PRIVATE PESTICIDE APPLICATOR STUDY MANUAL

ANR-1307

ALABAMA COOPERATIVE EXTENSION SYSTEM, ALABAMA A&M AND AUBURN UNIVERSITIES

www.aces.edu

Private Pesticide Applicator Study Manual

IMPORTANT TELEPHONE NUMBERS

EMERGENCY NUMBERS

In an emergency dial 911, especially if the person is unconscious, has trouble breathing, or has convulsions.

POISON CONTROL CENTERS (HUMAN OR ANIMAL)

National Poison Control Hotline (Spanish speakers available)

(800) 222-1222

Physician _____ **Ambulance**_____

FIRES, SPILLS, LEAKS, ETC.

Chemtrec (technical assistance 24 hours a day for fires, spills, and medical emergencies)

(800) 424-9300

Alabama Department of Environmental Management

(334) 271-7700

Alabama Emergency Management Agency

(205) 280-2200

Sheriff _____ **City Police**_____

Alabama Highway Patrol Post _____ **Fire Department**_____
(*HP (*47) for mobile phones)

ENDANGERMENT OF GAME OR FISH

Alabama Department of Conservation and Natural Resources (Nongame endangered species)

(334 242-3863)

U.S. Fish and Wildlife Service

(800) 344-WILD

WORKER PROTECTION STANDARD

The U.S. EPA Worker Protection Standard (WPS) requires agricultural employers to provide four basic protections for their employees: (1) employees must receive pesticide safety training; (2) information concerning pesticides applied in the work area must be posted in a central location; (3) employees must be excluded from treated areas or provided proper training and safety equipment if they may be exposed to pesticides; (4) employers must supply decontamination sites (soap, water, etc.) for workers. Emergency assistance must be available for any employee injured by pesticides. For details, refer to the EPA Worker Protection Standard for Agricultural Pesticides—How to Comply at http://www.epa.gov/pesticides/safety. Additional information is available from the Alabama Department of Agriculture and Industries at (334) 240-7243 or the Alabama Cooperative Extension System at (334) 844-2563.

PHONE NUMBERS FOR PESTICIDE INFORMATION

NONEMERGENCY

Alabama Cooperative Extension System
(334) 844-2563

Regional Poison Control Center, Children's Hospital, Birmingham, AL
Nonemergencies and educatonal information
(800) 292-6678

Alabama Poison Center, Shelton State Community College, Tuscaloosa, AL
Nonemergencies and educatonal information
(800)462-0800

National Pesticide Information Center (NPIC), Oregon State University - General information on toxicology, environmental hazard, etc.
(M-F, 8:30 a.m. to 6:30 p.m. CST)
(800) 858-7378

Pesticide Manufacturer - The telephone number should be listed on the pesticide label.

CropLife America - General information about the pesticide industry (M-F, 9:00 a.m. 5:00 p.m. EST)
(202) 296-1585

Chemtrec Referral Center
Refers caller to the company responsible for the pesticide (M-F, 9:00 a.m. to 6:00 p.m. EST)
(800) 262-8200

National Response Center
Refers caller to proper government agency for hazardous materials
(800) 424-8802 (Voice/TTY)

PESTICIDE DISPOSAL

Alabama Department of Agriculture & Industries
(334) 240-7237

Alabama Department of Environmental Management
(334) 271-7730

EPA Hazardous Waste Hotline (Superfund)
(800) 424-9346

HAZARD COMMUNICATION
Workplace Assistance

OSHA **(800) 321-OSHA (6742)**
TTY (877) 889-5627

Regional IV OSHA Office Alliance in Atlanta
(404) 562-2277

EPA SAFE DRINKING WATER HOTLINE
Interprets residue data and gives EPA drinking water regulations. **(800) 426-4791**

Or call your local health department or sanitarian.
County _____ City _____

ENFORCEMENT OF PESTICIDE LAWS

Alabama Department of Agriculture & Industries, Pesticide Management Division **(334) 240-7239**

EPA Region IV Pesticides Section **(404) 562-8956**

Applicator certification to use restricted use pesticides **(334) 240-7240**

Structural pest control certification
(334) 240-7241

Safety/Training/Information
(334) 240-7239 or **(334) 844-2563**

INTRODUCTION

As of October 21, 1977, anyone wishing to use restricted use pesticides must be certified. Certification is a method of ensuring that applicators know the safe and correct way to handle and apply pesticides.

The Environmental Protection Agency (EPA) has set minimum competency standards for pesticide applicators. These minimum standards include a practical knowledge of subject areas such as pest identification, pest control, label comprehension, pesticide laws, and environmental considerations. The actual certification of applicators is the responsibility of each individual state. Alabama law requires that anyone who applies restricted use pesticides on his or her own property or anyone who applies pesticides for hire must be certified as either a private or commercial pesticide applicator.

Private pesticide applicators are people who apply any restricted use pesticide for the production of an agricultural commodity on their own property or on the property of another person with whom they trade services. Employees of a permitted private applicator may apply a restricted use pesticide as long as they are being supervised by the permitted employer.

Pesticides may be federally restricted by the EPA, or they may be restricted for use in Alabama by the Department of Agriculture and Industries. Generally, pesticides are restricted because they may be especially harmful to the applicator, other people, or the environment unless they are applied correctly by competent individuals. The list of restricted use pesticides changes periodically. See your local Extension agent for a current list.

REQUIRED TRAINING AND CERTIFICATION

Federal regulations set minimum standards for anyone handling restricted use pesticides. Federal regulations change from year to year. Both the restricted use list and label registration change to meet changing federal regulations.

Certification Process

The Alabama Department of Agriculture and Industries is the state agency responsible for certification of pesticide applicators in Alabama. The Alabama Cooperative Extension System is responsible for providing assistance and training to applicants for certification. The Alabama Department of Agriculture issues certification permits and keeps records of each permit applicant. Permits are issued for a three-year period at a cost of $25.

The procedure for obtaining private applicator permits is as follows:

- The local Extension agent will provide pesticide use training to meet both federal and state certification requirements. Training will be provided at a designated time and place.
- The applicant will then complete an examination at the end of training. The Extension office will grade the examination to evaluate the training process and to keep a record of the applicant's proficiency.
- The applicant will fill out an application for a restricted use permit, stating that he or she agrees to follow all label directions. The completed application, along with a permit fee of $25 (use check or money order; no cash), should be mailed to the Alabama Department of Agriculture and Industries, P. O. Box 3336, Montgomery, Alabama 36109-0336.
- Permits will be valid for a three-year period and can be used to purchase all restricted pesticides.

Alternate Procedure

Applicants may obtain a self-study manual and examination at their local Extension office. They can complete the examination while reading their manuals, or they can take the package home to study and complete the examination and application. They then mail the examination, application, and a $25 fee to the Alabama Department of Agriculture and Industries, P.O. Box 3336, Montgomery, Alabama 36109-3336.

Emergency Situation

In past years, individuals could obtain emergency permission to purchase and use a restricted use pesticide without having a certification permit. However, due to reoccurring emergency requests from private applicators, this procedure is no longer available except in extreme pest emergencies. This procedure is good for a one-time purchase. The emergency must be reported to the Alabama Department of Agriculture and Industries by the local Extension agent and the Department will contact the pesticide dealer directly to approve the sale.

Recertification

Private applicators are required to become recertified after three years by the same procedure outlined above.

Much of the information in this manual was extracted and adapted for Alabama use from similar manuals used in Arkansas, Florida, Georgia, and North Carolina.

Chapter 1

Pest Management: Insects, Weeds, Plant Diseases

Insects thrive in more environments than any other group of animals. They live in plants, soil, and water. They are at home everywhere.

Insects can be divided into three categories according to their importance to us:

- Insects of minor importance include 99 percent of all species. They are food for other animals.
- Beneficial insects are a small but important group that includes predators and parasites, pollinators, and insects that produce silk, dyes, and paint.
- Destructive insects are those that usually come to mind when insects are mentioned; this category actually includes the fewest number of species. These are the insects that feed on, cause injury, or transmit disease to humans, animals, plants, food, fiber, and structures. Destructive insects include aphids, beetles, fleas, mosquitoes, caterpillars, and termites.

Recognizing Common Features of Insects

All adult insects have two things in common – they have six jointed legs and three body regions. But how do you tell one insect from another? For identification, the most important parts to compare are wings and mouthparts. The wings vary in shape, size, thickness, and structure. Some insects have no wings. Others have two or four.

Insects with chewing mouthparts have toothed jaws that bite and tear food. Insects with piercing-sucking mouthparts have long beaks that they force into a plant or animal to suck out fluids or blood.

Almost all insects change in shape, form, and size during their lives. This change is called metamorphosis. It may be a gradual change, involving little more than an increase in size, or it may be a very dramatic one in which the adult bears little resemblance to the young.

In simple metamorphosis, the insect that hatches from the egg looks like a miniature copy of the adult. The juvenile forms are called nymphs. These nymphs, which have no wings, go through several growing stages before changing into winged adults. Examples of insects that undergo simple metamorphosis are grasshoppers, cockroaches, aphids, and scales.

Other insects undergo complete metamorphosis. They go through four stages. The egg hatches into a larva which may be called a worm, caterpillar, grub, or maggot. These insects grow the most and do the most damage during this stage. The larva changes into a pupa. From the pupal stage, the insect develops into its adult form. The adult insect usually has wings. Examples of insects that undergo complete metamorphosis are mosquitoes, black cutworm, European corn borer, and corn rootworm beetles.

Insect-like Pests

Mites, ticks, spiders, sowbugs, pillbugs, centipedes, and millipedes are not classified as insects, but resemble them in size, shape, life cycle, and habits. These pests usually can be controlled with the same techniques and materials used to control insects.

Insect Pests of Field Crops

Many insects attack field crops in Alabama. Fortunately, most of these pests never build up to economically damaging numbers. However, several insects have the potential to cause substantial losses each year.

When you are scouting fields for insects, remember the four steps involved in any pest control decision:

1. Identify the pest and understand its life cycle.
2. Determine the number of pests present.
3. Consult the economic threshold for the pest to see if a control treatment is economically justified.
4. Evaluate control options – mechanical, cultural, biological, or chemical. Choose the most effective method, the least costly, and the most environmentally sound.

Cotton Insects

Many insects attack cotton in Alabama. Control is usually required at some time in each season.

Boll Weevil

The boll weevil has now been eradicated from the state. Neither economic weevil numbers nor damage should exist in any field. If any weevil reinfestations are observed, they should be reported immediately to the local BWEP. The adult boll weevil is about ¼ inch long with a long snout. They are grayish to brown in color.

Thrips

Thrips are tiny insects that may be seen by shaking plants over a white cloth. Thrips are about 1/16 inch long and are light yellow to dark gray. The larvae are wingless and light-colored. The adults are winged and darker. Thrips attack cotton upon emergence in the spring, feeding on young leaves, terminals, and other tender plant parts. Leaves usually crinkle and curl upward as a result of feeding. Primary damage is stunted and delayed cotton growth.

Bollworm and Tobacco Budworm

The bollworm and tobacco budworm are different insects that can cause extensive damage to cotton in Alabama. This threat is reduced when Bt cotton is planted. The adults are easily distinguishable. The bollworm is slightly larger and a reddish brown to a whitish green brown. The tobacco budworm is greenish with dark bars running across the wings. The larvae are indistinguishable in the field.

Plant Bugs and Stinkbugs

The low-spray environment with boll weevil eradication and Bt cotton production increases the chances for more plant bugs and stinkbugs, especially during July and August. There are three species of plant bugs that attack cotton in Alabama. These are the tarnished plant bug, clouded plant bug, and the cotton flea hopper. Three main species of stinkbugs occur on cotton: the green stinkbug, the southern green stinkbug, and the brown stinkbug.

SOYBEAN INSECTS

Many insects can be found in soybeans. Listed below are a few of economic importance.

Three-cornered Alfalfa Hopper

The three-cornered alfalfa hopper is a small insect with sucking-piercing mouthparts. The adult is ¼ inch long and green with a humpback appearance. The nymphs are smaller, wingless, and have a row of spines down their back. Damage is caused by feeding when the hoppers girdle the plant, causing the stem to weaken.

Green Cloverworm

Green cloverworms can build up high populations in a field but seldom require control. They may be considered beneficial since they serve as a food source for beneficial insects.

Corn Earworm

Corn earworms cause major damage by feeding on pods, but will also feed on stems and leaves.

Soybean Looper

The soybean looper appears from mid-season to late season and causes damage by defoliating soybeans.

Velvetbean Caterpillar

The velvetbean caterpillar can cause damage in soybeans by stripping plants of their foliage.

CORN INSECTS

Many insects attack corn in Alabama. Yields may be significantly reduced in years in which heavy infestations occur. For proper management, it is very important to be able to identify and understand the life cycle of the corn pests.

Seed Corn Maggot

The seed corn maggot may be a problem in corn planted in cool, wet weather. The maggot is the larvae of a small fly. It feeds on the seed in the ground, causing scattered irregular stands.

Southern Corn Rootworm

The southern corn rootworm is a black-headed, slender, white worm about ¾ inch long. The adult is also known as the 12-spotted cucumber beetle and, as the name implies, is a small green beetle about ½ inch long with 12 black spots on its back. The larvae feed on corn roots and can cause serious damage.

Wireworms

Wireworms are hard-shelled, brownish larvae of the click beetle. The larvae feed on kernels and young roots, causing stunted plants. They are often a problem following sod.

Whorl and Ear Feeders

Damage to buds can be caused by two insects, the corn earworm and the fall armyworm. The corn earworm adult is about ½ inch long and brownish. It has a dark spot on the center of each wing. The larva is a large caterpillar up to 1½ inches long that is variable in color. It is slightly hairy in appearance with short spines scattered on the body. The fall armyworm adult is slightly smaller and has dark brown wings mottled with dark gray and white. It has white spots near the tips of the front wings. The larva is a dark brown caterpillar about 1 inch long with one median and one lateral, pale, inverted "Y" on the front.

European Corn Borer

The European corn borer is a gray or tan larva with rows of light brown spots or pinkish lines running the length of its body. It causes damage by boring into the leaves and stem of the corn plant.

Southwestern Corn Borer

The southwestern corn borer is a white larva with black spots on its body. It tends to attack the lower half of corn plants.

GRAIN SORGHUM INSECTS

A variety of insects attack grain sorghum in Alabama, causing a wide range of damage.

Aphids

Several types of aphids attack sorghum in Alabama, causing different types of damage. The greenbug, corn leaf aphid, and yellow sugarcane aphid are the three main aphids that attack grain sorghum.

Chinch Bugs

The chinch bug is a small black insect with reddish-yellow legs. The chinch bug has piercing-sucking mouthparts and feeds on lower leaf sheaths, causing leaves to redden.

Sorghum Midge

The sorghum midge is a tiny orange fly that lays eggs in the flowering sorghum head. The larvae then feed on the developing seeds. This insect can be the most potentially destructive pest in grain sorghum.

Corn Earworm, Fall Armyworm, Sorghum Webworm

The corn earworm, fall armyworm, and sorghum webworm all feed on the developing sorghum heads, potentially causing serious damage.

Stinkbugs

Stinkbugs feed on the developing seeds in the sorghum head. The rice stinkbug and southern green stinkbug are the primary species that cause damage. The rice stinkbug is straw-colored and slightly smaller than the southern green stinkbug.

WHEAT INSECTS

Several insects attack wheat and potentially cause damage in Alabama.

Aphids

Several aphids attack wheat in Alabama. The greenbug is one of the major pests that attack wheat.

Armyworms and Cutworms

Armyworms are brown or gray caterpillars with a lighter stripe down each side of the body. They hide during daylight hours and come out to feed only at night. They sometimes cut developing wheat heads off, which can cause economic losses. Larval droppings of frass can be seen on the ground and the larvae can be found at the base of the plants.

Cutworms are large gray caterpillars with a greasy appearance. The larvae have rows of darker spots running down their backs. These larvae also feed at night and can usually be found in the ground near the bases of plants during daylight hours.

Armyworms and cutworms have several natural enemies, including parasites and predators to keep them in check.

Hessian Fly

The Hessian fly is a serious wheat pest. The adult lays eggs in winter wheat in the fall. The eggs hatch and the larvae feed on the stems, between the leaf sheath and the stem. Larvae overwinter and adults emerge in the spring to lay more eggs. These hatch and the larvae pass the winter and summer under the leaf sheath in a puparium that looks similar to a flax seed. This stage can be found by peeling back leaf sheaths near the nodes of the wheat stem. Effective control of the Hessian fly requires planting resistant varieties at recommended planting times.

WEEDS

Effective weed control depends on correctly identifying a weed and understanding its life cycle. Identification was not as important when weed control was primarily a matter of using cropping and physical control methods, but the successful use of herbicides dictates the necessity of being able to identify major weed groups. Identification of individual species is essential for precise, economical use of herbicides.

Classification

When weeds are classified on the basis of life cycles, they are placed into three groups: **annuals, biennials**, and **perennials**.

Annual weeds complete their life cycles in one year and reproduce only by seeds. Annuals are subdivided into winter and summer annuals. **Summer annuals** germinate in the spring, grow during the summer, and die in the fall. Crabgrass, ragweed, and pigweed are examples of summer annual weeds. **Winter annuals** germinate in late summer or fall, grow during the winter, and die in the late spring. Henbit, chickweed, and mustard are examples of winter annual weeds.

Biennial weeds require two years to complete their life cycles. During the first year, biennials produce a circular cluster of basal leaves called a rosette and store food in the roots. The second year a flower stalk is produced followed by flowers and seeds. The weed then dies. Biennials spread only by seed and are usually only problems in untilled areas. Bull thistle, wildcarrot, and common evening primrose are examples of biennials.

Perennial weeds live for more than three years. Perennials may reproduce from seeds or from vegetative structures such as roots, rhizomes, stolons, corns, tubers, and bulbs. **Simple perennials** spread only by seed and are thus easier to control. Dandelion is an example of a simple perennial. **Creeping perennials** may reproduce from underground vegetative structures. This characteristic makes creeping perennials difficult to control. Poison ivy, Johnsongrass, and horse nettle are examples of creeping perennials. **Bulbous perennials** reproduce vegetatively from underground bulbs or tubers. They also produce seed. An example is wild garlic.

Dormancy

Dormancy is a state in which a structure is not actively growing and is typically protected. The ability of seeds and vegetative reproductive structures to remain dormant until conditions are right for growth allows weeds to survive from year to year.

Normally, seed germination occurs when a seed is placed in an environment with the proper temperature, moisture, and oxygen requirements. However, dormant weed seeds may not germinate when placed in a suitable environment due to the presence of dormancy mechanisms. Known dormancy mechanisms that prevent weed seed germination are as follows:

(1) Hard seed coats that prevent water or oxygen from reaching the embryo, (2) immature embryos that require further development after being shed from the mother plant, (3) seed embryos that require a period of time to ripen or complete physiological development, or (4) the presence of chemical germination inhibitors in the seed.

Seed dormancy studies have shown that weed seeds are capable of surviving in the soil for long periods of time. A study conducted in Mississippi showed that after 5.5 years, weed seed survival ranged from 13 to 48 percent for selected species (see graph below).

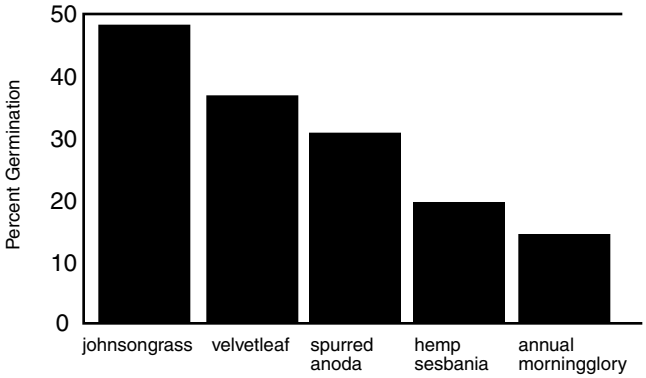


Figure 1. Seed Buried 5.5 Years

Long term survival, due to seed dormancy mechanisms and the fact that many weed species produce thousands of seeds per plant, is why it is necessary to use control practices every year to limit the growth and development of weeds. For this reason, we have included a section on herbicides.

Soil-Applied Herbicides

Preemergence herbicides are usually applied before the crop emerges, but may be applied after the crop emerges as in the case of layby treatments. Some preemergence herbicides require incorporation in the upper two to three inches of the soil. This method of application is referred to as a preplant incorporated treatment. Some herbicides must be incorporated into the soil because they evaporate or break down in sunlight.

Incorporated herbicides are usually mixed into the upper one to three inches of the soil. Incorporating too deep can reduce weed control. Check the label for incorporation methods and maximum delays allowed before incorporation.

Surface-applied preemergence herbicides rely on rainfall or irrigation to carry the herbicide into the weed seed germination zone. If adequate rainfall or irrigation does not occur, herbicides will not be effective.

Preemergence herbicides are effective because:

1. Most weed seeds germinate near the soil's surface. Ideally, a soil-applied herbicide is uniformly distributed in this zone of maximum weed seed germination.

2. Soil-applied herbicides selectively kill germinating weeds, but not crop seed. Selectivity may be due to physiological differences between the crop and weed seed or planting the crop seed below the herbicide zone, which may allow the crop to avoid absorbing the herbicide.

Herbicide carryover occurs when the herbicide does not completely break down before the next year's crop is planted. Most herbicides degrade completely between a few weeks and a few months, but certain herbicides can last longer. There is usually the risk of herbicide carryover following a dry season. Always check herbicide labels to make sure there is no risk to rotational crops to be grown in the next season.

Foliar-Applied Herbicides

Postemergence refers to the application of herbicides to weed foliage. Some soil-applied herbicides may also be applied to the leaves of weeds. Some herbicides are used only as postemergence treatments.

Postemergence herbicides may be applied after weed emergence, but before crop emergence, as in the case of nonselective herbicides in no-till cropping systems. Nonselective means that most plants contacted by the spray are injured or killed. Examples of this use would be using Roundup or Gramoxone to destroy existing vegetation before planting. Roundup and Gramoxone are postemergence only.

Additives, such as crop oils, surfactants, or liquid fertilizers, may be called for on postemergence herbicide labels. Additives may aid penetration of herbicides through the weed leaves. Never use an additive not specified on the herbicide label because it may cause crop injury or reduce weed control.

Some postemergence herbicides may also be applied over the top of the crop and weeds. Another use of postemergence herbicides is as a directed spray beneath the foliage of crop plants. For postemergence treatments to be effective, weeds must be smaller than the crop plants.

Movement of Herbicides in Plants

After application, contact herbicides move very little. Good coverage of the weed leaves and stems is important with contact herbicides because they kill only the plant tissue that the spray droplets reach.

Translocated herbicides can move inside the plant after application and uptake. Because they can redistribute in weeds, uniform coverage is not as important as with contact herbicides. Translocated herbicides are useful in controlling perennial weeds because the herbicide can move into the roots.

Translocated herbicides are usually more effective on large weeds than contact herbicides because the herbicide can move inside the plant to the growing points. However, large annual weeds are always harder to kill than small, tender weeds. Unlike annuals, the best time to treat perennial weeds is in the bud to bloom stage, when it is more likely that the herbicide will move into the roots.

Timing of postemergence herbicide application is crucial for optimum weed control. When using contact herbicides, weeds should be small. Labels often specify

maximum weed size for effective control. Spraying larger weeds may burn off leaves, but the stem and leaf buds at the base of the leaf stalks may not be killed, which allows the weed to regrow. Conditions such as dry weather or other stress may reduce weed control. Succulent, actively growing weeds are the easiest to kill. If contact herbicides are used on perennial weeds, the top growth may be burned off, but the plants will usually regrow from underground buds on roots and stems.

Application

Preemergence and postemergence herbicides may be used for broadcast or band applications. Broadcast applications cover an entire land area. Band applications continuously cover a restricted area such as a crop row. Band applications are cheaper and put less herbicide into the environment. Successfully using band applications requires cultivating row middles. Weather conditions may prevent timely cultivation.

Herbicide Rates

Herbicide rates are recommended by product labels and by state Extension services. Rates are based on research by industry, universities, and USDA personnel. The rate is a compromise between the amount needed for maximum weed kill and minimum crop injury. The use rate for a crop depends on:

(1) Crop tolerance of the herbicide; (2) soil type and texture, especially clay and organic matter content, and sometimes pH; (3) whether it is surface-applied or incorporated; (4) whether it is applied preemergence or postemergence; (5) movement in the soil; (6) residual life in the soil; (7) weed spectrum to be controlled; (8) climatic conditions; (9) formulation and adjuvant use; and (10) cost.

Herbicide Injury

Herbicide injury to crop plants can occur if label directions are not followed or if adverse weather reduces the crop's ability to tolerate herbicides. Weather conditions affect the activity of postemergence herbicides. Increased temperatures and humidity and soil moisture improve weed control and sometimes increase crop injury risk from postemergence herbicides.

Integrated Weed Control

Integrated weed control uses a combination approach. It is much more likely that a weed-free crop can be grown if preventive, cultural, mechanical, and chemical methods are combined in a total approach to weed control. Over-reliance on a single approach to weed control can result in unsatisfactory and expensive results.

Scouting for Weeds

An important activity in scouting for weeds is preparation of a weed map. A weed map is a diagram of the field with notations as to the location, type of weed, and estimated size of the weed-infested areas. Maps with the locations of different weed infestations are helpful in planning short- and long-term weed programs.

A weed map should be made prior to treatment either in the fall or early spring. Knowing the location of annual weeds may allow spot treatments and will allow efficient and timely herbicide application. By identifying such infestations, a grower will be better able to select the most appropriate herbicide and herbicide rate.

Another good time to prepare a field weed map is during the last visit to the field prior to harvest. Knowing the location of perennial weeds, such as redvine, will help the grower develop special tillage programs and future spot treatments with herbicides. Maps of annual weeds permit the planning of a long-range, integrated, annual weed control program, including spot treatments, tillage, and timing of herbicide application.

Avoiding Off-Target Movement of Herbicides

Drift occurs when herbicides move through the air and reach nontarget areas. Drift causes potential hazards to susceptible plants in the area and, in some cases, it may result in hazard to people, livestock, or wildlife. Illegal residues may accumulate in crops, livestock, and water supplies.

Highly active chemicals present the greatest drift problems because only very small amounts are necessary to produce injury symptoms on sensitive crops. It is important to remember that while some herbicides have more drift potential than others, all herbicides are subject to drift for considerable distances. Drift is affected by the method of application and environmental conditions at the time of application. Knowledge of air movement and droplet behavior can help reduce drift occurrences.

Types of Drift

Particle drift occurs during application when small spray droplets are carried by air movement. One way to reduce the danger of particle drift is to **use nozzles with larger openings that produce course sprays.**

Using **low spray pressure** also reduces the amount of fine particles that can easily drift. However, some postemergence contact herbicides require relatively fine particles for good weed control. Avoiding small droplets is the best way to reduce drift. Small droplets stay in the air much longer and move much farther than large droplets.

Spray Droplet Size And Its Effect On Spray Drift

Droplet Diameter In Microns	Type of Droplet	Number of Droplets per Square Inch from 1 gallon Sprayer per Acre	Travel distance of Droplet Falling 10″ with 3 mph wind
5	Fog	9,000,000	3 miles
20	Very fine spray	143,190	1,109 feet
50	Fine sprays	9,224	1,178 feet
100	Fine mist spray from aircraft	347	48 feet
240	Medium spray from aircraft	78	30 feet
400	Coarse spray from aircraft	18	8.5 feet
1000 (1.25″)	Moderate rain (course spray)	1.1	4.7 feet

This chart shows that with a 3 mph wind, medium-sized particles can move about 30 feet from the intended target.

Avoid spraying on windy days. If possible, spray when air movement is away from susceptible crops and ornamentals. Drift control agents make spray droplets larger, reducing particle drift.

Vapor drift results when certain herbicides with relatively high vapor pressure evaporate or turn into gas. The movement of such vapors or fumes with wind currents may injure nearby sensitive vegetation. Occasionally, injury can occur from an hour to a day or more after application.

Other Types of Off-Target Movement

Herbicides can also contaminate nontarget areas through surface movement. Movement may be by wind, rainfall, or irrigation water, usually with soil particles. Water is most often the cause of surface movement. Factors that affect surface movement of herbicides with water are: (1) slope, or steepness of the area, (2) permeability of the soil, (3) amount and intensity of rainfall, (4) herbicide formulation (mainly solubility), (5) rate of application, and (6) vegetative cover. In some cases, herbicides that are tightly bound to soil particles can be moved when there is enough water to carry soil away. Do not move herbicide-treated soils to locations where contamination can cause problems.

PLANT DISEASES

A plant disease is any harmful condition that makes a plant different from a normal plant in its appearance, function, or economic value. Plant diseases are divided into two major groups, noninfectious (abiotic) and infectious (biotic), based on their causes.

Noninfectious Plant Diseases

Noninfectious plant diseases are caused by nonliving agents or factors. These include any physical or chemical component of the environment that is harmful to plant growth or development. Causes of noninfectious plant diseases include:

- Temperature extremes
- Soil moisture extremes
- Reduced oxygen levels
- Unfavorable light conditions
- Deficiency, excess, or imbalance of soil nutrients
- Lightening, hail, wind
- Naturally occurring toxic chemicals
- Air pollutants
- Mechanical damage
- Adverse genetic changes
- Cultural practices

Because noninfectious diseases are caused by nonliving agents that do not reproduce or move, they cannot spread from plant to plant. Symptoms of noninfectious diseases may appear suddenly. Although symptoms on individual plants may become more severe over time, the number of affected plants may not increase.

Symptoms of noninfectious diseases often resemble those caused by infectious diseases. Some herbicide injury symptoms may resemble those of some virus diseases. Nutrient deficiency symptoms may resemble those of root rot diseases.

As a further complication, plants stressed by noninfectious diseases may be more prone to attack by infectious diseases. For example, corn stressed by inadequate or imbalanced fertility may be more sus-

ceptible to certain leaf spot diseases. Soybeans stressed by herbicide injury may be more prone to root rot diseases. Problems on field crops can result from more than one factor. When diagnosing a problem, take care to consider all possible causes of the problem. Some noninfectious diseases can be avoided or corrected; others cannot. Because noninfectious diseases are not directly subject to pest control strategies or the use of pesticides, the rest of the discussion will focus on infectious plant diseases.

Infectious Plant Diseases

Infectious plant diseases are caused by living microscopic agents, called pathogens, that live and feed on or in plants. They spread from one plant to another. The most common causes of infectious diseases are fungi, bacteria, viruses, and nematodes.

Fungi are microscopic plants that lack chlorophyll (green coloring) and therefore cannot make their own food. Of the more than 100,000 different fungi, many are microscopic. The fruiting structures of some are known as mushrooms and may become quite large. Most fungi reproduce by spores, which function about the same way seeds do. Fungi may attack a plant both above and below the soil surface.

Examples of diseases caused by fungi include Phytophthora root rot of soybeans, most leaf spots, wheat rust, and Verticillium wilt of cotton.

Bacteria are microscopic, one-celled plants. They usually reproduce by dividing in half. Each half becomes a fully developed bacterium. Because some can divide every 30 minutes, bacterial populations can build up rapidly under ideal conditions. Bacterial blight of soybeans, fire blight of fruit, and bacterial wilt of alfalfa are examples of diseases caused by bacteria.

Viruses are so small that they cannot be seen with the unaided eye or even with an ordinary microscope. They are generally recognized by their effects on plants. Viruses easily overwinter in bulbs, roots, cuttings, seeds, and perennial hosts. Many viruses are carried from plant to plant by insect vectors, usually aphids or leaf hoppers. Some viruses are transmitted when machines or people touch healthy plants after touching diseased plants. Barley yellow dwarf and maize dwarf mosaic are examples of diseases caused by viruses.

Nematodes are small, usually microscopic, roundworms commonly found in the soil. Many nematodes are harmless but others attack a wide variety of crops. Most species feed on or in the roots, but some species attack aboveground plant parts, such as leaves, stems, and seeds. They may feed at one root location or they may move through the roots. Nematodes usually do not kill plants, but reduce growth and plant vigor. They may weaken the plant and make it susceptible to other disease agents.

All parasitic nematodes that attack plants have a hollow feeding spear. They use it to puncture plant cells and feed on the cell contents. Nematodes may develop and feed either inside or outside a plant. There are several species of nematodes that damage most crops in Alabama.

Conditions that Favor Disease Development

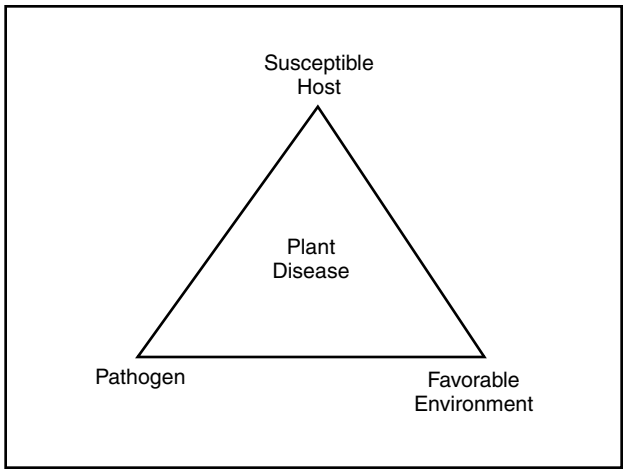
Once the disease has been correctly identified, an understanding of the conditions that favor the development of that disease is needed.

With noninfectious diseases, adverse environmental conditions or unfavorable production practices may be the actual cause of the problem. For example, low soil moisture may result in poor root development on corn plants, leading to stunted, yellow corn. A hard crust layer on the soil surface may delay or prevent soybean emergence and may result in distorted seedlings with swollen hypocotyls.

For an infectious plant disease to occur, it is necessary to have interaction between

- a susceptible host plant
- a pathogen, and
- an environment favorable for disease development.

If any one of these conditions is not met, a disease will probably not occur. The interaction of these three conditions is illustrated below.



Correct Identification of the Disease

The visible effects of a plant disease on the host plant are called symptoms. The symptoms are not the disease itself but evidence of the disease. Plant disease symptoms include any detectable changes in the color, shape, or functions of a plant in response to a pathogen. Although certain symptoms are characteristic of a particular disease, a number of pathogens may produce the same or similar symptoms. Futhermore, symptoms often change over time and their expression is often significantly influenced by environmental conditions.

When checking individual plants for symptoms, be certain to check the entire plant. Determine the distribution of symptoms on plants. Ask yourself questions. Did disease begin on lower, older leaves? Are symptoms confined to newest growth? Is the entire plant affected? Carefully dig up several plants to check the size and condition of the root systems. Also, cut several plants open to look for internal discoloration or damage.

It is also important to check for patterns of affected plants within a field. Are affected plants occurring in low, wet areas or on exposed hillsides? Does severity of symptoms vary depending on crop history or tillage practices? Try to determine any relationship between the occurrence and severity of the disease and field conditions or crop production practices. Such information can be very useful in both identifying the problem and developing management strategies to control it.

With some plant diseases, symptoms are distinctive and can be used to accurately identify the disease. In other cases, it is not always possible to tell one plant disease from another by symptoms alone. Because some disease agents cause similar symptoms, other evidence is needed. Identifying the pathogen is a better way to identify the disease. A microscope magnifying lens is usually necessary to see fungus spores, nematodes or their eggs, and bacteria. It may be necessary to consult trained specialists, such as your local Extension agent.

The role of the environment is very important in this interaction. If the environment is not suitable, disease will not develop, even in the presence of a susceptible host and pathogen. Temperature and moisture are probably the most important environmental factors for disease development, but other environmental factors such as relative humidity, soil pH, soil texture, light, and soil nutrient levels can also affect disease development. Compaction, tillage practices, planting depth, seed bed preparation, and residue management can also significantly affect disease development and should be considered under environmental factors.

Knowing the conditions that favor the development of a specific disease is very important in developing effective, practical disease management strategies. Plant disease control practices should be aimed at disrupting or reducing the interactions between the host, pathogen, and environment. By planting resistant varieties, by reducing or eliminating the pathogen population in a field, or by altering environmental conditions so they are not favorable for disease development, you can prevent or reduce disease losses.

Disease Control Options to Consider During Crop Production

Prior to Planting

- Site selection: soil type, texture, drainage, and topography
- Tillage method and amount of residue
- Variety selection
- Seed quality
- Seed treatments
- Rotation
- Fertility

At Planting

- Tillage
- Planting date
- Planting depth
- Planting population
- Soil conditions: texture, moisture, temperature
- Fungicide treatments
- Seed quality
- Weed control
- Insect control

During Growing Season

- Tillage
- Plant populations
- Fungicide treatments
- Weed control
- Insect control

Harvest and Storage

- Timely harvest
- Minimizing mechanical damage
- Proper drying

Scouting

Field scouting can be done for field crop diseases as well as insects or weeds. Problems with seed decay, seedling blights, or damping off can be pinpointed during early season stand counts. Take time to record information on planting conditions, depth, and planter performance, to examine seedlings for disease symptoms, and to dig in areas of low or no emergence to check for decayed seed. This information will be valuable if replanting is necessary and in preventing problems in future years.

During the growing season, scouts should record information on disease: time of first occurrence, location of problem (especially in relation to topography), rate of spread, and severity. Although some fungicides can be used during the growing season to control foliage diseases of corn, soybeans, and small grains, these are primarily used on seed crops because of treatment cost. However, recorded information can be useful in determining the extent and severity of disease and the need to change varieties or alter tillage, rotation, or other practices in that field in future years.

PRINCIPALS OF PEST CONTROL AND PESTICIDES

To solve pest problems, you must do the following:

1. Identify the pest and understand its biology
2. Know what control methods are available
3. Evaluate the benefits and risks of each method or combination of methods
4. Choose a method or combination of methods that are most effective, profitable, and least harmful to the environment
5. Know how to use the method
6. Know applicable local, state, and federal regulations

Control Methods

Biological Control This is the use of living organisms (predators, parasites, and disease agents) or the use of a favorable environment to control pests. Use a pesticide only when necessary and then in such a manner as to prevent harm to biological control agents. The choice of pesticide dosages, timing, and method of application can be extremely important. Biological control can be encouraged by proper crop rotation and cover crops. Some important biological control agents are lady beetles, ants, and various predator wasps.

Resistant Varieties Resistant or tolerant plants and animals have the ability to withstand damage from pest attacks. Some tomato varieties are resistant to nematodes. Cypress lumber is resistant to certain fungus rots, and some corn varieties, when in storage, are more resistant to weevil damage.

Cultural Methods Planting dates will affect pest damage potential. Harvesting and tillage practices may harm or help pests. Crop rotation, cultivation, irrigation, fertilization, and drainage all effect different pest populations. Controlling weeds can also help control diseases and insects.

Mechanical Methods Mechanical control includes the use of traps, barriers, lights to attract or repel, heat and cold, radiation, and electricity.

Sanitation Methods Sanitation is one of the more common methods of control in managing flies, cockroaches, rats, and many plant diseases. It includes cleaning up messes, spills, wood piles, garbage, dead plants, and damaged plant parts.

Legal Methods Legal control includes quarantines, inspections, embargoes, and compulsory crop or product destruction.

Pesticides - These are chemicals used to prevent harmful pest levels and should be used along with other methods, but only when needed.

Integrated Pest Method (IPM) Integrated means using all acceptable methods available to control a pest. Methods should be compatible. The goal of IPM is to obtain maximum benefits with minimum costs and risks.

Management is maintaining a pest population or its damage at an acceptable economic level, instead of reducing it to zero or an unnecessary level.

Alabama has developed programs that increase pest control effectiveness and are environmentally acceptable. An example is the cotton pest scouting program, which includes extensive field scouting to determine pest population situations and crop condition. After considering all available control methods, you may decide that a pesticide is needed.

The decision to apply controls is then made based upon an economic threshold. If a chemical is needed, the selection and rate are based upon the pest population and beneficial insect population. Recommendation rates are based upon crop size and other methods of control. Here are some things you should know in order to choose the right pesticide and use it more effectively.

Major Groups of Pesticides

Pesticides are chemicals used to destroy, prevent, or control pests. They also include chemicals used to attract or repel pests, to regulate plant growth, or to remove or coat leaves.

Some types and uses of pesticides:

Insecticide: controls insects and other related pests, such as ticks and spiders

Miticide: controls mites

Acaricide: controls mites, ticks, and spiders

Nematicide: controls nematodes

Fungicide: controls fungi

Bactericide: controls bacteria

Herbicide: controls, suppresses, or kills plants

Rodenticide: controls rodents

Avicide: controls birds

Piscicide: controls fish

Molluscicide: controls mollusks, such as slugs and snails

Predacide: controls vertebrate pests

Repellent: keeps pests away

Attractant: lures pests

Plant Growth Regulator: stops, speeds up, or otherwise changes normal plant processes

Defoliant: a chemical that causes leaves to drop from a plant

Desiccant: dries plant tissues and insects

Antitranspirant: coats the leaves of plants to reduce unwanted water loss (transpiration)

Nature of Pesticides

Pesticides can be grouped according to their chemical nature. These groups are:

Inorganic Pesticides – These are made from minerals. Minerals used most often are arsenic, copper, baron, lead, sulfur, tin, and zinc. Examples: lead arsenate, Bordeaux mixtures, and zinc phosphide.

Synthetic Organic Pesticides – These are man-made pesticides. They contain carbon, hydrogen, and one or more other elements, such as chlorine, phosphorous, and nitrogen. Examples: 2, 4-D, atrazine, captan, permethrin, and acephate.

Living Micro-organisms – These are viruses, bacteria, and fungi cultured by humans. Examples: the bacterium *Bacillus thuringiensis* and the polyhedrosis virus.

Plant-Derived Organic Pesticides – These are made from plants or plant parts. Examples: rotenone, red squill, pyrethrins, strychnine, and nicotine.

How Pesticides Work

Pesticides also can be grouped according to what they do. Many synthetic organic pesticides work in more than one way. Read the label to find what each pesticide will do. Some terms to describe how pesticides work are:

Protectants: applied to the plants, animals, structures, and products to prevent entry or damage by a pest.

Sterilants: make pests unable to reproduce.

Contacts: kill pests simply by contacting them.

Stomach poisons: kill when swallowed.

Systemics: taken into the blood of an animal or sap of a plant. They kill the pest without harming the host, plant, or animal.

Residual herbicides: soil-applied herbicides that remain active over a period of time.

Translocated herbicides: move within a plant. Frequently the term refers to herbicides applied to the foliage, which move downward to underground parts.

Fumigants: gasses that kill when they are inhaled or otherwise absorbed by the pest.

Anticoagulants: prevent normal clotting of blood.

Selective: more toxic to some kinds of plants or animals than to others.

Nonselective: toxic to most plants or animals.

Using Pesticides

Many terms used in labeling describe when and how to use pesticides. They are also found in leaflets and bulletins that you may get from your local Extension agent. You should know and understand these terms. They can help you get the best results from your pesticides with the least possible harm to you and the environment.

When to Use

Terms that tell you when to use the pesticide product are:

1. **Preplant:** applied to the soil surface before the crop is planted.
2. **Preemergence:** applied before crop or weeds emerge.
3. **Postemergence:** applied after the crop or weeds have emerged.

HOW TO USE

Terms that tell you how to use the pesticide product are:

Band: application to a strip over or along a crop row or on or around a structure.

Basal: application to stems or trunks at or just above the ground line.

Broadcast: uniform application to an entire field area.

Crack and crevice: application in structures to cracks and crevices where pests may live.

Dip: complete or partial immersion of a plant, animal, or object in a pesticide.

Directed: aiming the pesticide at a portion of a plant, animal, or structure.

Drench: saturating the soil with a pesticide or orally treating an animal with liquid pesticide.

Foliar: application to the leaves of plants.

In-furrow: application to or in the furrow where plants grow.

Over-the-top: application over the growing crop.

Pour-on: pouring the pesticide along the midline of the back of livestock.

Sidedress: application along the side of a crop row.

Soil application: application to the soil rather than to vegetation.

Soil incorporation: use of tillage implements to mix or blend the pesticide into the soil.

Soil injection: application beneath the soil surface.

Spot treatment: application to small area.

Accuracy Is Important

The rates and times of applications of pesticides are critical. Most pesticides work at very low rates. If you use too much, they can harm or even kill the plant or animal you wish to protect. Pesticides work best when applied at specific times. Applying them before or after the correct time reduces or eliminates their effectiveness.

Because all these chemicals work in small amounts, be careful to treat only the intended target. Avoid getting them on anything else as a result of drift or of residue in application equipment or soil.

Factors Affecting Pesticide Activity

Soil Factors – Organic matter in soils limits pesticide activity. Soils with high organic matter content may need higher rates of pesticides for good pest control. Follow label instructions.

Soil texture also affects how pesticides work. Soils with fine particles (silts and clays) provide the most surface area. They may need higher rates. Coarser soils (sands) have less surface area. Use lower rates on them. Follow label instructions.

Soil pH governs microbial activity as well as the degree to which pesticides give off or attract H+ (hydrogen ions). Soil microbial activity is greatest near neutral, pH 7. In general, the greater the microbial activity, the less the hazard for long residual times of pesticides in soil.

Some pesticides are sensitive to differences in soil pH. Because there are many pesticides, the most practical method of ensuring adequate performance of a given pesticide while providing optimum crop growth potential and minimizing environmental impact is to maintain soil pH values within the optimum range for the crops to be grown. Follow pesticide label instructions to ensure good pesticide performance and reduce residue carryovers associated with incompatible soil pH levels.

Weather Factors – Soil moisture and rain affect the way pesticides work. They also affect how long pesticides stay on soil and plants. Pesticides work best with moderate soil moisture. Wetness may keep the pesticide from contacting the soil particles. Rain causes soluble

pesticides to move downward (leach) through the soil. Rain is beneficial when preemergence pesticides are applied to the surface. It carries them down into the soil and the roots. But rain after over-the-top or foliar applications is not good. It may wash pesticides off the leaves. The pesticide should be allowed to dry on the leaves before exposure to rain or irrigation. This time span will vary depending on mode of application, crop type, temperature, and humidity.

Humidity and temperature also affect the way pesticides work. Herbicides work best when plants are growing fast. Low relative humidity and optimum temperatures usually cause pesticides to dry quickly. Low temperatures may slow down or stop the activity of some pesticides.

Light may break down some pesticides if they are left on the soil surface.

Pesticide Resistance – The ability of pests to resist poisoning is called pesticide resistance. Consider this when planning pest control programs that rely on the use of pesticides.

Rarely does any pesticide kill all the target pests. Each time a pesticide is used, it selectively kills the most sensitive pests. Some pests avoid the pesticide. Others are able to withstand its effects. Pests that are not killed may pass the trait that allowed them to survive to their offspring.

When one pesticide is used repeatedly in the same place, the pest population sometimes builds up resistance. Some pests have become immune to poisoning by certain pesticides.

Not every pesticide failure is caused by pest resistance. Make sure you:

- Used the correct pesticide.
- Used the correct dosage.
- Applied the pesticide correctly.

Plant Growth Regulators, Desiccants, Defoliants, and Antitranspirants

Plant growth regulators, desiccants, defoliants, and antitranspirants change normal plant processes. Each works in a different way.

Plant Growth Regulators – All plant parts are made up of tiny cells that continually multiply and grow. Plant growth regulators speed up, slow down, or otherwise affect cell growth and reproduction. They are used to:

- decrease preharvest drop
- increase fruit firmness
- reduce scald
- delay water core (water-soaked area around core of fruit)
- increase red color
- thin fruit
- increase flowering
- reduce cracking
- promote uniform bearing of fruit
- control plant height
- prevent or delay sprouting of tubers
- promote dense growth of landscape plants
- promote earlier flowering
- prevent seed formation
- induce branching
- reduce suckering
- hasten fruit maturity
- increase seed yield
- control excessive growth

Desiccants and Defoliants – These often are called harvest-aid chemicals because they help the farmer harvest the crop. Both are used to get rid of leaves, stems, and weeds in crops such as cotton and soybeans.

Antitranspirants – By reducing water loss, antitranspirants can prevent winter damage, maintain color in evergreens, protect against salt damage, help protect transplants, and prevent needle drop on Christmas trees.

Chapter 2

Pesticide Labels

The pesticide label is the information printed or attached to the container. Labeling includes brochures, flyers, and representation made by the product company's agent about the product. The label is a license to sell by the manufacturer; the state and federal government uses it as a method of control for distribution, storage, sale, use, and disposal of the product.

The pesticide label is a legal document to the user, manufacturer, and regulatory agencies and is used to determine if a misuse has occurred. **The label is the law.**

Information on the label is required by the EPA and explains the pesticide properties and human health and environmental hazards.

Information on the Label

Brand Name: The brand name is the most prominent name on the product and is most often used by the manufacturer in advertising and promotion to gain recognition. Different manufacturers and distributors may have the same active ingredients(s) but different brand or trade names.

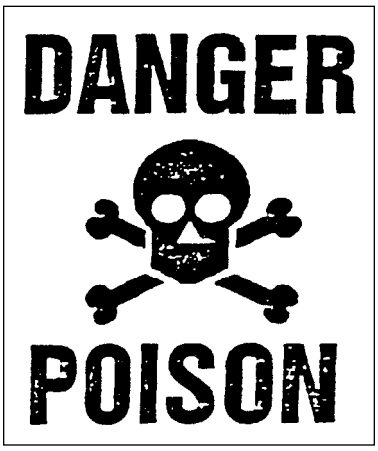
Most chemicals have three names: (1) brand or trade name; (2) accepted common name (a name that is common to the active ingredient of the pesticide regardless of the brand or trade name); and (3) chemical name of the active ingredient. For example, Sevin is a brand name. The common name for Sevin is Carbaryl. The active ingredient chemical name is 1-Naphthyl N-Methyl Carbamate.

Net Contents: Net contents expressed in some type of volumetric or weight basis (e.g. gallons, pounds, or liters) is required. The amount of each active ingredient is given as a percent by weight. Pounds of actual pesticides per gallon of a liquid concentrate will usually be given at the bottom of the active ingredient statement. The EPA does not require inert ingredients to be named, but the percent of the container contents is required.

The Name and Establishment of Manufacturer: The registration number must be on every pesticide label. It shows that the product has been registered with the EPA. It is usually found on the front panel of the label and will be written as "EPA Registration No 0000-00."

The EPA establishment number usually appears near the registration number. This identifies the plant location by state where the product was manufactured.

Signal Words and Symbols: Pesticides are toxic. Some may be hazardous to people. You can tell the toxicity of a product by reading the signal word and looking at the symbol on the label. The signal word is required to be on the front panel of the label immediately below the ingredient statement.



D A N G E R / POISON along with a skull and crossbones symbol must appear on the labels of all products that are highly toxic orally, dermally, or by inhalation. If the product is corrosive to eyes or skin, but is not considered highly toxic, only the signal word **DANGER** is required. Ingesting as little as a taste to a teaspoonful could kill an average size adult. **WARNING** is the signal word required on the labels of all products that are moderately toxic orally, dermally, or by inhalation, or that cause moderate eye and skin irritation. A teaspoonful to a tablespoonful by mouth could kill an average adult. **CAUTION** is the signal word required on the label of all products considered slightly toxic to relatively nontoxic orally, dermally, or by inhalation, or that cause slight eye and skin irritation. The ingestion of an ounce to more than a pint of one of these could kill an average size adult. The statement, "**Keep Out of Reach of Children**," is required on all labels.

Precautionary Statements:

Hazard to Humans/Domestic Animals: This section informs the user of special cautions to prevent injury to himself or herself, others, and domestic animals. Special instructions are given on use of protective equipment, such as goggles or face shields, respirator devices, and rubber gloves, and a statement is given to encourage avoiding skin and clothing contact. Some labels will state that the pesticide causes eye irritation in bold lettering to warn the user that eye protection is needed. A statement of practical treatment in case of accidental swallowing, skin contact, or direct eye contact is in this section of the label as well as a note to physicians for emergency treatment information and telephone number. The pesticide label is the most important information to take to the physician if poisoning occurs.

Environmental Hazards: This warns of special precautions to fish, shrimp, birds, beneficial insects

and other wildlife. Warnings are given about applying to sites such as swamps, potholes, marshes, and aquatic areas or the cleaning of equipment or disposal of waste near any such area. Examples of environmental hazard statements include: "This product is toxic to bees exposed to direct treatment or residues on blooming crops or weeds" and "Do not apply where runoff is likely to occur."

Worker Safety: A listing of special protective equipment and clothing to wear when mixing and loading, cleaning equipment, operating application equipment, and disposing of pesticides has been added. Reentry into treated areas will list special protection needed, precautions for sanitation when leaving treated areas, and personal hygiene instructions to follow after work. Restriction on reentry is stated as how long to wait before reentry. Posting of certain treated areas will be required on pesticide labels used in agricultural crop production, forestry uses, and commercial nurseries and commercial greenhouse production. A sample label containing worker protection standards can be found at the end of this section.

Directions for Use: "It is a violation of Federal Law to use this product in a manner inconsistent with its labeling" is a statement that appears at the beginning of most label directions. The directions may state, "Do not apply this product through any type of irrigation system," or "Do not allow livestock to graze treated areas." Various "Do not" statements are specific. If ignored, the user is violating label directions.

Specific directions also identify plants (site) and pests.

- How much (rate) of the formulation to use per acre, per animals, or per site. To exceed label rate application is a misuse.
- Where to use and how to direct the spray.
- When to apply (timing of applications, when to repeat applications).

Recommended application equipment and minimum amount of total spray mixture is usually listed. Calibration of different application equipment becomes very critical to ensure label directions are followed.

Some of the following statements may be found on the label:

- Do not contaminate water, food, or feed by storage, disposal, or cleaning of equipment. Open dumping is prohibited. Waste resulting from this product may be disposed of on site or at an approved waste disposal facility.
- Temperature restrictions.
- Instructions for handling spills, leaks, fires, and explosions.
- Keep pesticide in original containers.

Container disposal statements will vary between companies on the same chemical. Special triple rinse instructions, handling rinsate water, and disposal in a sanitary landfill or by incineration, if allowed by state and local authorities, can be found on most labels. The label statement on the sample label is typical of storage and disposal instructions.

Label terminology expresses meaning to the user as to when and how to use a pesticide. Some examples of label terminology are:

Preplant: Used before the crop is planted.

Preemergence: Used before crop or pests emerge. May also refer to use after crops emerge or are established, but before pests emerge.

Postemergence: Used after the crop and the pests have emerged.

Band: Application to a strip over or along a crop row or on or around a structure.

Broadcast: Uniform application to an entire area.

Foliar: Application to the leaves of plants.

In-furrow: Application to or in the furrow where plants grow.

Spot treatment: Application to a small area.

Other words and symbols used in labeling:

PSI: Pounds per square inch

RPM: revolution per minute

Bovine: Cattle or cow

Lactating: Production of milk by an animal

WPS: Worker Protection Standards

Terminology not understood needs to be determined to understand label directions.

RESTRICTED USE PESTICIDE

Due to very high toxicity to humans and birds.

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.

VIP DEPESTO I/M
Galactothion
Organophosphate

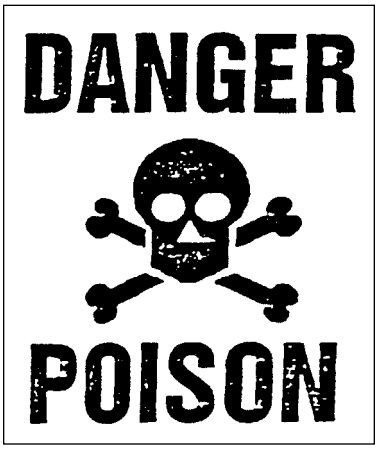
ACTIVE INGREDIENTS:

galactothion (0,0-diethyl methyl phosphorothioate).....20.9%
related isomers 1.1%
INERT INGREDIENTS: 78.0%
TOTAL 100.0%

Contains xylene aromatic solvents.

KEEP OUT OF REACH OF CHILDREN

DANGER



POISON

PELIGRO

Sí usted no entíende la etiqueta busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail.)

STATEMENT OF PRACTICAL TREATMENT

Call a doctor (physician), clinic, or hospital immediately. Explain that the victim has been exposed to galactothion and describe his/her condition. After first aid is given, take victim to clinic or hospital. **If breathing has stopped,** start artificial respiration immediately and maintain until doctor sees the victim. **If swallowed** -- Drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person. Get medical attention. **In case of contact,** immediately flush skin with plenty of water while removing contaminated clothing and shoes. See doctor immediately. Galactothion is an organophosphate that inhibits cholinesterase.

NOTE TO PHYSICIAN

Antidote – administer atrophine di-sulphate in large doses. **TWO** to **FOUR mg.** intravenously or intramuscularly as soon as cyanosis is overcome. Repeat at 5 to 10 minute intervals until signs of atropinization appear. 2-PAM chloride is also antidotal and may be administered in conjunction with atropine. **DO NOT GIVE MORPHINE OR TRANQUILIZERS.** Galactothion is a strong cholinesterase inhibitor affecting the central and peripheral nervous system and producing cardiac and respiratory depression. At first sign of pulmonary edema, the patient should be given supplemental oxygen and treated symptomatically. Continued absorption of the poison may occur and fatal relapses have been reported after initial improvement. **VERY CLOSE SUPERVISION OF THE PATIENT IS INDICATED FOR AT LEAST 48 HOURS**.

EPA registration No. 12345-10
EPA Establishment No. 56787-CO-3

VIP Chemical Company
2527 South VIP Drive
Biardspond, MI 22315

Net Contents:
55 Gallons

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS & DOMESTIC ANIMALS

DANGER:

Fatal if absorbed through the skin, fatal if swallowed, and poisonous if inhaled. Do not breather vapors or spray mist. Do not get on skin or clothing.

Personal Protective Equipment

Some materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for category C on an EPA chemical resistance category selection chart.

Applicators and other handlers must wear:

- Coveralls over long-sleeved shirt and long pants
- Chemical-resistant gloves such as barrier laminate or viton
- Chemical-resistant footwear plus socks
- Protective eyewear
- Chemical-resistant headgear for overhead exposures
- Chemical-resistant apron when cleaning equipment, mixing or loading
- Respirator with either an organic vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval prefix TC-23C) or a canister approved for pesticides (MSHA/NIOSH approval number TC-14G)

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this products concentrate. Do not reuse them. Follow manufactures instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon a possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

This pesticide is highly toxic to aquatic invertebrates and wildlife. Birds in treated areas may be killed. Shrimp and other aquatic organisms may be killed at recommended application rates. Do not contaminate water by cleaning of equipment or disposal of wastes.

PHYSICAL AND CHEMICAL HAZARDS

Do not use or store near heat or open flame. Not for use in or around the home.

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 Protections Standard, 40 CFR 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), notification to workers, and restricted-entry intervals. 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. The REI is 72 hours in outdoor areas where average annual rainfall is less than 25 inches a year.

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 over long-sleeved shirt & long pants
- Chemical-resistant gloves such as barrier laminate or viton
- Chemical-resistant footwear plus socks
- Protective eyewear
- Chemical resistant headgear.

Notify workers of the application by warning them orally and by posting warning signs at entrances to treated areas.

STORAGE AND DISPOSAL

PROHIBITIONS: Do not contaminate water, food, or feed by storage or disposal. Do not store under conditions which might adversely affect the container or its ability to function properly.

STORAGE: Do not store below temperature of 0 degrees F.

CONTAINER DISPOSAL: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

Chapter 3
Pesticide Formulations

The active ingredients in a pesticide are the chemicals that control the target pest. Most pesticide products also have other ingredients, called inert (inactive) ingredients. They are used to dilute the pesticide or to make it safer, more effective, easier to measure, mix, and apply, or more convenient to handle.

Usually the pesticide is diluted in water, a petroleum-based solvent, or another diluent. Other chemicals in the product may include wetting agents, spreaders, stickers, or extenders. This mixture of active and inert ingredients is called a pesticide formulation.

Some formulations are ready for use. Others must be further diluted with water, a petroleum-based solvent, or air (as in air blast of ULV applications) by the user before they are applied.

A single active ingredient often is sold in several different kinds of formulations. If more than one formulation is available for your pest control situation, you must choose the best one for the job. Before you make a choice, ask yourself several questions about each formulation:

- Do you have the necessary application equipment?
- Can the formulation be applied safely under the conditions in the application area?
- Will the formulation reach your target and stay in place long enough to control the pest?
- Is the formulation likely to harm the surface to which you apply it?

To answer these kinds of questions, you need to know something about the characteristics of different types of formulations and the general advantages and disadvantages of each type.

ABBREVIATIONS FOR FORMULATIONS

A = Aerosol
AF = Aqueous Flowable
AS = Aqueous Suspension
B = Bait
CM = Concentrate Mixture
CG = Concentrate Granules
D = Dust
DF = Dry Flowable (same as WDG)
E or EC = Emulsifiable Concentrate
F or L = Flowable
G = Granules
H/A = Harvest Aid
LC or C = Liquid Concentrate
LV = Low Volatile
M = Microencapsulated
MTF = Multiple Temperature Formulation
P or PS = Pellets
RTU = Ready to Use
S = Solution
SG = Soluble Granule
SP = Soluble Powder
ULV = Ultra Low Volume
W or WP = Wettable Powder
WDG = Water-Dispersible Granules (Dry flowable)
WS = Water Soluble
WSG = Water-Soluble Granule
WSL = Water-Soluble Liquid
WSP or SP = Water-Soluble Powder

Liquid Formulations

Emulsifiable Concentrates (EC or E)

An emulsifiable concentrate formulation usually contains a liquid active ingredient, one or more petroleum-based solvents, and an agent that allows the formulation to be mixed with water to form and emulsion. Each gallon of EC usually contains 25 to 75 percent (2 to 8 pounds) active ingredient. ECs are among the most versatile formulations. They are used against agricultural, ornamental and turf, forestry, structural, food processing, livestock, and public health pests. They are adaptable to many hydraulic sprayers, low-volume ground sprayers, mist blowers, and low-volume aircraft sprayers.

Advantages:
- Relatively easy to handle, transport, and store
- Little agitation required – will not settle out or separate when equipment is running
- Non-abrasive
- Do not plug screens or nozzles
- Little visible residue on treated surfaces

Disadvantages:
- High concentration makes it easy to overdose or underdose through mixing or calibration errors
- May cause unwanted harm to plants
- Easily absorbed through skin of humans and animals
- Solvents may cause rubber or plastic hoses, gaskets, and pump parts and surfaces to deteriorate
- May cause pitting or discoloration of painted finishes
- Flammable – should be used and stored away from heat and open flame
- May be corrosive

Solutions (S)

Some active ingredients dissolve readily in liquid solvents, such as water or a petroleum-based solvent. When mixed with the solvent, they form a solution that will not settle out or separate. Formulations of these pesticides usually contain the active ingredient, the solvent, and one or more other ingredients. Solutions may be used in any type of sprayer indoors or outdoors.

Ready-To-Use (RTU)

Some solutions are products that contain the correct amount of solvent when you buy them. No further dilution is required before application. These formulations are usually 1 percent or less of active ingredient per gallon.

Concentrate Solutions (C or LC)

Other solutions are sold as concentrates that must be further diluted with a liquid solvent before application. Occasionally, the solvent is water, but more often the solvent is a specially refined oil or petroleum-based solvent. Some uses of solutions are:
- Structural and institutional pest control
- Control of some household pests
- Livestock and poultry pest control
- Space sprays in barns and warehouses
- Shade tree pest control
- Mosquito control

Advantages:
- No agitation necessary

Disadvantages:
- Limited number of formulations of this type are available.

The other advantages and disadvantages of concentrate solutions vary depending on the solvent used, the concentration of the active ingredient, and the type of application involved.

Ultra-Low Volume (ULV)

These concentrates may approach 100 percent active ingredient. They are designed to be used as is or diluted with only small amounts of specified solvents. These special-purpose formulations are mostly for outdoor applications, such as in agricultural, forestry, ornamental, and mosquito control programs.

Advantages:
- Relatively easy to handle, transport, and store
- Little agitation required
- Not abrasive to equipment
- Do not plug screens and nozzles
- Little visible residue on treated surfaces

Disadvantages:
- Difficult to keep pesticide in the target site – high drift hazard
- Specialized equipment required
- Easily absorbed through skin of humans and animals
- Solvents may cause rubber or plastic hoses, gaskets, and pump parts and surfaces to deteriorate

Flowables (F or L)

Some active ingredients are insoluble solids. These may be formulated as flowables in which the finely ground active ingredients are mixed with a liquid, along with inert ingredients, to form a suspension. Flowables are mixed with water for application and are similar to EC or wettable powder formulations in ease of handling and use. They are used in the same types of pest control operations for which ECs are used.

Advantages:
- Rarely clog nozzles
- Easy to handle and apply

Disadvantages:
- Require moderate agitation
- May leave a visible residue

Aerosols (A)

These formulations contain one or more active ingredients and a solvent. Most aerosols contain a low percentage of active ingredients. There are two types of aerosol formulations – the ready-to-use type and those made for use in smoke or fog generators.

Ready-To-Use Aerosols (RTU)

These aerosol formulations are usually small, self-contained units that release the pesticide when the nozzle valve is triggered. The pesticide is driven through a fine opening by an inert gas under pressure, creating fine droplets. These products are used in greenhouses, in small areas inside buildings, or in localized outdoor

areas. Commercial models, which hold 5 to 10 pounds of pesticide, are usually refillable.

Advantages:
- Ready to use
- Easily stored
- Convenient way to buy small amount of a pesticide
- Retain potency over fairly long time

Disadvantages:
- Practical for very limited uses
- Risk of inhalation injury
- Hazardous if punctured, overheated, or used near an open flame
- Difficult to confine to target site or pest

Formulations for Smoke or Fog Generators

These aerosol formulations are not under pressure. They are used in machines that break the liquid formulation into a fine mist or fog (aerosol) using a rapidly whirling disk or heated surface. These formulations are used mainly for insect control in structures such as greenhouses and warehouses and for mosquito and biting fly control outdoors.

Advantages:
- Easy way to fill entire space with pesticide

Disadvantages:
- Highly specialized use and equipment
- Difficult to confine to target site or pest
- May require respiratory protection to prevent risk of inhalation injury

Invert Emulsions

This mixture contains a water-soluble pesticide dispersed in an oil carrier. Invert emulsions require a special kind of emulsifier that allows the pesticide to be mixed with a large volume of petroleum-based carrier, usually fuel oil. When applied, invert emulsions form large droplets that do not drift easily. Invert emulsions are most commonly used in vegetation control along right-of-way where drift to susceptible nontarget plants is a problem.

Dry Formulation Dusts (D)

Most dust formulations are ready to use and contain a low percentage of active ingredient (usually ½ to 10 percent), plus a very fine inert carrier made from talc, chalk, clay, nut hulls, or volcanic ash. The size of individual dust particles is variable.

A few dust formulations are concentrates and contain a high percentage of active ingredients. These must be mixed with dry inert carriers before they can be applied.

Dusts are always used dry and they easily drift into nontarget sites. They sometimes are used for agricultural applications. In structures, dust formulations are used in cracks and crevices and for spot treatments. They are widely used in seed treatment. Dusts are also used to control lice, fleas, and other parasites on pets and livestock.

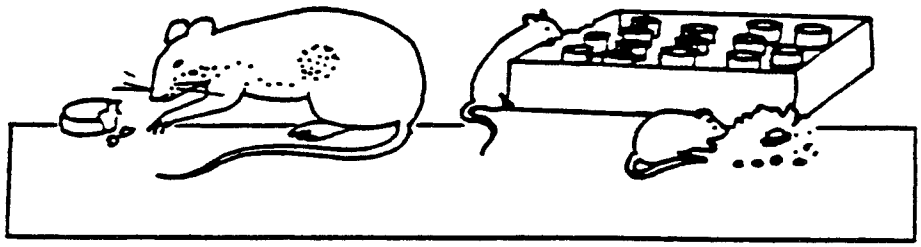
Advantages:
- Usually ready to use with no mixing
- Effective where moisture from a spray might cause damage
- Require simple equipment
- Effective in hard-to-reach indoor areas

Disadvantages:
- Easily drift off target during application
- Residue easily moved off target by air movement or water
- May irritate eyes, nose, throat, and skin
- Does not stick to surfaces as well as liquids do
- Difficult to get an even distribution of particles on surfaces

Baits (B)

A bait formulation is an active ingredient mixed with food or another attractive substance. The bait either attracts the pests or is placed where the pests will find it. Pests are killed by eating the pesticide the bait contains. The amount of the active ingredient in most bait formulations is quite low, usually less than 5 percent.

Baits are used inside buildings to control ants, roaches, flies, other insects, and rodents. Outdoors and in greenhouses they are used to control snails, slugs, and some insects. They are an important part of a fire ant management plan. In addition, they control vertebrate pests such as rodents, other mammals, and birds.



Advantages:

- Ready to use
- Entire area need not be covered, because pest goes to bait
- Control pests that move in and out of an area

Disadvantages:

- Can be attractive to children and pets
- May kill domestic animals and nontarget wildlife outdoors
- Pest may prefer the crop or other food to the bait
- Dead pests may cause odor problem
- Other animals may be poisoned as a result of feeding on the poisoned pests
- If baits are not removed when the pesticide becomes ineffective, they may serve as a food supply for the target pest or other pests

Granules (G)

Granular formulations are similar to dust formulations except that granular particles are larger and heavier. The coarse particles are made from an absorptive material such as clay, corn cobs, or walnut shells. The active ingredient either coats the outside of the granules or is absorbed into them. The amount of active ingredient is relatively low, usually ranging from 1 to 15 percent.

Granular pesticides are most often used to apply chemicals to the soil to control weeds, nematodes, and insects living in the soil. Granular formulations are sometimes used in airplane or helicopter applications to minimize drift or to penetrate dense vegetation.

Granular formulations are also used to control larval mosquitoes and other aquatic pests. Granules are used in agricultural, ornamental, turf, aquatic, right-of-way, and public health (biting insect) pest control operations.

Advantages:

- Ready to use – no mixing
- Drift hazard is low and particles settle quickly
- Little hazard to applicator – no spray, little dust
- Weight carries the formulation through foliage to soil or water target
- Uses simple application equipment, such as seeders or fertilizer spreaders
- May break down more slowly than WPs or ECs through a slow-release coating

Disadvantages:

- Does not stick to foliage or other non-level surfaces
- May need to be incorporated into soil or planting medium
- May need moisture to start pesticidal action
- May be hazardous to nontarget species, especially waterfowl and other birds that mistakenly feed on the seed-like granules.

Pellets (P or PS)

Most pellet formulations are very similar to granular formulations; the terms often are used interchangeably. In a pellet formulation, however, all the particles are the same weight and shape. The uniformity of the particles allows them to be applied by precision planting of pelleted seed. A few fumigants are formulated as pellets; however, these will be clearly labeled as fumigants and should not be confused with nonfumigant, granule-like pellets.

Wettable Powders (WP or W)

Wettable powders are dry, finely ground formulations that look like dusts. They usually must be mixed with water for application as a spray. However, a few products may be applied either as a dust or as a wettable powder – the choice is left to the applicator.

Wettable powders contain 5 to 95 percent active ingredient, usually 50 percent or more. Wettable powder particles do not dissolve in water. They settle out quickly unless constant agitation is used to keep them suspended.

Wettable powders are one of the most widely used pesticide formulations. They can be used for most pest problems in most types of spray equipment where agitation is possible.

Advantages:

- Easy to store, transport, and handle
- Less likely than ECs and other petroleum-based pesticides to cause unwanted harm to treated plants, animals, and surfaces
- Easily measured and mixed
- Less skin and eye absorption than EC's and other liquid formulations

Disadvantages:

- Inhalation hazard to applicator while pouring and mixing the concentrated powder
- Requires good and constant agitation (usually mechanical) in the spray tank and quickly settles out if agitation is turned off
- Abrasive to many pumps and nozzles, causing them to wear out quickly
- Difficult to mix in very hard or very alkaline water
- Often clogs nozzles and screens
- Residues may be visible

Soluble Powders (SP or WSP)

Soluble powder formulations look like wettable powders. However, when mixed with water, soluble powders dissolve readily and form a true solution. After they are mixed thoroughly, no additional agitation is necessary. The amount of active ingredient in soluble powders ranges from 15 to 95 percent; it usually is over 50 percent. Soluble powders have all the advantages of wettable powders and none of the disadvantages except the inhalation hazard during mixing. Few pesticides are available in this formulation because few active ingredients are soluble in water.

Microencapsulated Pesticides (M)

Microencapsulated formulations are particles of pesticides (liquid or dry) surrounded by a plastic coating. The formulated product is mixed with water and applied as a spray. Once applied, the capsule slowly releases the pesticide. The encapsulation process can prolong the active life of the pesticide by providing a timed release of the active ingredient.

Advantages:

- Increased safety to applicator
- Easy to mix, handle, and apply
- Releases pesticide over a period of time

Disadvantages:

- Constant agitation necessary in tank
- Some bees may pick up the capsules and carry them back to their hives, where the released pesticide may poison the entire hive.

Water-Dispersible Granules (Dry Flowables, WDG or DF)

Water-dispersible granular formulations are like wettable powder formulations, except the active ingredient is prepared as granule-sized particles. Water-dispersible granules must be mixed with water to be applied. Once in water, the granules break apart into fine powder. The formulation requires constant agitation to keep it suspended in water. Water dispersible granules share the advantages and disadvantages of wettable powders except:

- They are more easily measured and mixed.
- They cause less inhalation hazard to the applicator during pouring and mixing.

Fumigants

Fumigants are pesticides that form poisonous gases when applied. Some active ingredients are liquids when packaged under high pressure but change to gases when they are released. Other active ingredients are volatile liquids when enclosed in ordinary containers and so are not formulated under pressure. Fumigants are used for structural pest control, in food and grain storage facilities, and in regulatory pest control at ports of entry at state and national borders. In agricultural pest control, fumigants are used in soil, greenhouses, granaries, and grain bins.

Advantages:

- Toxic to a wide range of pests
- Can penetrate cracks, crevices, wood, and tightly packed areas such as soils and grains
- Single treatment usually will kill most pests in treated area

Disadvantages:

- The target site must be enclosed or covered to prevent the gas from escaping
- Highly toxic to humans and all other living organisms
- Require the use of specialized protective equipment, including respirators
- Require the use of specialized application equipment
- May kill germination of seed used for planting

Adjuvants

An adjuvant is a chemical added to a pesticide formulation or tank mix to increase its effectiveness or safety. Most pesticide formulations contain at least a small percentage of adjuvants. Some of the most common adjuvants are **surfactants** – "surface active ingredients" that allow the dispersing, spreading, and wetting properties of spray droplets.

Common adjuvants are:

- *Wetting agents* allow wettable powders to mix with water.
- *Emulsifiers* allow petroleum-based pesticides (ECs) to mix with water.
- *Invert emulsifiers* allow water-based pesticides to mix with petroleum carrier.
- *Spreaders* allow pesticide to form a uniform coating layer over the treated surface.
- *Stickers* allow pesticide to stay on the treated surface.
- *Penetrants* allow the pesticide to get through the outer surface to the inside of the treated area.
- *Foaming agents* reduce drift.
- *Thickeners* reduce drift by increasing droplet size.
- *Safeners* reduce the toxicity of a pesticide formulation to the pesticide handler or to the treated surface.
- *Compatibility agents* aid in combining pesticides effectively.
- *Buffers* allow pesticides to be mixed with diluents or other pesticides of different acidity or alkalinity.
- *Anti-foaming agents* reduce foaming of spray mixtures that require vigorous agitation.

Chapter 4
Pesticides in the Environment

Although pesticides provide efficient pest control, they can damage the environment if used improperly. Pesticides cause problems when they move off target – drifting out of the target area, moving by soil runoff or erosion, and leaching through the soil to groundwater. Pesticides can also contaminate the environment because of improper storage and disposal. Careful management of pesticides must be a concern for all pesticide applicators and the general public in order to prevent environmental contamination.

Pesticide Drift

Studies have shown that a significant percentage of pesticides never reach the intended site of application because of drift, volatility, or misapplication. It is impossible to totally eliminate particle drift or volatility, but it is possible to reduce them to acceptable levels. Where significant drift does occur, it can damage sensitive crops, pose health hazards, and contaminate soil and water in adjacent areas.

Drift can be defined simply as the movement of pesticides through the air to nontarget areas. It can occur either as solid or liquid particles or as vapors.

Reduce Spray Drift

Reduce spray drift by following these practices:

1. Amine or acid formulations of 2, 4-d are less likely to cause damage from vapor drift than ester formations.
2. Use drift control agents.
3. Smaller drops are produced as nozzle pressure increases. To control drift, use the lowest pressure that will produce a uniform spray pattern.
4. Use larger nozzle tips that will produce larger drops than nozzles with smaller openings.
5. Avoid spraying on windy days. Wind speed is the major weather condition affecting drift. In general, wind speed is reduced just before sunrise and just after sunset. Air is usually gustiest and most turbulent during mid-afternoon. Because wind velocities are lower closer to the ground, sprays should be released as close to the ground as possible, consistent with uniform application.

Pesticide Movement

A pesticide can move from the area in which it was applied in a variety of ways. It can:

- Volatize from plant or soils surfaces
- Be moved by wind or water from treated foliage to the soil
- Be carried laterally by surface water runoff through soil erosion
- Be incorporated into the soil with crop residues
- Be taken from the field as residue on the crop itself
- Leach through the soil

Eventually, a portion of the pesticides we apply ends up in the soil. Ultimately, trace amounts may find their way into surface waters or groundwater.

Pesticide and soil properties and climatic conditions determine the extent of pesticide movement.

Pesticide Properties

Adsorption – Pesticides vary in their degree of attachment of adsorption to soil particles. Some pesticides stick very tightly to soil grains; others stick a little harder but can be dislodged with enough water.

Water Solubility – Pesticides also vary in their degree of ability to dissolve in water. Those with greater solubility have a greater potential for movement with water. A heavy rain after an application of a soluble pesticide can move a significant portion away from the target area by runoff or leaching.

Volatility – The volatility of a pesticide is a measure of its tendency to turn into a vapor. Pesticides with greater volatility dissipate more rapidly into the air. Once a pesticide has been applied to the soil or plant surface, temperature and humidity will affect the rate of volatilization.

Degradation – The rate of pesticide degradation or chemical breakdown varies with each pesticide. When a pesticide degrades, it is changed chemically. For most pesticides, once significant degradation has occurred, they are no longer active as pesticides and pose no further risks of pollution.

Persistence – The persistence of a pesticide is a measure of how long it remains in an active form (still controlling the pest) in the environment before it degrades. Persistence is either desirable or undesirable. Where the objective is long-term control, a persistent pesticide may be desirable.

Persistence beyond the time needed, however, is often undesirable and is usually referred to as residue. It may make the crop unacceptable for sale or for use as feed or forage. It may also carry over in the soil and adversely affect succeeding crops.

Soil Properties

Many soil characteristics, such as soil texture and organic matter, affect pesticide activity and movement.

Texture – Soil texture is determined by the relative proportions of sand, silt, and clay. The sandier the soil, the faster the movement of percolating water and the less opportunity for adsorption of dissolved chemicals. Clay soils, on the other hand, are made up of extremely small particles that provide a vast surface area for adsorption.

Organic Matter – Soil organic matter influences how much water a soil can hold, and how well it will be able to adsorb pesticides. Increasing the soil organic content increases the soil's ability to hold both water and dissolved pesticides in the root zone where they will be available to plants.

Climatic Conditions

The movement and breakdown of pesticides in the soil can be affected by the amount and timing of water applied to the field, either by rainfall or irrigation. If cold rain cools the soil, breakdown reactions can be slowed. It can also wash pesticides off plants and into the soil, removing them from sunlight, which might otherwise promote breakdown. Too much water may cause excessive runoff and leaching of pesticides.

Pesticides and Groundwater

Groundwater is the source of water for wells and springs. It is found underground, within cracks of bedrock, or filling the spaces between particles of soil and rocks. The groundwater layer in which all available spaces are filled with water is called the saturated zone. The dividing line between the saturated zone and overlying unsaturated rock or sediments is called the water table. The geologic formation through which groundwater flows is called an aquifer. This can be a layer of sand, gravel, or other soil materials, or a section of bedrock with fractures.

Once groundwater is contaminated, fixing the problem is difficult and may be expensive. When pesticides contaminate groundwater, additional restrictions may be placed on certain pesticides. Clearly, the best solution is to keep pesticides and other contaminants out of groundwater through careful application, storage, and disposal practices.

Pesticides can reach groundwater in many ways. Direct contamination can occur as a result of back siphoning or pesticide spills at the well head.

Surface streams, contaminated with pesticide, may interact with shallow groundwater through surface flow. Normally, surface water becomes contaminated when water runs off treated fields. Pesticides can be carried, dissolved in runoff water, or held on the surface of eroded soil particles. Total herbicide runoff can be from 1 to 2 percent of the total applied. Runoff risk is greatest when heavy rains closely follow herbicide application on steep slopes.

Reducing water runoff and soil erosion can protect surface water quality by keeping the products on treated fields. Use of terraces and conservation tillage are techniques that can reduce water runoff potential by reducing the concentration of product on the soil surface. Ideally, as much crop residue as possible should be left on the soil surface to reduce erosion.

Grass strips are very effective in reducing herbicide runoff because they trap sediment containing pesticides and slow runoff water, allowing more pesticide to be taken out of the solution. Leaving untreated grass strips next to streams and ponds can trap most of the pesticides running off treated fields.

While it is easy to understand how direct contamination occurs (back siphoning, spills, surface runoff), it is more difficult to understand how pesticides can leach through soil. For many years it was believed that the soil acted as a filter, preventing the movement of any contaminate into the groundwater.

However, we now know that some pesticides do reach groundwater by moving through the soil. For a pesticide to leach into groundwater and present a hazard, it moves down through the soil and resists breakdown to nontoxic compounds. This is generally not a common occurrence and depends on three factors:

1. soil characteristics
2. pesticide properties
3. site conditions

Soil Characteristics

Sandy soil, low in organic matter with large pore spaces and small amounts of surface area, will allow leaching and little adsorption of pesticides.

Pesticide Properties

High solubility increases the possibility that the pesticide will be washed through the soil. Low adsorption of the pesticide to soil particles allows movement through the soil.

Persistent pesticides are present for longer periods of time, increasing their chance of leaching to the groundwater.

Site Conditions

A high water table reduces the filtering capacity of the soil and, therefore, increases the chance of groundwater contamination. Heavy rainfall or irrigation may move large amounts of water through the soil, carrying dissolved pesticides.

Groundwater Warning Statements

Groundwater warning statements are required on labels of pesticides that have been detected frequently in groundwater monitoring. Most groundwater statements are similar to: "This product is a chemical that can travel (seep or leach) through the soil and can contaminate groundwater that may be used as drinking water. This product has been found in groundwater as a result of agricultural use. Users are advised not to apply this product where the water table (groundwater) is close to the surface and where soils are very permeable or well-drained, such as loamy sands. Your local agricultural agencies can provide further information on the type of soil in your area and the location of groundwater."

Groundwater statements on labels help applicators choose appropriate treatments where soils are sandy or where extra precautions are desired to reduce contamination risk.

Reducing Groundwater Contamination Risk

Prevent groundwater contamination by following the recommendations listed below.

1. Follow Proper Pesticide Application Procedures

Integrated Pest Management (IPM) principals should be observed — apply pesticides only when and where necessary and only in amounts adequate to control pests. Other control methods should be used whenever possible. Pesticide application equipment should be calibrated regularly to ensure application of the correct rate. Scout fields to determine the type of pest present and the proper treatment needed. Spot treating fields only where pests are present can reduce pesticide use.

2. Identify Vulnerable Areas

The presence of sandy soil, sinkholes, and shallow groundwater increases the chance of groundwater contamination. Avoid pesticide application in those locations. If a pesticide application must be made, apply a pesticide that is less likely to leach, or reduce rates using techniques such as band application of herbicides.

Never dispose of empty pesticide containers in sinkholes or dump rinse sprayers into sinkholes. Unplugged abandoned wells can also allow surface water containing pesticides and other contaminants to directly enter groundwater. Do not store or mix herbicides around abandoned wells. These wells are sometimes in the middle of treated crop fields. Abandoned wells should be properly plugged. Most herbicides are normally held by soil particles near the soil surface until they naturally break down; this prevents significant leaching. However, very high rates of application, which can occur with spills or improper disposal, can overload the soil's ability to hold and degrade pesticides. This may then allow leaching. If sprayers are dumped or washed out in the same place over the years, concentrated sources of herbicide are created. If this activity is conducted near the well, the risk of contamination is increased, especially if the well is not properly cased and surface runoff can directly enter the well. Ideally, pesticides should be stored and mixed away from the well.

3. Product Selection

Whenever possible, use pesticides that are less likely to leach. Use pesticides that are tightly adsorbed to soil, low in water solubility, not persistent, and not highly toxic.

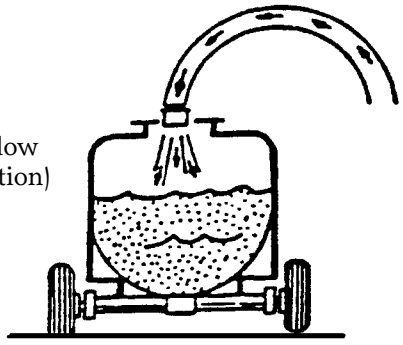
4. Pesticide Handling

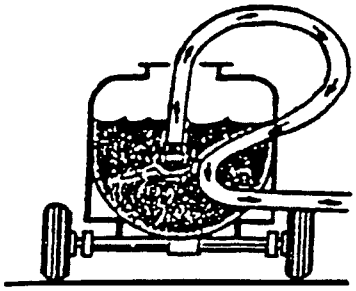
Pesticide spills on the ground or near water sources have the potential for reaching groundwater. Immediately contain and control pesticide spills. Check application equipment regularly for leaks and damage. Mix and load pesticides away from water sources. After the pesticide application is complete, follow label directions for proper container disposal.

Back siphoning can allow very large quantities of pesticide to directly enter groundwater at the depth of the well. This happens when the end of the water hose is allowed to extend below the spray solution line when filling sprayers. If the hydrant is inadvertently shut off or the pump fails with the hose still in the tank, the spray solution can back siphon down the well or into the water system. Positioning the hose end above the spray solution level with a bracket avoids the problem. Also, the hose should be removed prior to shutting off the hydrant. Pumping and metering systems for mixing pesticides should have anti–back siphoning devices. Similar problems can occur when applying herbicides with irrigation systems (chemigation). Anti–back siphoning devices must always be used with chemigation systems.

To prevent backflow, put the field hose in the top of the tank and do not let it slide down into the spray solution.

This...
(back flow
prevention)





...not this
(pesticides
siphoned back
into water supply)

Never dispose of excess spray mix by dumping. If possible, apply the material to a labeled site. Be careful not to exceed label rates.

Pesticide Effects on Nontarget Organisms

The effects of pesticides on nontarget organisms may involve direct and immediate injury or may be consequences of long-term environmental pollution. In the following sections, we will discuss the effects of pesticides on nontarget plants, bees and other beneficial insects, livestock, fish, and wildlife.

Effects on Nontarget Plants

Phytotoxicity is injury to plants due to exposure to a chemical; phytotoxic injury can occur on any part of a plant – roots, stems, leaves, flowers, or fruits. Nearly all pesticides can cause plant injury, particularly if they are applied at too high of a rate, at the wrong time, or under unfavorable environmental conditions. Most phyotoxic injury is caused by herbicides.

Herbicides such as trazine, which are persistent at the site of application, may also injure succeeding crops. Damage to crops or other plants in adjacent areas is primarily due to drift, although it may also be a consequence of surface runoff, particularly from sloping areas.

Effects on Bees

Bees pollinate many fruits, vegetables, and field crops. You should be aware of bee activity when applying pesticides. Prevention of bee loss is the joint responsibility of spray operators, farmers, and beekeepers. Before applying pesticides that are toxic to bees, notify commercial beekeepers in the area so that they can protect or move their bee colonies.

Losses of bees to insecticide poisoning can be minimized by being aware of several basic principals:

- Read the label and follow label recommendations.
- Apply chemicals in the evening or during early morning hours before bees forage. Evening applications are generally safer than morning application. If unusually warm evening temperatures cause bees to forage later than usual, delay the insecticide application.
- Do not spray crops in bloom except when absolutely necessary.
- Do not treat an entire field or area if local spot treatments will control pests.
- Use insecticides that are relatively nonhazardous to bees whenever possible.
- Choose the least hazardous pesticide formulations. Emulsifiable concentrates are safer than wettable powders, and granules are the safest and least likely to harm bees.
- Determine if bees are foraging in the target area so protective measures can be taken.
- Airplane applications are more hazardous to bees than ground equipment applications.

Effects on Other Beneficial Insects

Beneficial insects can also be harmed by pesticides. Even though they are valuable allies in keeping pest populations below damaging levels, we often overlook them in our pest control efforts. Pesticides often kill as many beneficial insects as pest insects. Always consider the harmful effects on beneficial insects before applying pesticides.

Effects on Livestock

The most important source of livestock poisoning by pesticides is contaminated feed or forage and contaminated drinking water. This is often the result of carelessness. Livestock deaths occur because producers do not observe grazing restrictions on pesticide labels.

Poisoning may result from improper transportation, storage, handling, application, disposal, or a simple lack of attention.

Effects on Fish and Wildlife

The potentially harmful effects of pesticides on fish and wildlife is the focus of widespread concern. Damage to fish and wildlife may occur as a direct and immediate consequence of improper pesticide application (direct fish kill resulting from drift into an aquatic environment), or as a result of indirect pollution from soil erosion, surface runoff, and leaching. Except where direct kills are concerned, pesticides with longer persistence are a significantly greater hazard.

Some persistent pesticides are of particular concern because they can accumulate in the fat tissue of animals. This process is referred to as bioaccumulation or bioconcentration. Many chlorinated hydrocarbons (DDT, hephachlor, chlordane) are both persistent and accumulative; these combined properties account for most of the environmental problems associated with their use.

Accumulative pesticides can build up in the food chain. A food chain simply describes the sequence where an animal feeds on a particular plant, animal, or microorganism and is in turn eaten by another animal and so forth. At each succeeding level, an animal usually eats a number of individuals from a lower level. An accumulative pesticide can, therefore, become increasingly concentrated as it moves up the food chain; this process is referred to as biomagnification. For example, a study has shown that where levels of DDT in the soil were 10 parts per million (ppm), it reached a concentration level of 141 ppm in earthworms and 444 ppm in robins.

Protection of Endangered Species

An endangered species is a plant or animal that is in danger of becoming extinct. There are two classifications of these plants and animals in danger — "endangered species" and "threatened species." The term endangered species is used here to refer to the two classifications collectively. Scientists believe that some pesticides may threaten the survival of some of America's endangered species if they are used in the

places where these plants and animals still exist. As a result, the Endangered Species Act requires the U.S. Environmental Protection Agency (EPA) to ensure that endangered species are protected from pesticides.

Under the Endangered Species Act, it is a federal offense to use any pesticide in a manner that results in the death of a member of an endangered species. Prior to making applications, the user must determine that endangered species are not located immediately adjacent to the site to be treated. If the users are not sure whether endangered species may be affected, they should contact the regional U.S. Fish and Wildlife Service Office (Endangered Species Specialist) or personnel of the State Fish and Game Office at 64 N. Union Street, Montgomery, Alabama 36130.

Importance of Preserving Endangered Species

Hundreds of animals (including fish, birds, mammals, reptiles, amphibians, insects, and aquatic invertebrates) and thousands of plants have been named as endangered or threatened species under the provisions of the Endangered Species Act. Some of these animals and plants are ones that most people know about, such as the bald eagle. Others are tiny, little-known creatures that may rarely be seen by anyone except trained naturalists.

Regardless of the size or apparent significance of these endangered species, it is important that each is allowed to survive. The extinction of a single species may set off a chain reaction of harm to other species. The disappearance of a single kind of plant from an area, for example, may lead to the disappearance of certain insects, higher-level animals, and other plants.

Habitats of Endangered Species

Habitats, sometimes called critical habitats, are the areas of land, water, and air that an endangered species needs for survival. Such areas include breeding sites, sources of food, cover, and shelter, and surrounding territory that gives room for normal population growth and behavior.

The U.S. Fish and Wildlife Service is responsible for identifying the current habitat and range of each endangered species. For aquatic species, the restricted habitat often will include an additional zone around the body of water to keep any drift, runoff, or leachate in the watershed from reaching the water.

The U.S. Fish and Wildlife Service is attempting to identify habitats as accurately as possible so that pesticide use will be limited only in locations where it is absolutely necessary. For this reason, limitations on pesticide use may apply on one property, while a similar adjoining property may not have these limitations.

Limitations on Use

Read all pesticide labeling carefully to find out whether the use of the product requires you to take any special steps to protect endangered species. The label may direct you to another source for the details about what you must do. When limitations do apply, they usually will be in effect only in some specific geographic locations. Use of a particular pesticide is usually limited in a particular location when the site is designated as the current habitat of an endangered species and when the endangered species that uses the site might be harmed by the use of the pesticide within or close to its habitat.

Your Role as a Certified Applicator

As a certified applicator, you have a clearly defined legal responsibility to protect endangered species against pesticide hazards. Careful use of pesticides in and around key habitat areas will help these fragile plants and animals survive and it also may prevent some important pesticides from being removed from the market. Some examples of pesticide labeling statements that alert you to concerns about endangered species are:

(a) "Under the Endangered Species Act, it is a Federal offense to use any pesticide in a manner that results in the death of a member of an endangered species. Prior to making applications, the user must determine that endangered species are not located in or immediately adjacent to the site to be treated. If the users are not sure whether endangered species may be affected, they should contact the regional U.S. Fish and Wildlife Service Office (Endangered Species Specialist) or personnel of the State Fish and Game office."

(b) "Endangered Species Restrictions: For Aerial Application – Do not use within 100 yards of aquatic habitats. For Ground Application – Do not use within 20 yards of aquatic habitats."

These restrictions and statements may be included on labels or on special restrictions furnished by the EPA.

Chapter 5
Using Pesticides Safely

There are two good reasons for using pesticides safely:

- To keep yourself and other people from being poisoned.
- To avoid harming the environment.

The hazard to man depends on the toxicity of the active ingredient plus the length of exposure to the product. There are three types of toxicity: acute, chronic, and allergic.

Acute effects are illnesses or injuries that may appear immediately after exposure to a pesticide (usually within 24 hours). Studying a pesticide's relative ability to cause acute effects has been the main way to assess and compare how toxic pesticides are. Acute effects can be measured more accurately than delayed effects and they are more easily diagnosed than effects that do not appear until long after the exposure. Acute effects usually are obvious and often are reversible if appropriate medical care is given promptly.

Chronic toxicity is the ability of a pesticide to cause injury, sickness, or death as the result of long-term exposure. Illnesses or injuries appear a long time, usually several years, after exposure. Types of long-term effects include:

- Oncogenicity is the ability of a substance to cause tumors. Carcinogenicity refers to the ability to cause malignant tumors.
- Mutagenicity is the ability of a substance to cause changes in the genetic composition of a cell. If this occurs in an egg or sperm cell, the change or defect may be passed on to offspring.
- Neurotoxicity indicates toxic effects to the nervous system. Loss of memory, headaches, and muscular weakness are possible results.
- Reproductive effects include birth defects, sperm activity, and toxicity to fetus.

Allergic effects are harmful effects that some people develop in reaction to substances that do not cause the same reaction in most other people. Allergic reactions are not thought to occur during a person's first exposure to a substance. The first exposure causes the body to produce large numbers of antibodies designed to respond to a substance. A later exposure results in the allergic response. This process is called sensitization and substances that cause people to become allergic are known as sensitizers.

The signal words on front of each pesticide label indicate the potential toxicity of the product. Measurements of toxicity are expressed as LD50, the lethal dosages to kill 50 percent of a test population orally or dermally, and LC50, the lethal concentration to kill 50 percent of a caged population in a confined area. The smaller LD50 figure indicates less chemical needed to cause death. Therefore, a less toxic material would have a larger LD50 rating.

How Pesticides Enter the Body

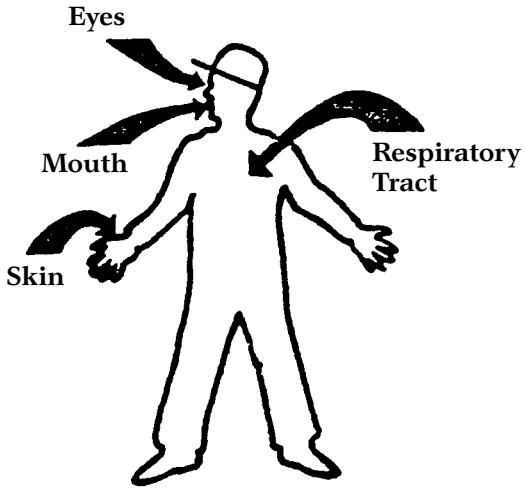
Pesticides may enter the body through the skin, mouth, lungs, and the eyes. In cases of direct contact, significant injuries can occur.

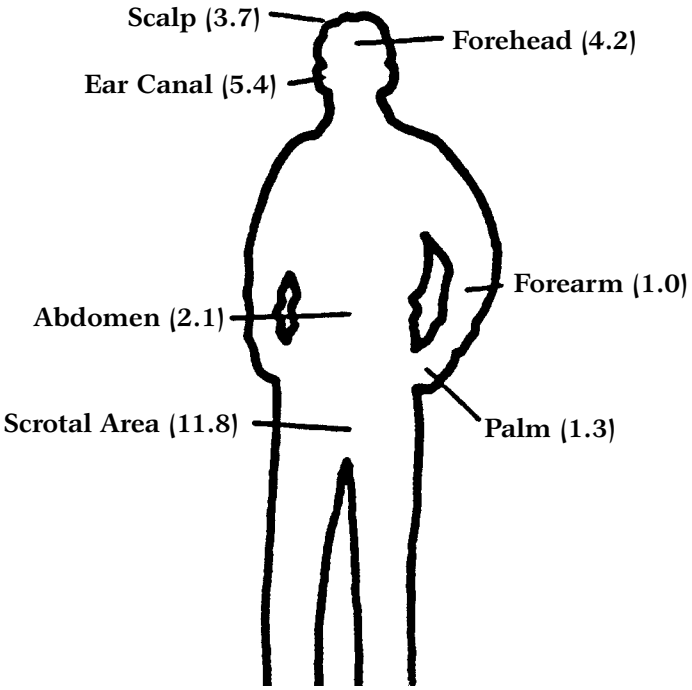
Dermal Exposure

Most pesticides can enter the body through the skin. With some pesticides, skin contact alone can cause death. Absorption through the skin is the most common route of poisoning of agricultural workers. Absorption may occur as the result of a splash, spill, or drift when mixing, loading, applying, or disposing pesticides. It may also result from exposure to large amounts of residue on a crop or when cleaning or repairing contaminated equipment.

Wettable powders, dusts, and granular pesticides are not as readily absorbed through the skin and other body tissues as are liquid formulations, such as emulsifiable concentrates.

Rates of absorption through the skin are different for different parts of the body. Using absorption through the forearm as the standard, absorption is more than 11 times faster in the lower groin area. Absorption through the skin in the scrotal area is rapid enough to approximate the effect of injecting the pesticide directly into the bloodstream. At this rate, the absorption of pesticide is more dangerous than swallowing it.





You should also be aware that it is not only the pesticide that is dangerous. Many pesticides are carried in oil-based materials. If this oil gets into the bloodstream, the results can be fatal. The oil crosses the skin barrier as rapidly as the pesticide in highly sensitive parts of the body. Wear rubber aprons or rubber trousers to protect the lower parts of the body.

Absorption continues to take place through all of the affected skin area as long as the pesticide is in contact with the skin. The seriousness of the exposure is increased if the contaminated area is large or if the material remains on the skin for a long period of time.

Remember that the face, scalp, neck, and groin absorb substances rapidly, whereas the palms of the hands and soles of the feet resist absorption.

Dermatitis

Many substances can cause dermatitis, or inflammation of the skin, on contact. Symptoms range from a slight redness of the skin to blisters or ulcerated lesions (large sores). Irritation levels are affected by the chemical properties of the substance, the duration and level of exposure, condition of the skin, temperature and humidity, and location of the contact.

Dermatitis is the most commonly reported effect associated with exposure. Individuals vary greatly in their susceptibility to skin effects.

If a pesticide is splashed or spilled on you, wash immediately. It is also important to wash hands thoroughly before smoking, eating, or using the bathroom.

Oral Exposure

If a pesticide is swallowed, it may result in serious illness, severe injury, or even death. Pesticides may be consumed by accident, through carelessness, or intentionally.

The most frequent cases of accidental oral exposure occur when pesticides have been taken from the original labeled container and put into an unlabeled bottle or food container. Children under 10 are the victims of at least half of the accidental pesticide deaths in the country. If pesticides were always handled correctly, children would never touch them.

Poisoning as a result of oral exposure to pesticides is almost always due to carelessness. Follow these rules:

- Always store a pesticide in its original labeled container.
- Never use your mouth to clear a spray line or nozzle or to begin siphoning a pesticide.
- Never eat, drink, or smoke until after leaving the work area and washing thoroughly.

Respiratory Exposure

Respiratory exposure is particularly hazardous because pesticides can be rapidly absorbed by the lungs. In addition, pesticides can be inhaled in sufficient amounts to cause serious damage to nose, throat, and lung tissue. Vapors and extremely fine particles pose the most serious risks.

Eye Exposure

The tissues of the eye are particularly absorbent. Besides the potential for chemical injury to the eye itself, some pesticides may be absorbed in sufficient amounts through the eye, resulting in serious or even fatal symptoms. Eye protection is needed when measuring or mixing pesticide concentrates and when applying highly or moderately toxic materials. Protective shields or goggles should be used whenever there is a chance that sprays or dusts may come into contact with the eyes. These pieces of protective equipment should always be available and clean.

Symptoms of Pesticide Poisoning

It is important to know what symptoms are caused by pesticides, as well as the conditions under which each one may cause illness.

Get medical advice quickly if unusual or unexplained symptoms appear at work or later the same day. A person who may have been poisoned should not be left alone. Do not let anyone get physically sick before calling a physician or going to a hospital. It is better to be too cautious than too late. Take the container or the label of the pesticide to the physician.

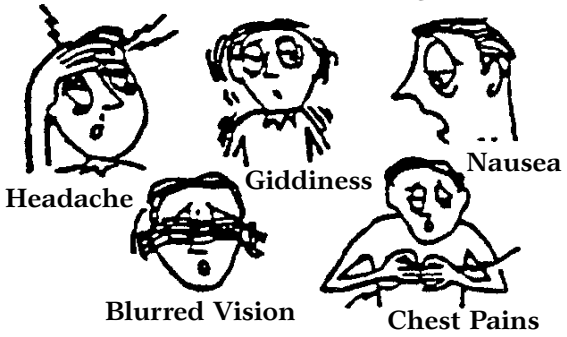
Some examples of the more common classes of pesticides used in agriculture and their poisoning symptoms include:

Organophosphates

These pesticides injure the nervous system. Organophosphates prevent the action of cholinesterase, resulting in excessive activity in the nervous system. The signs and symptoms go through stages. They normally occur in the following order:

Mild Poisoning: fatigue, headache, dizziness, blurred vision, excessive sweating and salivation, nausea and

General Symptoms Associated with Pesticide Poisoning



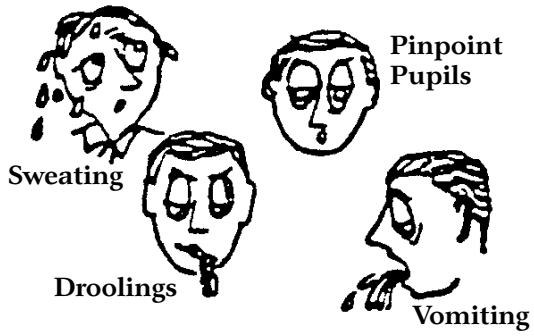
stomach cramps or diarrhea.

Moderate Poisoning: unable to walk, weakness, chest discomfort, muscle twitches, constriction of pupil of the eye, and more severe earlier symptoms.

Severe Poisoning: unconsciousness, severe constriction of the eye pupil, muscle twitches, secretions from mouth and nose, breathing difficulty, and death, if not treated.

Illness may be delayed a few hours, but if signs or symptoms start more than 12 hours after exposure to the pesticide, it is probably some other illness. Check with a physician to be sure.

Advanced Sure Signs of Poisoning



Carbamates

The only carbamates likely to make you ill on the job produce the same signs and symptoms as organophosphates. Illness caused by carbamates is usually not as severe or as enduring and they are considered safer than the highly toxic organophosphates.

Pyrethrins and Synthetic Pyrethroids

Pyrethrin is extracted from the flowers of chrysanthemum plants. Synthetic pyrethroids, which are chemically similar to pyrethrins, are manufactured in pesticide laboratories. Both of these insecticides are highly toxic to insects and fish but less toxic to humans than most insecticides. Pyrethrins and synthetic pyrethroids affect the central nervous system, and extremely high exposure results in convulsions and lack of coordination. However, because of their low level of toxicity, pyrethrins and synthetic pyrethroids usually only cause irritation to the skin and eyes.

Arsenicals

Ingestion is the route of most acute poisoning by arsenicals. Stomach pain, vomiting, and diarrhea are the primary symptoms of acute poisoning. Symptoms are sometimes delayed for hours. A garlic odor to the breath and feces helps to identify the poisoning agent.

Repeated intakes less than amounts necessary to produce acute symptoms result in chronic headache, stomach pain, and low-grade fever.

Anticoagulants

The injurious effects of anticoagulants are due to loss of blood, mainly into the body tissues. For example, the initial symptoms in chronic Warfarin poisoning are back pain and abdominal pain due to buildup of blood in these tissues.

Pyridyliums

Pyridylium herbicides may be harmful if inhaled or absorbed through the skin and may be fatal if swallowed. Lung fibrosis can develop if pyridyliums are swallowed or inhaled. The symptoms of injury may be delayed. Prolonged skin contact will cause severe irritation.

First Aid Procedures

Read the directions in the "Statement of Practical Treatment" on each pesticide label. These instructions can save your life and the lives of your employees. Get medical advice quickly if you or any of your coworkers have unusual or unexplained symptoms starting at work or later the same day. Do not let yourself or anyone else get dangerously sick before calling your physician or going to a hospital. It is better to be too cautious than too late. Take the pesticide container or the labeling to the physician. Do not carry the pesticide container in the passenger space of a car or truck.

First Aid for Pesticide Poisoning

First aid is the initial effort to help a victim while medical help is on the way. If you are alone with the victim, make sure the victim is breathing and is not being further exposed to the pesticide before you call for emergency help. Apply artificial respiration if the victim is not breathing. Do not become exposed to the pesticide while you are trying to help.

In an emergency, look at the pesticide labeling, if possible. If it gives specific first aid instructions, follow them carefully. If labeling instructions are not available, follow these general guidelines for first aid:

The best first aid in pesticide emergencies is to stop the source of pesticide exposure as quickly as possible.

Pesticide on skin:

- Drench skin and clothing with plenty of water. Any source of relatively clean water will work. If running water is not available, immerse the person in a pond, creek, or other body of water. Even water in ditches or irrigation systems will do, unless you think they may have pesticides in them.

- Remove personal protective equipment and contaminated clothing.
- Wash skin and hair thoroughly with a mild liquid detergent and water. If one is available, a shower is the best way to completely and thoroughly wash and rinse the entire body surface.
- Dry victim and wrap in a blanket or any clean clothing at hand. Do not allow victim to become chilled or overheated.
- If skin is burned or otherwise injured, cover immediately with loose, clean, dry, soft cloth or bandage.
- Do not apply ointments, greases, powders, or other drugs in first aid treatment of burns or injured skin.

Pesticide in eyes:

- Wash eyes quickly but gently.
- Use an eyewash dispenser if available. Otherwise, hold eyelid open and wash with a gentle drip of clean running water positioned so that it flows across the eye rather than directly into the eye.
- Rinse eyes for 15 minutes or more.
- Do not use chemicals or drugs in the rinse water. They may increase the injury.

Inhaled pesticide:

- Get victim to fresh air immediately.
- If other people are in or near the area, warn them of the danger.
- Loosen tight clothing on victim that would constrict breathing.
- Apply artificial respiration if breathing has stopped or if the victim's skin is blue. If pesticide or vomit is on the victim's mouth or face, avoid direct contact and use a shaped airway tube, if available, for mouth-to-mouth resuscitation.

Pesticide in mouth or swallowed:

- Rinse mouth with plenty of water.
- Give victim large amounts (up to 1 quart) of milk or water to drink.
- Induce vomiting only if instructions to do so are on the labeling.

Procedure for inducing vomiting:

- Position victim face down or kneeling forward. Do not allow victim to lie on back because the vomit could enter the lungs and do additional damage.
- Put finger or the blunt end of a spoon at the back of the victim's throat or give syrup of ipecac.
- Do not use salt solutions to induce vomiting.

Do not induce vomiting:

- If the victim is unconscious or is having convulsions.
- If the victim has swallowed a corrosive poison. A corrosive poison is a strong acid or alkali. It will burn the throat and mouth as severely coming up as it did going down. It may get into the lungs and burn there also.
- If the victim has swallowed an emulsifiable concentrate or oil solution. Emulsifiable concentrates and oil solutions may cause death if inhaled during vomiting.

Know the Law

The Occupational Safety and Health Act (OSHA), administered by the U.S. Department of Labor, contains some requirements that could affect you if you or one of your employees is involved in a pesticide-related injury or illness.

- Employers must keep records of all work-related deaths, injuries, and illnesses and make periodic reports. Minor injuries needing only first aid treatment need not be reported. You must keep records if the injury involved medical treatment, loss of consciousness, restriction of work or motion, or transfer to another job.
- OSHA will investigate employee complaints related to exposure to hazardous materials, such as pesticides.

Heat Stress

Heat stress is the illness that occurs when your body is subjected to more heat than it can cope with. Heat stress is not caused by exposure to pesticides, but may affect pesticide handlers who are working in hot conditions. Personal protective equipment worn during pesticide handling activities can increase the risk of heat stress by limiting your body's ability to cool down. If you are under a physician's care, you should consult your physician before working in hot conditions.

Signs and Symptoms of Heat Stress

Mild forms of heat stress will make you feel ill and impair your ability to do a good job. You may get tired sooner, feel weak, be less alert, and be less able to use good judgment. Severe heat stress is a serious illness. Unless victims are cooled down quickly, they can die. Severe heat stress is fatal to more than 10 percent of its victims, even young, healthy adults. Many who survive suffer permanent damage. Sometimes the victims remain highly sensitive to heat for months and are unable to return to the same work.

Learn the signs and symptoms of heat stress and take immediate action to cool down if you suspect you may be suffering from even mild heat stress. Signs and symptoms may include:

- Fatigue (exhaustion, muscle weakness)
- Headache, nausea, and chills
- Dizziness and fainting
- Severe thirst and dry mouth
- Clammy skin or hot, dry skin
- Heavy sweating or complete lack of sweating
- Altered behavior (confusion, slurred speech, quarrelsome or irrational attitude)

First Aid for Heat Stress

It is not always easy to tell the difference between heat stress and pesticide poisoning. The signs and symptoms are similar. Don't waste time trying to decide what is causing the illness. Get medical help.

First aid measures for heat stress victims are similar to those for pesticide poisoning victims:

- Get the victim to a cool or shaded area.
- Cool victim as rapidly as possible by sponging or splashing the skin, especially the face, neck, hands, and forearms, with cool water or, when possible, by immersing in cool water.
- Carefully remove all personal protective equipment and any other clothing that may be making the victim too warm.
- Have the victim, if conscious, drink as much cool water as possible.
- Keep the victim quiet until help arrives.

Severe heat stress or heat stroke is a medical emergency! Brain damage and death may result if treatment is delayed.

Heat Cramps

Heat cramps can be quite painful. These muscle spasms in the legs, arms, or stomach are caused by loss of body salt through heavy sweating. To relieve cramps, have the victim drink lightly salted water or "sports drinks." Stretching or kneading the muscles may temporarily relieve the cramps. However, if you suspect that stomach cramps are being caused by pesticides rather than heavy sweating, get medical help right away.

Medical Antidotes

By law, highly toxic pesticides must have instructions for the physician on the label in case of pesticide poisoning. Such instructions will include information on medical antidotes if such information is available. Remember that medical antidotes can be very dangerous if misused. They should never be used as a preventive treatment and should be prescribed and given only by a qualified physician.

If instructions for the physician are not given on the pesticide label, contact a poison control center or poison treatment center.

First Aid Kit

A well-equipped, readily available first aid kit can be important in a pesticide emergency. Make up a kit from a lunch pail, tool box, or sturdy wooden box. It should have a tight-fitting cover with a latch so that it will not open or allow pesticides to leak inside. Label it clearly with paint or a waterproof marker. A first aid kit for field and on-the-job use should include:

- A small plastic bottle of a common detergent to quickly wash pesticides off the skin.
- A container of clean water. If there is no clean water available, use any pond or stream water in an emergency.
- Simple bandages and tape. All cuts and scrapes should be covered to prevent pesticides from easily entering the body.
- Telephone numbers of doctors, hospitals, and poison centers
- Saline eye wash — at least 1 quart.

Safety Precautions

Recognizing the potential hazards of some pesticides, the responsible applicator will take every precaution to avoid health hazards. Keeping your exposure level to a minimum is the key to reducing risk. Reading label directions before each application is important. Make sure you and your helpers follow label directions and the recommendations in this chapter.

Washing

Since pesticides can be absorbed through the skin, it is important to shower at the end of every day when you have been working with pesticides. Wash your hands before eating, drinking, smoking, or chewing tobacco or gum. Take care not to rub your mouth or eyes during application. Pesticides are absorbed very easily if they contact the genitals; wash your hands before using the bathroom.

Eating

Never eat or store food in areas where pesticides are being applied or stored; the food could be contaminated.

Alabama Pesticide Emergency Numbers

For information on pesticide poisoning call the National Poison Control Hotline (Spanish speakers available) at 800-222-1222.

For non-emergency questions about pesticides, call your county Extension agent. You may also call the National Pesticide Information Center at (800) 858-7378 between 8:30 a.m. and 6:30 p.m. (CST), seven days a week. You can also visit the Web site at http://npic.orst.edu. This center provides information on pesticide product safety, environmental and health effects, and cleanup and disposal procedures. It is funded by the Environmental Protection Agency (see foreward).

Chapter 6
Personal Safety Equipment

Protective Clothing and Gear

When using any pesticide, regardless of its toxicity, wear a hat, long-sleeved shirt, long trousers or a coverall garment, underwear, socks, and shoes. It is advisable to wear coveralls over regular clothing. When handling pesticide concentrates during mixing and loading or when using highly or moderately toxic materials, you should also wear rubber boots, rubber gloves, a rubber or vinyl apron, and goggles. An apron will provide protection if the pesticide concentrate is spilled. Store personal protective equipment away from pesticide mixing and storage areas.

Gloves. Generally, when handling concentrated or highly toxic pesticides, wear liquid-proof neoprene or vinyl gloves. They should be long enough to protect the wrists. Gloves should not be lined with fabric, which is hard to clean if a chemical gets on it. Sleeves should be outside of the gloves to keep pesticides from running down the sleeves and into the gloves.

Do not wear cotton or leather gloves. They absorb the pesticide, provide constant exposure, and can be more hazardous than not wearing gloves. Before removing your gloves, rinse them to prevent contaminating your hands, then wash the inside of the gloves. Check for holes in gloves before using them by filling with water and looking for leaks. Gloves can be contaminated on the inside and the moist warm conditions there may foster pesticide absorption. To avoid this problem, discard gloves often.

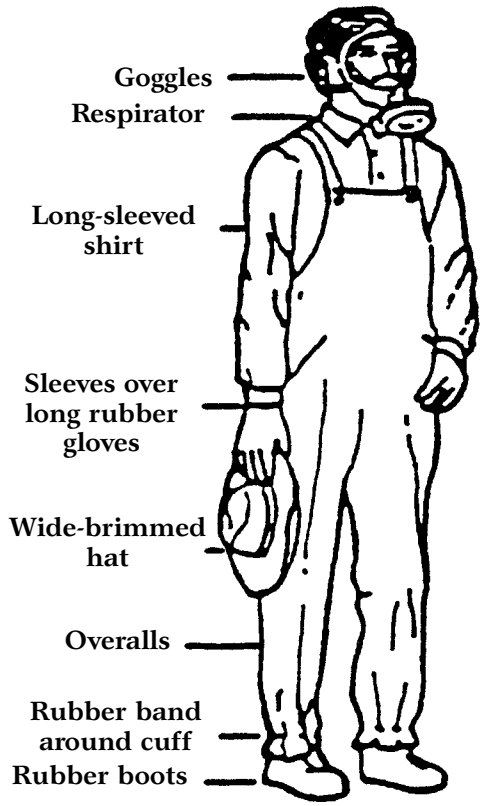


Figure 1. Protective Clothing and Gear

Hat. Wear something to protect your head. A wide-brimmed, waterproof hat will protect neck, eyes, mouth, and face. It should not have a cloth or leather sweatband. Sweatbands are hard to clean if chemicals get on them.

Boots. Wear unlined rubber boots. Leather and canvas shoes absorb and hold pesticides, providing a constant source of skin exposure. Pant legs should go over the top of boots to prevent pesticides from running in the boots. Wash boots thoroughly inside and outside to remove any pesticide residue.

Goggles or Face Shield. Wear goggles or a face shield when there is any chance of getting pesticides in your eyes. Tight-fitting goggles with antifog lenses and indirect venting are best. Wash goggles or face shield with detergent and water at least once a day. Store in a plastic bag away from pesticides to avoid contamination. Wearing contaminated equipment can increase absorption.

Respirators for Agricultural and Pesticide Workers

Several kinds of respiratory protective devices (commonly called face masks, respirators, or gas masks) are available to prevent workers from breathing dust and chemical vapors. The pesticide worker needs to know what types are available and which hazards they will protect against. Never try to use one type of respirator for all kinds of hazards. **Use the respirator designed for the pesticide and the job.** The pesticide label tells which respirator to use for the pesticide you will be applying.

- A **dust filter mask** covers the nose and the mouth but contains only a dust filter and should not be used with pesticides. It is useful in haying, cultivating dusty fields, applying lime and fertilizer, and similar operations.
- A **cartridge respirator** (half face mask) protects against certain pesticide dusts, mists, and fumes. It covers the mouth and nose but does not protect the eyes. The face piece has one or two cartridges that contain an absorbent material, such as activated charcoal and dust filters (see Figure 2).

Figure 2. Half-Face Mask.

- A **canister-type gas mask** protects the lungs as well as the eyes against certain chemical dusts, mists, and fumes. It has a canister on the face piece or attached to the face piece by a flexible hose. The canister holds more absorbing material and longer-life filters than the cartridge respirator (see Figure 3).

Figure 3. Full-Face Canister Mask

- A **supplied-air respirator** is used when oxygen is deficient or where highly toxic gases are so concentrated that you need your own air supply, such as in silos and grain elevators, around manure pits, and in fumigation operations. It brings fresh air through a hose from a safe, distant supply to the operator's hood. The fresh air is usually pumped by a blower.
- **A self-contained breathing apparatus** serves the same purpose as the supplied-air respirator but allows you to take your air supply with you for short-term jobs. The mask is connected to an oxygen cylinder, usually carried on your back.

Take care of your respirator. Change filters twice a day or more often if breathing becomes difficult. Change cartridges after eight hours of actual use or more often if the pesticide odor is detected. Remove the filters and cartridges and wash the face piece after each use. Place the face piece in a well-ventilated area to dry. Store respirators, gas masks, filters, and cartridges in a clean, dry place, away from pesticides.

The use of respirators does not eliminate the need for other precautions in handling toxic pesticides. Many pesticides can cause harm through skin exposure. Gloves, protective clothing, and proper ventilation are also important in handling pesticides safely.

Special protection equipment may be required under the worker protection standards. Follow label directions for proper safety measures to use.

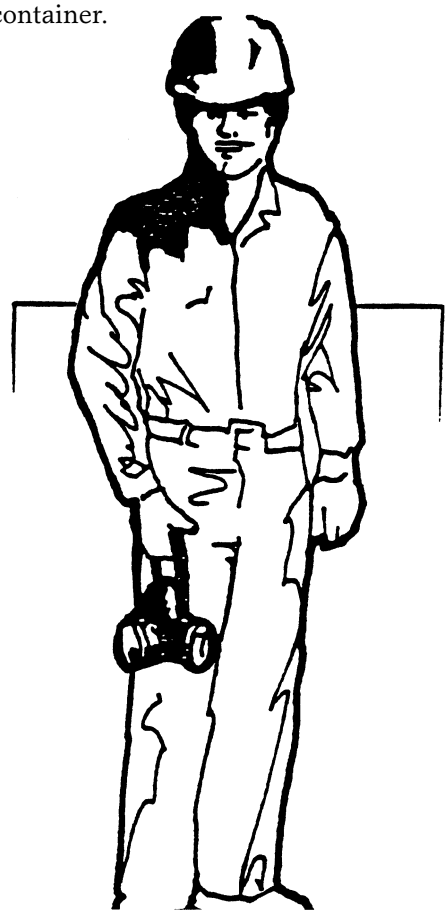
What to Do When Clothes Are Soiled with Pesticides

The need for pesticide safety does not stop after pesticide application. Protective clothing, as well as pesticide equipment, can become contaminated. Proper handling and washing of pesticide contaminated clothing is important to your health and your family's health. The following guidelines for laundering pesticide contaminated clothing are important.

1. Clothes worn while applying pesticides should be removed outdoors. If a granular pesticide has been used, shake clothing outdoors and empty pockets and cuffs. Wear gloves while removing clothes and shoes to help avoid pesticide contact with the hands. If fabric clothing is saturated with a highly toxic pesticide, discard the clothing. Place it immediately in a plastic trash bag; close the bag tightly and dispose of it in a solid waste landfill, if label permits. (Follow disposal directions on the pesticide label.) Remember to wear rubber, vinyl, or plastic gloves when handling severely contaminated clothing.
2. Do not put pesticide contaminated clothes with other clothes to be laundered. Have a separate covered container for them. A garbage can lined with a garbage bag works well. Never send clothing worn while applying pesticides to a commercial laundry service.
3. Wash protective clothing after each use. When clothing is repeatedly exposed or soiled, more pesticide remains in the clothing after washing and there are higher concentrations of chemicals in the rinse water.
4. Pre-rinse clothing before washing. This helps remove a large amount of pesticide. Pre-rinsing can be done by hosing clothing off outdoors, then soaking in a tub or bucket or by using the presoak cycle in the washer.
5. Wash pesticide soiled clothing in water heated to 140 degrees or higher. Hot water removes more pesticide.
6. Use a heavy-duty liquid laundry detergent. They are better at removing pesticides and are especially helpful in removing oil-based pesticides. Use the amount of detergent recommended on the product label. Neither bleach nor ammonia seem to affect pesticide removal. (Never mix these two products together.)
7. Use the full level on the machine and wash only a few clothes at a time so water can circulate freely.
8. Wash clothes on the longest available cycle and use a double rinse cycle if possible.
9. Wash the clothing twice. Drying is not necessary between washings.
10. Line dry clothes whenever possible. Exposure to sunlight may help break down pesticides. This will also prevent contamination of the dryer. If a dryer must be used, wipe the inside of the dryer with a damp cloth after clothes have been removed.
11. Before washing regular clothing, clean the washing machine by running an empty load with hot water and detergent.

12. Thoroughly wash all boots, hats, gloves, aprons, and goggles in detergent and hot water. Test gloves for leaks by filling them with water and squeezing. Always dispose of leaky gloves.

13. If respirators are used, clean and store according to manufacturer's instructions, usually in a dry, tight container.



Example of a Label Statement

Personal Protective Equipment

Applicators and other handlers must wear: Coveralls over long-sleeved shin and long-legged pants

Chemical-resistant gloves such as butyl or nitrile

Chemical -resistant footwear plus socks

Eye protection

Respirator with an organic vapor-removing cartridge and a prefilter approved for pesticides MSHA/NIOSH approval prefix (23C) or canister approved for pesticides — MSHA/NIOSH approval number (14G)

Overhead applications: add chemical-resistant wide-brimmed hat or hood

Mixers/loaders and cleaners of equipment: add chemical-resistant apron

Chapter 7
Pesticide Handling Decisions

Many aspects of pesticide handling involve some risk of pesticide injury: transporting, mixing and loading, applying, cleaning equipment, cleaning up spills, storing and disposing surplus pesticides and empty containers.

Once the decision is made to use a pesticide, the first step is to read the label and any material safety data sheets carefully. Failure to choose the right pesticide could result in illegal residue, failure to control the pest, and possible harmful off-site effects.

Safe mixing and loading involves wearing the protective clothing listed on the label. Mix pesticides according to label directions. All mixing and loading sites should have water, soap, towels, and a change of clothing so that in case of a spill, proper decontamination can be accomplished. Mixing and handling highly toxic material should be done by two people, or someone should be nearby to give assistance if needed.

A spray tank should be loaded away from a water well to prevent groundwater contamination during filling and a person should be present to prevent back siphoning and tank over-flow. Pesticide poisoning is most likely to occur during mixing and loading.

The following safety procedures will help prevent pesticide contamination.

- Wear rubber or nitrile gloves, a chemical resistant apron, and goggles.
- Wear the respirator that the label recommends.
- When removing pesticide from the container, keep the container and pesticide below eye level. Pouring or loading equipment above eye level could cause serious problems if a spill occurs.
- Clean gloves, apron, boots, respirator, and goggles after mixing to prevent skin contact later.
- Stand upwind when mixing and loading.

Transporting Pesticides

Individuals handling unopened containers are not considered to be in high risk. Regardless, personal hygiene should be followed to prevent skin contact. Transporting concentrates to and from storage areas carries a high risk of accidental poisoning and environmental contamination. Pesticides should always be transported in their original containers with label intact. Never transport in a passenger vehicle or with food or feed. Never leave a vehicle containing pesticides unattended. Pesticides transported on the back of a truck should be tied down securely to prevent spills or being lost from vehicle. Special regulations require reporting spills that occur off of your property and on public roads.

Avoid Equipment Accidents

Check equipment thoroughly before beginning. Make sure it is working properly, is calibrated with correct nozzles, pressure, droplet size, has no leaks, and is in proper condition.

Cleaning Equipment

After application, equipment should be cleaned immediately to prevent damage later. Use a water/detergent solution (2 pounds of detergent in 20 to 40 gallons of water) to clean inside the tank. Allow the water/detergent solution to circulate through the system for several minutes. Apply this cleaning solution to site of chemical application. Refill tank with water, remove nozzles and screens, clean, and flush system to remove soap solution.

Nozzles should be cleaned with a soft-bristled brush. Do not use a metal object. Never attempt to clean a nozzle by blowing through it with your mouth. Diluted spray mixtures can be toxic.

When storing your sprayer, add 1 to 5 gallons of lightweight oil (depending on the size of the tank) before the final flushing. As water is pumped from the sprayer, the oil will leave a protective coating on the inside of the tank, pump, and plumbing.

To prevent corrosion, remove nozzle tips and screens and store them in a can of light oil, such as diesel fuel or kerosene. Cover nozzle openings with tape to prevent contamination.

Pesticide Spills

Even when proper procedures are followed, pesticide spills can occur. Knowing what steps to take in the event of a pesticide spill will allow you to respond quickly and properly. **Always be sure to wear proper protective clothing when dealing with pesticide spills and to clean up your equipment and clothing when you are finished.**

1. **Control the spill.** Immediately after a spill has occurred, make sure that the source of the spill has been identified and controlled. As soon as possible, call authorities, such as your local fire department, for help controlling the spill.
2. **Contain the spill.** Contain the spill with a dike of soil or sand. It is particularly important not to allow any chemical to get into any body of water, including sewers. Never hose down spills; this will only spread the chemical.
3. **Clean up the spill.** Use an absorbent material, such

as dirt or kitty litter, to soak up the spill. Shovel all contaminated material into a leak-proof container for proper disposal. Once the spill has been cleaned up, it may be necessary to decontaminate the area. Common household bleach is usually effective for decontamination. However, read the pesticide label for specific decontamination directions. Call the emergency telephone number listed on the label or call Chemtrec at (800) 262-8200 for additional information. The following information should be reported:

- Name, address, and telephone number of person reporting
- Exact location of spill
- Name of company involved and location
- Specific pesticide spilled
- Estimated quantity of pesticide spilled
- Source of spill
- Cause of spill
- Name of body of water involved, or nearest body of water to the spill area
- Action taken for containment cleanup
- Other agencies that have been notified

EMERGENCY PLANNING

EPA's Title III Superfund Amendment and Reauthorization Act of 1986 (SARA) requires individuals who handle or store extremely hazardous chemicals to take the following precautions.

1. Emergency Planning – If you use pesticides that are on the following list, you must report the threshold planning quantity (TPQ) to the Alabama Emergency Management Agency, which in turn informs your county Local Emergency Planning Committee (LEPC), which includes firefighters. Your inventory list should include the locations of all extremely hazardous chemicals so that when firefighters are responding to emergencies, they can take adequate precautions.

2. Spills – In case of spills or the releasing of a pesticide into the environment, Title III SARA requires a report to be filed. A report is required if a spill occurs off of your property, such as a road – highway accident, or if a spill occurs that could potentially contaminate ground or surface water of the environment. The reportable quantities (RQ) of some important pesticides are listed below. A report is required even if you properly handle the spill. If the amount released is a large amount, the report should be made to the National Response Center at (800) 262-8200. Do not call in a spill unless the RQ has been released.

The use of EPA registered pesticides in a manner directed by its label is a legal release into the environment. The use on a site not listed on the label is an illegal release and is subject to prosecution.

Pesticide Name	THRESHOLD Planning Quantity (pounds A.I.)*	Reportable Quantity (RG)(spills) (pounds) on releases in the environment
Aldicarb (Temik)	100	1
Azinphos-Methyl (Guthion)	2 (10)	1
Carbofuran (Furadan)	2 (10)	10
Discotophos (Bidrin)	100	1
Disulfoton (Di-Syston)	500	1
Endosulfan (Thiodan)	2 (10)	1
Fensulfothiion (Dasanit)	1000 (500)	1
Fonofos (Dyfonate)	500	1
Lindane	1000	1
Methamidophos (Monitor)	100	1
Methomyl (Lannate)	500	100
Methyl Bromide	1000	1000
Mevinphos (Phosdrin)	500	10
Oxamyl (Vydate)	100	1
Paraquat (Gramoxone)	10	1
Parathion-ethyl	100	1
Parathion-methyl	100	100
Pentachlorophenol (Pcp)	10,000	10
Phorate (Thimet)	10	1
Phosphamidon	100	1
Sodium Pentachlorophenenate	100	1
Terbufos (Counter)	100	1
Trichlorophon (Dylox)	10,000	100

* Pounds of A.I. = active ingredient. For example, Paraquat Gramoxone contains 2 lbs A.I. per gallon of product. Five gallons on a farm would equal the threshold planning quantity, and a spill of ½ gallon or 1 lb. A.I. would meet Reportable Quantity. These reportable quantities are made to the Alabama Emergency Management Agency.

Storing Pesticides

As soon as pesticides are delivered to your property, store them in a locked and posted facility where children and other untrained people cannot get to them. Read the label for correct storage procedures.

Site Selection

The site should be in an area where flooding is unlikely. It should be downwind and downhill from sensitive areas, such as houses, play areas, and ponds. Also, the site should be located so that runoff or drainage from the site cannot contaminate surface or underground water. Storage facilities should be located away from human and livestock habitations to avoid or minimize contamination in case of fire.

Storage Area

Store pesticides and pesticide containers in a separate building, room, or enclosure, depending on the size of your pesticide inventory. Pesticides should be kept dry, cool, and out of direct sunlight.

Some pesticides require protection against freezing or extreme heat and have suitable warnings on the label. Sacks, cartons, and fiber boxes should be stored on wooden pallets or on shelves off the floor. The storage area should be securely locked. Weatherproof signs stating, "Danger-Pesticides. Keep Out!" or similar warnings should be hung over every door and window.

An adequate supply of detergent or soap, hand cleanser, and water is essential in the storage area. Water is quick first aid in a poisoning emergency.

A pesticide storage area, whether it is a cabinet or a room, should be used only for pesticides. Never store near food, feed, fertilizers, seed, veterinary medicines, or other products.

Store pesticides only in the original container with the label plainly visible. Pesticides should never be stored in anything used as a food or drink container, even for a short time. Pesticides stored in a soft drink bottle, fruit jar, milk carton, etc. are a common cause of accidental pesticide poisoning of humans, especially children.

Do not buy more pesticide than you will need. Remove only the amount needed for one day's operation and be sure to reseal and return any unused pesticide and empty containers to the storage area at the end of the each day. Do not leave empty containers in the fields or on open dumps. Keep all empty containers in a locked storage area until they can be disposed of properly.

Disposal

Excess Pesticides

There are only a few environmentally safe ways to dispose of leftover or unwanted pesticides. Federal guidelines recommend highly sophisticated disposal techniques, such as detoxification, high-temperature incineration, reprocessing of waste, and controlled land disposal. Recommended disposal techniques currently available in Alabama are limited. For more information, contact Alabama Department of Environmental Management at (334) 271-7730 or the Alabama Department of Agriculture and Industries at (334) 240-7237.

Preventing surplus pesticides is the best way to avoid the disposal problem. However, often it is not possible to avoid having unusable, damaged, or canceled pesticides in storage. If possible and legal, use these pesticides by applying them according to label directions.

Pesticide Clean Day Program

The Pesticide Clean Day Program allows farms, nurseries, pest control operators, homeowners, etc. to take advantage of safe disposal of unwanted pesticide wastes at no charge. Clean day programs are sponsored events that are conducted when funds are available. The events are advertised by the Alabama Department of Agriculture and Industries and the Alabama Cooperative Extension System. The Department of Agriculture and Industries administers the program.

Dilute Rinsate Solutions

Waste solutions from washing equipment, rinsing tanks and booms, surplus tank mixtures, and spilled pesticides must be disposed of with minimal impact on the environment. If you mix too much pesticide for a job or have surplus pesticide mixtures, try to find other areas with the same pest problem and use up any extra tank mix or rinse water on these areas.

To avoid being faced with the disposal of a tankful of wrong pesticide, check out the job carefully before selecting a pesticide. After you have selected the proper pesticide, mix only enough for the particular job so that you end up with an empty tank or hopper.

Containers

Pesticide labels usually provide some information on container disposal. Always comply with the label directions, as well as with state and federal regulations. Regardless of the disposal method, all empty pesticide containers (other than paper bags) must be triple rinsed or pressure rinsed prior to disposal.

Triple rinse all noncombustible containers in the following manner:

- Empty the container in the spray tank and let it drain for 30 seconds.
- Fill the container one-fifth to one-fourth full of water.
- Replace the closure and rotate the container. Upend the container so the rinse reaches all the side surfaces.
- Drain the rinse water from the container into the spray tank and let it drain 30 seconds after emptying.
- Repeat the procedure at lease two more times.

Pressure rinsing forces remaining pesticide from containers by using a special nozzle attached to the end of a hose. Pressure rinsing can be used with plastic and nonpressurized metal pesticide containers. Pressure rinse in the following manner:

- Empty the pesticide into the spray tank and let the container drain for 30 seconds.
- Insert the pressure rinse nozzle by puncturing through the bottom of one side of the pesticide container.
- Rise for length of time recommended by the manufacturer, rotating the nozzle while rinsing.

Never reuse a pesticide container once it has been rinsed. Even rinsed containers will still contain some pesticide residues.

Do not allow empty containers to accumulate in an easily accessible area. This will prevent unauthorized salvaging and conversion to other uses.

Some pesticide containers may be returned to the dealer. All properly rinsed containers may be disposed of by burial in any sanitary landfill that accepts pesticide containers. Each label will have disposal instructions.

Example of a Label Statement

Storage and Disposal

PROHIBITIONS: Do not contaminate water, food, or feed by storage or disposal. Do not store under conditions which might adversely affect the container or its ability to function properly.

STORAGE: Do not store below temperature of 0°F. Store in a safe manner. Store in original container only. Keep container tightly closed when not in use. Reduce stacking height where local conditions can affect package strength. Personnel should see clothing and equipment listed under "PRECAUTIONARY STATEMENTS" when handling open containers.

SPILLED MATERIAL: Block or dike to prevent spreading of spill. Cover with absorbent material such as lime, clay, or sawdust. Wash area with strong lye solution, absorb, and place in a disposable container.

PESTICIDE DISPOSAL: Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, contact your Stale Pesticide or Environmental Control Agency, or the Hazardous Wastes representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL: Metals -Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by State and local authorities.

Plastics — Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incinerate.

Chapter 8
Equipment and Calibration

Pesticide labels specify how much pesticide must be applied per acre, per animal, or per recognized site. This amount is usually given in terms of the undiluted pesticide. The undiluted pesticide then has to be mixed with water or another carrier applied by a sprayer. Dusts and granular formulations are applied undiluted with equipment calibrated to deliver the correct amount.

It is necessary to calibrate equipment for two reasons: (1) to make sure the correct amount of pesticide is applied, and (2) in the case of liquid application, to determine how much chemical to mix with the carrier in the tank to cover the desired area.

Equipment that must be calibrated includes mechanical dusters; granule spreaders; hand, backpack, boom, handgun, high pressure, air blast and fumigant applicators. Special brochures are available from your equipment dealer for most application equipment.

In brief, the area sprayed is often an easy-to-calculate fraction of an acre, such as 1/10 of an acre measured to determine output on the area.

Another method is called the refill method, which involves filling the tank and spraying a measured area of land (usually one to several acres). The amount of liquid needed to refill the tank to the original level is the amount applied to the sprayed acreage.

The 1/128-Acre Calibration Method

This method involves collecting the output of one nozzle spraying 1/128 acre. There are 128 fluid ounces in one gallon, so the number of ounces applied on 1/128 acre equals the gallons applied per treated acre.

Calibration Distance for the 1/128-Acre Method*

Nozzle Spacing (Broadcast) or Band Width (inches)	Calibration Distance (feet)	Nozzle Spacing (Broadcast) or Band Width (inches)	Calibration Distance (feet)
6	681	24	170
8	510	30	136
10	408	36	113
12	340	38	107
14	292	40	102
16	255	42	97
18	227	48	85
20	204		

* Nozzle spacing is measured in inches, while calibration distance is measured in feet; one ounce of output per nozzle equals 1 gallon per acre.

It is assumed that the nozzle spacing is uniform along the boom and that all nozzles are applying the same volume of fluid per minute. Nozzles should be replaced if they apply 5% more or less than the average output of all tips.

To find the number of ounces applied on 1/128 acre –

1. Determine the nozzle spacing (inches) on the boom for broadcast applications. For band applications, determine the width of the sprayed band (in inches). Convert this spacing to feet.
2. Find the calibration distance to drive in the field for a single nozzle to spray 1/128 acre (340 sq ft). Use the table or the formula:

$$\text{distance} = \frac{\text{340 square feet}}{\text{average nozzle spacing or band width, measured in feet}}$$

3. Set the working pressure for the desired spray pattern and mark the distance obtained from Step 2 either in the field to be sprayed or on a similar surface.
4. Determine the time required to drive this distance using the tractor gear and engine rpm that will be used in the actual spraying.
5. Collect the output from one average nozzle for the amount of time required to drive the above distance. Be sure to use the same nozzle pressure planned for the actual spray.
6. One ounce of output per nozzle represents 1 gallon per acre. For example, if you collected 10 ounces of liquid from the nozzle, the application rate is 10 gallons per acre.

Amount of Chemical to Put into the Tank

1. Determine how many acres a tankful will spray:

$$\text{Acres treated} = \frac{\text{tank capacity (gal)}}{\text{spray rate (gal/acre)}}$$

2. Determine the amount (lb, gal, qt, pt) of chemical to add:
   Number of acres treated with tankful X (lb, qt, pt ...) per acre = amount of chemical to add to the tank.
   If you need less than a tankful—
   1. Determine the amount of water needed for the area to be sprayed:
      Number of acres to be sprayed x spray rate (gal/acre) = amount of water (gal)

2. Determine the amount (lb, gal, qt, pt ...) of chemical to add:
   (lb, gal, pt ...) per acre x acres to be sprayed = amount of chemical

Granular Applicators Using 1/100-Acre Method

1. Determine the length of row for 1/100 acre (435.6 sq ft) from table below or use

$$\text{length of row (ft)} = \frac{\text{435.6 square feet}}{\text{row spacing (ft)}}$$

Length of Row to Equal 1/100 Acre

Row Spacing (inches)	Length (feet)	Row Spacing (inches)	Length (feet)
12	436	44	119
18	290	48	109
24	218	54	97
30	174	60	87
36	145	72	72.6
38	138	84	62.2
40	131	96	54.5
42	125	108	48.4
		120	43.6

2. Mark the distance obtained from Step 1 in the field.
3. Catch fertilizer or granules from the tube as the tractor moves the marked distance. Weigh the sample. Maintain the speed to be used in the actual application. If the applicator is not ground drive, you can determine the time it would take your tractor to cover the distance and catch the output for the time with the applicator sitting still. Be sure the applicator drive is running at the same speed used in the field.
4. Multiply the weight of your sample by 100 to get the per-acre rate. For fertilizer, the weight can be measured in pounds. For granules, the small amounts caught will usually be measured in ounces or grams. To convert to pounds, either divide ounces by 16 or divide grams by 454.

Application Equipment

The pesticide application equipment you use is important to the success of your pest control job. First, you must select the right kind of application equipment, then you must use it correctly and take good care of it.

This unit provides an overview of some things you should know about choosing, using, and caring for equipment. To use your pesticide application equipment safely and effectively, **study the manufacturer's directions carefully**. Some pesticide applications, such as air blast spraying, fumigation, aerial application, and chemigation are highly specialized. You will need special training to use the equipment these applications require.

Sprayers

Sprayers are the most common pesticide application equipment. They are standard equipment for nearly every pesticide applicator and are used in every type of pest control operation. Sprayers range in size from simple, hand-held models to intricate machines weighing several tons.

Hand Sprayers

Hand sprayers are often used to apply small quantities of pesticides. They can be used in structures, outside for spot treatments, and in hard-to-reach areas. Most operate on compressed air supplied by a hand pump.

Advantages:

- Simple to operate.
- Easy to clean and store.

Limitations:

- Pressure and output rate fluctuate.
- Often provide too little agitation to keep wettable powders in suspension: must be shaken frequently.

Pressurized Can (aerosol sprayer)

This type of sprayer consists of a sealed container of compressed gas and pesticides. The pesticide is driven through an aerosol-producing nozzle when the valve is activated. Pressurized cans usually have a capacity of less than 1 quart and are not reusable. Larger reusable cylinders are available for some specialty agricultural uses.

Trigger Pump Sprayer

Pesticide is not packaged under pressure in trigger pump sprayers. Instead, the pesticide and diluent are forced through the nozzle by pressure created when the trigger is squeezed. The capacity of trigger pump sprayers ranges from 1 pint to 1 gallon.

Hose-End Sprayer

This device causes a fixed rate of pesticide to mix with the water flowing through the hose to which it is attached. The mixture is expelled through a high-volume nozzle. These sprayers usually hold no more than 1 quart of concentrated pesticide, but because the concentrate mixes with the water, they may deliver 20 gallons or more of finished spray solution per fill.

Push-Pull Hand Pump Sprayer

This type of sprayer depends on a hand-operated plunger that forces air out of a cylinder, creating a vacuum at the top of a siphon tube. The suction draws pesticide from a small tank and forces it out with the air flow. Capacity is usually 1 quart or less.

Compressed Air Sprayer

This is usually a hand-carried sprayer that operates under pressure created by a self-contained manual pump. The air in the tank is compressed by the pump. The compressed air forces liquid pesticide through the hose and nozzle whenever the control valve is opened. A few types of these sprayers use carbon dioxide cartridges instead of a hand pump for compression. Capacity is usually ½ to 3 gallons.

Bucket or Trombone Sprayer

These sprayers involve a double-action hydraulic pump, which is operated with a push-pull motion. The pesticide is sucked into the cylinder and pushed out through the hose and nozzle with the return stroke. Pressure up to 150 psi can be generated. The separate tank often consists of a bucket with a capacity of 5 gallons or less.

Backpack (Knapsacks) Sprayer

One type of backpack sprayer is a compressed air sprayer with a harness that allows it to be carried on the operator's back.

Another type of backpack sprayer has a hand-operated hydraulic pump that forces liquid pesticide through a hose and one or more nozzles. The pump is usually activated by moving a lever. A mechanical agitator plate may be attached to the pump plunger. Some of these sprayers can generate pressures up to 100 psi or more.

Capacity of both these types of backpack sprayers is usually 5 gallons or less.

Wheelbarrow Sprayer

Wheelbarrow sprayers are similar to backpack sprayers, but have a larger tank and longer hose line. The tank is mounted on a wheeled cart for easy transport. The capacity of these sprayers is usually less than 25 gallons.

Small Motorized Sprayers

Some small sprayers have all of the components of larger field sprayers but usually are not self-propelled. They may be mounted on wheels so they can be pulled manually; mounted on a small trailer for pulling behind a small tractor; or skid-mounted for carrying on a small truck. They may be low-pressure or high-pressure, according to the pump and other components with which they are equipped.

Standard equipment includes a hose and an adjustable nozzle on a handgun. Some models have multi-nozzle booms. These sprayers are suitable for relatively small outdoor areas.

Advantages:

- Larger capacity than hand sprayers
- Low- and high-pressure capacity
- Built-in hydraulic agitation
- Small enough for limited spaces

Limitations:

- Not suitable for general field use

Estate Sprayers

These sprayers are mounted on two-wheeled carts with handles for pushing. Trailer hitches are available for towing the units. Spray material is hydraulically agitated. Some models have 15 to 30 gallon tanks. Pumps deliver 1½ to 3 gallons per minute at pressures up to 250 psi.

Larger models have 50 gallon tanks and pumps that deliver 4 gallons per minute at pressures up to 400 psi. Power is supplied by an air-cooled engine of up to 5 horsepower.

Power Backpack Sprayers

This backpack-type sprayer has a small gasoline-powered engine. The engine drives the pump, which forces the liquid pesticide from the tank through a hose and one or more nozzles. The engine also drives air blowers, which help propel the spray droplets. This model can generate high pressure and is best suited for low-volume applications of diluted or concentrated pesticide.

Power Wheelbarrow Sprayers

This sprayer, like the manually operated wheelbarrow sprayer, has a tank mounted on a wheel for easy transport. It may deliver up to 3 gallons per minute and can develop pressures up to 250 psi. The 1½ to 3 horsepower engine is usually air-cooled. The tank sizes range from 12 to 18 gallons. The spray mixture may be either mechanically or hydraulically agitated.

Large Power-Driven Sprayers (Low Pressure)

These sprayers are designed to distribute diluted liquid pesticides over large areas. They deliver a low to moderate volume of spray, usually 10 to 60 gallons per acre, at pressures ranging from 10 to 80 psi.

These sprayers usually are mounted on tractors, trucks, boats, etc. but some are self-propelled. Roller pumps and centrifugal pumps are most often used and provide outputs from 5 to more than 20 gallons per acre. Tank sizes range from less than 50 gallons to 1,000 gallons. The spray material is usually hydraulically agitated, but mechanical agitation may be used.

Advantages:

- Medium to large tanks permit relatively large areas to be covered per fill
- Versatility

Limitations:

- Low pressure limits pesticide penetration and reach

Boom Sprayers

Low-pressure sprayers are often equipped with sprayer booms ranging from 10 to 60 feet long. The most common booms are between 20 and 35 feet long and contain several nozzles. The height of the sprayer boom must be easily adjustable to meet the needs of the job. Boom supports should allow the boom to be set

at any height from 12 to 72 inches above the surface being sprayed. Many nozzle arrangements are possible and special-purpose booms are available.

Boomless Sprayers

Low-pressure sprayers that are not equipped with booms generally have a central nozzle cluster that produces a horizontal spray pattern. The resulting swath is similar to the pattern made by a boom sprayer. These sprayers are useful in irregularly shaped areas because they can move through narrow places and avoid trees and other obstacles. Some low-pressure sprayers are equipped with a hose and handgun nozzle for applications in small or hard-to-reach areas.

Large Power-Driven Sprayers (High Pressure)

These sprayers are used to spray through dense foliage, thick animal hair, to the tops of tall trees, and into other areas where high-pressure sprayers are necessary for adequate penetration and reach. Often called hydraulic sprayers, they are equipped to deliver large volumes of spray – usually 20 to 500 gallons per acre – under pressures ranging from 150 to 400 psi or more.

These sprayers usually are mounted on tractors, trailers, trucks, or boats, or are self-propelled. Piston pumps are used to provide outputs up to 60 gallons or more per minute. Large tanks (500 to 1,000 gallons) are required, because the application rate is usually 100 gallons per acre or more.

Mechanical agitators are usually standard equipment, but hydraulic agitators may be used. When fitted with correct pressure unloaders, these sprayers can be used at low pressures. All hoses, valves, nozzles, and other components must be designed for high pressure applications.

High-pressure sprayers may be equipped with a hose and single handgun nozzle for use in spraying trees and animals. These sprayers may also be fitted with a boom for broadcast agricultural applications.

Advantages:

- Provide good penetration and coverage of plant surfaces.
- Usually well-built and long-lasting if properly cared for.

Limitations:

- Large amounts of water, power, and fuel needed.
- High pressure may produce fine droplets that drift easily.

Airblast Sprayers

Airblast sprayers use a combination of air and liquid to deliver the pesticide to the surface being treated.

These sprayers usually include the same components as low-pressure or high-pressure sprayers plus a high-speed fan. Nozzles operating under low pressure deliver spray droplets directly into the high-speed airstream. The air blast shatters the drops of pesticide into fine, small droplets and transports them to the target. The air blast is directed to one or both sides as the sprayer moves forward or it may be delivered through a movable nozzle.

Most airblast sprayers are trailer-mounted, but tractor-mounted models are also available. Tank capacity ranges from 100 to 1,000 gallons. Most of these sprayers can be adapted to apply either high or low volumes of spray material as well as concentrates. The spray mixture is usually mechanically agitated. An airblast sprayer may cover a swath up to 90 feet wide and reach trees up to 70 feet tall.

Advantages:

- Good coverage and penetration
- Mechanical agitation
- High capacity
- Can spray high or low volumes
- Low pump pressures

Limitations:

- Drift hazards
- Use of concentrated pesticides may increase chance of dosage errors
- Not suitable for windy conditions
- Hard to confine discharge to limited target area
- Difficult to use in small areas
- High power and fuel use

Other Sprayers

Ultra Low-Volume (ULV) Sprayers

These are sprayers that use special pesticide concentrates. ULV sprayers may be hand-held or mounted on either ground equipment or aircraft.

Advantages:

- No water is needed, so less time and labor are involved.

Limitations:

- Drift hazards
- Coverage may not be thorough
- High concentration presents safety hazards
- Use of concentrated pesticides may increase chance of dosage errors
- Few pesticides are labeled ULV

Controlled Droplet Applicators (CDA)

These applicators are a spinning disk (or cup) that breaks the liquid into uniformly sized droplets by centrifugal force. The droplets may be carried to the target by gravity or by an airstream created by a fan. Power to spin the disk or cup is provided by a small electric or hydraulic motor. Most CDAs do not use pumps. CDAs range in size from small hand-held types to large tractor-mounted and trailer-mounted units.

Advantages:

- Requires a low volume of water
- Produces narrower range of droplet sizes than conventional nozzles, thus reducing drift
- Droplet size can be adjusted by speed of rotation

Limitations:

- Gravity type may not penetrate foliage well
- Not suitable for use in windy conditions

Electrostatic Sprayers

Electrostatic sprayer systems give the pesticide a positive electric charge as it leaves the nozzles. Plants naturally have a negative charge, so the positively charged pesticide is attracted to the plants. The spray is directed horizontally through or above the crop, depending on the pesticide being applied.

Advantages:

- Pesticide adheres to foliage well, so less pesticide is needed per acre
- Coverage is more even than with other types of equipment
- Minimizes the likelihood of drift

Limitations:

- Useful only for foliar application

Sprayer Parts

Large Tanks

Tanks should have large openings for easy filling and cleaning. Tanks should be designed to allow the use of strainers during filling and also should allow mechanical or hydraulic agitation devices to be installed. The tank should be made of corrosion-resistant material such as stainless steel or fiberglass. If made of mild steel, it should have a protective lining or coating.

The tank should have a large drain and other outlets should be sized to the pump capacity. If you use dual tanks, make sure the plumbing allows both tanks to have agitation and adequate withdrawal rates. All tanks should have a gauge to show the liquid level. External gauges should be protected to prevent breakage. All tanks should have a shutoff valve for storing liquid pesticide temporarily while other sprayer parts are being serviced.

Pumps

The pumps must have enough capacity to supply the needed volume to the nozzles and the hydraulic agitator and to maintain the desired pressure. The pump parts should resist corrosion and they should be abrasion-resistant if abrasive materials such as wettable powders will be used. Select gaskets, plunger caps, and impellers that resist the swelling and chemical breakdown caused by many liquid pesticides. Consult your dealer for available options.

Never operate a sprayer pump at speeds or pressures above those recommended by the manufacturer. Pumps will be damaged if operated when dry or with restricted flow at the inlet or outlet. Pumps depend on the spray liquid for lubrication and for cooling the heat caused by friction.

Roller Pumps

Roller pumps are the most widely used of all sprayer pumps. They provide moderate volumes (10 to 300 psi). Often used on low-pressure sprayers, roller pumps are self-priming. The pump case is usually cast iron or a nickel-iron alloy.

The rollers, made of nylon, Teflon, or rubber, wear rapidly in wettable powders but are replaceable. A pump subjected to such wear should have a capacity about 50 percent greater than that needed to supply the nozzles and agitator. This reserve capacity will extend the life of the pump.

Roller pumps are usually the best choice for emulsifiable concentrates, soluble powders, and other nonabrasive pesticide formulations.

Gear Pumps

Gear pumps are used on sprayers with low operating pressures. They provide low to moderate volume (5 to 65 gpm) at low to moderate pressures (20 to 100 psi). Gear pumps are often self-priming, but the self-priming ability is rapidly lost as the pump wears.

Gear pumps are designed for use with formulations that use oil as a diluent. They wear rapidly when wettable powders are used. The parts are generally not replaceable. The pump is not affected by most solvents because all parts are metal. The pump case may be bronze with stainless steel impellers or it may be made entirely of bronze.

Centrifugal Pumps

Centrifugal pumps are adaptable to a wide variety of spray applications. Generally, they deliver high volume (up to 200 gpm) at low pressures (5 to 70 psi); however, two-stage pumps develop high pressures (up to 200 psi). Pressure regulators and relief valves are not necessary.

Centrifugal pumps are self-priming and must be mounted below the tank outlet or provided with a built-in priming system. Centrifugal pumps are well adapted for spraying abrasive materials because the impeller does not contact the pump housing. Many models are easily repairable. The pump case is usually iron: the impeller is iron or bronze.

Diaphragm Pumps

Diaphragm pumps are generally used to deliver low volume (3 to 10 gpm) at low to moderate pressures (10 to 100 psi), but they can also be used for high-volume, high pressure-applications.

Diaphragm pumps withstand abrasion from wettable powder mixtures much better than gear, roller, or pis-

ton pumps because the spray mixture does not contact any moving metal parts except the valves. Diaphragm pumps are self-priming. The rubber or neoprene diaphragm may be damaged by some solvents. The pump case is usually iron.

Piston Pumps

Piston pumps deliver low to medium volumes (2 to 6 gpm) at low to high pressures (20 to 800 psi). Used for high-pressure sprayers or when both low and high pressures are needed, piston pumps are self-priming. They have replaceable piston cups made of leather, neoprene, or nylon fabric, making the pump abrasion-resistant and capable of handling wettable powders for many years. The cylinders are iron, stainless steel, or porcelain-lined. The pump casing is usually iron.

Strainers (Filters)

Pesticide mixtures should be filtered to remove dirt, rust flakes, and other foreign materials from the tank mixture. Proper filtering protects the working parts of the sprayer from undue wear and avoids time loss and uneven application caused by clogged nozzle tips.

Filtering should be progressive, with the largest mesh screens in the filler opening and in the suction line between the tank and the pump. Filters should be keyed to the size of the nozzle opening. Total screen area should be large enough so that the flow will not be restricted. This requires at least 2 square inches of screen area for each gpm of flow in the suction line.

Put a smaller mesh strainer in the pressure line between the pump and the pressure regulator, with at least 1 square inch of screen area for each gpm of flow. Put the finest mesh strainer in the suction line of a centrifugal pump, but be sure the tank has a strainer to take out large particles.

In general, strainers should be placed:

- On the filler opening (12 to 25 mesh)
- On the suction or supply line to the pump (15 to 40 mesh)
- Between the pressure relief valve and the boom (25 to 100 mesh)
- On the nozzle body (50 to 100 mesh)

Clean strainers after each use or during use if they become clogged. A shutoff valve is needed between the tank and the suction strainer to allow the strainer to be cleaned without draining the tank. Replace damaged or deteriorated strainers.

Strainers are your best defense against nozzle plugging and pump wear. Nozzle screens should be as large as nozzle size permits; however, the screen opening should be less than the nozzle opening. Check nozzle catalogs for the proper screen size for each nozzle.

Hoses

Select neoprene, rubber, or plastic hoses that:

- Have burst strength greater than the peak operating pressures
- Have a working pressure at least equal to the maximum operating pressure
- Resist oil and solvents present in pesticides
- Are weather resistant

Suction hoses should be reinforced to resist collapse. They should be larger than pressure hoses, with an inside diameter equal to or larger than the inlet part of the pump. All fittings on suction lines should be as large as or larger than the inlet part of the pump.

Keep hoses from kinking or being rubbed. Flush hoses after use and wash them often to prolong life. During the off-season, store the sprayer out of the sun. Replace hoses at the first sign of surface deterioration (cracking or checking).

Pressure Gauges

Pressure gauges monitor the line pressure of your spraying system. They must be accurate and have the range needed for your work. For example, a 0 to 100 psi gauge with 2-pound gradations would be adequate for most low-pressure sprayers.

Check system gauges frequently for accuracy using an accurate gauge. Excess pressure will destroy a gauge. If yours does not zero, replace it. Use gauge protectors to guard against corrosive pesticides and pressure surges.

Pressure Regulators

The pressure regulator controls the pressure and, indirectly, the quantity of spray material delivered by the nozzles. It protects pump seals, hoses, and other sprayer parts from damage caused by excessive pressure.

Keep the bypass line from the pressure regulator to the tank fully open and unrestricted. The bypass line should be large enough to carry the total pump output without excess pressure buildup. The pressure range and flow capacity of the regulator must match the pressure range you plan to use and the capacity of the pump. Never attach hydraulic agitation devices to the bypass line discharge.

Pressure regulators are usually one of three types:

Throttling valves simply restrict pump output, depending on how much the valve is open. These valves are used with centrifugal pumps, whose output is very sensitive to the amount of restriction in the output line.

Spring-loaded bypass valves (with or without diaphragm) open and close in response to changes in pressure, diverting more or less liquid back to the tank to keep pressure constant. These valves are used with roller, diaphragm, gear, and small piston pumps.

Unloader valves work like spring-loaded bypass valves when the sprayer is operating. However, when the nozzles are shut down, they reduce strain on the pump by moving the overflow back into the tank at low pressure. These valves should be used on larger piston and diaphragm pumps to avoid damage to the pump or other system components when the nozzles are cut off.

Agitators

Every sprayer must have agitation to keep the spray material uniformly mixed. If there is too little agitation, the pesticide will be applied unevenly. If there is too much agitation, some pesticides may foam and interfere with pump and nozzle operation. The type of agitation needed depends on the pesticide formulation.

Bypass Agitators

Bypass agitation uses the returning liquid from the pressure relief valve to agitate the tank. The return must extend to the bottom of the tank to prevent excessive foaming. Bypass agitation is sufficient for soluble powders and for liquid formulations such as solutions and emulsifiable concentrates that do not require much agitation.

Do not use bypass agitation for wettable powders or in tanks larger than 55 gallons unless the system has a centrifugal pump. Centrifugal pumps usually have large enough outputs to make bypass agitation adequate even for wettable powders in tanks less than 100 gallons.

Hydraulic (Jet Action) Agitators

Hydraulic agitation is provided by the high-pressure flow of surplus spray material from the pump. Hydraulic agitation is required for wettable powder and flowable formulations in small tanks and for liquid formulations in 100-gallon or larger tanks with gear, roller, piston, or diaphragm pumps.

The jet or jets for a hydraulic agitator are located at the bottom of the tank. The agitator is connected to the pressure side of the pump. Never place jet agitator nozzles in the bypass line.

The pump and tank capacity and operating pressure determine the minimum number of jets:

- 55 gallons = 1 or more jets
- 100 to 150 gallons = 3 or more jets
- 200 gallons and larger = 5 or more jets

Mechanical Agitation

Wettable powder formulations are best mixed and kept in suspension with mechanical agitation. The mechanical agitator usually consists of flat blades or propellers mounted on a shaft that is placed lengthwise along the bottom of the tank. The paddles or propellers are rotated by the engine to keep the material well mixed. Mechanical agitators are usually found only on large high-pressure hydraulic sprayers.

Control Valves

Quick-acting cutoff valves should be located between the pressure regulator and the nozzles to provide positive on-off action. These control valves should be rated for the pressures you intend to use and should be large enough not to restrict flow when open. Cutoff valves to stop all flow or flow to any section of the spraying system should be within easy reach of the sprayer operator.

There are many kinds of control valves. Mechanical valves must be accessible to the operator's hand: electrically operated valves permit remote control of flow for tractors or self-propelled sprayers with enclosed cabs; remote-controlled valves permit all hoses carrying pesticides to be kept safely outside the cab.

Nozzles

Most nozzles have four major parts: the nozzle body, the cap, the strainer (screen), and the tip or orifice plate. They also may include a separate spinner plate. Successful spraying depends on correct nozzle selection, assembly, and maintenance.

The nozzle **body** holds the strainer and tip in proper position. Several types of tips that produce a variety of spray patterns may be interchanged on a single nozzle body made by the same manufacturer.

The **cap** is used to secure the strainer and tip to the body. The cap should not be over tightened.

The nozzle **strainer** is placed in the nozzle body to screen out debris that may clog the nozzle opening. The type of nozzle strainer needed depends on the size of the nozzle opening and the chemical being sprayed.

Special nozzle screens equipped with a check valve help prevent nozzle dripping. Check valves should be used in situations where a sprayer must be stopped and started frequently, such as in small target areas, near sensitive crops or areas, indoors, or for right-of-way treatments. The operator must check these spring-loaded ball valves frequently to be sure they are working properly.

Nozzle tips break the liquid pesticide into droplets. They also distribute the spray in a predetermined pattern and are the principal element that controls the rate of application. Nozzle performance depends on:

- Nozzle design or type
- Operating pressure
- Size of the opening
- Discharge angle
- Distance of nozzle from the target

Nozzle Patterns

Nozzle patterns are of three basic types: solid stream, fan, and cone. Some special-purpose nozzle tips or devices produce special patterns. These include "rain drops," "flooding," and wide-angle fan or cone-shaped patterns.

Solid Stream Nozzles

These nozzles are used in handgun sprayers to spray a distant or specific target such as livestock or tree pests. They are also used for crack and crevice treatment in and around buildings. Solid stream nozzles may be attached to booms to apply pesticides in a narrow band or to inject them into the soil.

Fan Pattern Nozzles

At least three types of nozzle tips have fan patterns. They are used mostly for uniform spray coverage of

surfaces; for example, broadcast soil applications of herbicides or insecticides.

The **regular flat fan** nozzle tip makes a narrow oval pattern with tapered ends. It is used for broadcast herbicide and insecticide spraying at 15 to 60 psi. The pattern is designed to be used on a boom and to be overlapped 30 to 50 percent for even distribution. Spacing on the boom, spray angle, and boom height determine proper overlap and should be carefully controlled.

The **even flat fan** nozzle makes a narrow oval pattern. Spray delivery is uniform across its width. It is used for band spraying and for treating walls and other surfaces. It is not useful for broadcast applications. Boom height and nozzle spray angle determine the width of the band sprayed.

The **flooding (flat fan)** nozzle delivers a wide-angle flat spray pattern. It operates at very low pressure and produces large spray droplets. Its pattern is fairly uniform across its width but not as even as the regular flat fan nozzle pattern. If used for broadcast spraying, it should be overlapped to provide double coverage. It is often used for applying liquid fertilizers or fertilizer-pesticide mixtures or for directing herbicide sprays up under plant canopies.

Cluster nozzles are used either without a boom or at the end of booms to extend the effective swath width. One type is a large flooding deflector nozzle that will spread spray droplets over a swath up to 70 feet wide from a single nozzle tip. Cluster nozzles are a combination of a center-discharge and two or more off-center-discharge fan nozzles.

The spray droplets vary in size from very small to very large. The small droplets may cause a drift problem. Coverage may be variable because the spray pattern is not uniform. Since no boom is required, these nozzles are particularly well suited for spraying hedgerows, fence rows, and other hard-to-reach locations where uniform coverage is not critical.

Cone Pattern Nozzles

Hollow and solid cone patterns are produced by several types of nozzles. These patterns are used where penetration and coverage of plant foliage or other irregular targets are desired. They are most often used to apply fungicides and insecticides to foliage, although some types are used for broadcast soil applications of herbicides or fertilizers or combinations of the two.

When cone pattern nozzles are used for airblast sprayer broadcast application, they should be angled to spray between 15 degrees and 30 degrees from the horizontal and should be spaced at the top of the manifold so the spray pattern will overlap up to 100 percent.

The **side-entry hollow cone** or **"whirl-chamber"** nozzle produces a wide angle hollow cone spray pattern at very low pressure. It has a large opening and resists clogging. Because of the wide spray angle, the boom can be operated low, reducing drift. Spacing for double coverage and angling 15 degrees to 45 degrees to the rear is recommended for uniform application. These nozzles may be used in place of flat fan nozzles tips in broadcast applications.

Core-insert cone nozzles produce either a solid or hollow cone spray pattern. They operate at moderate pressures and give a finely atomized spray. They should not be used for wettable powders because their small passages clog easily and they wear rapidly due to abrasion.

Disk-core nozzles produce a cone-shaped spray pattern, which may be hollow or solid. The spray angle depends on the combination of disk and core used and also, to some extent, on the pressure. Disks made of very hard materials resist abrasion well, so these nozzles are recommended for spraying wettable powders at high pressures.

Adjustable cone nozzles change their spray angle from a wide cone pattern to a solid stream when the nozzle collar is turned. Many manual sprayers are equipped with this type of nozzle. Handguns for powder sprayers have adjustable nozzles that usually use an internal core to vary the shape angle.

Nozzle Materials

Most nozzle parts are available in several materials. Here are the main features of each kind:

Brass:

- Resists corrosion from most pesticides
- Wears quickly from abrasion
- Probably the best material for general use
- May be corroded by liquid fertilizers

Plastic:

- Will not corrode
- Resists abrasion better than brass
- May swell when exposed to some solvents
- Useful life about equal to that of brass nozzles

Stainless steel:

- Resists abrasion, especially if hardened
- Good corrosion resistance
- Suited for high pressures, especially with wettable powders
- Lasts longer than brass

Aluminum:

- Resists some corrosive materials
- Easily corroded by some fertilizers
- Useful life much shorter than brass

Tungsten carbide and ceramic:

- Highly resistant to abrasion and corrosion
- Best material for high pressures and wettable powders
- Lasts much longer than brass

Chapter 9
Laws and Regulations

Terms to Know

DOT – U.S. Department of Transportation

EPA – U.S. Environmental Protection Agency

FAA – Federal Aviation Administration

FIFRA – Federal Insecticide, Fungicide, and Rodenticide Act, as amended

OSHA – Occupational Safety and Health Administration, part of the U.S. Department of Labor

RCRA – Resource Conservation and Recovery Act

SARA – Superfund Amendments and Reauthorization Act, amendments to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

USDA – U.S. Department of Agriculture

WPS – Worker Protection Standard for agricultural pesticides

Laws and Regulations

Many federal laws and regulations have been adopted to help protect the public, the environment, pesticide handlers, and agricultural workers from possible adverse effects caused by pesticide use. This unit briefly describes some of those that are likely to affect private pesticide applicators. You may need to learn more about the laws and regulations that apply to your specific situation.

Most states, tribes, and many local areas have their own legal requirements concerning pesticide use. You are responsible for knowing about these requirements and complying with them.

Be sure to keep up to date with legal requirements at all governmental levels – laws and regulations are constantly evolving as pesticide application becomes more complex and more is learned about potential hazards. Ignorance of the law is never an accepted excuse for a violation.

Federal Laws

FIFRA

A law passed by Congress in 1947 and substantially amended in 1972, 1975, 1978, and 1988 regulates the registration, manufacture, sale, transportation, and use of pesticides. The Federal Insecticide, Fungicide, and Rodenticide Act is commonly referred to by its initials – FIFRA. It is administered by the U.S. Environmental Protection Agency (EPA).

Major Provisions of FIFRA

FIFRA affects certified applicators in many ways. For example, it provides that:

- EPA must register pesticides and pesticide uses.
- All pesticides must be used only as directed on the labeling.
- EPA must classify as "restricted use" those pesticides which, even when used as directed on the product labeling, may cause unreasonable adverse effects to the environment, including humans.
- Anyone who buys or uses a restricted use pesticide must be certified in an applicable pest control category or be directly supervised by a person with such certification.
- States may establish stricter standards governing pesticides, but not more permissive standards.
- Persons who use pesticides in a way that is "inconsistent with the pesticide labeling" are subject to penalties.
- All farmers who are certified/permitted are referred to as private applicators and, by definition, are applying or supervising the application of a restricted use pesticide to crops or sites on their own properties or leased/rented properties.

Penalties Under FIFRA

If you violate FIFRA or regulations issued under it, you are subject to civil penalties. Penalties can be as much as $1,000 for each offense for private applicators ($5,000 for commercial applicators). Before EPA can fine you, you have the right to ask for a hearing in your own city or county.

Some violations of the law also may subject you to criminal penalties. These can be as much as $1,000 and/or 30 days in prison for private applicators ($25,000 and/or 1 year in prison for commercial applicators). States may establish higher penalties.

Residues and Tolerances

Any pesticide that remains in or on food or feed is called a residue. A long-lasting residue is sometimes desirable for long-term pest control. Residues that remain in food or feed at harvest or slaughter, however, are carefully monitored to avoid hazards to the humans and domestic animals that will eat them.

The federal government sets residue tolerances for all pesticides used in the production of crop and animal products intended for food or feed, and for pesticides applied after harvest. A tolerance is the maximum amount

of pesticide residue that may legally remain on or in treated crops and animals (and animal products, such as milk and eggs) that are to be sold for food or feed.

Federal agencies monitor food and feed products for tolerance variations. Any products that exceed the tolerances may be condemned and seized, and violators may be prosecuted.

A pesticide applicator cannot measure residues on crops and livestock because such measurements require highly specialized equipment and techniques. **Only by following labeling instructions** can you be sure that treated products will have residues well below tolerance level when marketed. Especially important are instructions on correct application rate and on minimum days between the pesticide application and harvest, slaughter, freshening, or grazing.

Worker Protection Standard

The U.S. Environmental Protection Agency's Worker Protection Standard (as revised in 1995) must be complied with when pesticide products are used on agricultural establishments (farms, forests, nurseries, and greenhouses) for the commercial or research production of agricultural plants. The Worker Protection Standard (WPS) requires employers to provide agricultural workers and pesticide handlers with protections against possible harm from pesticides.

Persons who must comply with these instructions include owners/operators of the agricultural establishment and owners/operators of commercial businesses that are hired to apply pesticides on the agricultural establishment or to perform crop-advising tasks on such establishments.

You and any family members who work on your agricultural or commercial pesticide establishment are considered "employees" in many situations and must receive some of the required protections.

Some of the basic requirements the WPS establishes for employers include:

- **Displaying information** about pesticide safety, emergency procedures, and recent pesticide applications on an agricultural establishment.
- **Training** workers and handlers about pesticide safety.
- Helping employees get **medical assistance** in case of a work-related pesticide emergency.
- Setting up **decontaminated sites** for washing pesticide residues off hands and body.
- Compliance with **restricted-entry intervals** – the time immediately after a pesticide application when workers may not enter the treated area.
- **Notifying** workers (through posted or oral warnings) about areas where applications are taking place and areas where restricted-entry intervals are in effect.
- Allowing only trained and equipped pesticide handlers to be present during a pesticide application.
- Providing **personal protective equipment** for pesticide handlers and also for workers who enter pesticide-treated areas before expiration of the restricted-entry interval (in the very few limited circumstances permitted by the WPS).
- **Protecting pesticide handlers** by giving them safety instructions about the correct use of personal protective equipment and mixing, loading, and application equipment; inspecting and maintaining equipment they will be using; and monitoring them in hazardous situations.

For detailed information about your responsibilities under the WPS, get a copy of EPA's manual "Worker Protection Standards for Agricultural Pesticides – How to Comply." It will tell you what you need to do to be in compliance with the federal worker protection requirements. The manual may be available from EPA regional offices, state or tribal pesticide agencies, Extension offices, pesticide dealers, the Government Printing Office, and other commercial sources.

Field Sanitation

The Field Sanitation Standard is a 1987 Occupational Safety and Health Administration (OSHA) regulation. In general, it applies to agricultural employers who employ more than 10 field workers or who maintain a labor camp.

The Field Sanitation Standard requires these employers to provide three things to their employees who are exposed to agricultural chemicals: toilet facilities, handwashing facilities, and clean drinking water.

The Standard also requires the employers to inform each employee about the following good hygiene practices:

- Use the water and facilities provided for drinking, handwashing, and elimination.
- Drink water frequently, especially on hot days.
- Urinate as often as necessary.
- Wash hands both **before** and **after** using the toilet.
- Wash hands before eating and smoking.

Pesticide Recordkeeping

A 1993 U.S. Department of Agriculture regulation requires certified private pesticide applicators to keep records of federal restricted-use pesticide applications. The recordkeeping is administered by the USDA's Agricultural Marketing Service.

Where such records were already required by state law, applicators may continue to follow the state regulations. In other areas, applicators must begin keeping records that comply with the USDA requirements.

You should be able to get details about the recordkeeping requirements from the Extension agricultural agent in your area or from your state agency in charge of pesticide regulation. In general, the records you keep must contain:

- The brand or product name of the federal restricted-use pesticide and its EPA registration number.
- The size of the area treated.
- The total amount of product applied.
- The crop, commodity, stored product, or site to which the pesticide was applied.
- The location of the application.

- The month, day, and year of the application.
- The certified applicator's name and certification number (if numbers are assigned in your state).

There is no required form that you must use for this recordkeeping. Any form is acceptable as long as the required information is included. You must keep the records for two years from the date of the pesticide application.

If a commercial applicator performs work for you, that applicator must provide you with a written copy of the necessary information about that application.

If you do not comply with the recordkeeping requirements, you may be fined up to $500 for a first offense and not less than $1,000 for any later offense (unless it is determined that you have made a good-faith effort to comply).

Transportation

Shipment of pesticides and other dangerous substances across state lines is regulated by the U.S. Department of Transportation (DOT). The DOT issues the rules for hauling these materials. If you ever haul pesticides between states, you should know that:

- The pesticides must be in their original containers. Each container must meet DOT standards.
- The vehicle must have a DOT-approved sign.
- The pesticides may not be hauled in the same vehicle with food or feed products or with packaging material intended for use with such products.
- You must contact DOT after each accident:
  - o when someone is killed,
  - o when someone is injured badly enough to go to a hospital, or
  - o when damage is more than $50,000.
- You must tell DOT about all spills during shipment.

Contact the state, tribal, or territorial DOT office for detailed information on which pesticides are listed as hazardous substances and what rules apply to them during transportation.

Aerial Application

Application of pesticides from airplanes is regulated by the Federal Aviation Administration (FAA) and may be regulated by your state. FAA judges both the flying ability of pilots and the safety of their aircrafts. FAA rules say, as FIFRA does, that an aerial applicator may not apply any pesticide except as the labeling directs.

Other Regulations

Other federal regulations may affect some of the tasks you perform as a certified private pesticide applicator. In some cases, the pesticide label will alert you to laws or regulations you must comply with.

For more information about some laws that affect all categories of certified applicators, see the EPA/USDA manual "Apply Pesticides Correctly – A Guide for Private and Commercial Applicators." It includes information about:

- The Endangered Species Act, a law that makes it a federal offense to use any pesticide in a manner that results in the death of a member of an endangered species. The U.S. Fish and Wildlife Service (FWS) of the Department of the Interior and the Endangered Species Act (ESA) makes it illegal to kill, harm, or collect endangered or threatened animals or plants. A part of the ESA requires all federal agencies to assist with the intent of this law. EPA has initiated a protection program through pesticide label wording. Special restrictions will appear on labels for certain uses. Private applicators need to be familiar with these restrictions as to uses and locations of species that could be affected. Special EPA publications will be printed at a future date to more fully acquaint users with special restrictions. Otherwise the container label will be your guide.
- Provisions of the Occupational Safety and Health Act that may require you to provide certain information to your workers and to keep records of pesticide-related injuries or illnesses. Provisions of the Superfund Amendments and Reauthorization Act of 1986 (SARA Title III) relating to pesticide storage and spills. Sara Title II administered by EPA requires you to notify the Alabama Department of Environmental Management about any hazardous chemicals (pesticides) you have on your farm. Inventory levels called reportable quantities can be found in section 7 – pesticide handling decisions.
- The Resource Conservation and Recovery Act (RCRA), which regulates the disposal of some pesticide wastes.
- The U.S. Food and Drug Administration monitors food for humans and feed for animals for any adulteration. Pesticide residues are monitored for violation of legal tolerances. Tolerances have to be established before a new pesticide can be used on food or feed crop.
- The U.S. Department of Agriculture Consumer Marketing Services, Meat and Poultry Inspection, samples meat for pesticide residues and investigates any near tolerance level residues.

State Laws

The Alabama Department of Agriculture and Industries, under authority of the Alabama Pesticide Law of 1971, is responsible for enforcing regulations on pesticides.

Pesticides sold and used in Alabama have to be registered.

Farmers/Private Applicators desiring to use a restricted use pesticide have to obtain training to meet minimum standards before they will be certified or permitted.

The Alabama Agriculture Department requires dealer licensing of firms selling restricted use pesticides. They require that pesticides be sold only in labeled containers and that people become certified before legally using restricted use pesticides.

The Department enforces both state and federal regulations. Penalties vary from injunctive procedure revocation of permits to civil fines. Established maximum penalties under civil assessment are wholly at the discretion of the Commissioner of Agriculture and Industries. A misuse is not following label instructions.

1. Proven misuse of a restricted use pesticide can be up to $10,000.
2. Using a restricted use pesticide without a permit can be up to $3,000.

The Alabama Department of Health has responsibility for solid waste disposal. Pesticide containers that have been power rinsed or properly triple rinsed can be legally disposed of in most sanitary solid waste landfills.

The Alabama Department of Environmental Management (ADEM) has the responsibility for regulating the disposal of toxic waste, including problems with contaminated sites, such as storage and pesticide loading facilities. When water quality in streams is affected by pesticide misuse, ADEM is usually the investigating agency. Sara – Title III is the law concerning hazardous waste and is enforced in state by ADEM.

ALABAMA COOPERATIVE Extension SYSTEM

Your Experts for Life

ANR-1307

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Trade names are used only to give specific information for educational purposes. The Alabama Cooperative Extension System does not endorse or guarantee any product and does not recommend one product instead of another that might be similar.

For more information, call your county Extension office. Look in your telephone directory under your county's name to find the number.

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