin, or zinc.

insect. An arthropod characterized by a body composed of three segments and three pairs of legs.

insect growth regulator (IGR). A synthetic hormone used as an insecticide to control or stop the development of a pest insect.

insecticide. Pesticides used to control or prevent damage caused by insects.

Integrated Pest Management (IPM). The use of all suitable pest-control methods to keep pest populations below the economic injury level. Methods include cultural practices; use of biological, physical, and genetic control agents; and the selective use of pesticides.

inversion, temperature. An undesirable weather condition for spraying pesticides. Inversions occur when a layer of cooler air is trapped a short distance above the ground by a higher level of warmer air. This creates very stable air conditions that may hold pesticide particles in the air at abnormally high levels of concentration.

ISDA (Idaho State Department of Agriculture). The state regulatory agency that administers pesticide laws and rules.

label. All printed material attached to or part of a pesticide container.

labeling. Supplemental pesticide information that complements the information on the label, but which is not necessarily attached to or part of the container.

larvae (singular: larva). The immature form of an insect or other insect-like organism that hatches from the eggs.

LC50. The concentration of a pesticide, usually in air or water, that can kill 50% of a test population of animals when ingested or absorbed through the skin. The LC50 is usually expressed in parts per million (ppm). The lower its value, the more acutely toxic the chemical.

LD50. The dose or amount of a pesticide that can kill 50% of test animals when ingested or absorbed through the skin. The LD50 is expressed in milligrams of chemical per kilogram of body weight of the test animal (mg/kg). The lower the LD50 the more acutely toxic the chemical.

leaching. The movement of a substance through soil with water.

legal control. Action that limits the development of a pest population by restricting human activity. Normally done by a series of laws or legal actions such as inspections, quarantines, or orders. See also **biological control**; **chemical control**; **cultural control**; **mechanical control**; **natural control**; and **physical control**.

mechanical control. The use of devices to prevent the spread or reduce the infestation of pests. Hand destruction, traps, screens, nets, and fences are examples of mechanical devices used for control. See also **biological control**; **chemical control**; **cultural control**; **mechanical control**; **natural control**; and **physical control**.

metabolite. In the case of pesticides, a compound derived from changes in the active ingredient through chemical, biological, or physical reactions. The metabolite may be simpler or more complex and may or may not be more poisonous than the original chemical.

metamorphosis. A change in the shape, size, and/or form of an animal.

microbial degradation. The breakdown of a chemical by microorganisms.

microbial pesticide. Bacteria, viruses, fungi, and other microorganisms used to control pests.

microorganism. An organism so small that it cannot be seen without the aid of a microscope.

miscible liquids. Two or more liquids that can be mixed and remain mixed under most conditions. Water and ethyl alcohol are miscible; water and oil are not.

mist blower. Specialized spray equipment that applies liquid pesticides in extremely fine droplet form, assisted by pressurized air that propels the droplets at 120–200 mph. Also called "cold foggers."

mite. A small arthropod similar to an insect but with eight legs. Its body is divided into two parts and has no antennae. A relative of spiders.

miticide. A pesticide used to control mites; synonymous with acaricide.

mode of action. The way in which a pesticide affects the target plant or animal or microorganism.

molluscicide. A chemical used to control mollusks such as snails and slugs.

MP3 (Managed Pollinator Protection Plan). A state-level plan to provide assistance and coordination to responsible agencies, organizations, growers, and beekeepers for the protection of insect pollinators.

mutagenic. The ability of a substance or agent to cause genetic changes in living cells.

mycelium. The mass of filaments that forms the body of a fungus.

mycoplasma. A microorganism possessing many virus-like properties. Some cause plant diseases.

narrow spectrum pesticide. A pesticide that is toxic to some pests, but has little or no effect on other similar species at certain doses. See also **selective pesticide**.

natural control. Objects or measures that control pests without the intervention of humans. Includes climate (wind, sunshine, temperature, rain, etc.); topographic features (rivers, mountains, canyons, etc.); and naturally occurring predators, parasites, and pathogens. See also **biological control**; **chemical control**; **cultural control**; **legal control; mechanical control**; and **physical control**.

natural enemies. The predators, parasites, and pathogens that attack and often kill other organisms.

necrosis. Death of plant or animal tissues which results in the formation of discolored, sunken, or necrotic (dead) areas.

nematicide. A pesticide used to control nematodes.

nematodes. Microscopic, nonsegmented worm-like animals that live as parasites or saprophytes. Many cause diseases of plants or animals.

neurotoxic. The ability of a substance or agent to cause disorders of the nervous system.

nonpersistent pesticide. A pesticide that does not remain active in the environment for more than one growing season.

nonpoint source (NPS) pollution. Water contamination that comes from a widespread area. An example is the movement of pesticides from an agricultural field or several fields, large turf area, or right of way applications into a stream or river or into the groundwater.

nonresidual. A pesticide product that, once applied, breaks down immediately and is only active for a very short time.

nonselective pesticide. A pesticide that is toxic to a wide range of plants or animals without regard to species. For example, a nonselective herbicide kills or damages all plants it contacts.

nontarget organism. Any plant or animal other than the intended target of a pesticide application.

noxious weed. A plant defined by law as being particularly troublesome, undesirable, and difficult to control. For Idaho, visit https://invasivespecies.idaho.gov/noxious-weed-program.

Occupational Safety and Health Administration (OSHA). The federal agency that issues and enforces regulations for workplace health and safety. They publish the Safety Data Sheets (SDS).

oncogenic. The property to produce tumors (not necessarily cancerous) in living tissues. See also **carcinogenic**.

oral toxicity. Ability of a pesticide to cause injury when taken in through the mouth.

organic pesticides. Pesticide products that contain carbon, hydrogen, nitrogen, and other elements and are not mineral in origin.

organophosphates. A large group of pesticides that contain the element phosphorus. Most are nonpersistent insecticides/miticides. The toxicity of these pesticides ranges from highly toxic to slightly toxic. Examples: malathion, parathion, diazinon.

ovicide. A material that destroys eggs.

parasite. A plant, animal, or microorganism living in, on, or with another living organism for the purpose of obtaining all or part of its food.

pathogen. A disease-causing organism.

pellet. A pesticide formulation consisting of a dry, active ingredient and inert ingredients pressed into a uniformly sized, ready-to-use material. Pellets are larger than granules.

penetrant. An adjuvant added to a spray mixture to enhance the absorption of a pesticide.

perennial. A plant that lives for more than two years.

persistent pesticide. A pesticide or its metabolites that remains active in the environment for more than one growing season. These compounds sometimes accumulate in animal and plant tissues. Examples: DDT, chlordane, dieldrin. Some herbicides, when applied at labeled rate, remain in the soil for years.

pest. An undesirable organism (insect, fungus, nematode, weed, virus, rodent, etc.) that is injurious to humans, desirable plants and animals, and manufactured products or natural products.

pest control. The process by which a pest population is repelled, mitigated, or killed to the benefit of humans, animals, sites, or facilities.

pesticide. A chemical or other agent used to kill or otherwise control pests or to protect something from a pest.

pesticide-impregnated materials. Materials that are impregnated with pesticide to control a pest where the materials are placed. Some common materials are granular fertilizer, ear tags (livestock), collars (pets), and gaskets (herbicides).

Pesticide Safety Education Programs (PSEP). Educational programs, conducted by UI Extension or the ISDA, to train pesticide applicators to become licensed or to maintain their licenses.

pH. A measure of the acidity/alkalinity: acid below pH 7 and basic or alkaline above pH 7.

pheromone. A substance emitted by an animal to influence the behavior of other animals, usually of the same species. Some are synthetically produced for use in insect traps.

photodegradation. The breakdown of chemicals by the action of sunlight (UV radiation).

physical control. Manipulation of a pest's physical environment by affecting temperature, water, or humidity. Also, the use of electric shock, light, or other radiant energy to control pests. See also **biological control**; **chemical control**; **cultural control**; **legal control**; **mechanical control**; and **natural control**.

phytotoxic. Toxic to plants.

piscicide. A chemical used to control pest fish.

point of runoff. When a spray starts to run or drip from the leaves and stems of plants or the hair or feathers of animals.

point source pollution. The contamination of water or soil from a specific and identifiable point or location. Example: a pesticide spill or cleaning site.

Poison Control Center. A regional or local entity that provides information for the proper first-aid techniques and antidotes for poisoning emergencies. Listed in telephone directories or call 800-222-1222.

Positive Power, Air-Purifying Respirator (PAPR). Respirator that supplies positive-pressure air, with air purified through filters, to the nose and mouth of the wearer.

postemergence. After weeds or crop plants have appeared through the soil. Generally used to specify the timing of herbicide applications.

potentiation. Occurs when a pesticide becomes significantly more toxic after combining with another pesticide.

PPM. Parts per million. A way to express the amount of chemical in or on food, plants, animals, water, soil, or air. One part per million equals 1 pound in 500 tons (PPB = parts per billion).

precipitate. A solid substance that forms in a liquid and settles to the bottom of a container; a material that no longer remains in suspension.

predator. An animal that attacks, feeds on, and kills other animals. Examples of predaceous or predatory animals are hawks, owls, snakes, fish, and many insects.

preemergence. Before weeds or crop plants have appeared through the soil. Generally used to specify the timing of herbicide applications.

preharvest interval. The amount of time that must elapse between the application of a pesticide and the harvesting of the crop or commodity.

premix. A pesticide product formulated with more than one active ingredient.

preplant pesticide. A pesticide applied before planting a crop.

preslaughter interval. The amount of time that must elapse between the application of a pesticide to animals and the slaughter of those animals for consumption.

private applicator. A pesticide applicator who applies Restricted Use Pesticides (RUP) to land they own, rent/lease, or has managerial control for the purpose of growing a commodity. Also refers to an applicator who is employed by someone who owns, rents/leases, or has managerial control over land used for agricultural production.

professional applicator. A pesticide applicator who applies pesticides to land they do not own, rent/lease, or have managerial control of for monetary compensation. Also refers to an applicator who promotes, presents, or advertises themselves or their business as pesticide applicators.

propellant. The inert ingredient in self-pressurized products that forces the active ingredient from the container. Propellants are often used in over-the-counter flying insect control pesticides.

protectant. A pesticide applied to a plant or animal before infection or attack by the pest in order to prevent infection or injury by the pest.

protective equipment. Also known as personal protective equipment (PPE). Equipment intended to protect a person from exposure during the handling and application of pesticides. Includes long-sleeved shirts and long trousers, coveralls, suitable hats, gloves, shoes, respirators, and other safety items as needed.

pupa. The intermediate developmental stage of some insects between larva and adult.

quarantine. Regulatory method to control the introduction and dissemination of plant and animal pests (animals, insects, weeds, and disease-causing organisms) into new areas. Involves inspections, treatments, and destruction of contaminated organisms or their parts.

rate of application. The amount of pesticide applied to a plant, animal, unit area, or surface; usually measured as per acre, per 1,000 square feet, per linear foot, or per cubic foot.

RCRA (Resource Conservation and Recovery Act). The US federal law regulating the transport, storage, treatment, and disposal of hazardous waste.

ready to use (RTU). A type of pesticide formulation that is low in concentration and requires no further dilution before application.

recertification training. Part of PSEP (Pesticide Safety Education Program). It is specifically designed as continuing education for pesticide applicators who are currently licensed and wish to maintain their applicator license.

registered pesticide. A pesticide product that has been approved and registered by the EPA for the uses listed on its label.

Registration Number, EPA. Unique and specific number assigned by the EPA to each pesticide product produced. Identifies the pesticide product, concentration, and volume of container, among other important information. Necessary for pesticide recordkeeping.

repellent. A pesticide compound that does not kill the target pest, but keeps insects, rodents, birds, or other pests away from plants, domestic animals, buildings, or other treated areas.

reregistration. Process in which a previously registered pesticide undergoes reevaluation of the data concerning its use. Used to determine whether the pesticide should retain federal registration.

residual pesticide. A pesticide that continues to remain effective on a treated surface or area for an extended period following application. See **persistent pesticide**.

residue. A pesticide's active ingredient or its breakdown product(s) (metabolites) that remains in or on the target after treatment.

resistance. The inherited ability of an organism (pest) to overcome (be less susceptible to) a specific method of control (generally chemical control).

resistant. A population of organisms that are uninjured or unaffected by a certain dosage of pesticide chemical used to control other populations of the same organism successfully. Also, plants and animals that are unaffected by a pest species. See **tolerant**.

Restricted entry interval (REI). The amount of time that must elapse between a pesticide application and the time when a person can reenter and handle a crop without wearing protective clothing or equipment or receiving early entry training. Sometimes called the reentry interval.

restricted-use pesticide (RUP). A pesticide that can be purchased only by certified pesticide applicators and used only by certified applicators or persons directly under their supervision. These pesticides are not available for use by the general public because of high toxicity and/or environmental hazards.

rodenticide. A pesticide used to control rodents.

runoff. The movement of water and associated materials on the soil surface.

safener. An adjuvant used to reduce the phytotoxic effects of a pesticide.

saprophyte. An organism that obtains its food from dead or decaying organic matter.

Section 3 Registration. The section in FIFRA Registration of a pesticide product through the EPA that provides for a federal registration. The process takes many years and extensive data to complete.

Section 18 Exemption. Also called an Emergency Exemption to FIFRA. Granted by the EPA to control a specific pest under emergency situations where there is no alternative method of control available.

Section 24(c) Registration. Also called a Special Local Needs (SLN) registration. This refers to the FIFRA section that is used by ISDA to register an expanded use of certain registered pesticides.

seed protectant. A pesticide applied to seeds before planting to protect them from insects, fungi, and other soil pests.

selective pesticide. A pesticide that is toxic to some pests, but has little or no effects on other similar species at certain doses. See also **narrow spectrum pesticide**.

Self-Contained Breathing Apparatus (SCBA). Respirator that uses pressurized gas canisters to supply breathable air to the user, thus making it unlikely for the user to breathe external air when functioning properly.

serial application. The application of one pesticide immediately or shortly after the application of another.

signal words. Required word(s) that appear on every pesticide label to denote the relative toxicity of the product. The signal words are DANGER-POISON used with a skull-and-crossbones symbol for highly toxic compounds, DANGER for severe skin and eye damage, WARNING for moderately toxic compounds, or CAUTION for slightly toxic compounds.

silvicide. A pesticide/herbicide used to destroy brush and trees, such as in wooded areas.

site. Location of a pesticide application. The crop, animal, structure, commodity, or area.

site of action. The site or biochemical process within the pest where the pesticide interacts and disrupts normal functions and growth.

slurry. A thick suspension of a pesticide made from a wettable powder and water.

soil application. A pesticide application made directly to or in the soil.

soil drench. To soak or wet the ground surface with a pesticide. Large volumes of a pesticide mixture are usually needed to saturate the soil to any depth.

soil incorporation. The movement of a pesticide product into soil using mechanical means or irrigation/rainfall.

soil injection. The placement of a pesticide below the surface of the soil, performed with the aid of an injection tool. Soil injection is a common application method for fumigants and termiticides.

soil sterilant. A chemical or agent that prevents the growth of all organisms present in the soil: A nonselective pesticide. Soil sterilization may be temporary or permanent, depending on the chemical. Also known as a **Total Vegetation Control (TVC)** product.

solubility. The ability of a pesticide to dissolve in a solvent, usually water.

soluble powder. A finely ground, dry pesticide formulation that dissolves in water or some other liquid carrier.

solution. Mixture of one or more substances in another substance (usually a liquid) in which all the ingredients are completely dissolved. Example: sugar in water.

solvent. A liquid such as water, oil, or alcohol that dissolves another substance (solid, liquid, or gas) into a solution.

space spray. A pesticide applied as a fine spray or mist to a confined area.

Special Local Needs Registration. See **Section 24(c) Registration**.

spore. The reproductive unit of a fungus. A spore is analogous to a plant seed.

spot treatment. Application to small areas. Generally, less than ⅒ of an acre.

spray deposit. The amount of pesticide chemical that remains on a sprayed surface after the droplets have dried.

spreader. An adjuvant used to enhance the spread of a pesticide over a treated surface, thus increasing the area that a given volume of liquid covers.

sticker. An adjuvant used to improve the pesticide spray droplet by allowing better adherence to a plant, animal, or other treated surface.

stomach poison. A pesticide that must be ingested (eaten) by an insect or animal in order to be effective. Stomach poisons do not kill by contacting the organism.

structural pests. Pests that attack and destroy buildings and other structures, clothing, stored food, and manufactured or processed goods. Examples: termites, cockroaches, clothing moths, rats, dry rot fungi.

summer annual. Plants that germinate from seed in the spring or early summer and complete their life cycle prior to winter of the same year.

surfactant. A component of many adjuvants that improves the spreading, dispersing, and/or wetting properties of a pesticide mixture.

surface water. Bodies of water on the earth's surface, such as lakes, rivers, and streams.

susceptible. A plant, animal, or site that is affected by a pest. Also refers to pest populations that can be controlled by pesticides.

suspension. A pesticide mixture consisting of fine particles dispersed within a liquid. Example: wettable powders in water.

swath. The width of the area covered by one sweep of an airplane, ground sprayer, spreader, or duster.

synergism. When the effect of two or more pesticides applied together is greater than the sum of the individual pesticides applied separately. Example: Pesticide X kills 40% of an insect population, Pesticide Y kills 20%. When applied together, X and Y kill 95%.

systemic pesticide. A pesticide that is absorbed and translocated (moved) within a plant or animal.

tank mix. The mixture of pesticides (and possibly fertilizers) in a spray tank. Also known as a spray mix.

target. The plants, animals, structures, areas, or pests at which the pesticide or other control method is directed.

technical material. The pesticide active ingredient, in pure form, as manufactured by a chemical company. It is combined with inert ingredients or additives in formulations, such as wettable powders, dusts, emulsifiable concentrates, or granules. Also known as technical grade material.

teratogenic. The ability of a substance or agent to produce abnormalities or defects in living human or animal embryos and fetuses. These defects are not usually inheritable.

termiticide. An insecticide used to control termites.

thickener. A drift-control adjuvant such as cellulose or gel used to promote the formation of greater proportions of large droplets in a spray mixture.

tolerance. A regulation that establishes the maximum amount of pesticide residue (active ingredient or certain metabolites) that may legally remain in or on a raw agricultural commodity (food or feed product) at harvest or slaughter.

tolerant. The property of organisms, including pests, to withstand a certain degree of stress, such as pest attack, poor weather, or pesticides.

Total Vegetation Control (TVC). Method of plant or vegetation control, whereby all plant and vegetation growth stops. Generally uses soil-applied herbicides.

toxic. Denoting a substance poisonous to living organisms.

toxicant. A poisonous substance, such as the active ingredient in a pesticide formulation.

toxicity. The degree or extent to which a chemical or substance is poisonous.

toxin. A naturally occurring poison produced by plants, animals, or microorganisms. Examples: The poison produced by the black widow spider; the venom produced by certain snakes.

translocation. The movement of materials (chemicals) within a plant or animal from the site of entry. A systemic pesticide is translocated.

tree injection. The placement of a pesticide injected under the bark of trees.

triple-rinse. The process of cleaning up an empty pesticide container. Partially fill the container with water, replace the lid, shake the container, and pour into the spray tank. Repeat this three times. Triple-rinsed pesticide containers are considered clean and ready for pesticide container recycling programs.

tree injection. The placement of a pesticide injected under the bark of trees.

Ultra-Low Volume (ULV). Sprays that are applied at 0.5 gallon or less per acre or sprays applied as undiluted formulation.

vapor drift. The movement of chemical vapors from the application site.

vapor pressure. The property that causes a chemical to evaporate. The higher the vapor pressure of a chemical, the more volatile that chemical is and the easier it evaporates.

vector. An animal (for example, insect, nematode, mite) or plant (for example, dodder) that carries and transmits a pathogen from one host to another.

vertebrate. An animal characterized by a segmented backbone or spinal column.

virus. Submicroscopic parasites composed of proteins. Viruses only multiply in living tissues and cause many animal and plant diseases.

volatility. The degree to which a substance changes from a liquid or solid state to a gas at ordinary temperatures when exposed to air.

warning. The signal word assigned to pesticide products that are classified as moderately toxic: The oral LD50 is 50–500 ppm/kg.

water-dispersible granule. A dry, granular pesticide formulation that forms a suspension in water.

water-soluble packet. Wettable powder or soluble powder pesticide formulation packaged in a plastic bag that dissolves when added to the spray tank. The pesticide product is released into the spray mixture.

water table. The upper level of the water-saturated zone in the ground.

weed. A plant that causes injury to other plants, animals, or humans or is a nuisance.

wettable powder. A dry pesticide formulation in powder form that forms a suspension when added to water.

wetting agent. An adjuvant used to reduce the surface tension between a liquid and contact surface for more thorough coverage.

winter annual. Plants that germinate from seed in the fall and generally complete their life cycle (reaches maturity) in the late spring or early summer.

wood preservatives. Pesticides that treat wood and wood products so they are not used as a food source by insects and fungi.

Worker Protection Standard (WPS). Federal regulations specific to the protection of agricultural workers. In reference to pesticides, it has specific requirements for agricultural employers for safety issues regarding pesticide handlers, mixers, loaders, and workers who may come into contact with sprayed fields or application sites.

APPENDIX A:
Pesticide Labels

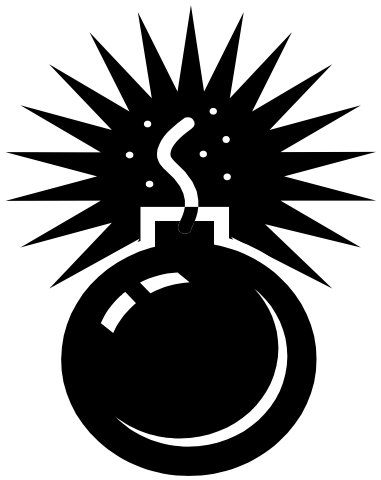
IDACHEM

IDACHEM Inc.
1313 Small Particle Road
Boise, Idaho 83714

CARBOM® 4L

Insecticide

For Agricultural and Commercial Use Only



ACTIVE INGREDIENT:

Carbaryl (1-naphthyl N-methyicarbamate)	43.0%
Inert Ingredients	57.0%
Total	100.0%

2.5 gallons

EPA REG. NO. 34704-447 **EPA EST. NO. 347-ID-447**

KEEP OUT OF REACH OF CHILDREN

CAUTION

PRECAUTIONARY STATEMENTS

HAZARD TO HUMANS AND DOMESTIC ANIMALS

MAY BE HARMFUL IF SWALLOWED. Avoid breathing of spray mist. Do not take internally. Avoid contact with skin, eyes and clothing. Do not use this product in food areas of commercial food-handling establishments, restaurants or other places where food is prepared or processed.

Personal Protective Equipment:

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Waterproof gloves
- Shoes and socks

Engineering Control Statement:

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets with 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 the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED: Call a physician or Poison Control Center immediately. Give victim 1 or 2 glasses of water and induce vomiting by touching the back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious or convulsing person.

IF IN THE EYES: Flush eyes with plenty of water. If irritation persists, get medical attention.

IF ON SKIN: Wash skin with soap and water.

IF INHALED: Remove victim to fresh air. Apply artificial respiration if indicated.

NOTE FOR PHYSICIAN: CARBOM 4L is a moderate, reversible, cholinesterase inhibitor. Atropine is antidotal. Do not use 2 -PAM opiates, or cholinesterase-inhibiting drugs. **FOR A MEDICAL EMERGENCY INVOLVING THIS PRODUCT CALL: 1-800-228-5635, EXT. 136, OR CALL COLLECT 612-852-8180, EXT. 136.**

ENVIRONMENTAL HAZARDS

This product is extremely toxic to aquatic and estuarine invertebrates. For terrestrial uses, do not apply directly to water or when surface water is present or to intertidal areas below the mean high water mark. Discharge from rice fields may kill aquatic and estuarine invertebrates. Do not contaminate water by cleaning equipment or disposal of wash waters.

BEE CAUTION

This product is highly toxic to bees exposed to direct treatment or residues on blooming crops and weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.

DIRECTIONS FOR USE

IT IS A VIOLATION OF FEDERAL LAW TO USE THIS PRODUCT IN A MANNER INCONSISTENT WITH ITS LABELING.

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

(Continued on page 2)

This is a Fictitious Pesticide Label Intended for Training and Testing Purposes Only

(Continued from page 1)
handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions to the statements on this label about personal protective equipment (PPE), 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 12 hours.
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.

NON-AGRICULTURAL USE REQUIREMENTS

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

The area being treated must be vacated by unprotected persons.

Keep unprotected persons out of the treated areas until sprays have dried.

STORAGE AND DISPOSAL

PROHIBITIONS: Do not contaminate water, food, or feed by storage or disposal. Open dumping is prohibited. Do not reuse empty container. Do not store under conditions which might adversely affect container or its ability to function properly.
STORAGE: Store in a safe manner. Store in original container only. Reduce stacking height where local conditions can affect package strength. Personnel should use clothing and equipment consistent with good pesticide handling.
PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on-site or at an approved waste disposal facility.
CONTAINER DISPOSAL: METAL: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill. **PLASTIC:** Triple-rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

GENERAL INFORMATION

CARBOM 4L is a suspension of a microfine carbaryl insecticide in an aqueous medium. It is dispersible in water and may be applied by ground or air.

PREPARATION OF SPRAY

Before using, agitate, stir or recirculate product in container to assure product uniformity. Be certain mix tanks and entire spray system are clean and free from foreign matter. Flush with clean water. Fill tank 1/2 to 3/4 with desired amount of water. Begin agitating tank and slowly add the required amount of this product. Add the remaining volume of water. Continually agitate spray during mixing and application to assure a uniform suspension. Do not store spray mix for prolonged periods. Prepare only as much spray mix as can be applied on the day of mixing.

PRODUCT COMPATIBILITY

When diluted with an equal volume of water, this product may be tank mixed with a wide range of pesticides. If compatibility with another product and the resulting crop response are unknown, the combination should be tested on a small scale. Do not mix this product with diesel fuel, kerosene, fuel oil or aromatic solvents.

When tank mixing, first add this product to at least an equal volume of water, mix thoroughly, and then add combination products. Do not apply this product in a tank mix unless previous experience indicates that the mixture is effective and will not result in application problems, excessive residues, or plant injury. Observe all precautions and limitations on labeling of all products used in mixtures.

This product is unstable under highly alkaline conditions and is not effective if used with alkaline materials such as Bordeaux, lime-sulfur and casien-lime spreaders.

APPLICATION

For all applications, use sufficient spray volume to obtain thorough and uniform coverage. Calibrate spray equipment to deliver the required volume. Use 50 mesh strainers in spray system and 25 mesh slotted strainers behind nozzles.
To clean spray system after use, drain and flush with a water and detergent mixture. Rinse thoroughly with clean water. Refer to the storage and disposal section for disposal instructions.
Note: staining may occur on certain surfaces such as stucco, brick, cinder block, and wood. Spray deposits on painted or stained surfaces or finishes (i.e. cars, houses, trailers, boats, etc.) should be immediately removed by washing to prevent discoloration. Avoid applications to surfaces where visible spray residues are objectionable.
Ground Application:
Apply in sufficient volume for adequate coverage on all crops and sites. To prepare small volumes of spray mixture, use 1/3 fluid ounce (approximately 2 teaspoons) of this product in an adequate amount of water and apply to 500 square feet where rates of 1 quart per acre are indicated.
Aerial Application:
For adequate distribution, use at least 10 gallons of spray mixture per acre for application for tree and orchard crops or at least 2 gallons of spray mixture per acre for application to other crops.
Resistant Species:
All references to armyworm on the crops listed below refer to the species Pseudaletia unipuncta; except where indicated otherwise, this product is not registered for the control of other armyworm species. Regional differences have been noted in

(Continued on page 3)

(Continued from page 2)

the susceptibility of certain strains of fall armyworm, diamondback moth, Colorado potato beetle and southern green stink bug to CARBOM 4L. If local experience indicates inadequate control, use an alternative pesticide.

CAUTIONS AND RESTRICTIONS

PLANT RESPONSE PRECAUTIONS

Application to wet foliage or during periods of high humidity may cause injury to tender foliage. Do not use on Boston ivy, Virginia creeper, and maidenhair fern as injury may result. CARBOM 4L may also injure Virginia and sand pines. The use of adjuvants may increase the potential for crop injury to sensitive crops.

PREHARVEST AND GRAZING RESTRICTIONS AND LIMITATIONS

Tolerances established under the Federal Food, Drug and Cosmetic Act permit the sale of labeled crops bearing probable CARBOM 4L residues when this product is used in accordance with the label directions. If used as directed, treated forage may be grazed or used as feed for dairy and meat animals without causing illegal residues in meat or milk. Do not apply at greater rates or at more frequent intervals than stated on the label. To do so may result in illegal residues in crops, meat and milk.

Do not use reclaimed irrigation water from crops treated with CARBOM 4L or crops for which carbaryl tolerances are not established

Do not plant rotational food and feed crops not listed on this or other carbaryl labels in CARBOM 4L treated soil.

FRUIT, VEGETABLE, AND GRAIN CROPS

CROP	INSECT	QTS OF PRODUCT/ ACRE	SPECIFIC INSTRUCTIONS
Broccoli Brussels Sprouts Cauliflower Cabbage, Chinese Collards, Kale Kohlrabi Mustard greens	Flea beetles Harlequin bug Leafhoppers	1/2 to 1	Repeat applications as needed up to a total of 4 times but not more often than once every 7 days.
	Armyworm, Aster leafhopper, Corn earworm, Fall armyworm, Lygus bugs, Tarnish plant bugs	1 to 2	Do not apply more than a total of 6 quarts per acre per crop.

NOTE: For Chinese Cabbage, Collards, Kale, and Mustard Greens, do not apply within 14 days of harvest. For Broccoli, Brussels Sprouts, Cabbage, Cauliflower, and Kohlrabi, do not apply within 3 days of harvest.

Begin application when insect populations reach recognized economic threshold levels. Consult the Cooperative Extension Service, or other qualified authorities to determine appropriate threshold levels for treatment and specific use information in your area. Where a dosage range is indicated, use the lower rate on light to moderate infestations, young plants and early instars and use the higher rate on heavy infestations, mature plants, advanced instars, and adults. Thorough and uniform spray coverage is essential for effective control.

CROP	INSECT	QTS OF PRODUCT/ ACRE	SPECIFIC INSTRUCTIONS
Carrots Parsnips Garden Beets Horseradish Radishes Rutabagas Salsify Potatoes	Flea beetles, Leaf hoppers	1/2 to 1	Repeat applications as needed up to a total of 8 times but not more often than once every 7 days. For cutworm control, this product is most effective against species which feed on the upper portions of the plant.
	Armyworm, Aster leafhopper, Colorado potato beetle, Corn earworm, Cutworms, European corn borer, Fall armyworm, Lacebugs, Lygus bugs, Spittlebugs, Stink bugs, Tarnished plant bugs	1 to 2	

NOTE: Do not apply more than a total of 6 quarts per acre per crop. Do not apply within 7 days of harvest.

CROP	INSECT	QTS OF PRODUCT/ ACRE	SPECIFIC INSTRUCTIONS
Field corn Popcorn	Armyworms, Chinch bugs, Corn earworm, Corn rootworm adults, European corn borer, Fall armyworm, Flea beetle, Sap beetles, Southwestern corn borer, Leafhoppers	1 to 2	**OBSERVE BEE CAUTION** Repeat applications as needed up to a total of 4 times but not more often than once every 14 days. Optimum timing and good coverage are essential for effective control For optimum chinch bug control, use ground equipment to apply at least 20 gallons of water per acre and direct spray towards stalk to provide thorough coverage. For optimum European corn borer control, do not apply in less than 3 gallons of water per acre by air and 15 gallons of water for ground. For optimum cutworm control, apply in a 12 inch band, over the row, using sufficient volume of water to obtain thorough coverage. For broadcast applications, use at least 20 gallons by ground or 5 gallons by air
	European corn borer	1 1/2 to 2	
	Cutworms, Western bean cutworm	2	

NOTE: Do not apply more than a total of 8 quarts per acre per crop. Do not apply within 48 days of harvest of grain and fodder or within 14 days of harvest or grazing of forage or silage.

TREE FRUIT AND NUT CROPS

For all tree fruit and nut crops, apply in sufficient volume for adequate coverage. This will vary depending upon the pest and its severity, the tree conditions, size, density, and other factors.

CROP	INSECT	QTS OF PRODUCT/ ACRE	SPECIFIC INSTRUCTIONS
Apples Pears Loquats Crabapples Oriental pears	White apple leafhopper	1/2 to 1 1/2	**OBSERVE BEE CAUTION** On apples, avoid use during the period from full bloom until 30 days after full bloom unless fruit thinning is desired. Use for pest control during this period also may result in fruit removal. Repeat applications as necessary up to a total of 8 times per crop (including thinning sprays on apples) but not more often than once every 14 days. For psylla control, apply when eggs hatch or young nymphs are present. For scale control, apply when crawlers are present.
	Apple aphid, Codling moth	1 to 3	
	Apple aphid, Apple maggot, Apple mealy bug, Apple rust mite, Bagworms, Pear sawfly, European apple sawfly, Eyespotted bud moth, Fruit tree leafroller, Gypsy moth, Japanese beetle, Lesser appleworm, Lygus bugs, Pearleaf blister mite, Pear psylla, Pear rust mite, Periodical cicada, Plum curculio, Redbanded leafroller, Rosy apple aphid, Scale insects, Tarnished plant bug, Tentiform leafminers, Woolly apple aphids, Yellowheaded fireworm	1 1/2 to 3	

NOTE: Do not use on pears between the tight flower cluster up to the 20 mm fruit size. Do not use on quince. Do not apply more than a total of 15 quarts per acre per crop. Do not make more than a total of 8 applications per crop. Do not apply within 3 days of harvest.

CROP	INSECT	QTS OF PRODUCT/ ACRE	SPECIFIC INSTRUCTIONS
Pistachios	Brown soft scale, Lecarium scale, Navel orangeworm	3 to 5	Repeat applications as necessary up to a total of 4 times per crop (including any applications at the dormant or delayed dormant timing) but not more often than once every 7 days. For scale control, apply when crawlers are present. For dormant or delayed dormant timing, apply in combination with a recommended dormant oil.
	Scale insects	4 to 5	

NOTE: Do not apply more than a total of 15 quarts per acre per crop, including any application at the dormant or delayed dormant timing. Do not apply within 14 days of harvest.

FORAGE CROPS

CROP	INSECT	QTS OF PRODUCT/ ACRE	SPECIFIC INSTRUCTIONS
Alfalfa Clovers Birdsfoot trefoil	Blister beetles, Mexican been beetle,	1	**OBSERVE BEE CAUTION** On dense growth, use 25 to 40 gallons of water per acre with ground equipment to ensure adequate coverage.
	Alfalfa caterpillar, Bean leaf beetle, Cucumber beetles, Green cloverworm, Japanese beetle, Leafhoppers, Three cornered alfalfa hopper, Thrips, Velvet bean caterpillar	1 to 1 1/2	
	Alfalfa weevil larvae, Armyworm, Clover head weevil, Corn earworm, Egyptian alfalfa weevil larvae, Essex skipper	1 to 1 1/2	For alfalfa weevil larvae, if pretreatment damage is extensive, cut alfalfa and treat the stubble, This product is not effective against adult alfalfa weevils. For cutworm control, this product is most effective against species which feed on the upper portions of he plant.
	European alfalfa beetle, Fall armyworm, Yellow striped armyworm, Alfalfa weevil larvae (west of the Rocky Mountains)	1 1/2	

NOTE: Do not apply more than once per cutting. Do not exceed 1 1/2 quarts per acre per cutting. Carbaryl may cause a temporary bleaching of tender alfalfa foliage. Do not apply within 7 days of harvest or grazing.

NONCROPLAND

CROP	INSECT	QTS OF PRODUCT/ ACRE	SPECIFIC INSTRUCTIONS
Conservation Reserve Programs Acreage Set-aside Program Acreage Wasteland Rights-of-way Hedgerows Ditchbanks Roadsides	Black grass bug	1/4 to 1/2	Repeat applications as needed up to a total of 4 times but not more often than once every 7 days. Do not apply more than a total of 6 quarts per acre per crop.
	Mormon cricket, Range caterpillar, Range crane fly	1/2 to 1	
	Ticks	1 to 1 1/2	

NOTE: Do not apply more than a total of 3 quarts per acre per year. Do not apply within 14 days of grazing or harvest for forage of hay.

TREES AND ORNAMENTALS

For dilute-spray ground applications to trees (including shade trees, shelter belts, non-urban forests, tree plantations, Christmas trees, rangeland trees, parks and recreations areas, rural

(Continued on page 5)

(Continued from page 4)

shelter belts), ornamentals, woody plants and shrubs, apply at the specified dosage per 100 gallons of water. For concentrate spray ground applications, apply the specified dosage per acre in sufficient spray volume to provide thorough coverage. For aerial applications to forest trees (including shade trees, shelter belts, plantations, parks and recreations areas) and commercially grown ornamentals, woody plants and shrubs apply the specified dosage per acre in sufficient spray volume to provide thorough coverage. Avoid direct application to lakes, streams and ponds.

INSECT	3 GAL	100 GAL	SPECIFIC DIRECTIONS
Ants, Apple aphid, Armyworm, Azalea leafminer, Bagworms, Birch leafminer, Blister beetle, Boxelder bug, Boxwood leafminer, Brown tail moth, Cankerworms, Catalpa sphinx, Chiggers, Cooley spruce gall aphid, Cutworms, Cypress tip moth, Douglas fir tussock moth, Eastern spruce gall aphid, Elm leaf aphid, Elm leaf beetle, Elm spanworm, Eriophyid mites, European pine shoot moth, Fall armyworm, Flea beetles, Fuller rose beetle, Gall midges, Gall wasps, Green striped mapleworm, Grasshoppers, Gypsy moth, Hackberry nipplegall maker, Holly bud moth, Holly leafminer, Jackpine budworm, Japanese beetle, Jeffrey pine needleminer, June beetles Lace bugs, Leafhoppers, Leafrollers, Locust borers, Maple leafcutters, Mealybugs, Mimosa, webworms, Nantucket pine tip moth, Oak leafminers, Oak leaf skeletonizer, Oakworm complex, Oleander caterpillar, Olive ash borer, Orangestriped oakworm, Orange tortrix, Periodical cicada, Pine sawfly, Pine spittlebug, Pitch pine tip moth, Plant bugs, Poinsettia horn worm, Psyllids, Puss caterpillars, Red humped oak worm, Rose aphid, Rose chafer, Roseslug, Saddled prominent, Scale insects, Sowbugs, Springtails, Spruce budworm, Spruce needleminer, Subtropical pine tip moth, Tent caterpillars, Thornbug, Ticks, Webworms, Western hemlock looper, Western spruce budworm, Willow leaf beetles, Yellow poplar weevil	1 oz.	1 qt.	Use sufficient spray volume to obtain thorough coverage of upper and lower leaf surfaces. To control scale insects, treat trunks, stems, and twigs in addition to plant foliage. For optimum worm control, treat when in early instars. Addition of a sticker may improve residual control. Observe plant response precautions. Applications for control of Maple leafcutter on sugar maple should be made when larvae are in 2nd instar after mining, and as cases are being formed. Repeat treatments as necessary up to a total of 2 times per year but not more often than once every 7 days.
Elm bark beetle, Engraver beetles, Mountain pine beetle, Roundheaded pine beetle, Western Pine beetle	18 oz.	4 gals.	Effective as a preventive treatment only. Repeat annually as required to prevent beetle attacks. Apply 1 gallon of spray per 50 square feet of bark in may to early July or prior to beetle attack. Treat tree trunks from ground level up until trunk diameter is less than 5 inches.

NOTE: Do not make more than 2 applications per year. DO NOT ALLOW PUBLIC USE OF TREATED AREAS DURING APPLICATIONS OR UNTIL SPRAYS HAVE DRIED.

PEST CONTROL AROUND BUILDINGS

GENERAL INFORMATION

Note: Staining may occur on certain surfaces such as stucco, brick, cinderblock and wood. Therefore, applications of this product to surfaces where a noticeable residue or discoloration is objectionable should be avoided. Do not use this product in commercial food areas of food handling establishments, restaurants, or other places where food is prepared or processed. Do not use in serving areas while food is exposed.

PERIMETER TREATMENTS

Residual spray for control of ants, bees and wasps, brown dog ticks, carpenter ants, centipedes, cockroaches, crickets, earwigs, firebrats and silverfish, fleas, millipedes, scorpions and spiders. Mix 16 ounces of this product per 50 gallons of water (2 fluid ounces per 3 gallons), and apply via power spray or other spray methods. To prevent infestations of buildings by the above pests, outside perimeter treatment should be in a band 6 to 10 feet wide and confined to shrub beds, foundation plantings and lawn or soil areas immediately adjacent to the structure. Direct application to structures should be minimal and restricted to cracks and crevices and other areas where insects tend to congregate.

NOTICE

It is impossible to eliminate all risks inherently associated with the use of this product. Crop injury, ineffectiveness, or other unintended consequences may result because of such factors as weather conditions, presence of other materials, or the manner of use or application, all of which are beyond the control of IDACHEM, INC., the manufacturer or seller. In no case shall IDACHEM, Inc., the manufacturer or seller be liable for consequential, special or indirect damages resulting from the use or handling of this product. All such risks shall be assumed by the buyer.

Except as expressly provided herein, IDACHEM, Inc. the manufacturer or seller makes no warranties, guarantees, or representations of any kind, either express or implied, or by usage of trade, statutory or otherwise, with regard to the product sold, including, but not limited to, merchantability, fitness for a particular purpose, use or eligibility of the product for any particular trade usage. Buyer's or Users exclusive remedy and IDACHEM, INC., the manufacturer's or seller's total liability shall be for damages not exceeding the cost of the product.

IDACHEM

For product information, call:
1-888-IDA-CHEM

Visit our website at:
www.idachem.com/ag/com/

IDACHEM Inc.
1313 Small Particle Road
Boise, Idaho 83714

This is a Fictitious Pesticide Label Intended for Training and Testing Purposes Only

2.5 gallon net contents

CAVERN® 68

Broadleaf Herbicide

For selective control of broadleaf weeds in certain agricultural crops and non-agricultural areas.

EPA Reg. No. 264-2 **EPA Est. No. 264-MO-1**

ACTIVE INGREDIENT:

2,4-D dma (Dichlorophenoxyacetic acid, dimethylamine salt*).....	**67.8%**
INERT INGREDIENTS:	**32.2%**
Total	**100.0%**

*** 2,4-Dichlorophenoxyacetic acid equivalent 47.9% by weight or 4.8 pounds per gallon**
*** Isomer specific by AOAC method No. 978.05**

RESTRICTED USE PESTICIDE

Due to very high potential for secondary environmental damage and water contamination. For sale to and use only by certified applicators or persons under their direct supervision and only for those persons uses covered by certified applicator's certification. Direct supervision for this product is defined as the certified applicator being physically present during application mixing, loading, repair and cleaning of application equipment.

KEEP OUT OF REACH OF CHILDREN

DANGER PELIGRO

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.)

STATEMENT OF PRACTICAL TREATMENT

IF ON SKIN: Wash skin with plenty of soap and water. Remove contaminated clothing. Get medical attention.
IF SWALLOWED: If patient is conscious and alert, give 2 to 3 glasses of water or milk to drink. If available, give one tablespoon of Syrup of Ipecac to induce vomiting. Alternatively, induce vomiting by touching back of throat with finger. Do not make an unconscious person vomit. Get medical attention.
IF IN EYES: Flush with water for at least 15 minutes. Get medical attention, PREFERABLY AN OPHTHAMOLOGIST.
IF INHALED: Move to an uncontaminated area. Get medical attention.

NOTE TO PHYSICIAN

This product contains a phenoxy herbicidal chemical. There is no specific antidote. All treatments should be based on observed signs and symptoms of distress in the patient. Overexposure to materials other than this product may have occurred.

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

DANGER

Corrosive. Causes irreversible eye damage. Harmful if swallowed. May be fatal if absorbed through the skin. Avoid breathing vapors or spray mist. Do not get in eyes, on skin or on clothing.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Applicators and other handlers must wear: coveralls over short-sleeved shirt and short pants, waterproof gloves, chemical-resistant footwear plus socks, chemical-resistant headgear for overhead exposure and protective eye wear. A chemical-resistant apron must also be worn when cleaning equipment, mixing or loading.

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry. After each day of use, clothing or PPE must not be reused until it has been cleaned.

ENGINEERING CONTROL STATEMENT:

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 (personal protective equipment) may be reduced or modified as specified in the WPS.

For containers over 1 gallon, but less than 5 gallons, mixers and loaders who do not use a mechanical system (probe and pump) to transfer the contents of this container must wear coveralls or a chemical-resistant apron in addition to the other required PPE. For containers of 5 gallons or more, a mechanical transfer system (probe and pump) must be used for transferring the contents of the container. If the contents of non-refillable pesticide containers are emptied, the probe must be rinsed before removal. If the mechanical system is used in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(4)], 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 the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

This product is toxic to aquatic invertebrates. Drift or runoff may adversely affect aquatic invertebrates and non-target plants. For terrestrial uses, do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment wash-

THIS IS A FICTITIOUS LABEL INTENDED FOR TESTING AND TRAINING PURPOSES ONLY

waters. Do not apply when weather conditions favor drift from treated areas. Do not use the same spray equipment for other purposes unless thoroughly cleaned.
Do not contaminate water used for irrigation or domestic purposes especially in areas where grapes, cotton, tomatoes or other susceptible plants are grown.
Do not treat irrigation ditches in areas where water will be used to overhead (sprinkler) irrigate susceptible crops especially grapes, tomatoes, tobacco, and cotton.
Do not apply CAVERN® 68 Broadleaf Herbicide directly to, or permit to drift onto cotton, okra, grapes, tomatoes, fruit trees, vegetables, flowers or other desirable crops or ornamental plants that are susceptible to 2,4-D herbicide. Do not apply near susceptible plants since very small quantities of 2,4-D will cause severe injury during the growing or dormant periods. Crops contacted with CAVERN® 68 Broadleaf Herbicide sprays or spray drift may be killed or suffer significant stand loss with extensive quality and yield reduction.
Do not apply when a temperature air inversion exists. Such a condition is characterized by little or no air movement and an increase in air temperature with an increase in height. In humid regions, a fog or mist may form. An inversion may be detected by producing a smoke column and checking for a layering effect. If questions exist pertaining to the existence of an inversion, consult with local weather services before making an application.
Use coarse sprays to minimize drift. Do not apply with hollow cone-type insecticide or other nozzles that produce fine spray droplets. Drift from aerial or ground application may be reduced by: (1) applying as near to the target as possible in order to obtain coverage; (2) by increasing the volume of spray mix per acre; (3) by decreasing the pounds of pressure at the nozzle tips; (4) by using nozzles which produce a coarse spray pattern; and (5) by not applying when wind is blowing towards susceptible crops or valuable plants.

MIXING AND LOADING
Most cases of ground water contamination involving phenoxy herbicides, such as 2,4-D, have been associated with mixing/loading and disposal sites. Caution should be exercised when handling 2,4-D pesticides at such sites to prevent contamination of groundwater supplies. Use of closed systems for mixing or transferring this pesticide will reduce the probability of spills. Placement of the mixing/loading equipment on an impervious pad to contain spills will help prevent groundwater contamination.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Read entire label before using this product.

Do not apply this product in a way that will contact workers or other person, 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.

GENERAL CAUTIONS AND RESTRICTIONS

Do not apply CAVERN® 68 Broadleaf Herbicide through any type of irrigation system. Do not use in or near a greenhouse.

APPLICATION PROCEDURES

Apply by air or ground equipment in sufficient amounts to obtain adequate coverage, except as otherwise directed on this label. Use 2 or more gallons per acre for aerial application and 10 or more gallons of water for ground application.

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), and restricted entry interval (REI). The requirements in this box only apply to uses of this product that are covered by the WPS.

(Agricultural Use Requirements Continued):
Do not enter or allow entry into treated areas during the Restricted Entry interval (REI) of 48 hours.
PPE required for early entry to treated areas that is permitted under the WPS and that involves contact with anything that has been treated such as plants, soil or water is: coveralls over short sleeved shirt and short pants, waterproof gloves, chemical-resistant footwear plus socks, chemical-resistant headgear for overhead exposure and protective eyewear.

NON-AGRICULTURAL USE REQUIREMENTS

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard (WPS) for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries or greenhouses.

For ornamental turf uses (golf courses, cemeteries, parks and other turf grass areas), do not enter treatment areas until sprays have dried. Do not allow people (other than applicator) or pets on treatment area during application.

STORAGE AND DISPOSAL

STORAGE
Do not contaminate water, food or feed by storage or disposal. Store in original container in a dry, secure storage area. Keep container tightly closed when not in use.

PESTICIDE DISPOSAL
Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law and may contaminate ground water. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL
Triple-rinse or equivalent. Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration. If allowed by state and local authorities, by burning. If burned, stay out of smoke.

RETURNABLE — REFILLABLE CONTAINERS
After use, return the container to the point of purchase or designated locations. This container must only be refilled with CAVERN® 68 Broadleaf Herbicide. DO NOT REUSE THE CONTAINER FOR ANY OTHER PURPOSE. Prior to refilling, inspect thoroughly for damage, such as cracks, punctures, abrasions and damaged or worn or threads on closure devices. Do not refill or transport damaged or leaking containers. Check for leaks after refilling and before transportation. If the container is not being refilled, return it to the point of purchase.

MIXING INSTRUCTIONS

Add about one-half the water to the mixing tank, then add CAVERN® 68 Broadleaf Herbicide with agitation and finally the rest of water with agitation.

THIS IS A FICTITIOUS LABEL INTENDED FOR TESTING AND TRAINING PURPOSES ONLY

COMPATIBILITY

If CAVERN® 68 Broadleaf Herbicide is to be tank mixed with fertilizers or with other pesticides, compatibility should be tested prior to mixing. To test for compatibility, use a small container and mix a small amount (0.5 to 1 qt) of spray, combining all ingredients in the same ratio as the anticipated use. If any indication of physical incompatibility develop, do not use this mixture for spraying. Indications of incompatibility usually will appear within 5 to 15 minutes after mixing. Read and follow all directions and precautions on this label and on the labels of any products for which a tank mixture is being considered.

GENERAL INFORMATION

INJURY TO CROPS FROM THIS HERBICIDE MAY OCCUR. IF YOU ARE NOT PREPARED TO ACCEPT SOME DEGREE OF CROP INJURY DO NOT USE THIS PRODUCT.

Crop varieties vary in response to 2,4-D and some are easily injured. Apply CAVERN® 68 Broadleaf Herbicide only to varieties known to be tolerant to 2,4-D. If you are uncertain about tolerant varieties or local use situations that may affect crop tolerance to 2,4-D, consult your seed company, State Agricultural Extension Service of qualified crop consultant for advice.

Be sure that use of this product conforms to all applicable laws, rules and regulations. Certain states have restrictions pertaining to application distances from susceptible crops. The applicator should become familiar with these laws, rules or regulations and follow them exactly.

GENERAL WEED LIST

Annual and Biennial Weeds

beggarticks	*mallow (Venice or little)	Russian thistle
bullthistle	marshelder	Salsify (western/common)
coffeeweed	morningglory	*smartweeds (annuals)
common cocklebur	*musk thistle (***)	sowthistles
common burdock	mustards (except blue)	sunflower
common primrose	pepper weeds	*vervains
lambsquarters	**pigweeds	vetches
hairy galinsoga	prickly lettuce	wild carrot
jimsonweed	ragweed	wild lettuce
*knotweed	rough fleabane	wild parsnips

Perennial Weeds

*bindweed	*goldenrod	**nettles

CROPS	RATE	DIRECTIONS
Wheat, Barley, Oats and Rye (not underseeded with legumes) Annual/biennial weeds Perennial weeds	 1/2-2 pints* 1-2 pints*	Apply after grain is fully tillered (usually 4 to 8 high) but not forming joints in the stem. Do not spray grain in the boot to dough stage.
Wheat, Barley, Oats and Rye (underseeded with legumes)	1/4-1/2 pint*	Apply after grain is 8 inches tall. Do not spray grain in boot to dough stage. Do not spray alfalfa or sweet clover unless the infestation is severe and injury to these legumes can be tolerated

blue lettuce	*ground ivy	orange hawkweed
*Canada thistle	healall	plantains
catnip	*hoary cress	sowthistle (perennial)
chicory	*ironweed	*vervains
dandelion	Jerusalem-artichoke	*wild garlic
*docks	many flowered aster	*wild onion
*dogbanes		

*These species may require repeated applications and/or use of the higher rate recommended on this product label even under ideal conditions for application.

**Control of pigweeds in High Plains areas of Texas and Oklahoma may not be satisfactory with this product.

CEREAL GRAINS (CONTINUED)

CROPS	RATE	DIRECTIONS
Emergency weed control in Wheat Perennial weeds	3 pints	Apply when weeds are approaching bud stage, after the grain dough stage. Do not spray during the boot to dough stage. The 3 pints per acre application can produce injury to wheat. Balance the severity of your weed problem against the possibility of crop damage. Where perennial weeds are scattered, spot treatment is suggested to minimize the extent of crop injury.

RESTRICTIONS AND LIMITATIONS FOR USE ON CEREAL GRAINS

For aerial application on grain apply CAVERN® 68 Broadleaf Herbicide in 3 to 10 gallons of water per acre.

For ground application a minimum of 10 to 15 gallons of water per acre is recommended for proper spray coverage.

Do not permit dairy animals or meat animals being finished for slaughter to forage treated grain fields within 2 weeks after treatment.

Do not feed treated straw to livestock if an emergency treatment as described above is applied.

*Use the lower rate if small annual and biennial weeds are the major problem. Use the higher rate if perennial weeds or annual and biennial weeds are present which are in the hard-to-kill categories as determined by local experience. The higher rates increase the risk of grain injury and should be used only where the weed control problem justifies the grain damage risk. Do not apply CAVERN® 68 Broadleaf Herbicide to grain in seedling stage.

CROPS	RATE	DIRECTIONS
CORN (Field and Sweet) **Preplant**	 1 to 2 pints	To control emerged broadleaf weed seedlings or existing cover crops prior to planting corn, apply 7 to 14 days before planting. Do not use on light, sandy soil, or where soil moisture is inadequate for normal weed growth. Use high rate for less susceptible weeds or cover crops, such as alfalfa.
Preemergence	2 to 3 pints	Apply 3 to 5 days after planting but before corn emerges. Do not use on light, sandy soils or where soil moisture is low.
Postemergence Annual Weeds Perennial Weeds	 1/2 to 1 pint 1-1 1/2 pint	Apply when weeds are small and corn is less than 8 inches tall (to top of canopy). When corn is over 8 inches tall, use drop nozzles and keep spray off foliage. Treat perennial weeds when they are in the bud to bloom stage. Do not spray corn in the tassel to dough stage. Corn treated with 2,4-D may become temporarily brittle. Wind or cultivation may cause stalk breakage during the period of time when the corn is brittle.
Grain Sorghum (Milo) **Postemergence**	 1 Pint	Apply when sorghum is 6 to 15 inches tall. If sorghum is taller than 8 inches to top of the canopy, use drop nozzles and keep spray off the foliage. Do not treat during the boot, flowering or dough stage.

CORN AND SORGHUM

RESTRICTIONS AND LIMITATIONS FOR USE ON CORN AND SORGHUM. Do not forage or feed fodder for 7 days following application.

THIS IS A FICTITIOUS LABEL INTENDED FOR TESTING AND TRAINING PURPOSES ONLY

FALLOWLAND AND CROP STUBBLE

CROPS	RATE	DIRECTIONS
Fallowland and Crop Stubble Annual Weeds	1-2 pints	Use the lower rate when weeds are small (2 to 3 inches tall) and actively growing. Use the higher rate on older and drought-stressed plants.
Biennial Weeds	2-4 pints	Spray while musk thistles or other biennial species are in the seedling to rosette stage and before flower stalks become apparent. The lower rate can be used in the spring during rosette stage. Use the highest rate in the fall or after flower stalks have developed.
Perennial Weeds	2-6 pints	Spray weeds in the bud to bloom stage or while in good vegetative growth. Do not disturb treated areas for at least 2 weeks after treatment, or until tops are dead.
Wild garlic and onions in crop stubble	4-6 pints	Apply to new regrowth of wild garlic or onion, which occurs in the fall following harvest of small grains, corn or grain sorghum.
Wheat, Barley, Oats and Rye (underseeded with legumes)	1/4-1/2 pint*	Apply after grain is 8 inches tall. Do not spray grain in boot to dough stage. Do not spray alfalfa or sweet clover unless the infestation is severe and injury to these legumes can be tolerated

RESTRICTIONS AND LIMITATIONS FOR USE IN FALLOWLAND AND CROP STUBBLE. Do not plant any crop for 3 months after treatment or until chemical has disappeared from the soil.

ESTABLISHED GRASS PASTURES, RANGELANDS,

WEEDS	RATE	DIRECTIONS
Annual broadleaf weeds Biennials and perennial broadleaf weeds	2 pints 2-4 pints	Apply when weeds are small and actively growing and prior to bud stage. Spray while musk thistles or other biennial species are in the seedling to rosette stage and before flower stalks become apparent. The lower rate can be used in the spring during rosette stage. Use the highest rate in the fall or after flower stalks have developed. Use the highest rates for perennial weed control. Do not apply to newly seeded areas until grass is well established. Do not apply to grass in the early boot through milk stage, if grass seed production is desired. Bentgrass and legumes may be injured by this treatment.

FORESTS, AND CONSERVATION RESERVE PROGRAM AREAS

RESTRICTIONS AND LIMITATIONS FOR USE IN PASTURES AND RANGELANDS

Do not graze (dairy) cattle in treated areas for 7 days after application.
Do not cut forage for hay within 30 days of application.
Do not permit dairy animals or meat animals being finished for slaughter to forage treated fields within 3 days of slaughter.

RESTRICTIONS FOR FOREST AREAS

Do not allow persons in the application area until sprays have dried.
Do not spray in tree nursery areas, this product is for mature trees only.
Do not allow sprays to contact tree foliage or damage may occur.

CONSERVATION RESERVE PROGRAM AREAS

WEEDS	RATE	DIRECTIONS
Annual broadleaf weeds in young grasses In established grasses	1/2-1 pints 1/2-2 pints	Apply to actively growing annual broadleaf weeds. Use 1/2 to 1 pint when weeds are small; use higher rates on older weeds. Do not apply to young grasses with fewer than 6 leaves of prior to tillering. Do not apply more than 1 pint until grasses are well established, as excessive injury may result.
Biennial and perennial broadleaf weeds In established grasses	2-4 pints	Treat when biennial weeds are in the seedling to rosette stage and before flower stalks become apparent. Treat perennial weeds in the bud to bloom stage. Apply to actively growing weeds.

RESTRICTIONS AND LIMITATIONS FOR USE ON CONSERVATION RESERVE PROGRAM AREAS.

Use at least 2 gallons of water per acre by air and 5 gallons of water per acre by ground.
Do not harvest or graze treated Conservation Reserve Program areas.
Do not apply to grasses in the boot to dough stage if grass seed production is desired.

WEEDS	RATE	DIRECTIONS
Annual and perennial broadleaf weeds	2-4 pints	Apply to established stands in spring from tiller to early boot stage. Do not spray in boot stage. New spring seedlings may be treated with the lower rate after grass seedlings have at least 5 leaves. Perennial weed regrowth may be treated in the fall.

GRASSES FOR SEED PRODUCTION

RESTRICTIONS AND LIMITATIONS FOR USE ON GRASSES FOR SEED PRODUCTION

Do not graze dairy animals or cut forage for hay within 7 days of application.

NON-CROPLAND

Such as fencerows, hedgerows, roadsides, drainage ditches,

WEEDS	RATE	DIRECTIONS
Annual broadleaf weeds Biennial and perennial broadleaf weeds	2-4 pints 4 to 8 pints	Treat when weeds are young and actively growing. Perennial weeds should be near the bud stage, but not flowering at application. Do not use on susceptible southern grasses such as St. Augustine. Do not apply to newly seeded areas until grass is well established. Bentgrass, clover, legumes and dichondria may be injured by this treatment.

rights-of-way, utility power lines, railroads and other non-crop areas

RESTRICTIONS AND LIMITATIONS FOR USE ON NON-CROPLAND

Do not graze dairy animals for 7 days following application.
Use sufficient spraymix volume for thorough and uniform coverage.

SPOT TREATMENT IN NON-CROP AREAS

Mix 2 to 3 fluid ounces of CAVERN® 68 Broadleaf Herbicide in 3 gallons of water. Wet all weeds and stems thoroughly. For best results, treat when weeds are actively growing.

WEEDS IN ORNAMENTAL TURF AREAS

Golf courses, parks, turfgrass, and other grass areas

WEEDS	RATE	DIRECTIONS
Annual broadleaf weeds	2-4 pints	Treat when weeds are young and actively growing. Perennial weeds should be near the bud stage, but not flowering at application. Do not use on susceptible southern grasses such as St. Augustine. Do not apply to newly seeded areas until grass is well established. Bentgrass, clover, legumes and dichondria may be injured by this treatment

RESTRICTIONS AND LIMITATIONS FOR USE ON ORNAMENTAL TURF AREAS

Use sufficient spraymix volume for thorough and uniform coverage
Do not apply more than 2 broadcast applications per year per treatment site. This does not exclude spot treatments.
Do not allow people (other than applicator) or pets on treatment area during application.
Do not enter treatment areas until sprays have dried.

WEEDS	RATE	DIRECTIONS
Annual broadleaf weeds	3 pints	For control of weeds on the orchard floor, apply using coarse sprays and low pressure in sufficient volume of water to obtain thorough wetting of weeds. Treat when weeds are small and actively growing. Do not use on light, sandy soil. Do not use in California.

APPLES, PEARS, STONE FRUIT AND NUT ORCHARD

RESTRICTIONS AND LIMITATIONS FOR USE IN STONE FRUIT AND NUT ORCHARDS

Do not apply to bare ground as injury may result.
Do not apply immediately before irrigation and withhold irrigation for 2 days before and for 3 days after treatment.
Do not allow spray drift to contact foliage, fruit, stems, trunks of trees or exposed roots, as injury may result.
Do not apply to newly established or young orchards. Trees must be at least 1 year old and in vigorous condition.
Do not apply during bloom.
Do not graze or feed cover crops from treated orchards.
Do not make more than 2 applications per year.
Do not harvest stone fruit within 40 days of application.
Do not harvest nuts within 60 days of application.

WEEDS AND BRUSH IRRIGATION CANAL DITCHBANKS

(Seventeen Western States: Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, New Mexico, Nevada, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming)

For control of annual and perennial broadleaf weeds, apply 1 to 2 quarts of CAVERN® 68 Broadleaf Herbicide per acre at a rate of 20 to 100 gallons of spraymix per acre. Treat when weeds are young and actively growing before the bud or early boom stage. For harder-to-control weeds, a repeat spray after 3 to 4 weeks using the same rates may be needed for maximum results. Apply no more than two treatments per season.

For woody brush and patches of perennial broadleaf weeds, mix 1 gallon of CAVERN® 68 Broadleaf Herbicide in 150 gallons of water. Wet foliage thoroughly using about 1 gallon of solution per square yard.

SPRAYING INSTRUCTIONS

Apply with low pressure (10 to 40 psi) power spray equipment mounted on a truck, tractor, or boat. Apply while traveling upstream to avoid accidental concentration of chemical into water. Spray when the air is fairly calm, 5 mph or less. Do not use on small canals (less than 10 cfs) where water will be used for drinking purposes.

Do not boom spray onto water surface or allow any spray to contact open water. Do not cross-stream spray to opposite banks. When spraying shoreline weeds, do not allow overspray onto water.

Do not allow dairy animals to graze on treated areas for at least 7 days after spraying. Water within treated banks should not be fished.

LIMITED WARRANTY AND DISCLAIMER

The manufacturer warrants that this product conforms to the chemical description on the label; that this product is reasonably fit for the purposes set forth in the directions for use when it is used in accordance with such directions; and that the directions, warnings and other statements on this label are based upon responsible experts' evaluation of reasonable tests of effectiveness, of toxicity to laboratory animals and plants, of residues on food crops, and upon reports of field experience. Tests have not been made on all varieties or in all states or under all conditions. THE MANUFACTURER NEITHER MAKES NOR INTENDS, NOR DOES IT AUTHORIZE ANY AGENT OR REPRESENTATIVE TO MAKE, ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, AND IT EXPRESSLY EXCLUDES AND DISCLAIMS ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

THIS WARRANTY DOES NOT EXTEND TO, AND THE BUYER SHALL BE SOLELY RESPONSIBLE FOR, ANY AND ALL LOSS OR DAMAGE WHICH RESULTS FROM THE USE OF THIS PRODUCT IN ANY MANNER WHICH IS INCONSISTENT WITH THE LABEL DIRECTIONS, WARNINGS OR CAUTIONS.

BUYER'S EXCLUSIVE REMEDY AND MANUFACTURER'S OR SELLER'S EXCLUSIVE LIABILITY FOR ANY AND ALL CLAIMS, LOSSES, DAMAGE, OR INJURIES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT, WHETHER OR NOT USED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY IN TORT OR OTHERWISE SHALL BE LIMITED, AT THE MANUFACTURER'S OPTION, TO REPLACEMENT OF, OR THE REPAYMENT OF THE PURCHASE PRICE FOR, THE QUANTITY OF PRODUCT WITH RESPECT TO WHICH DAMAGES ARE CLAIMED. IN NO EVENT SHALL MANUFACTURER OR SELLER BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGE RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT.

NOTICE TO BUYER

Purchase of this material does not confer any rights under patents governing this product or the use thereof in countries outside of the United States.

MARISTREET AG PRODUCTS, INC.

PO Box 19325, NW Elizabeth Drive
Court Pontiac, North Carolina 27715

CAVERN® 68 is a registered trademark of Maristreet Ag Products, Inc.

For PRODUCT USE Information, Call 1-800-334-9745
For EMERGENCY Information ONLY Call 24 Hours-A-Day 1-800-334-7577

Radiant 40F

Flowable Fungicide

Turf and Ornamental Fungicide

Rightstep Chemical, LLC

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).

Active Ingredient:

Chlorothalonil (tetrachloroisophthalonitrile)	40.4%
Inert Ingredients:	59.6%
Total:	100.0%

Contains 4.17 pounds chlorothalonil per gallon (500 grams per liter)

Precautionary Statements
Hazards to Humans and Domestic Animals

WARNING—AVISO

Causes substantial, but temporary, eye injury. Harmful if swallowed, or absorbed through the skin. Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals. Avoid contact with skin. DO NOT get in eyes or on clothing. DO NOT take internally.

Note to User: This product may produce mild bronchial irritation and temporary irritation of the skin characterized by redness or rash on exposed skin areas. Affected persons should consult a physician.

FIRST AID
If swallowed: Call physician or Poison Control Center. 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.
If in eyes: Immediately flush eyes with plenty of water and continue for 15 minutes. Seek medical attention for eyes immediately.
If on skin: Wash with plenty of soap and water. Get medical attention.
Note to physician: Persons having temporary irritation may respond to treatment with antihistamines or steroid creams and/or systemic steroids.

Personal Protective Equipment (PPE)
Applicators and other handlers must wear long sleeved shirt and long pants, waterproof gloves, shoes plus socks, and protective eyewear. For exposures in enclosed areas, applicators and other handlers must wear a respirator with either an organic-vapor-removing cartridge with a pre-filter approved for pesticides (MSHA/NIOSH approved number prefix TC-23C), or a canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G).

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.

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. DO NOT reuse them. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

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.

Environmental Hazards
This product is toxic to fish, aquatic invertebrates, and marine/estuarine organisms. Runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. DO NOT apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. DO NOT apply when weather conditions favor drift from treated areas. Apply only to areas specified on label. DO NOT contaminate water when disposing of equipment washwaters.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling
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 requirement 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 the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamina-

This is a Fictitious Pesticide Label for Testing and Training Purposes Only.

tion, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) 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.

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, shoes plus socks, and protective eyewear.

Radiant 40F Flowable Fungicide is an excellent disease control agent when used according to label directions for control of a broad spectrum of plant diseases. Radiant 40F Flowable Fungicide is recommended for use in programs that are compatible with the principles of Integrated Pest Management (IPM), which include the use of disease-resistant crop varieties, cultural practices, pest scouting and disease forecasting systems that reduce unnecessary applications of pesticides.

Radiant 40F Flowable Fungicide is effective for strategic use in programs that attempt to minimize disease resistance to fungicides. Some other fungicides that are at risk for disease resistance exhibit a single-site mode of fungicidal action Radiant 40F Flowable Fungicide, with a multi-site mode of action, may be used to delay or prevent the development of resistance to single-site fungicides. Consult with your Federal or state Cooperative Extension Service representatives for guidance on the proper use of Radiant 40F Flowable Fungicide in treatment programs to minimize the occurrence of disease resistance to other fungicides.

DO NOT combine Radiant 40F Flowable Fungicide in the spray tank with pesticides, surfactants or fertilizers, unless your prior use has shown the combination physically compatible, effective and noninjurious under your conditions of use. DO NOT combine Radiant 40F Flowable Fungicide with Dipel 4L, Foil, Triton AG-98, Triton B-1956, Latron AG-98 or CARBOM 4L as phytotoxicity may result from the combination when applied to some species on this label.

Dipel is a registered trademark of Abbott Laboratories; Foil is a registered trademark of Ecogen, Inc. Latron B-1956 and AG-98 are trademarks of Rohm and Hass Company. CARBOM 4L is a trademark of IDACHEM, Inc.

The required amount of Radiant 40F Flowable Fungicide should be added slowly into the spray tank during filling while tank is being agitated. With concentrate sprays, pre-mix the required amount of Radiant 40F Flowable Fungicide in a clean container and add to the spray tank as it is being filed. Keep agitator running when filing spray tank and during spray operations.

Golf Course Fairways, Lawns and Other Turfgrasses:
Apply Radiant 40F Flowable Fungicide in 30 to 40 gallons of water per acre. Begin applications when conditions favor disease development and repeat applications as long as these conditions persist. Under severe disease conditions use the highest rate and shortest interval corresponding with the application schedule selected from the table below.

DO NOT mow or water after treatment until spray deposited on turfgrass is thoroughly dry; Radiant 40F Flowable Fungicide should always be used in conjunction with good turf management practices.

* Low rate is not effective on intensively mowed turfgrasses, such as golf course tees and greens.

Golf Course Tees/Greens, and Ornamental Turfgrass:
Apply Radiant 40F Flowable Fungicide in an adequate amount of water to provide complete coverage. This amount may vary from 90 to 450 gallons per acre. See below for suggested rates and timing. Under severe disease conditions, use the high rate and apply on a 7-day schedule.

Diseases Controlled*	Interval of Application	Application Rate per Acre
Dollar spot	7-10 days 14-21 days	4 to 8 pts 8 to 14 pints
Leaf spot, Melting-out, Brown blight	7-10 days 14-21 days	8 pts 8 to 14 pts
Brown patch	7-14 days	8 to 14 pts
Gray leaf spot	7-10 days	8 to 16 pts
Red thread	7-10 days	8 to 24 pts
Anthracnose	7-14 days	12 to 24 pts

Diseases Controlled*	Interval of Application	Rate: Liquid Ounces Per 1000 Sq. Ft.	
		Before Disease Occurs	After Disease Has Occurred
Dollar spot	7-14 days	3-6	6-11
Brown patch	7-14 days	3-6	6-11
Leaf Spots, Melting-out	7-10 days	3-6	6-11
Gray leaf spot	7-10 days	3-6	6-11
Red thread	7-10 days	3-9	9-11
Anthracnose	7-14 days	5-9	———
Copper spot	7-10 days	6-9	9-11
Stem rust (bluegrass)	7-14 days	6-9	9-11
DICHONDRA: Leaf spot (California Only)	7-14 days	6-9	9-11

*Diseases listed are caused by fungi, some of which are named as follows:

1. Dollar Spot: *Sclerotina homeocarpa; Lanzia or Moellerodiscus* spp.
2. Brown patch: *Thizoctonia solani, R. zeae, R. cerealis*
3. Leaf spots, Melting-out, Brown blight: *Drechslera* spp. (including *D. poae, D. siccans*), *Bipolaris sorokiniana, Curvularia* spp.
4. Gray leaf spot: *pyricularia grisea, P. oryzae*
5. Red thread: *Laetisaria fuciformis*
6. Anthracnose: *Colletotrichum graminicola*
7. Copper spot: *Gloeocercospora sorghi*
8. Stem rust: *Puccinia graminis*
9. Dichondra leaf spot: *Alternaria* spp.

This is a Fictitious Pesticide Label for Testing and Training Purposes Only.

Gray snow mold caused by *Typhula* spp.—Apply in sufficient water to obtain adequate coverage (2 to 10 gallons per 1,000 square feet). Apply 8 to 16 fluid ounces of Radiant 40F Flowable Fungicide per 1,000 square feet of turf area. Application must be made before snow cover in autumn. Use the higher rate if turf layer remains frozen prior to snow cover. If snow cover is intermittent or lacking during the winter, re-apply Radiant 40F Flowable Fungicide at 8 fluid ounces per 1,000 square feet at monthly intervals until gray snow mold conditions no longer prevail. In areas where pink snow mold (Gerlachia or Fusarium patch) is likely to occur, apply Radiant 40F Flowable Fungicide at 8 fluid ounces per 1,000 square feet in combination with products containing either benomyl at 1 ounce active ingredient per 1,000 square feet, or iprodione at 2 ounces active ingredient per 1,000 square feet of turf area. Read and observe all label directions for products containing these active ingredients.

Fusarium (Gerlachia) Patch: For control of Fusarium patch only in areas where snow cover is intermittent or lacking during the winter, apply 8 to 14 fluid ounces of Radiant 40F Flowable Fungicide per 1,000 square feet of turf area. Begin applications in late autumn and re-apply in 21 to 28 day intervals until conditions favorable for Fusarium patch no longer prevail.

Algae: For prevention of algae on turfgrasses, apply Radiant 40F Flowable Fungicide at the rate of 3 to 6 ounces per 1,000 square feet on a 7 to 14 day schedule. Under severe algae conditions, use the high rate and apply on a 7 day schedule. When algae is well established, every attempt should be made to dry out the afflicted area. Once dry, spiking or verticutting should be done to enhance turfgrass recovery in conjunction with Radiant 40F Flowable Fungicide at the rate of 6 to 11 ounces per 1,000 square feet on a 7 to 14 day schedule. Several applications of Radiant 40F Flowable Fungicide at the high rate may be necessary for turfgrass recovery. Only a preventive spray program with Radiant 40F Flowable Fungicide will prevent a recurrence of the algae when environmental conditions are favorable.

Ornamental Plants
Apply Radiant 40F Flowable Fungicide at a rate of 2 pints per 100 gallons of water, unless other directions are given in the following tables. Apply in a spray to the point of run-off, when conditions are favorable for disease development. Repeat applications at 7 to 14 day intervals until conditions are no longer favorable. During periods when conditions favor severe disease incidence, generally cloudy or wet weather, apply Radiant 40F Flowable Fungicide at 7 day intervals. Radiant 40F Flowable Fungicide should be applied to plants when both foliage and flowers are dry or nearly dry.

Use of Radiant 40F Flowable Fungicide is recommended for control of fungal diseases referred to by numbers in parentheses following each ornamental. Ornamentals listed on this label have been tested and found to tolerate applications of Radiant 40F Flowable Fungicide at the recommended rates. The user should test for possible phytotoxic responses, using recommended rates on ornamental plants on a small area prior to commercial use. Applications made during bloom may damage flowers and/or fruits.
Fruits and other structures which may be borne on treated plants MUST NOT BE EATEN.

Ornamentals Recommended for Treatment with Radiant 40F Flowable Fungicide

BROADLEAF SHRUBS AND TREES

Andromeda (pleris) (4)	Flowering Cherry (1,2)	Photinia (1)
Ash (Fraximus) (1)	Flowering Peach (1,2)	Poplar (1)
Aspen (1)	Flowering Plum (1,2)	Privet (Ligustrum) (1)
Azalea (1,2,4)	Flowering Quince (1,2)	Rhododendron (1,2,4)
Buckeye, Horsechestnut (1)	Hawthorn (1,6)	Sand Cherry (1,2)
	Holly (1)	Sequoia (1)
Cherry-Laurel (1)	Lilac (5)	Spiraea (1)
Crabapple (1,6,8)	Magnolia(1)	Sycamore, Planetree (1)
Dogwood (1)	Maple (1)	
Eucalyptus (3)	Mountain Laurel (1)	Viburnum (5)
Euonymus (1)	Oak (red group only) (1,7)	Walnut (Juglans) (1)
Firethorn (Pyracantha) (1)	Oregon-Grape (Mahonia) (6)	
Flowering almond (1,2)		

FLOWERING PLANTS[1] AND BULBS

Arabian Violet (2)	Geranium (1,6)	Narcissus (1)
Begonia (1)	Gladiolus (1,2)	Pansy (1)
Camellia (2)	Hollyhock (6)	Petunia (1,4)
Carnation (1,2)	Hydrangea (foliage only) (1,6)	Phlox (1)
Chrysanthemum (1,2)	Iris (1,2)	Poinsettia[2] (1)
Crocus (1)	Lilly (1)	Rose[3] (1)
Daffodil (1)	Marigold (1)	Statice (1)
Daisy (1)		Tulip (1)
		Zinnia (1,5)

[1] Avoid applications during bloom period on plants where flower injury is unacceptable.
[2] Discontinue applications prior to bract formation, phytotoxicity is possible on the bracts.
[3] Use 1.5 pints per 100 gallons of water.

FOLIAGE PLANTS

Aplaonema (1)	Ficus (1)	Parlor palm (Chamaedorea) (1)
Areca palm (1)	Florida Ruffle Fern (1)	Peperomia (1)
Artemesia (1)	Leatherleaf Fern (1)	Philodendron (1,4)
Boston fern (1)	Lipstick plant (1)	Prayer plant (Maranta) (1)
Dumbcane (Diffenbachia) (1)	Ming aralia (1)	Syngonium (1)
	Oyster plant (Rhoeo) (1)	Zebra plant (Aphelandra) (1)
Dracaena (1)	Pachysandra [4] (1)	
Tatsia (Aralia) (1)		

[4] Use 4 pints of Radiant 40F Flowable Fungicide per 100 gallons of water.

DISEASES CONTROLLED BY RADIANT 40F FLOWABLE FUNGICIDE

1. Leafspots/Foliar Blights:

Actinopelte leafspot	Cylindrosporium leafspot
Alternaria leafspot/leaf blight	Dactylaria leafspot
Anthracnose leaf blotch, spot	Didymellina leafspot
Anthracnose (Discula) blight	Dreschlera leafspot
Ascochyta blight	Fabraea (Entomosporium) leafspot
Bipolaris (Helminthosporium) leafspot	Fusarium leafspot
	Ink spot (Drechslera)
Black spot on Roses	Marssonina leafspot
Botrytis leafspot, leaf blight	Monilinia blossom blight, twig blight
Cephalosporium leafspot	Mycosphaerella ray blight
Coryneum blight (shothole)	Myrothecium leafspot, brown rot
Corynespora leafspot	Nemostella leaf blight
Curvularia leafspot	Rhizoctonia web blight

This is a Fictitious Pesticide Label for Testing and Training Purposes Only.

1. Leafspots/Foliar Blights (Continued):

Ramularia leafspot	Stagonospora leaf scorch
Septoria leafspot	Tan leafspot (Curvularia)
Sphaeropsis leafspot	Volutella leaf blight

2. Flower spots/blights:

Botritis flower spot, flower blight	Ovulinia flower blight
Curvularia flower spot	Rhizopus blossom blight
Monilinia blossom blight	Sclerotinia flower blight

3. Cylindrocladiumn stem canker

4. Phytophthora leaf blight, dieback

5. Powdery mildews:

Erysiphe cichoracearum	*Microsphaera* spp.

6. Rusts:

Gymnosporangium spp.	Puccinia spp.
Pucciniastrum hydrangeae	

7. Taphrina blister

8. Scab (*Venturia inaequalis*)

The following ornamental plant species which have been tested with Radiant 40F Flowable Fungicide at recommended rates did not exhibit phytotoxicity:

Botanical Name	Common Name
Aechmea fasciata	Aechmea
Araucaria heterophylla	Norfolk Island Pine
Asplenium nidus	Birdnest Fern
Bougainvillea spp.	Bougainvillea
Caladium spp.	Caladium
Calathea makoyana	Peacock plant
Calistephus chinesis	Aster
Carissa grandiflora	Natal plum
Clerodendron thomsonae	Bleeding Heart
Codiaeum spp.	Croton
Cordyline terminalis	Ti Plant
Crassula argentea	Jade Plant
Cyrthomium falcatum	Holly Leaf Fern
Dionaea muscipula	Venus Fly Trap
Dizygotheca elegantissima	False Aralia
Epipremnum aureum	Golden Pothos, Scindapsus
Episcia cupreata	Flame Violet
Fittonia spp.	Silver-nerve Plant
Gerbera jamesonii	Gerbera Daisy
Gynura sarmentosa	Purple Passion Vine
Gypsophila paniculata	Baby's Breath
Hoya spp.	Wax Plant
Ilex cornuta	Chinese Holly
Ilex crenata	Japanese Holly
Impatiens spp.	Impatiens
Pilea cadierei	Aluminum Plant
Platycerium spp.	Staghorn Fern
Sansevieria trifasciata "Hahnii"	Birdsnest Sansevieria
Tolmeia menziesii	Piggy-back Plant
Yucca elephantipes	Spineless Yucca
Zygocatus truncatus	Christmas Cactus

NOTE: DO NOT apply Radiant 40F Flowable Fungicide to either green or variegated Pittosporum or to Schefflera, as multiple applications have been demonstrated to cause phytotoxic responses.

CONIFERS: Apply Radiant 40F Flowable Fungicide in sufficient water and with proper calibration to obtain uniform coverage of tree canopy. Application with ground equipment is preferable to aerial application because ground applications generally give better coverage of the tree canopy. If application with ground equipment is not feasible, Radiant 40F Flowable Fungicide may be applied with aircraft using at least 20 gallons per acre. When concentrate sprays are used or when treating non-bearing or immature trees, the lower rate of Radiant 40F Flowable Fungicide listed may be used. DO NOT allow livestock to graze in treated areas. The following spray volumes are recommended as gallons of spray per acre:

	Dilute	Concentrate
Forest stands	Not used	10 to 20 (Aircraft)
Christmas Trees	100	10 to 50 (Aircraft or ground equipment)
Nursery beds	100	5 to 10 (Ground equipment only)

Disease Controlled	Radiant 40F Rate Per Acre	100 Gall*	Application Directions
Swiss needlecast	4-8 pts	4-8 pts	Single application technique: In Christmas Tree plantations or forest stands make one application in the spring when new shoot growth is 1/2 to 2 in. in length.
Scleroderris canker (pines), Swiss needlecast (Douglas-fir)	2-4 pts	2-4 pts	Make the first application in spring when new shoot growth is 1/2 to 2 in. in length. Make additional applications at 3-4 week intervals until conditions no longer favor disease development. For use in nursery beds, apply the highest rate specified on a 3 week schedule.
Sirococcus tip blight	3-5 pts	3-5 pts	
Rhizosphaera needlecast (spruces), Scirrhia brown spot (pines)	8 pts	8 pts	
Cyclaneusma and Lophodermium needlecast (pines)	4-9 pts	4-8 pts	Apply in early spring prior to budbreak. Repeat applications at approximately 6-8 week intervals, until spore release ceases in late fall. Apply monthly during periods of frequent rainfall, and where Lophodermium infections occur during dormancy (Pacific NW). During drought periods, applications may be suspended, then resumed upon next occurrence of needle wetness.
Rhabdocline needlecast (Douglass fir)	2-4 pts	2-4 pts	Apply at budbreak and repeat at 3 -4 week intervals until needles are fully elongated and conditions no longer favor disease development. In plantations of mixed provenance, or when irregular budbreak occurs, apply weekly until all trees have broken bud, then every 3-4 weeks as specified above. In nursery beds, use the high rate on a 3 week schedule.
Botrytis seedling blight Phoma twig blight	2-4 pts	2-4 pts	Begin applications in nursery beds when seedlings are 4 in. tall and when cool, moist conditions favor disease development. Make additional applications at 7- 14 day intervals as long as disease favorable conditions persist.

* Volumetric Rates to be used only with full dilute spray volume specified on the label.

Application and Calibration Techniques for Sprinkler Irrigation

Apply this product only through center pivot, motorized lateral move, solid set or portable (Wheel move, side roll, end tow, or hand move) irrigation system(s). DO NOT apply this product through any other irrigation system. DO NOT use Radiant 40F Flowable Fungicide through sprinkler irrigation equipment on golf courses.

Crop injury, lack of effectiveness, or illegal pesticide residue in the crop can result from non-uniform distribution of treated water.

If you have questions about calibration, you should contact State Extension Service specialists, equipment manufacturers or other experts.

DO NOT apply this product through irrigation systems connected to a public water system. "Public water system" means a system provided to the public of piped water for human consumption, if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily, at least 60 days per year.

Controls for both irrigation water and pesticide injection systems must be functionally interlocked, so as to automatically terminate pesticide injection when the irrigation water pump motor stops. A person knowledgeable of the irrigation system and responsible for its operation shall be present, so as to discontinue pesticide injection and make necessary adjustments, should the need arise.

The irrigation water pipeline must be fitted with a functional, automatic, quick-closing check valve to prevent the flow of treated irrigation water back toward the water source. The pipeline must also be fitted with a vacuum relief valve and low pressure drain, located between the irrigation water pump and the check valve, to prevent back-siphoning of treated irrigation water into the water source.

Always inject Radiant 40F Flowable Fungicide into irrigation water after it discharges from the irrigation pump and after it passes through the check valve. Never inject pesticides into the intake line on the suction side of the pump.

Pesticide injection equipment must be fitted with a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump. Interlock this valve to the power system, so as to prevent fluid from being withdrawn from the chemical supply tank when the irrigation system is either automatically or manually turned off.

The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump. The irrigation line or water pump must include a functional pressure switch to stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.

Spray mixture in the chemical supply tank must be agitated at all times, otherwise settling and uneven application may occur. Do not apply when wind speed favors drift beyond the area intended for treatment.

Posting of areas to be chemigated is required when 1) any part of a treated area is within 300 feet of sensitive areas, such as residential areas, labor champs, businesses, day care centers, hospitals, in-patient clinics, nursing homes, or any public areas, such as schools, parks playgrounds or other public facilities not including public roads, or 2) when the chemigated area is open to the public.

Posting must conform to the following requirements. Treated areas shall be posted with signs at all usual points of entry and along likely routes of approach from the listed sensitive areas. When there are no usual points of entry, signs must be posted in the corners of the treated areas and in any other location affording maximum visibility to sensitive areas. The printed side of the sign should face away from the treated area towards the sensitive area. The signs shall be printed in English. Signs must be posted prior to application and must remain posted until foliage has dried and soil surface water has disappeared. Signs may remain in place indefinitely, as long as they are composed of materials to prevent deterioration and maintain legibility for the duration of the posting period.

All words shall consist of letters at least 2 1/2 inches tall, and all letters and the symbol shall be a color that sharply contrasts with their immediate background. At the top of the sign shall be the words KEEP OUT, followed by an octagonal stop sign symbol at least 8 inches in diameter containing the word STOP. Below the symbol shall be the words PESTICIDES IN IRRIGATION WATER.

This sign is in addition to any sign posted to comply with the Worker Protection Standard.

Radiant 40F Flowable Fungicide may be used through two basic types of sprinklers irrigation systems as outlined in Section A and B below. Determine which type of system is in place, then refer to the appropriate directions provided for each types.

A. **Center Pivot, Motorized Lateral Move and Traveling Gun Irrigation Equipment**. For injection of pesticides, these continuously moving systems must use a positive displacement injection pump, of either diaphragm or piston type, constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock and capable of injection at pressures approximately 2-3 times those encountered within the irrigation line. Venturi applicator units cannot be used on these systems.

   Fill chemical supply tank of injection equipment with water. Operate system for one complete revolution or run across the field, measuring time required, amount of water injected, and acreage covered.

   Thoroughly mix recommended amount of Radiant 40F Flowable Fungicide for acreage to be covered into same amount of water used during calibration and inject into system continuously for one revolution or run. Mixture in the chemical supply tank must be continuously agitated during the injection run. Shut off injection equipment after one revolution or run, but continue to operate irrigation system until Radiant 40F Flowable Fungicide has been cleared from last sprinkler head.

B. **Solid Set and Portable (Wheel Move, Side Roll, End Tow, or Hand Move) Irrigation Equipment**

   With stationary systems, an effectively designed in-line venturi applicator unit is preferred, which is constructed of materials that are compatible with pesticides; however, a positive-displacement pump can also be used.

   Determine acreage covered by sprinkler. Fill tank of injection equipment with water and adjust flow to use contents over a thirty to forty-five minute period. Mix desired amount of Radiant 40F Flowable Fungicide for acreage to be covered with water so that the total mixture of Radiant 40F Flowable Fungicide plus water in the injection tank is equal to the quantity of water used during calibration, and operate entire system at normal pressures recommended by the manufacturer of injection equipment used, for amount of time established during calibration. Agitation is recom-

mended. Radiant 40F Flowable Fungicide can be injected at the beginning or end of the irrigation cycle or as a separate application. Stop injection equipment after treatment is completed and continue to operate irrigation system until Radiant 40F Flowable Fungicide is cleared from last sprinkler head.

Storage and Disposal

DO NOT contaminate water, food or feed by storage or disposal. Open dumping is prohibited.

Storage: Store in a cool place. Protect from excessive heat.

Pesticide Disposal: Pesticide wastes are toxic. Improper disposal of excess pesticide, pesticide spray or rinsate is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for Guidance.

Container Disposal: Triple-rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incinerate. If allowed by state and local authorities, by burning. If burned, stay out of smoke.

Warranty and Limitation of Damages

Seller warrants to those persons lawfully acquiring title to this product that at the time of the first sale of this product by Seller that this product conformed to its chemical description and was reasonably fit for the purposes stated on the label when used in accordance with Seller's directions under normal conditions of use, and Buyers and users of this product assume the risk of any use contrary to such directions. EXCEPT AS PROVIDED ELSEWHERE IN WRITING CONTAINING AN EXPRESSED REFERENCE TO THIS WARRANTY AND LIMITATION OF DAMAGES, SELLER MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OR GUARANTEE, INCLUDING ANY OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS OR MERCHANTABILITY, AND NO AGENT OF SELLER IS AUTHORIZED TO DO SO. In no event shall Seller's liability for any breach of warranty or guarantee exceed the purchase price of the product as to which a claim is made.

Buyer and users of this product are responsible for all loss or damage from use or handling of this product which results from conditions beyond the control of Seller, including, but not limited to, incompatibility with other products unless otherwise expressly provided in the Directions for Use of this product, weather conditions, cultural practices, moisture conditions, or other environmental conditions outside of the ranges that are generally recognized as being conductive to good agricultural and/or horticultural practices.

PRODUCT INFORMATION

Radiant 40F Flowable Fungicide is distributed by Rightstep Chemicals, LLC. Comments and questions concerning Sniper® Plus Landscape and Aquatic Herbicide may be directed to Rightstep Chemicals, LLC Consumers Affairs Division, 1496 Columner Drive, Machares, Indiana 46269. You can also telephone our Consumer Affairs Division at 1-800-456-3288 and specify the product and the nature of the comment.

Rightstep Chemicals, LLC is a subsidiary of Palaides Industrial Chemical, LLC.

Rightstep Chemicals, LLC

www.rightstepchem.com

This is a Fictitious Pesticide Label for Testing and Training Purposes Only.

APPENDIX B:
Telephone Numbers

Office of the Governor, State of Idaho

Phone	(208) 334-2100
Fax	(208) 334-3454

Office of Emergency Management

Phone	(208) 846-7610
Emergency	(800) 632-8000

Idaho State Department of Agriculture

Director

Phone	(208) 332-8500

Division of Agricultural Resources

Phone	(208) 332-8605

University of Idaho Extension

Associate Director

Phone	(208) 885-5883
Fax	(208) 885-6654

Idaho State Police

ISP Headquarters	(208) 884-7000
Fax (Meridian)	(208) 884-7290

Department of Transportation

Director

Phone	(208) 334-8000
Fax	(208) 334-3858

National Poison Control

Phone	(800) 222-1222

Idaho Alfalfa and Clover Seed Commission (IACSC)

Phone	(208) 888-0988
Fax	(208) 888-4586

Idaho Apple Commission and Cherry Commission

Phone	(208) 722-5111
Fax	(208) 722-6582

Idaho Barley Commission

Phone	(208) 334-2090
Fax	(208) 334-2335

Idaho Bean Commission

Phone	(208) 334-3520
Fax	(208) 334-2442

Idaho Dairy Products Commission (United Dairymen of Idaho)

Phone	(208) 327-7050

Idaho Grape Growers and Wine Producers Commission

Phone	(208) 332-1538
Fax	(208) 334-2505

Idaho Honey Commission

Phone	(208) 949-8865

Idaho Hop Commission

Phone	(208) 722-5111
Fax	(208) 722-6582

Idaho Mint Commission

Phone	(208) 888-0988
Fax	(208) 888-4586

Idaho Pea and Lentil Council

Phone	(208) 882-3023
Fax	(208) 882-6406

Idaho Potato Commission

Phone	(208) 334-2350

Idaho Oilseed Commission

Phone	(208) 888-0988
Fax	(208) 888-4586

Idaho Rangeland Resource Commission

Phone	(208) 398-7002

Idaho Sheep Commission

Phone	(208) 334-3115
Fax	(208) 336-9447

Idaho Wheat Commission

Phone	(208) 334-2353
Fax	(208) 334-2505

APPENDIX C:
Conversion Table

To use this conversion table, multiply the number in the left-hand column by the conversion factor in the center column. This converts your original number to the units in the right-hand column.

MULTIPLY	BY	TO GET
Acres	43,560	Square Feet
Acres	4,840	Square Yards
Acres	0.405	Hectares
Bushels	64	Pints (dry)
Bushels	32	Quarts (dry)
Cubic Feet	1,728	Cubic Inches
Cubic Feet	0.037	Cubic Yards
Cubic Feet	7.481	Gallons (liquid)
Cubic Feet	59.84	Pints (liquid)
Cubic Feet	29.92	Quarts (liquid)
Cups	8	Ounces (liquid)
Cups	16	Tablespoons
Feet	30.48	Centimeters
Feet	12	Inches
Feet	0.305	Meters
Feet	⅓ or 0.333	Yards
Gallons (liquid)	128	Ounces (liquid)
Gallons (liquid)	8	Pints (liquid)
Gallons (liquid)	4	Quarts (liquid)
Gallons of Water	8.345	Pounds of Water
Grams	0.001	Kilograms
Grams	1,000	Milligrams
Grams	0.035	Ounces
Grams Per Liter	1,000	Parts Per Million

MULTIPLY	BY	TO GET
Miles	5,280	Feet
Miles	1,760	Yards
Miles Per Hour	88	Feet Per Minute
Miles Per Hour	1.467	Feet Per Second
Miles Per Minute	88	Feet Per Second
Miles Per Minute	60	Miles Per Hour
Ounces (dry)	28.35	Grams
Ounces (dry)	0.063	Pounds
Ounces	0.063	Pints
Ounces (liquid)	0.031	Quarts (liquid)
Parts per million	0.001	Grams per liter
Pecks	16	Pints (dry)
Pecks	8	Quarts (dry)
Pints	0.125	Gallons
Pints (liquid)	0.473	Liters
Pints (liquid)	2	Cups
Pints (liquid)	16	Ounces (liquid)
Pints	0.5	Quarts
Pounds	453.592	Grams
Pounds	16	Ounces (dry)
Pounds	0.0005	Tons
Quarts	2	Pints
Quarts	0.25	Gallons
Quarts (liquid)	0.946	Liters

MULTIPLY	BY	TO GET
Hectares	2.47	Acres
Inches	2.54	Centimeters
Kilograms	1,000	Grams
Kilograms	2.205	Pounds
Kilometers	3,281	Feet
Kilometers	0.621	Miles
Liters	0.264	Gallons (liquid)
Liters	2.113	Pints (liquid)
Liters	1.057	Quarts (liquid)
Meters	100	Centimeters
Meters	3.281	Feet
Meters	39.37	Inches
Meters	0.001	Kilometers
Meters	1,000	Millimeters
Meters	1.094	Yards

MULTIPLY	BY	TO GET
Quarts (liquid)	32	Ounces (liquid)
Quarts	2	Pints
Rods	16.5	Feet
Square Miles	640	Acres
Square Yards	27,878,400	Square Feet
Square Yards	1,296	Square Inches
Tablespoons	3	Teaspoons
Temperature (C) + 17.98	1.8	Temp. °F
Temperature (F) - 32	0.555	Temp. °C
Tons (US)	907.185	Kilograms
Tons (US)	2,000	Pounds
Yards	3	Feet
Yards	36	Inches
Yards	0.914	Meters

Formulas

Calculate the area of a

1. Rectangle = Length × Width
2. Circle = $\pi \times R^2$ ($\pi = 3.14$, R^2 = radius squared)

Calculate the circumference of a circle = πd ($\pi = 3.14$, d = diameter)