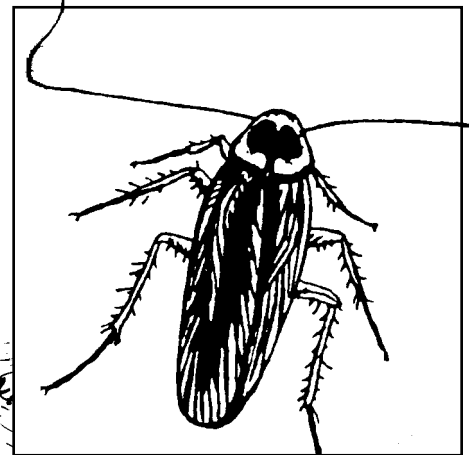
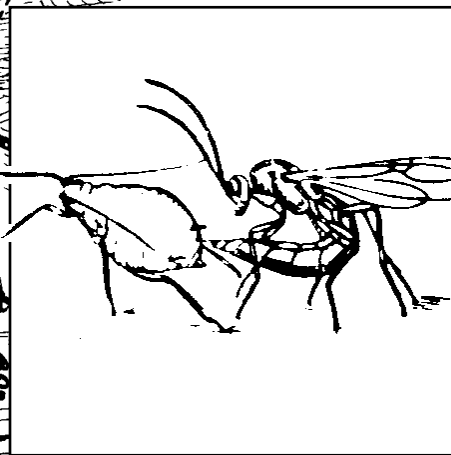
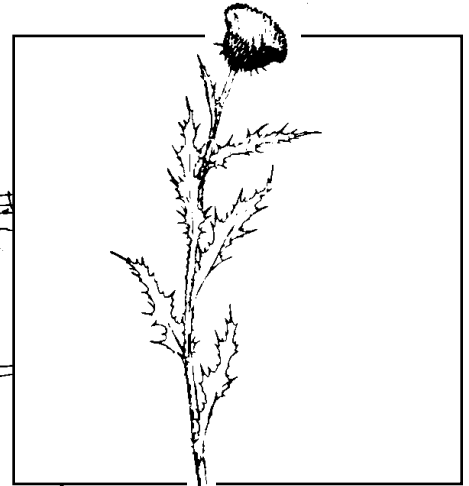
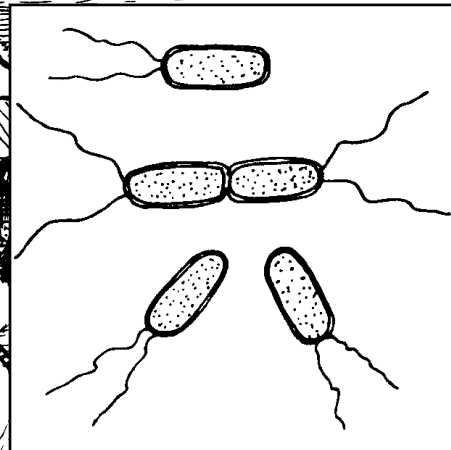


# General Manual



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## Directions for Using this Manual

This is a self-teaching manual. At the end of each major section is a list of study questions to check your understanding of the subject matter. By each question in parenthesis is the page number on which the answer to that question can be found. This will help you in checking your answers.

These study questions are representative of the type which are on the certification examination. By reading this manual and answering the study questions, you should be able to gain sufficient knowledge to pass the Kansas Commercial Pesticide Applicators Certification and Recertification examination.

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# Certification


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## Procedure

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This manual has been written to assist those persons who are preparing themselves for an examination over the General Standards portion of the commercial pesticide applicator certification exam. State and Federal regulations specify that certain standards of competency relating to both general and specific topics must be met by an individual before they are allowed to apply or supervise the application of Restricted Use Pesticides. The General Standards portion of the examination must be successfully completed by all categories of applicators. Therefore, this manual may contain information over topics that do not directly relate to your specific categories or types of application work.

By law a pesticide is defined as follows: "Pesticide" means, but is not limited to, (1) any substance or mixture of substances used to prevent, destroy, control, repel, attract or mitigate any pest (including weeds) and (2) any substance or mixture of substances intended to be used as a plant regulator, defoliant or desiccant.

Pesticides are classified by the EPA as either Restricted Use or General Use (not restricted). A certified applicator is required when a restricted use pesticide is being used. Under the Kansas Pesticide Law, a "certified commercial applicator" means a certified applicator, whether or not he/she is a private applicator with respect to some uses, who uses or supervises the use of any pesticide which is classified for restricted use for any purpose or on any property other than that provided for in the definition of "certified private applicator." A "certified private applicator" is one who uses or supervises restricted use pesticides for purposes of: (a) Producing any agricultural commodity, (1) on property owned or rented by the individual or such individual's employer, or (2) on the property of another for no compensation than trading of personal services between producers; or (b)

controlling ornamental shrubbery or turf pests on property owned or rented by the individual and such property is used as the individual's residence.

*Commercial* certification may not be necessary if restricted use pesticides are used:

- a. within the authority granted by a private applicator certification
- b. under the supervision of a certified commercial applicator. (This does not apply to aerial applicators or where supervision is prohibited by label direction or other legal authority.)
- c. by veterinarians or physicians, as part of their professional services
- d. by laboratory personnel in pesticide research

In order to qualify for certification you must:

- a. be at least 18 years old,
- b. submit a completed application for certification,
- c. pass the "General Exam" (covered by this manual) plus an exam in at least one category / subcategory of application,
- d. Pay the required fees. There is a separate application fee and exam fee. Applicants who fail a specific category exam may take another exam upon paying an additional exam fee. No fee is required to take the "General Exam."

Upon meeting the qualifications for certification, a certificate and a pocket card will be issued by the Kansas Department of Agriculture. Your certification will expire on December 31 of the second calendar year following the year it was issued. For example, if you are issued your certificate on June 1, 1995, it will expire on December 31, 1997.

Recertification can be obtained by either of two options:

1. Passing an examination over the general manual and your specific category manual, similar to your initial certification, or
2. Attending a pesticide appli-

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# Certification

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## Procedure

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cator training meeting approved by the secretary (no examination required).

In order to qualify for recertification, you must submit a new application and pay the applicable fees. Note that if the required training is not attended during your effective period of certification, then to be certified again you must retake and pass a “current examination.”

Certification in another state does not replace the requirement for an applicator to have Kansas commercial applicator certification. Kansas has entered into reciprocal agreements with a few states, whereby commercial certification in any of those states may be used in lieu of passing Kansas commercial certification exams.

However, the applicator is required to complete the other requirements for Kansas certification, including submitting an application and paying fees. Further details on reciprocal certification are available from the Plant Health Division of the Kansas Department of Agriculture.

### **Business License**

A “Kansas Pesticide Business License” is required before any commercial pest control efforts, including advertising, are attempted. Obtaining this business license has different procedures and requirements from those for becoming a certified commercial pesticide applicator. In brief, there are four requirements to obtain the business license:

1. complete the application;
2. pay the fee (calendar year basis);
3. furnish proof of financial responsibility; and
4. have at least one person certified in the categories/subcategories of business.

Additional information on the Kansas Pesticide Business License can be found in the chapter on Laws and Regulations in this manual. Also, for an informational packet, write the Kansas Department of Agriculture, Plant Health Division, Certification Record Center, 901 So. Kansas Ave., Topeka, KS 66612-1280, or phone 785/296-2263.

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# Pests and Pest Control

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A pest is anything that:

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

Pests can be placed in five main categories:

- insects (and related animals),
- plant disease agents,
- weeds,
- mollusks, and
- vertebrates.

As a certified applicator, you must be familiar with the pests likely to be encountered in the area covered by your certification category. To be able to identify and control the pests, you need to know about some aspects of:

- the common features of pest organisms,
- characteristics of the damage they cause, and
- pest development and biology.

You can get identification aids, publications, and pictures from your Cooperative Extension Service agent or ask other experts for advice.

To solve pest problems, the applicator must:

- identify the pest,
- know what control methods are available,
- evaluate the benefits and risks of each method or combination of methods,
- choose the methods that are most effective and will cause the least harm to people and the environment,
- use each method correctly,
- observe local, state, and federal regulations that apply to the situation.

The most important principle of pest control is this: Use a pesticide only when necessary and at the lowest labeled rate which will prevent the pest from causing more damage than is reasonable to accept.

Even though a pest is present, it may not do very much harm. It could cost more to control the pest than would be lost because of the pest's damage.

The three main objectives of pest control are:

- prevention—keeping a pest from becoming a problem,
- suppression—reducing pest numbers of damage to an acceptable level,
- eradication—destroying an entire pest population from a limited defined area.

## Pest Control Methods

The use of a combination of methods to control pests is basic to all pest control. Successful pest control is based on the ability to:

- keep pest damage to a minimum by choosing an appropriate combination of control methods,
- recognize when direct action, such as a pesticide application, is necessary, and
- endanger the environment as little as possible.

The combination of methods you choose will depend on the kind and amount of control you need.

## Natural Forces

Some natural forces/controls act on pests, causing the populations to rise and fall. These natural forces act independently of humans and may either help or hinder pest control. You usually cannot alter the action of natural forces on a pest population, but you should be aware of their influence and take advantage of them whenever possible. Some forces which affect the pest population include climate, natural enemies, topography, and food and water supply.

## Climate

Weather conditions, especially temperature, day length, and humidity, affect pests' activity and their rate of reproduction. Pests may be killed or suppressed by rain, frost, freezing temperatures, drought, or other adverse weather.

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# Pests and Pest Control

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Climate also affects pests indirectly by influencing the growth and development of their hosts. The population of plant-eating pests is related to growth of the host plants. Unusual weather conditions can change normal patterns so that increased or decreased damage results.

## Natural Enemies

Birds, reptiles, amphibians, fish, mammals, and predatory and parasitic insects feed on some pests and help control their numbers. More than half of all insect and insect-like species feed on other insects, some of which are pests. Disease organisms often suppress pest populations.

## Topography

Features, such as mountains and large bodies of water restrict the spread of many pests. Other features of the landscape can have similar effects. Soil type is a prime factor affecting wireworms, grubs, nematodes, and other soil organisms. Some pests live in heavy, poorly drained soil, others in light, sandy soils. Soil type also affects the distribution of plants (including weeds), which in turn affects the population of insects and other plant pests.

## Food and Water Supply

Pest populations can thrive only as long as their food and water supply lasts. Once the food source—plant or animal—is exhausted, the pests die or become inactive. The life cycle of many pests depends on the availability of water.

## Agricultural Forces

Unfortunately, natural controls/forces often do not control pests quickly enough to prevent unacceptable injury or damage—other pest control methods must be initiated.

Those available include:

- host resistance,
- biological control,
- cultural control,
- mechanical control,
- sanitation, and
- chemical control.

## Host Resistance

Some crops, animals, and structures resist pests better than others. Some varieties of crops, wood, and animals are immune to certain pests. Use of resistant types helps keep pest populations below harmful levels by making the environment less favorable for the pests. Host resistance works in two main ways:

- chemicals in the host prevent the pest from completing its life cycle,
- the host is more vigorous or tolerant than other varieties and thus less likely to be seriously damaged by pest attacks.

## Biological Control

Biological control involves the use of naturally occurring enemies—parasites, predators, and disease agents (pathogens). It also includes methods by which the pest is biologically altered, as in the production of sterile males and the use of pheromones or juvenile hormones. Most kinds of biological control agents occur naturally. Releasing more of a pest's enemies into the target area can supplement this natural control.

Biological control is never complete. The degree of control fluctuates. There is always a time lag between pest population increase and the corresponding increase in natural controls. But, under proper conditions, sufficient control can be achieved to eliminate the threat to the crop or animal to be protected. Biological control can be a low-cost control method particularly suited to low-value crops (pastureland, clover, and hay crops) or in areas where some injury can be tolerated (golf course fairways, forest areas).

## Cultural Control

Cultural practices are agricultural practices used to alter the environment, the condition of the host, or the behavior of the pest to prevent or suppress an infestation. Planting, growing, harvesting, and tillage practices sometimes can be manipulated

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# Pests and Pest Control

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to reduce pest populations. Other practices such as crop or pasture rotation, varying the time of planting, and use of trap crops also affect pests.

## **Mechanical Control**

Devices and machines used to control pests or alter their environment are called mechanical controls. Traps, screens, barriers, radiation, and electricity can sometimes be used to prevent the spread of pests or reduce an infestation. Lights, heat, and refrigeration can alter the environment sufficiently to suppress or eradicate some pest populations.

## **Sanitation**

Sanitation practices help to suppress some pests by removing sources of food and shelter. Other forms of sanitation which help prevent pest spread include using pest-free seeds or plants and decontaminating equipment, livestock, and other possible carriers before allowing them to enter a pest-free area.

## **Chemical Control**

Pesticides are chemicals used to destroy pests, control their activity, or prevent them from causing damage. Some pesticides either attract or repel pests. Chemicals which regulate plant growth or remove foliage may also be classified as pesticides.

Pesticides are generally the fastest way to control pests. In many instances, they are the only weapon available. Choosing the best chemical for the job is important.

By selecting pesticides wisely and applying them correctly, the responsible pesticide applicator can use these chemicals for the benefit of the environment.

## **Pest Resistance to Pesticides**

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 susceptible pests. Some pests avoid the pesticide. Others are able to with-

stand its effects. Pests that are not destroyed may pass along to their offspring the trait that allowed them to survive.

When we use one pesticide repeatedly in the same place, against the same pest, the surviving pest population may show greater resistance to the pesticide than did the original population. Some pests have become partially immune to poisoning by certain pesticides.

Not every pesticide failure is caused by pest resistance, however. Make sure that you have used the correct pesticide and the correct dosage, and that you have applied the pesticide correctly. Also remember, the pests that are present may be part of a new infestation that occurred after the chemical was applied.

## **Factors Affecting Pesticide Use Outdoors**

**Soil Factors**—Organic matter in soils may “tie up” pesticides, limiting their activity. Soils with high organic matter content may need higher rates of some pesticides for best control.

Soil texture also affects the way pesticides work. Soils with fine particles (silts and clays) have the most surface area. They may need higher rates for total coverage. Coarser soils (sands) have less surface area. Use lower rates on them.

**Surface Moisture**—Pesticides work best with moderate surface moisture. Wetness may keep the pesticide from adequately contacting the protected surface. Dryness may prevent the pesticide from spreading evenly over the surface and contacting the target pest.

Rain may interfere with pest control by causing pesticides to run off or to leach down through the soil. Rain during or soon after over-the-top or foliar applications may wash pesticides off the plant. However, some protectant fungicides are sometimes purposely applied just before periods of expected high humidity and light rain. When pre-emergence pesticides are applied to the surface, moderate rainfall aids in carrying them down

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# Pests and Pest Control

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through the soil to the pests. Rain may also release pesticide action after some granular applications.

**Humidity and Temperature**—Humidity also affects the way pesticides work. Herbicides often work best when weeds are growing fast—usually in high humidity and optimum temperature. However, these same conditions may make the protected plant more susceptible to pesticide injuries.

High temperature and sunlight will cause some pesticides to break down when they are left exposed on top of the soil or on other surfaces. Low temperatures may slow down or stop the activity of some pesticides.

**Wind**—Wind speed and direction can greatly alter the effectiveness of a pesticide application. Excessive wind can blow the pesticide off target and result in inadequate control. Even moderate winds can greatly alter the coverage of Ultra Low Volume Concentrate Solutions (ULV) and mist blower applications. Sometimes the applicator can compensate for minor winds by applying the pesticides at an angle where the winds blow the chemical towards the area to be protected.

## Principles of Pest Control

We often talk about the “war” against insects, plant diseases, weeds, and rats. In a war between countries, would a national leader use only the Army? Wouldn’t he/she also use other tools—Navy, Air Force, and propaganda?

Yet, in our struggle against pests, how often do we use the handiest or least expensive pesticide? How often do we forget to consider other methods or combinations of methods? How often do we forget about effects on the environment? It may be too often.

The use of a combination of methods to control pests is basic to all pest control. Modern pest control uses all available methods to keep pests below economically harmful levels, and damages the environment as little as possible in the process.

The challenge lies in our ability to control pests so that injury caused by them is held to a minimum, and to recognize when direct action, such as a pesticide application, is necessary.

## Integrated Pest Management (IPM)

Integrated Pest Management (IPM) is the planned manipulation of pest populations in an attempt to achieve a balance between costs and returns, and between farm production and the overall environment. Integrated Pest management practices include use of: cultivation, changes in cropping sequence, barriers, pest resistant or tolerant varieties, sanitation, traps, beneficial insects, timely planting and harvesting, and judicious use of chemical pesticides. IPM is accomplished by growers who consider all alternative pest control practices that are available on their farms, then use one or more cost-effective pest control practices that are least harmful to the environment.

Use of effective IPM practices must be based on current information about the pest problem, such as the numbers and kinds of pests in the specific crop or herd. Inadequate knowledge or improper diagnosis of the pest problem results in wasteful use of time and money and disappointing control of the pest(s).

## Management Tests

IPM must be practical and tailored to each pest problem on your farm. Three tests of practicality are:

1. Is it available (to this farm, when needed)?
2. Does it fit the entire crop or herd management program (or can present management be feasibly changed to accommodate the pest management practice(s) being considered)?
3. Cost effectiveness. The “bottom line” when one’s livelihood is involved must always be: “Will it pay?”

The third factor is the basis of the two concepts, economic injury level and economic threshold. Economic injury level is the lowest number of



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# Pests and Pest Control

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pests that will cause an amount of injury equal to the cost of applied control practices. Economic threshold, sometimes called the “action threshold” is the pest number or density at which remedial control practices should be taken to prevent the pests from exceeding the economic injury level. The economic threshold is necessarily lower than the economic injury level to allow time to apply control practices and to permit time for those control practices to control the pests.

Integrated pest management consists of selection of specific control practices which work well together to best solve a specific set of pest problems under the conditions which prevail at that time and place.

## Insects

There are more kinds of insects on earth than all other living animals combined. They are found in soil, hot springs, water, snow, air, and inside plants and animals. They eat the choicest foods from our table. They can even eat the table.

The large number of insects can be divided into three categories according to their importance to man:

- species of minor importance—About 99 percent of all species are in this category. They are food for birds, fish, mammals, reptiles, amphibians, and other insects. Some have aesthetic value.
- beneficial insects—In this small but important group are the predators and parasites that feed on destructive insects, mites, and weeds. Examples are ladybird beetles, some bugs, ground beetles, tachinid flies, praying mantids, many tiny parasitic wasps, and predaceous mites. Also in this category are the pollinating insects, such as bumblebees and honeybees, some moths, butterflies, and beetles. Without pollinators, many kinds of plants could not grow. Honey from honeybees is food for humans. Secretions

from some insects are made into dyes and paints. Silk comes from the cocoons of silkworms.

- destructive insects—Although this is the category which usually comes to mind when insects are mentioned, it includes the fewest number of species. These are the insects that feed on, cause injury to, or transmit disease to humans, animals, plants, food, fiber, and structures. In this category are, for example, aphids, beetles, fleas, mosquitoes, caterpillars, and termites.

## Physical Characteristics

All insects in the adult stage have two physical characteristics in common. They have three pairs of jointed legs, and they have three body regions—the head, thorax, and abdomen.

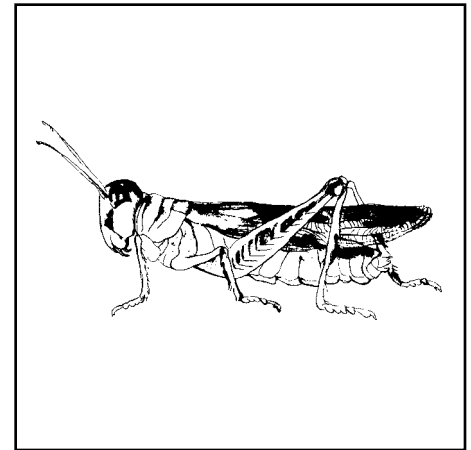
### Head

The head supports antennae, eyes, and mouthparts. The antennae vary in size and shape and can be a help in identifying some pest insects. Insects have compound eyes, made up of many individual eyes. These compound eyes enable insects to discern motion, but probably not clear images.

The four general types of mouthparts are:

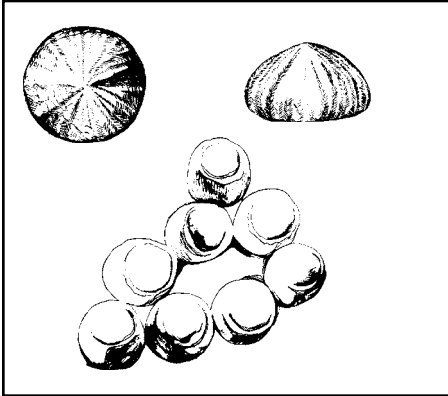
- chewing,
- piercing-sucking,
- sponging, and
- siphoning.

**Chewing mouthparts** contain toothed jaws that bite and tear the food. Cockroaches, ants, beetles, caterpillars, and grasshoppers are in this group. **Piercing-sucking mouthparts** consist of a long slender tube which is forced into plant or animal tissue to suck out fluids or blood. Insects with these mouthparts are stable flies, sucking lice, bed bugs, mosquitoes, true bugs, and aphids. **Sponging mouthparts** have a tubular tongue-like structure with a spongy tip to suck up liquids or soluble food. This type of mouthpart is found in the flesh flies, blow flies, and house flies.

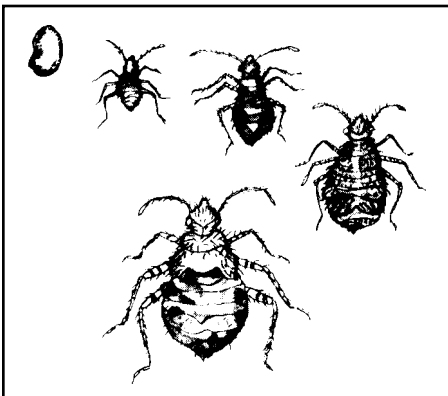


*Grasshopper*

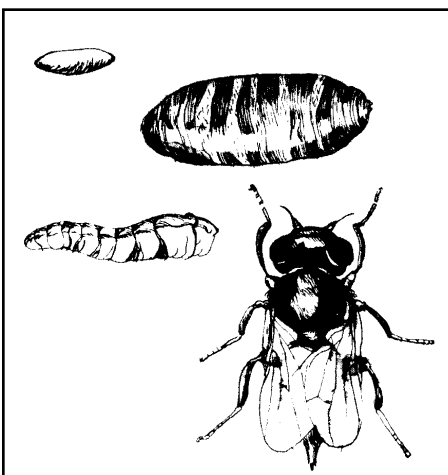
# Pests and Pest Control



*Insect eggs*



*Gradual Metamorphosis*



*Complete Metamorphosis*

**Siphoning mouthparts** are formed into a long tube for sucking nectar. Butterflies and moths have this type.

## *Thorax*

The thorax supports the three pairs of legs and (if present) the wings. The various sizes, shapes, and textures of wings and the pattern of the veins can be used to identify insect species.

The forewings take many forms. In the beetles, they are hard and shell-like; in the grasshoppers, they are leathery. The forewings of flies are membranous; those of true bugs are part membranous and part hardened. Most insects have membranous hindwings. The wings of moths and butterflies are membranous but are covered with scales.

## *Abdomen*

The abdomen is usually composed of 11 segments. Along each side of most of the segments are openings (called spiracles) through which the insect breathes. In some insects, the tip end of the abdomen carries tail-like appendages.

## **Insect Development**

Most insect reproduction results from the males fertilizing the females. The females of some aphids and parasitic wasps produce eggs without mating. In some of these insect species, males are unknown. A few insects give birth to living young; however, life for most insects begins as an egg. Temperature, humidity, and light are some of the major factors influencing the time of hatching. Eggs come in various sizes and shapes—elongate, round, oval, and flat. Eggs of cockroaches, grasshoppers, and praying mantids are laid in capsules. Eggs may be deposited singly or in masses on or near the host—in soil or on plants, animals, or structures.

## **Metamorphosis**

The series of changes through which an insect passes in its growth from egg to adult is called metamorphosis.

When the young first hatches from an egg, it is either a larva, nymph, or naiad. After feeding for a time, the

young grows to a point where the skin cannot stretch further; the young molts and new skin is formed. The number of these stages (called instars) varies with different insect species and, in some cases, may vary with the temperature, humidity, and availability and kinds of food. The heaviest feeding generally occurs during the final two instars.

## *No Metamorphosis*

Some insects do not change except in size between hatching and reaching the adult stage. The insect grows larger with each successive instar until it reaches maturity. Examples are silverfish, firebrats, and springtails. The food and habitats of the young (called nymphs) are similar to those of the adult.

## *Gradual Metamorphosis*

Insects in this group pass through three quite different stages of development before reaching maturity: egg, nymph, and adult. The nymphs resemble the adult in form, eat the same food, and live in the same environment. The change of the body is gradual, and the wings (when present) become fully developed only in the adult stage. Examples are cockroaches, lice, termites, aphids, and scales.

## *Incomplete Metamorphosis*

The insects with incomplete metamorphosis also pass through three stages of development: egg, naiad, and adult. The adult is similar to the young, but the naiads are aquatic. Examples: dragonflies, mayflies, and stoneflies.

## *Complete Metamorphosis*

The insects with complete metamorphosis pass through four stages of development: egg, larva, pupa, and adult. The young, which may be called larvae, caterpillars, maggots, or grubs, are entirely different from the adults. They usually live in different situations and in many cases feed on different foods than adults. Examples are beetles, butterflies, flies, mosquitoes, fleas, bees, and ants.

Larvae hatch from the egg. They grow larger by molting and passing

# Pests and Pest Control

through one to several instars. Moth and butterfly larvae are called caterpillars; some beetle larvae are called grubs; most fly larvae are called maggots. Caterpillars often have legs; maggots are legless. Weevil grubs are legless; other kinds of beetle larvae usually have three pairs of legs.

The pupa is a resting stage during which the larva changes into an adult with legs, wings, antennae, and functional reproductive organs.

## Insect-Like Pests

Mites, ticks, spiders, sowbugs, pillbugs, centipedes, and millipedes resemble insects in size, shape, life cycle, and habits. Pest species usually can be controlled with the same techniques and materials used to control insects.

### Arachnids

Ticks, scorpions, spiders, and mites have eight legs and only two body regions. They are wingless and lack antennae. The metamorphosis is gradual and includes both larval nymphal stages. Eggs hatch into larvae (six legs) which become nymphs (eight legs) and then adults. Ticks and mites have modified piercing-sucking mouthparts; spiders and scorpions have chewing mouthparts.

### Crustaceans

Sowbugs and pillbugs, water fleas, and wood lice have 14 legs. They are wingless and contain only one segmented body region. They have two pairs of antennae and chewing mouthparts. Sowbugs and pillbugs have a hard, protective shell-like covering and are related to the aquatic lobsters, crabs, and crayfish. The metamorphosis is gradual, and there may be up to 20 instars before adulthood is reached.

### Centipedes and Millipedes

Centipedes are made up of 30 segments, each containing one pair of legs. They have chewing mouthparts. Some species can inflict painful bites on humans.

Millipedes contain 30 segments and are cylindrical like an earthworm. The body is wingless and each seg-

ment bears two pairs of legs. The antennae are short and mouthparts are comblike. Millipedes feed on decaying organic matter, seeds, bulbs, and roots.

There is no metamorphosis; centipedes and millipedes do not change except in size between hatching and reaching the adult stage.

## Controlling Insects

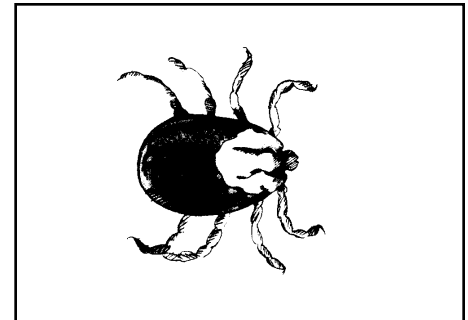
Control of insects and their relatives may involve any of the three basic pest control objectives. Control is usually aimed at suppression of pests to a point where the presence or damage level is acceptable. Prevention and eradication are useful only in relatively small, confined areas such as indoors or in programs designed to keep foreign pests out of a new area.

The key to successful control of insect and insect-like pests is knowledge of the stage(s) of their life cycle in which they are most vulnerable. It is generally difficult to control insects in either the egg or pupal stage, because these stages are inactive: not feeding, immobile, and often in inaccessible areas such as underground, in cocoons or cases, and in cracks or crevices.

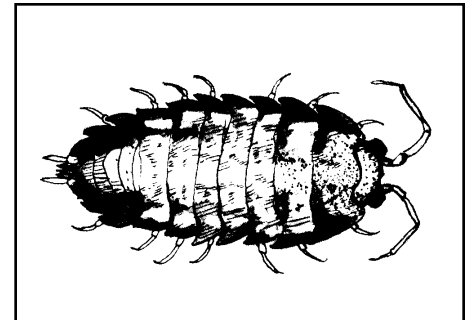
Controlling insects in the late instar and adult stages is moderately successful. The insects, because of their size, are most visible in these stages and usually are causing the most destruction. Therefore, control attempts are often begun at these times. However, the larger insects are often more resistant to pesticides, and adults already may have laid eggs for another generation.

The best control usually is achieved during the early larval or nymphal stages when the insects are small and vulnerable. Control during these stages requires careful monitoring of pest populations and thorough knowledge of the pest's life cycle, habitats, and feeding patterns.

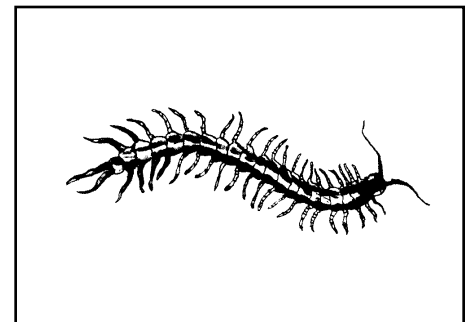
Environmental conditions, such as humidity, temperature, and availability of food, can alter the rate of growth of insects and thus affect the length of the life cycle. Optimum environments



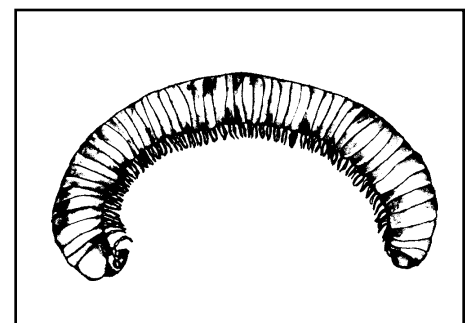
*Arachnid*



*Crustacean*



*Centipede*



*Millipede*

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# Pests and Pest Control

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(usually warm and humid) can decrease the time of development from egg to adult.

## **Insect Control Strategy**

Control methods used for insects include: host resistance, biological control, cultural control, mechanical control, sanitation, and chemical control.

### **Host Resistance**

Some crops, animals, and structures resist insects and their relatives better than others. Some varieties of crops and wood are nearly immune to certain insects. Use of resistant types helps keep pest populations below harmful levels by making the environment less favorable for the pests.

### **Biological Control**

Biological control of insects includes:

- predators and parasites,
- pathogens,
- sterile males,
- pheromones, and
- juvenile hormones.

#### **Predators and Parasites—**

Organisms known to attack insect (and insect-like) pests in their native environment can be imported or reared in laboratories and released in infested areas. This is done only after the parasites or predators are determined to be harmless to man, animals, plants, and other beneficial organisms. For example, several kinds of parasites and predators of the alfalfa weevil have been imported from Europe and Asia and released in the infested areas in this country. Several species have become established and are helping to reduce pest numbers. However, they do not always prevent serious outbreaks and the resultant damage.

**Pathogens—**Parasitic bacteria, viruses, and fungi may be introduced into an infested area to control insects by subjecting them to disease. These disease agents, like predators, are often found in the pest's native environment. They can be imported or they can be reared in laboratories.

For example, the use of pathogens is an important part of the pest

control program for Japanese beetles. Japanese beetles are subject to attack by two naturally occurring species of bacteria which cause the fatal milky disease. Preparations containing spores of the contagious bacteria are produced commercially and released in infested areas. Another example is *Bacillus thuringiensis* or Bt, used to control European cornborer, cabbage looper and many other caterpillars.

**Sterile Males—**Males of some pest insect species may be reared and sterilized in laboratories and released in large numbers into infested areas to mate with native females. These matings produce infertile eggs or sterile offspring and help reduce the pest population. This technique has been used successfully in only a few species and is still being developed. The screw worm, which attacks cattle, is one insect on which this technique has been effective.

**Pheromones—**Some insects (and insect-like organisms) produce natural chemicals, called pheromones, which cause responses in other insects of the same or very closely related species. Once a particular insect pheromone is identified and the chemical is synthetically produced, it can be used to disrupt the behavior of that insect species. Synthetic pheromones may be used to disrupt normal reproduction, or they may be used to attract the pests into a trap.

Because each pheromone affects only one specific group of insects, their use poses no risk of harm to other organisms, including man. Unfortunately, only a few have been discovered and produced synthetically, and the use of pheromones is still in the experimental stages. It is very costly to discover, produce, and market a chemical which will be useful in controlling only one pest species.

**Juvenile Hormones—**Another type of species-specific chemical is also being developed. Juvenile hormones interrupt the metamorphosis of insects (and insect-like organisms). These chemicals prevent reproduction by keeping immature insects from maturing into adults. Each chemical

acts against a single pest species and has the same advantages and disadvantages as pheromones. The few juvenile hormones available are usually applied as a broadcast spray to reach as many target pests as possible.

## Cultural Control

Cultural control methods for insects include:

- crop rotation,
- trap crops,
- delay of planting, and
- harvest timing.

**Crop Rotation**—Taking infested fields out of production and leaving them fallow or planting an alternate crop may deprive pests of host plants on which to feed and reproduce. Rotations are most effective against insects which have long life cycles and infest the crop during all stages of growth. Many of the traditional rotational schemes were developed to reduce pest problems such as corn rootworm.

**Trap Crops**—Other crops attractive to the pests may be planted early or nearby to draw pests away from the main crop. Destruction of such crops at the proper time breaks the reproductive cycle of the pest before the desired crops are infested. To control the pickle worm in cucumbers, for example, the grower might also plant yellow squash, to which the pest is more attracted. The squash crop can be sprayed or destroyed before the pest can complete its development.

**Delay of Planting**—Delaying the date of planting may reduce the population of certain pests by eliminating the host plant needed for food and reproduction when the pest population is at its peak. For example, prevention of Hessian fly damage in wheat can be avoided by delaying planting until fly reproduction has ended for the year.

**Harvest Timing**—Crops should not be left in the field after maturity if they are susceptible to pest attack. For example, wireworm damage to mature potatoes causes a serious quality reduction. Damage increases if the crop is left in the ground even for a very short time after maturity.

## Mechanical Control

Mechanical controls used on insects are:

- screens and other barriers,
- traps,
- light,
- heat and cold, and
- radiation and electrocution.

**Screens and Other Barriers**—A major aspect of insect control indoors is the use of screens and other barriers to keep insects out. Flying insects, such as mosquitoes, wasps, and flies, are kept outside by blocking any openings with screening. The effective mesh size depends on the size of the smallest flying insect pests in that environment. Crawling insects are also kept outside by screens or other barriers, such as tightly sealed doors and windows. Barriers made of sticky substances sometimes can stop crawling insects from entering an area.

**Traps**—Traps are sometimes used to control the target pest. More often, however, they are used to survey for the presence of insect pests and to determine when the pest population has increased to the point where control is needed.

**Light**—Many insect pests may be attracted to artificial light at night. However, since not all the pests are killed, the light attractant may actually help create infestations around swimming pools and other limited size areas.

**Heat and Cold**—It is sometimes possible to expose insect pests to the killing effects of the heat of summer or cold of winter. Insects that feed on stored grain and flour, for example, can sometimes be controlled by ventilating grain elevators in winter.

**Radiation and Electrocution**—Radiation and electrocution are sometimes used to kill pests in a limited area. The electric screens in such places as outdoor restaurants and amusement parks are used to attract and electrocute a variety of nocturnal insect pests. Ionizing radiation is used to sterilize pests by destroying reproductive tissues, and ultrasonic radiation is used to kill pests in some products.

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# Pests and Pest Control

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## Sanitation

Cultivation, moldboard plowing, and burning of crop residues soon after harvest greatly aid in the control of some insect pests on agricultural crops. Pink bollworm infestations in cotton, for example, can be greatly reduced by plowing the field immediately after harvest.

Removing litter from around buildings helps control pests which use it for breeding or shelter. Ants, termites, and some other indoor pests may be suppressed by using this technique.

Sanitation is important in the control of animal parasites and filth flies. Fly control in and around barns and livestock pens, for example, is greatly aided by proper manure management. A major aspect of fly control in residential areas and cities is weekly or biweekly garbage removal. This scheduling prevents fly eggs and maggots in the garbage from reaching adult fly stage, since the fly's life cycle is 10 to 14 days, even in very warm weather.

Indoors, sanitation is a major method of preventing insect pest problems. Keeping surfaces in rest-rooms and food preparation areas immaculately clean and dry is an important factor in suppressing or eliminating ant, fly, and cockroach infestations.

## Chemical Control

Chemicals used to control insects and insect-like pests include insecticides, miticides, and acaricides. Most chemicals used to control insects act in one of two ways:

- repellents—These products keep pests away from an area or from a specific host. Products designed to keep mosquitoes, chiggers, and ticks off humans are an example.
- direct poisons—Common insecticides include chemicals that poison one or more life systems in the pest. Some will poison an insect if they are eaten (stomach poisons); others require only contact with the insect's body (contact poisons).

A few insecticides interfere mechanically with the insect's functions. For example, mineral oils suffocate insects; silica dusts destroy their body water balance by damaging their protective wax covering.

**Outdoors**—With few exceptions, insecticides labeled for outdoor use are designed to be used for full coverage of an area. The objective is to cover the entire surface to be protected with a residue of active insecticide. Insects which then eat or otherwise contact the treated surface are killed.

Thorough knowledge of the target insects helps determine the frequency of application and the choice of chemicals. One well-timed application of an effective pesticide may provide the desired control. Sometimes repeated insecticide applications will be necessary as the insect infestation continues and pesticide residues break down.

The pesticide label, Cooperative Extension Service recommendations, and other sources usually indicate a range of treatment intervals and dosages. By carefully observing the pest problem and applying chemicals when the pests are most vulnerable, you often will be able to use lower doses of pesticides and apply them less often. Over a long growing period, this can mean considerable savings in time, money, and total pesticide chemicals applied.

Most control strategies take advantage of the natural controls provided by the pest's natural enemies. When you choose a pesticide, consider what affect it will have on these beneficial organisms. Ask your pesticide dealer, your agricultural Extension agent, or other experts for advice.

**Indoors**—Most indoor insect control is aimed at prevention or eradication of the pest problem while minimizing the exposure of humans and animals to chemicals. The most common application techniques are crack and crevice treatments, spot treatments, and fumigation of entire structures, commodities, or individual pieces of equipment.

## Plant Disease Agents

### Importance of Plant Diseases

All plants are subject to plant diseases. Diseases have plagued agricultural plants since the dawn of history. The Romans were particularly troubled by cereal rusts and went so far as to invent a festival to appease Robigo, the god of rust. The famous Irish potato famine of 1845 and 1846 was caused by a disease called late blight. It resulted in the starvation of hundreds of thousands of people and the emigration of more than 1.5 million to the United States. Today, plant diseases remain a major limiting factor in the production of agricultural and horticultural crops and the maintenance of landscapes.

### What Is a Plant Disease?

A plant disease is any harmful condition that makes a plant different from a normal plant in its structure (appearance) or function (ability to grow and yield). The study of plant diseases is called plant pathology. Plant diseases are usually manifested by visible symptoms. Yellowing, leaf spots, root rot, mottling or mosaics, galls, wilting, or stunting are examples of plant disease symptoms.

### Causes of Plant Disease

Plant diseases can be divided into two main groups based on their cause. Abiotic (nonliving) causal agents include temperature extremes, moisture extremes, air pollutants, nutrient deficiencies, mineral toxicities, pesticide toxicity, etc. Abiotic causal agents cannot spread from plant to plant and so are nonparasitic and noninfectious.

Biotic (living) causal agents include fungi, bacteria, mycoplasma-like organisms (MLO's), viruses, and nematodes. Biotic causal agents are also called pathogens. Some plant pathologists also include parasitic plants like dodder or mistletoe as pathogens. Pathogens gain nutrients at the expense of the living host plant so they are generally parasitic. Some also have the ability (faculty) of living

on dead host tissue so they are called facultative saprophytes. Pathogens that cannot live as facultative saprophytes are called obligate parasites. Since pathogens are able to spread from plant to plant, they are considered infectious.

All pathogens except viruses have standardized Latin scientific names consisting of a genus and species name (for example, *Fusarium graminearum*). The purpose of scientific names is to allow scientists to specify exactly the name of a pathogen to avoid confusion. Unfortunately, these scientific names are often difficult to remember and are sometimes subject to revision as we learn more about the organisms. For most practical purposes, the common name of the disease is used rather than the scientific name of the pathogen.

Particular pathogens can infect only certain species or varieties of plants. This group of plants is called the host range of the pathogen. Some pathogens have a broad host range, while others have a very narrow host range. When a plant cannot be parasitized by a pathogen, it is called resistant. If it is easily parasitized, it is fully susceptible. Some plants are parasitized to a lesser extent and are called moderately susceptible.

In order for a biotic disease to develop, there must be three components present: (1) a pathogen, (2) a susceptible host, and (3) a favorable environment. Certain pathogens, such as viruses that require a vector (carrier) have a fourth component. If any of the components is missing, disease will not occur. The initial population of the pathogen is called the inoculum. Many control strategies aim to destroy or reduce the inoculum so that disease will be prevented or delayed. Crop susceptibility may be affected by temperature, fertility, and stage of crop growth. Important environmental factors for disease development include temperature, rainfall duration and frequency, wind speed, humidity, and soil moisture.

# Pests and Pest Control

## Major Groups of Pathogens

### Fungi

The fungi are the most important group of plant pathogens. However, fungi also include many important organisms that are used in the making of bread, some cheeses, or beer. They are also critical in the decay and cycling of organic debris. Fungi are usually composed of multi-celled, thread-like filaments called hyphae. Hyphae absorb the water and nutrients needed for growth of the fungus. Most fungi are microscopic, but some, such as mushrooms may become quite large.

Most fungi reproduce by spores which function like tiny seeds. Spores of different species vary greatly in color, size, and shape. Some types of spores remain viable for years, and others last only hours. Spores may be borne on the hyphae or within specialized structures called fruiting bodies. Fruiting bodies are usually barely visible with the naked eye and vary from flask-shaped structures to disk-shaped or cushion-shaped structures. Plant pathologists can usually identify a fungus by careful examination of the spores and fruiting bodies.

Fungi may attack the fruits, flowers, leaves, stems, or roots of a plant. They may be airborne, soilborne, waterborne, seedborne, or insectborne. Water or high humidity is nearly always essential for spore germination and growth of hyphae. Most pathogenic fungi can complete a generation in a week or less. Fungus diseases include apple scab, corn smut, powdery mildew of blue-grass, rose black spot, wheat leaf rust, and corn ear rot.

### Bacteria

Bacteria are single-celled organisms which are much smaller than fungi. They usually reproduce by simply dividing in half. Each half becomes a fully developed bacterium. Bacteria can build up fast under ideal conditions. Some can divide every 30 minutes. As with fungi, most bacteria are favored by water and high humidity. Plant pathogenic bacteria are facultative saprophytes and some are commonly found on the surface

of plants in the absence of disease symptoms. Bacteria can be identified by their ability to grow on different types of agar media or with serological techniques. Fireblight of apple, halo blight of beans, alfalfa bacterial wilt, potato soft rot, and bacterial leaf spot of peaches are caused by bacteria.

### Mycoplasma-Like Organisms (MLO's)

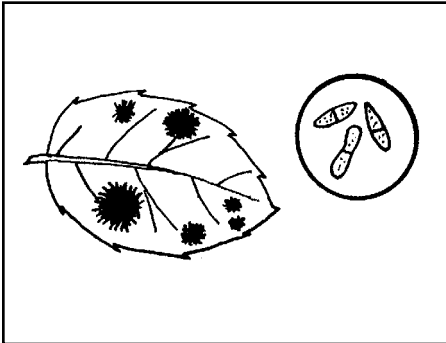
MLO's are actually a type of bacteria which lack a cell wall. They have become highly specialized obligate parasites that inhabit the food conducting vessels (phloem) of the plant circulatory system. They are transferred from plant to plant by leafhoppers or by grafting. MLO diseases often involve yellowing, stunting, or excessive proliferation shoots. These symptoms are similar to those caused by some viruses. However, unlike viruses, MLO's are sensitive to antibiotics, particularly tetracycline. Aster yellows and elm phloem necrosis are two examples of MLO diseases.

### Viruses

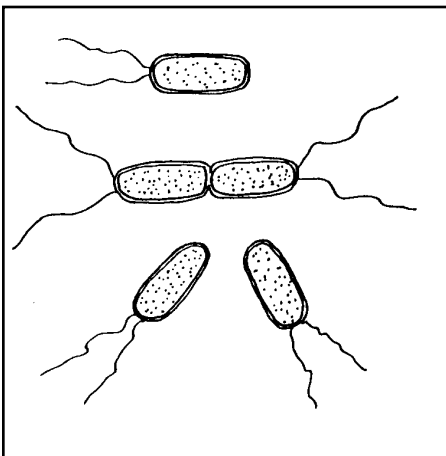
Viruses are much smaller than bacteria and are composed simply of some genetic material (DNA or RNA) in a protein coat. Since viruses lack the ability to live freely, they must take over a host cell and direct it to reproduce the virus. Viruses come in a variety of shapes and sizes, but they can only be seen with a high-powered electron microscope.

Characteristic symptoms are often used for preliminary virus identification. Confirmation of identity is usually done with a technique called ELISA (Enzyme Linked Immunosorbent Assay) that uses specific antibodies. Many viruses that cause plant disease are carried by insects or mites. Aphids and leafhoppers are the two most common vectors (carriers).

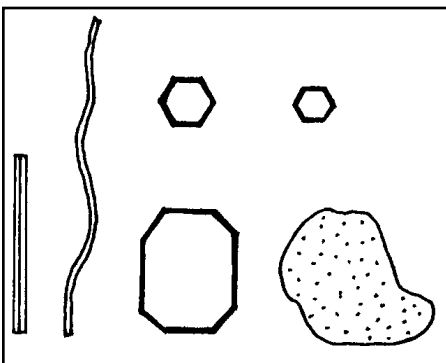
Viruses may also be transmitted on contaminated shears, on hands, by grafting, in infected bulbs or cuttings, and in seeds. A few viruses are transmitted by pollen, nematodes, or soilborne fungi. Wheat streak mosaic, tomato spotted wilt, and maize dwarf mosaic are examples of virus diseases.



Fungi



Bacteria reproducing by division



Different kinds of viruses



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# Pests and Pest Control

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## Nematodes

Nematodes are small (usually microscopic), colorless, slender roundworms. Most nematodes are harmless, but some are parasites of animals and others have adapted to feeding on plants. Plant pathogenic nematodes have a specialized hollow feeding spear that they use like a straw to suck the contents from plant cells. Nematodes may attack the aboveground portion of the plant but normally feed on roots. They feed on the outside of a root or enter inside and feed within the root cortex. Root lesions, galls, or stubby roots are all possible symptoms of nematode feeding. Feeding causes stunting of the root system which often leads to symptoms of drought or nutrient stress.

The life cycle of nematodes includes an egg, four larval stages, and an adult. Most larvae look like adults, but are smaller. Many nematodes migrate from root to root. The females of some, such as the root knot and cyst nematodes, become fixed in the plant tissue. The root knot nematode deposits its eggs in a mass outside of its body. The cyst nematode keeps part of its eggs inside its body after death. They may survive there for many years. Root knot, soybean cyst, pine wilt, and stubby root are examples of nematode diseases.

## Diagnosis of Plant Diseases

Attempting to control plant diseases without sufficient information usually results in failure. For maximum effectiveness, it is important to diagnose the problem correctly. The first step is to evaluate the visible symptoms. Look at the whole plant, including the roots. What plant parts are affected? Is the symptom a wilt, leaf spot, gall, root rot, etc.? Is it worse on the upper or lower leaves? Is the stem vascular tissue discolored? When did symptoms first appear? Is the disease pattern related to soil type, topography or edges of the field? Are healthy and diseased plants interspersed? Additional information is often useful. What is the cropping

history of the field? Have there been any chemicals sprayed? What is the variety?

Often an examination for symptoms will reveal the pathogen itself. When the pathogen is large enough to see without the aid of a microscope, it is called a sign. This is in contrast to a symptom which is a change in the structure or function of the host. Finding a sign often leads to a prompt diagnosis.

Be aware of the major diseases in your area. When you arrive at a tentative diagnosis, make sure it is consistent with all the facts. Often diagnosis is challenging and may require the help of your county Extension agent. Help is also available from the KSU Plant Diagnostic Clinic.

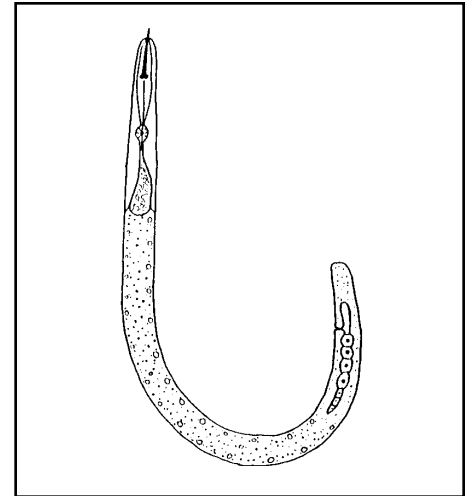
## Principles of Plant Disease Management

For some plant diseases, it is possible to achieve complete control. An example would be wheat Karnal bunt. It is completely controlled in the USA by quarantine regulations that prevent its introduction. However, for many diseases, complete control is impossible or too expensive. Disease management attempts to maximize profits by reducing disease severity to the economic threshold. The economic threshold is the point where the cost of disease management and the economic benefits of disease reduction are balanced.

Plant disease management attempts to alter one of the three components necessary for disease development. Control measures may be directed at: (1) reducing or eliminating the pathogen, (2) reducing susceptibility of the host plant, or (3) reducing the favorability of the environment for disease development. The ease of control of a disease often depends on the stage in the life cycle of the pathogen. Disease control measures are usually directed at the most vulnerable stage of the pathogen life cycle. The principles of disease control include the following.

## Genetic Resistance

Plant breeders attempt to improve the yield and quality of important



*Nematode with feeding spear extended*

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# Pests and Pest Control

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plants by incorporating high levels of genetic disease resistance.

## **Exclusion**

Exclusion is the prevention of establishment of a pathogen in a previously uninvaded area. Many plant pathogens are controlled by quarantines which regulate the movement of plants into this country. The principle of exclusion can also be applied to greenhouse crops where it is important to prevent the introduction of infected stock plants.

## **Protection**

Protection involves some type of barrier between the host and the pathogen. Nonsystemic chemical fungicides are considered protectants because they form a chemical barrier over the surface of the plant that protects against fungal invasion. Protectant fungicides must be applied prior to infection in order to prevent invasion since they have no effect on established infections.

## **Eradication**

Eradication is the practice of removing or destroying a pathogen after it has become established in an area.

## **Avoidance**

Avoidance is the practice of growing plants in places or at times when the pathogen is inactive, rare or absent.

## **Therapy**

Therapy is the curing of disease or lessening of disease severity of a plant that is already infected. Systemic fungicides can be used for therapy because they can stop the development of fungi that have already infected. Another example is heat therapy of infected wheat seed to rid it of internal loose smut infections. Therapy is often impractical or more costly than other control measures.

## **Methods of Plant Disease Management**

### **Disease Resistant Varieties**

Plant disease resistant varieties are one of the most effective and economical ways to control plant diseases. For many diseases, resistance is the only

practical control measure. In addition, resistance is usually long-lasting. There are some notable exceptions, however. For example, wheat leaf rust resistance can be short-lived if the leaf rust fungus mutates and adapts to the host resistance.

There are different levels of genetic resistance ranging from highly susceptible, moderately susceptible, moderately resistant, to highly resistant. Plants which get diseased, yet still manage to yield well are called tolerant to infection.

### **Crop Rotation**

Many pathogens survive between crops in the soil or on crop debris. However, the majority of pathogens do not cross over between different crop species. Therefore, crop rotation can break the life cycle of the pathogens and reduce the inoculum.

### **Sanitation**

Since many pathogens survive on crop debris, destruction or removal of debris can be an effective control measure. Removal of infected volunteer plants, destruction of weed hosts, fumigating or steaming of soil, and roguing of diseased plants are all examples of sanitation.

### **Planting Date**

Planting date can have a large effect on many pests including diseases, insects, and weeds.

### **Field Selection**

Certain plant diseases are more prevalent in certain types of fields. For example, Phytophthora root rot of alfalfa is more common in poorly drained bottomland fields. It is often best to avoid putting susceptible crops in fields that are predisposed to certain disease problems.

### **Disease-free Seed or Propagation Materials**

Many diseases are carried in the seed or in infected stock. Certified, clean seed should be free of most seedborne pathogens. Many horticultural crops are subject to diseases that are spread by propagation. New plants should be carefully inspected for symptoms of disease. Suspicious

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# Pests and Pest Control

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shipments should be refused or held in isolation while being checked for pathogens. Diagnostic tests may be necessary to verify that stock is disease-free. These are available through the Cooperative Extension Service.

## Changing the Environment to be Less Favorable

Certain horticultural practices tend to favor diseases by making the environment more conducive. For example, watering plants in the greenhouse in the evening can result in long periods of leaf wetness compared to watering in the morning. Good greenhouse ventilation can reduce humidity levels and suppress many diseases. Growing plants above or below their optimum temperature can cause stress and make plants more susceptible to root rots.

For field crops, excessive overhead irrigation can promote foliar diseases. High nitrogen fertilization can promote overly lush foliage which creates a humid microenvironment which favors diseases like powdery mildew.

## Quarantines

The transport of important pathogens to new locations can sometimes be prevented by quarantine regulations. Quarantines tend to be costly to enforce.

## Chemical Control

Fungicides, bactericides, and nematicides have been developed for plant disease control. There are no chemicals to control viruses. Fungicides can be divided into nonsystemic, protectant types, and systemic types. Protectant fungicides must be applied before infection, while systemic fungicides can sometimes be applied after infection as a therapeutic agent. Protectant fungicides tend to have very broad activity against many fungi. Certain systemic fungicides have fairly narrow activity.

Chemical control efficacy is variable. It is most effective on fungal diseases of aboveground plant parts. Chemical control tends to be expensive and sometimes multiple applications are required. Unfortunately, many diseases have no labelled chemi-

cal control options. Pesticide use is regulated by the EPA. Always consult pesticide labels for directions and restrictions on use.

Chemical control is most likely to be used when: (1) the crop has a high value, (2) resistant varieties are not available, (3) there is a lack of adequate cultural control practices, or (4) when crop quality is paramount (as with apples).

## Weeds

Any plant can be considered a weed when it is growing where it is not wanted. Weeds are a problem because they reduce crop yields, increase costs of production, and reduce the quality of crop and live-stock products. In addition, some weeds cause skin irritation and hay fever, and some are poisonous to man and livestock. Weeds also can spoil the beauty of turf and landscape plants.

Weeds interfere with crop production by:

- competing for water, nutrients, light, and space,
- contaminating the product at harvest,
- harboring pest insects, mites, vertebrates, or plant disease agents, and
- releasing toxins in the soil which inhibit growth of desirable plants.

Weeds may become pests in water by:

- hindering fish growth and reproduction,
- promoting mosquito production,
- hindering boating, fishing, and swimming, and
- clogging irrigation ditches, drainage ditches, and channels.

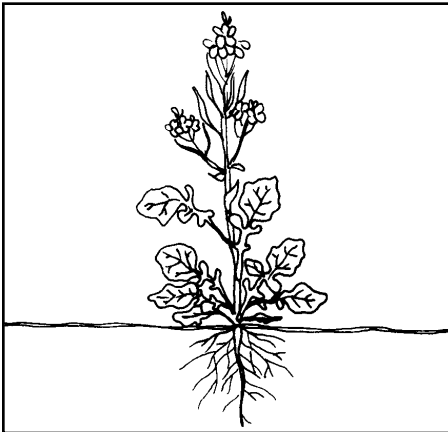
Weeds can harm grazing animals by:

- poisoning, and
- causing an "off-flavor" in milk and meat.

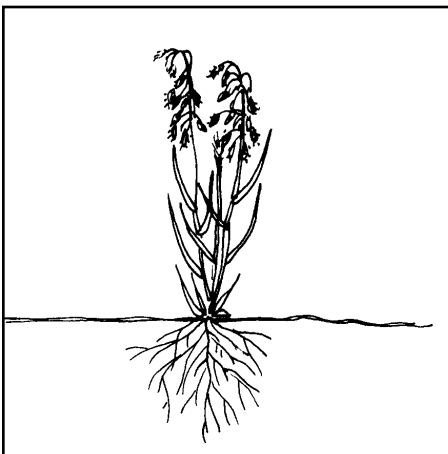
Weeds are undesirable in rights-of-way because they:

- obscure vision, signs, guideposts, crossroads, etc.,
- increase mowing costs,
- hinder travel,
- provide cover for rodents and

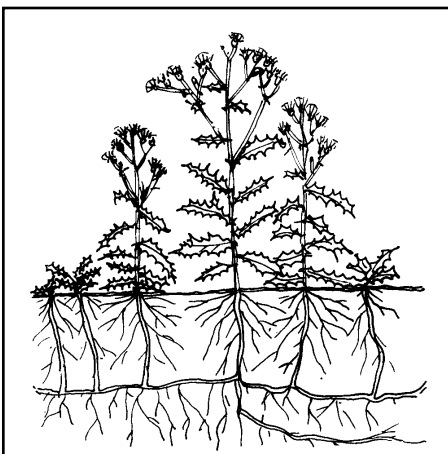
# Pests and Pest Control



Annuals



Biennials



Perennials

other pest animals, and  
■ clog drainage areas.

The type of weed problems encountered depends on:

- current crop or vegetation,
- cropping history,
- tillage practices,
- frequency of mowing,
- herbicide used, and
- management practices.

## Development Stages

All plants have four stages of development:

- seedling—young plant recently established from a germinating seed.
- vegetative—rapid growth; production of stems, roots, and foliage.
- seed production—energy directed toward production of seed. Uptake of water and nutrients is slow and is directed mainly to flower, fruit, and seed structures.
- maturity—little or no energy production or movement of water and nutrients.

## Life Cycles of Plants

### Annuals

Plants with a one-year life cycle are annuals. They grow from seed, mature, and produce seed for the next generation in one year or less. They include grasses and broadleaf plants. There are two types:

**Summer annuals** are plants that grow from seeds which sprout in the spring. They grow, mature, produce seed, and die before winter. Examples: crabgrass, foxtail, cocklebur, pigweed, and lambsquarters.

**Winter annuals** are plants that grow from seeds which sprout in the fall. They grow, mature, produce seed, and die before summer. Examples: downy brome, cheat, henbit, mustards and pennycress.

### Biennials

Plants with a two-year life cycle are biennials. They grow from seed and develop a large tap root and compact cluster of leaves (called a rosette) the first year. In the second year, they

mature, produce seed, and die. Examples: mullein, burdock, and bull thistle.

### Perennials

Plants which live more than two years and may live indefinitely are perennials. Perennial plants may mature and reproduce in the first year and then repeat the vegetative, seed production, and maturity stages for several following years. In other perennials, the seed maturity and production stages may be delayed for several years. Some perennial plants die back each winter; others, such as trees, may lose their leaves, but do not die back to the ground. Most perennials grow from seed; many also produce tubers, bulbs, rhizomes (below-ground root-like stems), or stolons (above-ground stems that produce roots). Examples of perennials are johnsongrass, field bindweed, dandelion, and plantain.

Simple perennials normally reproduce by seeds. However, root pieces which may be left by cultivation can produce new plants. Examples: dandelions, plantain, trees, and shrubs.

Bulbous perennials may reproduce by seed, bulblets, or bulbs. Wild garlic, for example, produces seed and bulblets above ground and bulbs below ground.

Creeping perennials produce seeds but also produce rhizomes (below-ground stems), or stolons (above-ground stems that produce roots). Examples: johnsongrass, field bindweed, and Bermudagrass.

## Weed Classification

### Land Plants

Most pest plants on land are grasses, sedges, or broadleaves.

### Grasses

Grass seedlings have only one leaf as they emerge from the seed. Their leaves are generally narrow and upright with parallel veins. Most grasses have fibrous root systems. The growing point on seedling grasses is sheathed and located below the soil surface. Some grass species are annuals; others are perennials.

# Pests and Pest Control

## *Sedges*

Sedges are similar to grasses except that they have triangular stems and three rows of leaves. They are often listed under grasses on the pesticide label. Most sedges are found in wet places, but principal pest species are found in fertile, well-drained soils. Yellow and purple nutsedge are perennial weed species which produce rhizomes and tubers.

## *Broadleaves*

Broadleaf seedlings have two "seed leaves" as they emerge from the cotyledons or soil. Their leaves are generally broad with netlike veins. Broadleaves usually have a taproot and a relatively coarse root system. All actively growing broadleaf plants have exposed growing points at the end of each stem and in each leaf axil. Perennial broadleaf plants may also have growing points on roots and stems above and below the surface of the soil. Broadleaves contain species with annual, biennial, and perennial life cycles.

## *Aquatic Plants*

### *Vascular Plants*

Many aquatic plants are similar to land plants and have stems, leaves, flowers, and roots. Most act as perennial plants—dying back and becoming dormant in the fall and beginning new growth in the spring. They are classified as:

- emergent (emersed)—plants rooted in the bottom and produce most of their leaves and flowers at or above the water surface. Examples are watershield arrowhead and water primrose.
- floating—all or part of the plant floats on the surface. Examples are waterlilies, duckweeds, water meal and American lotus.
- marginal—emersed weeds that can and frequently do grow on saturated soil above the water surface. Examples are sedge, bulrush, rush, cattails and smartweeds.

- submergent (submersed)—all of the plant grows beneath the water surface. Example are watermilfoil, elodea, naiads, pondweeds (*Potamogeton*), and coontails.

Emergent and floating plants, like some land plants, have a thick outer layer on their leaves and stems which hinders herbicide absorption. Submergent plants have a very thin outer layer on their leaves and stems and are very susceptible to herbicide injury.

## *Algae*

Algae are aquatic plants without true stems, leaves, or vascular systems. For control purposes, they may be classified as:

- plankton algae—microscopic plants floating in the water. They sometimes multiply very rapidly and cause "blooms" in which the surface water appears soupy green, brown, or reddish brown, depending on the algal type.
- filamentous algae—long, thin strands of plant growth which form floating mats or long strings extending from rocks, bottom sediment, or other underwater surfaces. Examples are cladophora and spirogyra.
- macroscopic freshwater algae—these larger algae look like vascular aquatic plants. The two should not be confused, because their control is different. Many are attached to the bottom and grow up to 2 feet tall; however, they have no true roots, stems, or leaves. Examples are chara and nitella.

## *Parasitic Seed Plants*

Dodder and witchweed are important weeds on some agricultural, ornamental, and forest plants. They live on and get their food from the host plants. They can severely stunt and even kill the host plants by using the host plant's water, food, and minerals. These plants reproduce by seeds. Some can also spread from plant to plant in close stands by vining and twining.



*Grasses*



*Sedges*

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# Pests and Pest Control

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## Controlling Weeds

Weed control is nearly always designed to suppress a weed infestation. Prevention and eradication are usually only attempted in regulatory weed programs.

To control weeds which are growing among or close to desirable plants, you must take advantage of the differences between the weeds and the desired species. Be sure that the plants you are trying to protect are not susceptible to the weed control method that you choose. Generally, the more similar the desirable plant and the weed species are to one another, the more difficult weed control becomes. For example, broad-leaf weeds are most difficult to control in broadleaved crops, and grass weeds are often difficult to control in grass crops.

## Weed Control Strategy

A plan to control weeds may include:

- biological control,
- cultural control,
- sanitation, and
- chemical control.

## Biological Control

Biological weed control usually involves the use of insects and disease-causing agents which attack certain weed species. An example is the control of St. Johnswort by the Chrysolina beetle in the western United States. To be effective, biological control requires two things:

- the insect or disease must be specific to the weed to be controlled: otherwise, it may spread to other species, such as crops and ornamentals, and become a pest itself.
- the insects must have no natural enemies that interfere with their activity.

Grazing is another form of biological control sometimes used to control plant growth along ditches, fencerows, and roadsides. Sheep and goats are used most often, but geese are used for weeding some crops.

## Cultural Control

**Tillage**—This is an effective and often-used method to kill or control weeds in row crops, nurseries, and forest plantings. However, tillage may bring buried seeds to the surface where they can either germinate and compete with the newly planted crop or be spread to nearby fields. Tillage also may increase soil erosion and may help to spread established plant diseases to uninfected areas of the field.

**Time of Planting**—Crops can be planted early to give the crops a competitive advantage over later emerging weeds, or the planting date can be delayed until after weeds have germinated and been destroyed by cultivation or herbicides.

**Nurse Crops**—Plant species (usually annuals) which germinate quickly and grow rapidly are sometimes planted with a perennial crop to provide competition with weeds and allow the crop to become established. The nurse crop is then harvested or removed to allow the perennial crop to take over. For example, oats are sometimes used as a nurse crop to help establish alfalfa or clover. Annual ryegrass is sometimes used in mixtures to provide a nurse crop for perennial rye, fescue, or bluegrass.

**Burning**—Fire may be used to control limited infestations of annual or biennial weeds. Fire destroys only the aboveground parts of plants and is usually not effective against many herbaceous perennial weeds.

**Mulching**—Mulching is used to prevent light from reaching weed seeds, thus preventing weed growth between rows, around trees and shrubs, or in other areas where no plants are desired.

**Mowing**—Mowing may be used to reduce competition between weeds and crops and to prevent seed production of annual or biennial weeds. Mowing is often used in orchards to control weeds and prevent soil erosion. To be most effective, mowing height must be adequate to ensure

control of weed plants and encourage desired vegetation. Mowing is an important aspect of turfgrass weed control.

Mowing and harvesting is good for both short-term and long-term control of aquatic weeds. It depletes the nutrients, removes seeds, and reduces vegetative spread.

**Flooding**—Flooding has long been used for weed control in rice. The water covers the entire weed, killing it by suffocation.

**Reduced Tillage**—This method has been used successfully to reduce weed growth and to reduce soil erosion. With limited tillage, weed seeds are not turned up and those that do germinate do not have as much light or space to get started. However, the remaining debris may harbor insects and plant disease agents.

**Shading**—Aquatic weeds are sometimes controlled by shading them with floats of black plastic, adding dye to the water, or using similar methods for shading out the sunlight. Land weeds can be shaded by planting crops so closely together that they block the light from emerging weeds.

### **Sanitation**

The use of crop seed with few weed-seed contaminants is important in reducing weed problems.

### **Chemical Control**

Chemicals used to control weeds are called herbicides. They kill plants by contact or systemic action. Contact herbicides kill only the plant parts which the chemical touches. Systemic herbicides are absorbed by roots or foliage and carried throughout the plant. Systemic herbicides are particularly effective against perennial weeds because the chemical reaches all parts of the plant—even deep roots and woody stems—which are relatively inaccessible. Contact herbicides are usually used to control annuals and biennials and are characterized by the quick die-back they cause. Systemics may take a longer time to provide the desired result, up to 2 or 3 weeks, or even longer for woody perennials.

Herbicide activity is either selective or nonselective. Selective herbicides are used to kill weeds without significant damage to nearby plants. They are used to reduce weed competition in crops, lawns, and ornamental plantings. Nonselective herbicides are chemicals that kill all plants present if applied at an adequate rate. They are used where no plant growth is wanted, such as fencerows, ditch banks, driveways, roadsides, parking lots, and recreation areas.

Herbicide selectivity may vary according to the application rate. High rates of selective herbicides usually will injure all plants at the application site. Some nonselective herbicides can be used selectively by applying them at a lower rate. Other factors that affect selectivity include the time and method of application, environmental conditions, and the stage of plant growth.

Several factors affect a plant's susceptibility to herbicides:

**Growing Points**—Those that are sheathed or located below the soil surface are not reached by contact herbicide sprays.

**Leaf Shape**—Herbicides tend to bounce or run off narrow, upright leaves. Broad, flat leaves tend to hold the herbicide longer.

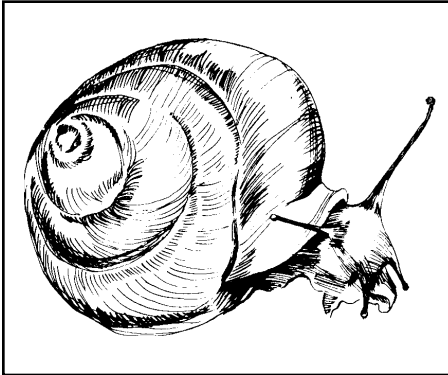
**Wax and Cuticle**—Foliar sprays may be prevented from entering the leaf by a thick wax and cuticle layer. The waxy surface also tends to cause a spray solution to form droplets and run off the leaves.

**Leaf Hairs**—A dense layer of leaf hairs holds the herbicide droplets away from the leaf surface, allowing less chemical to be absorbed into the plant. A thin layer of leaf hairs causes the chemical to stay on the leaf surface longer than normal, allowing more chemical to be absorbed into the plant.

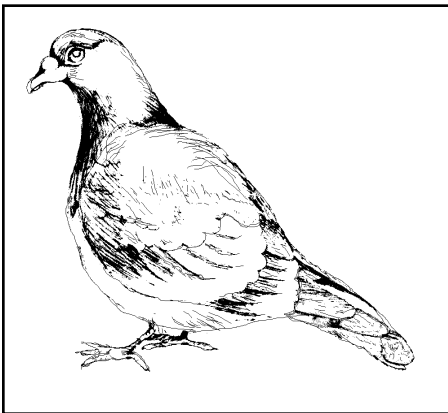
**Size and Age**—Young, rapidly growing plants are more susceptible to herbicides than are larger, more mature plants.

**Metabolism**—Certain plants can detoxify herbicides and are less sus-

# Pests and Pest Control



Snail



Pigeon



Rodents

ceptible to injury from these chemicals. Such plants may become dominant over a period of time if similar herbicides are used repeatedly.

**Plant Growth Stage**—Seedlings are very susceptible to herbicides and to most other weed control practices. Plants in the vegetative and early bud stages are susceptible to translocated herbicides. Plants with seeds or in the maturity stage are the least susceptible to weed control practices.

**Stages in the Life Cycle**—Plants that germinate and develop at different times than the crop species may be susceptible to carefully timed cultivation or herbicide applications.

## Chemicals Which Change Plant Processes

Plant growth regulators, defoliants, and desiccants are classified as pesticides in federal laws. These chemicals are used on plants to alter normal plant processes in some way. They must be measured carefully, because they usually are effective in very small amounts. Overdosing will kill or seriously damage the plants.

A plant growth regulator will speed up, stop, retard, prolong, promote, start, or in some other way influence vegetative or reproductive growth of a plant. These chemicals are sometimes called growth regulators or plant regulators. They are used, for example, to thin apples, control suckers on tobacco, control the height of some floral potted plants, promote dense growth of ornamentals, and stimulate rooting.

A defoliant causes the leaves to drop from plants without killing the plants. A desiccant speeds up the drying of plant leaves, stems, or vines. Desiccants and defoliants are often called “harvest-aid” chemicals. They usually are used to make harvesting of a crop easier or to advance the time of harvest. They are often used on cotton, soybeans, tomatoes, and potatoes.

## Mollusks

Mollusks are a large group of land and water animals including slugs

and snails. They have soft, unsegmented bodies and often are protected by a hard shell.

## Snails and Slugs

Land snails and slugs are soft-bodied and have two pairs of antennae-like structures. Their bodies are smooth and elongated. Snails have a spiral-shaped shell into which they can completely withdraw for protection when disturbed or when weather conditions are unfavorable. Slugs do not have a shell and must seek protection in damp places.

Snails and slugs feed on plants at night. They tear holes in foliage, fruits, and soft stems, using a rasp-like tongue. They may eat entire seedlings. As they move, snails and slugs leave a slime-like mucous trail which dries into silvery streaks. These streaks are undesirable on floral and ornamental crops and on those portions of crops to be sold for human food.

Snails and slugs deposit eggs in moist, dark places. The young mature in a year or more, depending on the species. Adults may live for several years. They overwinter in sheltered areas, and are active all year in warm regions and in greenhouses.

## Controlling Mollusks

Mollusk pests on land (snails and slugs) can be controlled by many of the same techniques that are used to control insects outdoors. Effective techniques include:

- cultural practices—especially cultivation and trap crops,
- mechanical controls—especially traps and barriers,
- sanitation—especially eliminating crop debris and other sources of moisture, and
- chemicals—many insecticide formulations also control mollusks and may be used if mollusks are listed as target pests on the label. In addition, specific molluscicides are available, usually as baits.



# Pests and Pest Control

## Wildlife Damage Control

All vertebrate animals have a jointed backbone. They include mammals, birds, reptiles, amphibians, and fish. Native vertebrate animals are usually not pests. They are a necessary and enjoyable part of our environment.

A few native vertebrate animals can be pests in some situations. Some, such as blackbirds, woodchucks, raccoons, or deer may eat or injure agricultural and ornamental crops. Pheasants and ground squirrels may eat newly planted seed. Housesparrows and Norway rats consume stored food and often contaminate and ruin even more than they eat. Coyotes and wild domestic dogs may prey on livestock and poultry. Large numbers of roosting blackbirds and crows can soil populated areas.

Sometimes rodents, other mammals, and some non-native birds are potential reservoirs of diseases of humans and domestic animals. Non-native rodents are an annoyance and a health hazard when they inhabit homes, restaurants, offices, and warehouses.

Burrowing and gnawing mammals may damage dams, drainage and irrigation tunnels, turf, and outdoor wood products.

Beavers may cause flooding in low-lying land by building dams.

Undesirable fish species may crowd out desirable food and sport species. The few species of poisonous snakes become a problem.

## Controlling Vertebrates

As in insect pest control, techniques for control of vertebrate pests depend on proper pest identification.

Indoor vertebrate pest control usually is aimed at preventing pest entrance and eradicating non-native pest infestations. Nearly all indoor vertebrate pests are non-native rodents or birds, but others, such as bats and raccoons, also may require control.

Outdoors, the strategy usually is to remove individual animals to a level where the damage or injury is economically acceptable.

Local and state laws may prohibit the killing or trapping of some animals, such as birds, muskrats, and beavers without special permits. Always check with local authorities before beginning a control program.

## Vertebrate Damage Control Strategy

Methods of vertebrate damage control include:

- prevention of damage,
- mechanical control,
- sanitation, and
- chemical control.

### Prevention of Damage

Prevention of damage should always be an alternative. Planting alternate crops, harvesting date changes, penning livestock, protection of young livestock, lambing in sheds, use of guardian dogs, lighting and biological control methods are only a few ways that should be considered to prevent future damage.

### Mechanical Control

Mechanical control methods for vertebrate pests include traps, barriers, gunning, attractants, and repellents.

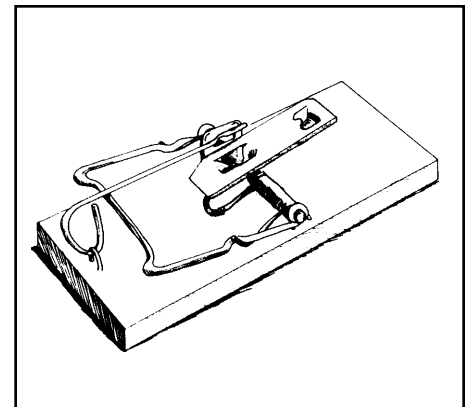
**Traps**—Traps are sometimes desirable in vertebrate pest control. Leg-hold traps have been used traditionally. Such traps are often a good choice in remote rural areas for large predators such as coyotes. Body gripping traps are more desirable in some situations for some animals such as beavers, muskrats and smaller mice and rats. Traps should be checked daily to maintain their effectiveness.

**Barriers**—Barriers are designed to prevent pests from passing through. These include fences, screens, and other barriers which cover openings, stop tunneling, and prevent gnawing. Materials used include sheet metal, hardware cloth, concrete, and similar materials. This kind of approach is especially effective in control of rodents, bats, and birds in structures.

**Shooting**—Shooting, though highly selective, is expensive and time-consuming. It works best in combination with other methods.



Snake



Mousetrap

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# Pests and Pest Control

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**Attractants**—Many techniques, such as scents and sound, are used to attract pests to a trap. Predator calling can increase the efficiency of shooting efforts on larger predators.

**Repellents**—Repellents include a variety of devices aimed at keeping pets from doing damage. Automatic exploders, noisemakers, recordings of scare calls, moving objects, and lights are some of the repellents used. The efficacy of some of these devices is variable and may be highly dependent on placement and frequency of movement to a new location.

## **Sanitation**

Removing sources of food and shelter helps to suppress most vertebrate pests. Sanitation techniques are used widely to control rodents in and around homes, institutions, restaurants, food-processing facilities, and other related areas.

## **Chemical Control**

The chemicals used to control vertebrate pests include rodenticides, piscicides (fish), avicides (birds), and predacides (predators).

Pesticides for vertebrate pest control usually are formulated in baits. The chemicals may be highly toxic to humans, livestock, and other animals. Therefore, correct bait placement is important in order to control the pest while protecting non-pest species. Thorough knowledge of the pest's habits is necessary.

Few pesticides are available for native vertebrate pest control, and most require special local permits for use. The chemicals which are registered are usually bait applications.

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# Pests and Pest Control

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## Study Questions

1. (5) Natural forces are important because:
  - a) you cannot do anything about them
  - b) they can cause pest populations to rise and fall
  - c) you can never spray anywhere in the winter time
  - d) the rain and wind always makes it necessary to respray the area.
2. (6) Biological control:
  - a) is always 100% effective
  - b) is never complete
  - c) never occurs naturally
  - d) always interferes with commercial chemical control operations.
3. (7) Resistance to pesticides develops in pest species:
  - a) because some applicators use the least expensive chemicals
  - b) the chemical companies plan it to happen
  - c) the pesticides are not poisonous enough
  - d) rarely does any pesticide kill all the pests and those that survive pass this ability on to their offspring.
4. (8) Integrated Pest Management practices include the use of:
  - a) chemical pesticides
  - b) cultivation and barriers
  - c) sanitation and traps
  - d) all the above.
5. (9) In the case of insects:
  - a) they are only important because they give entomologists something to talk about
  - b) they must all be killed as soon as possible
  - c) about 99% of all species are of minor importance
  - d) they all feed on plants which could be eaten by people.
6. (10) The insect thorax:
  - a) is where the insect antennae are located
  - b) supports the legs and wings (if present) of the adult insect
  - c) is always a very small orange spot on right side of the head
  - d) is difficult to distinguish from the legs.
7. (11) An example of an Arachnid is:
  - a) a butterfly
  - b) an insect
  - c) a spider
  - d) a pigweed.
8. (12) The use of host resistance:
  - a) helps keep pest populations below harmful levels
  - b) means that any pesticide use will not result in killing the host
  - c) involves treating the host with insecticides repeatedly at low rates so as not to kill it
  - d) should always be discouraged because it is never effective.
9. (13) Screens and other barriers:
  - a) are no longer effective because insects have learned to avoid them
  - b) are too "old fashioned" to work
  - c) can be a major way of controlling pests in some situations
  - d) should always be painted red or yellow to help repel the pest.
10. (14) The major objective in outdoor chemical pest control is:
  - a) to cover the entire surface to be protected with a residue
  - b) rely on drift to reach the "hard to get" areas
  - c) use the most toxic chemical possible to reduce the number of applications
  - d) spray every other day to stay ahead of pest buildup.

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# Pests and Pest Control

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## Study Questions

11. (15) For most biotic plant diseases to develop, there must be \_\_\_\_\_ present:
  - a) a pathogen
  - b) a susceptible host
  - c) a favorable environment
  - d) all the above.
12. (16) Micoplasmas are actually a type of \_\_\_\_\_ which lacks a cell wall.
  - a) fungus
  - b) bacteria
  - c) virus
  - d) nematode.
13. (17) Root knot, soybean cyst, and pine wilt are examples of \_\_\_\_\_ diseases.
  - a) nematode
  - b) fungus
  - c) bacteria
  - d) virus.
14. (18) Quarantines that regulate the movement of plants into this country are a form of disease control called:
  - a) avoidance
  - b) protection
  - c) exclusion
  - d) eradication.
15. (19) Weeds interfere with crop production by:
  - a) competing for water
  - b) harboring pest insects, mites, etc.
  - c) releasing toxins into the soil
  - d) all the above.
16. (20) All plants, including weeds, have how many stages of growth?
  - a) 1
  - b) 2
  - c) 3
  - d) 4
17. (21) An aquatic plant without a true stem, leaves or vascular system is called:
  - a) broadleaf weed
  - b) annual grass
  - c) algae
  - d) fungi.
18. (22) Controlling weeds usually involves:
  - a) visiting with a neighbor
  - b) the use of livestock to pack the soil so the seedlings can not emerge
  - c) taking advantage of the differences between the weeds and desired species
  - d) burning the soil surface with a combination of chemicals.
19. (23) Chemicals used to control weeds are pesticides called:
  - a) rodenticides
  - b) miticides
  - c) insecticides
  - d) herbicides.
20. (24) Snails and slugs are in a group of animals called:
  - a) herbivores
  - b) carnivores
  - c) mollusks
  - d) phagaphores.
21. (25) Vertebrate pest control is similar to insect control in that it depends on:
  - a) seeing each pest before spraying
  - b) spraying only in the day time
  - c) proper pest identification
  - d) the use of a registered insecticide.
22. (26) The most common chemical formulation of vertebrate poisons is:
  - a) baits
  - b) wettable powders
  - c) emulsifiable concentrates
  - d) dusts.

# Pesticide Formulations

The active ingredients in a pesticide are the chemicals that control the target pest. The pesticide product you purchase is rarely made up only of active ingredients. Usually, the pesticide is diluted in water or a petroleum solvent, and other chemicals are added before the product is offered for sale. These other chemicals may include wetting agents, spreaders, stickers, extenders, or diluents. They usually make the product safer, easier to apply, more convenient to handle, and more accurate to measure. This mixture of active and inert (inactive) ingredients is called a pesticide formulation. Some formulations are ready for use. Others must be further diluted with water, a petroleum solvent, or air by the user before they are applied.

## Types of Formulations

Any particular active ingredient often is sold in several different kinds of formulations. You must choose the formulation that will be best for each use. In making your choice, consider:

- the plant, animal, or surface to be protected (phytotoxicity, animal absorption, pitting or marring surface),
- application equipment available and best suited for the job,
- hazard of drift and runoff (nearness to sensitive areas, likelihood of wind or rain),
- safety to applicator, helpers, and other humans and pets likely to be exposed,
- habits or growth patterns of the pest (bait versus broadcast spray, granular versus foliar spray),
- cost,
- type of environment in which the application must be made (agricultural, aquatic, forest, urban, etc.)

## Liquid Formulations

### Emulsifiable Concentrates (EC or E)

An emulsifiable concentrate formulation usually contains the active

ingredient, one or more petroleum solvents, and an emulsifier which allows the formulation to be mixed with water. Each gallon of EC usually contains 2 to 9 pounds of active ingredient. EC's 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 types of application equipment, from small, portable sprayers to hydraulic sprayers, low-volume ground sprayers, mist blowers, and low-volume aircraft sprayers.

#### Advantages:

- high concentration means price per pound of active ingredient is relatively low and product is easy to handle, transport, and store,
- little agitation required; not abrasive; will not settle out or separate when equipment is running,
- little visible residue on fresh fruits and vegetables and on finished surfaces.

#### Disadvantages:

- high concentration requires extra care when mixing and loading equipment,
- high concentration makes it easy to overdose or underdose through mixing or calibration errors,
- phytotoxicity hazard usually greater,
- easily absorbed through skin of humans or animals,
- solvents may cause rubber or plastic hoses, gaskets, and pump parts and surfaces to deteriorate,
- may cause pitting or discoloration of painted finishes,
- may be corrosive.

#### Solutions (S)

A few pesticide active ingredients dissolve readily in water. Formulations of these pesticides contain the active ingredient and one or more additives. When mixed with water, they



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# Pesticide

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## Formulations

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form a solution which will not settle out or separate. Solutions may be used in any type of sprayer indoors or outdoors.

**Advantages:**

- no agitation necessary.

**Disadvantages:**

- very few formulations of this type available,
- may move off target because of their high water solubility.

**Ultra Low Volume Concentrate Solutions (ULV)**

ULV concentrate solutions contain 8 or more pounds of active ingredient per gallon. They may approach 100 percent active ingredient. ULV concentrate is designed to be used as is or to be diluted with only small quantities of specified solvents. These special-purpose formulations must be applied with highly specialized spray equipment. They are mostly used in outdoor applications such as in agricultural, forestry, ornamental, and mosquito control programs. The advantages and disadvantages are similar to those for emulsifiable concentrates.

**Low Concentrate Solutions (S)**

These formulations, usually solutions in petroleum solvents, contain small amounts (usually 1 percent or less) of active ingredient per gallon. They are designed to be used without further dilution. Low concentrate solutions are used for:

- structural and institutional pests,
- clothes moths,
- livestock and poultry pests,
- space sprays in barns and warehouses,
- mosquito control.

**Advantages:**

- no mixing necessary,
- household formulations have no unpleasant odor; do not stain fabric.

**Disadvantages:**

- expensive,
- limited number of uses.

**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 formulations in ease of handling and use. They are used in the same types of pest control operations for which EC's are used.

**Advantages:**

- seldom clog nozzles,
- easy to handle and apply.

**Disadvantages:**

- require moderate agitation,
- may leave a visible residue.

**Aerosols**

These formulations contain one or more active ingredients and a solvent. Most aerosols contain a low percentage of active ingredient. 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 are usually small, self-contained units which 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 hold 5 to 10 pounds of pesticide, and these are usually refillable.

**Advantages:**

- ready to use,
- easily stored,
- convenient way of buying small amount of a pesticide,
- retain their potency over fairly long time.

**Disadvantages:**

- expensive,
- 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 are not under pressure. They are used in machines which break the liquid formulation into a fine mist or fog (aerosol) using a rapidly whirling

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# Pesticide Formulations

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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 method of filling entire space with pesticide.

## Disadvantages:

- highly specialized use,
- fairly expensive for pounds of active ingredient per gallon,
- difficult to confine to target site or pest,
- risk of inhalation injury.

## Invert Emulsions

This unusual 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 carrier, usually fuel oil. When applied, invert emulsions form large droplets which do not drift easily. Invert emulsions are most commonly used in vegetation control along rights-of-way where drift to susceptible nontarget plants is a problem.

## Fumigants

Fumigants are pesticides which form poisonous gases when applied. Sometimes the active ingredients are gases which become liquids when packaged under high pressure. These formulations become gases when released during application. Other active ingredients are volatile liquids when enclosed in an ordinary container and so are not formulated under pressure. They become gases during application. Others are solids that release gases when applied under conditions of high humidity or in the presence of water vapor.

Fumigants are used for structural pest control, in food and grain storage facilities, and in regulatory pest control at ports of entry and at state and national borders. In agricultural pest control, fumigants are used in soil and in greenhouses, granaries, and grain bins.

## Advantages:

- toxic to a wide range of pests,

- can penetrate cracks, crevices, wood, and tightly packed areas, such as soil or grains,
- single treatment will usually kill most pests in treated area.

## Disadvantages:

- the target area must be enclosed or covered to prevent the gas from escaping,
- highly toxic to humans—specialized protective equipment, including respirators, must be used with fumigants,
- no residual activity.

## Dry Formulations

### Dusts (D)

Most dust formulations are ready to use and contain a low percentage of active ingredient (usually 1 to 10 percent), plus a very fine dry inert carrier made from talc, chalk, clay, nut hulls, or volcanic ash. The size of individual dust particles is variable.

Dust concentrates contain a greater percentage of active ingredient. These must be mixed with dry inert carriers before they can be applied.

Dusts are always used dry and easily drift into nontarget areas. 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 domestic animals and poultry.

## 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:

- drift hazard high,
- expensive because of low percentage of active ingredient,
- leave an obvious surface residue,

### Baits (B)

A bait formulation is an active ingredient mixed with food or another

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# Pesticide

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## Formulations

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attractive substance. The bait attracts the pests, which are then killed by eating the pesticide it contains. The amount of active ingredient in most bait formulations is quite low, usually less than 5 percent. Baits are used inside buildings to control ants, roaches, flies, and other insects and for rodent control. Outdoors they are sometimes used to control slugs and some insects, but their main use is for control of vertebrate pests such as birds, rodents, and other mammals.

### Advantages:

- ready to use,
- entire area need not be covered, since pest goes to bait,
- controls pests which move in and out of an area.

### Disadvantages:

- often 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 feeding on the poisoned pests may also be poisoned,
- application costs are high.

### 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. They also may be used as systemics—formulations that are applied to the soil, then absorbed into the plant through the roots and carried throughout the plant. They are applied by aircraft and ground equipment. 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—particles settle quickly,
- low hazard to applicator—no spray, little dust,
- weight carries the formulation through foliage to soil target (except for woody vegetation),
- simple application equipment—often seeders or fertilizer spreaders,
- may be more persistent than WP's or EC's.

### Disadvantages:

- more expensive than WP's or EC's,
- may need to be incorporated into soil,
- may need moisture to activate pesticidal action.

### Pellets (P or PS)

Pelleted formulations are uniform sized particles, usually of clay or similar material, created by extruding or molding under pressure. The result are particles of uniform size and specific weight. The active ingredient is usually absorbed into the pellet and released by water into the soil. The amount of active ingredient ranges from 1 to over 40 percent.

Pelleted formulations are most often used to apply pesticides to the soil to control weeds, brush and nematodes. They are applied by aircraft, ground applicators and spot treatment methods. Uses include agriculture, ornamental, turf, rights-of-way and non-cropland operations.

### Advantages:

- ready to use: no mixing,
- drift hazard is low—pellets settle quickly,
- low hazard to operator—no spray, some dust,
- excellent distribution due to uniform size,
- generally more persistent than WP's or EC's,
- some pesticides can be applied in off season period by commercial applicators.



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# Pesticide

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## Formulations

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### Disadvantages:

- more expensive than WP's or EC's,
- moisture needed to activate or move active ingredient into soil,
- precision application equipment needed for broadcast application,
- storage requirements may be greater than liquid or fine particle formulations,
- in woody vegetation, aerial application must be made during dormant season for best distribution.

### Wettable Powders (WP or W)

Wettable powders are dry, finely ground formulations which look like dusts. They usually must be mixed with water for application as a spray. A few products, however, 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 and in most types of spray machinery where agitation is possible.

#### Advantages:

- low cost,
- easy to store, transport, and handle,
- lower phytotoxicity hazard than EC's and other liquid formulations,
- 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,
- require good and constant agitation (usually mechanical) in the spray tank,
- abrasive to many pumps and nozzles, causing them to wear out quickly,

- residues may be visible.

### Soluble Powders (SP)

Soluble powder formulations look like wettable powders. However, when mixed with water, soluble powders dissolve readily and form a true solution. After they are thoroughly mixed, no additional agitation is necessary. The active ingredient in soluble powders ranges from 15 to 95 percent— usually over 50 percent.

Soluble powders have all the advantages of the 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.

### Microencapsulation

Microencapsulated formulations are microscopic particles of pesticides (either liquid or dry) surrounded by a very thin 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.

#### Disadvantages:

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

### Water-Dispersible Granules (Dry Flowables)

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. 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,

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# Pesticide

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## Formulations

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- they cause less inhalation hazard to the applicator during measuring and mixing.

### Adjuvants

An adjuvant is an inert material added to a pesticide formulation or tank mix to increase the effectiveness of the active ingredient. Most pesticide formulations contain at least a small percentage of additives. Some applicators add additional adjuvants while mixing for special applications. Some product labels may caution the user against adding adjuvants. Common adjuvants are:

**Wetting agents**—allow wettable powders to mix with water and stick on plant or animal surfaces.

**Emulsifiers**—allow petroleum-based pesticides (EC's) 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 agent**—may reduce drift by decreasing fines.

**Drift Suppressants**—may reduce drift by increasing droplet size.

**Safeners**—reduce phytotoxicity of pesticide to protected crop.

**Compatibility agents**—aid in combining pesticides effectively.

**Buffers**—allow mixing of pesticides of different acidity or alkalinity.

**Antifoaming agents**—reduce foaming of spray mixtures that require vigorous agitation.

### Compatibility

Two or more pesticides which can be mixed together to control a wider range of pests with a single application are said to be compatible with each other. Sometimes, the pesticides are formulated together by the manufacturer, but the applicator often must mix separate formulations in the tank. It is important to remember that not all pesticides work well in combination. Pesticides which are not compatible can cause:

- loss of effectiveness against the target pests,
- injury to the treated surface (phytotoxicity in plants, toxicity in treated animals, stains or corrosion on treated surfaces),
- separation of ingredients into layers or settling out of solids.

Some pesticide labels list other pesticides with which the product is compatible. Pesticide publications, land grant universities, and independent experts can supply information based on local experience. Be careful with do-it-yourself mixes; they could cost time and money.

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# Pesticide Formulations

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## Study Questions

1. (29) The pesticide formulation includes:
  - a) only the active ingredients
  - b) only the inert ingredients
  - c) both active and inert ingredients
  - d) none of the above.
2. (30) Low concentrate solutions usually contain:
  - a) 1% or less active ingredient
  - b) 2 to 5% active ingredient
  - c) 6 to 10% active ingredient
  - d) 11 to 15% active ingredient.
3. (31) Pesticide formulations which form a gas when applied are called:
  - a) aerosols
  - b) fumigants
  - c) fungicides
  - d) flowables.
4. (32) An advantage of pelleted formulations is:
  - a) drift hazard is low
  - b) no mixing—ready to use
  - c) excellent distribution due to the uniform size
  - d) all the above.
5. (33) A finely ground formulation which looks like a dust, is mixed in water but does not dissolve in the water is called:
  - a) sprayable concentrate
  - b) emulsifiable concentrate
  - c) soluble powder
  - d) wettable powder.
6. (34) Pesticides which are not compatible can:
  - a) cause loss of effectiveness if mixed
  - b) cause injury to treated surfaces, animals, plants, etc.
  - c) cause separation of ingredients into layers or settling out
  - d) all the above.

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# Labels and Labeling

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Each pesticide you buy has a label that gives instructions on how to use the product. The manufacturer may also provide additional forms of labeling.

Labeling is all information that you receive from the manufacturer about the product. Labeling includes not only the label on the product container, but also any supplemental information accompanying the product. This may include such things as brochures, leaflets, and information handed out by your dealer.

The label is the information printed on or attached to the container of pesticides.

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

Some labels are easy to understand. Others are complicated. All labels will tell you how to use the product correctly. This section will explain the items that must be on a label.

## Parts of the Label

### Brand, Trade, or Product Names

Each manufacturer has a brand name for its products. Different manufacturers may use different brand names for the same pesticide active ingredient. Most companies register each brand name as a trademark and will not allow any other company to use that name. The brand or trade name is the one used in ads and by company salespersons. The brand name shows up plainly on the front panel of the label. Applicators must beware of choosing a pesticide product by brand name alone. Many companies use the same basic

name with only minor variations to designate entirely different pesticide products. For example:

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

### Ingredient Statement

Each pesticide label must list what is in the product. The list is written so you can quickly see what the active ingredients are and the amount (in percentage) of each ingredient listed. The ingredient statement must list the official chemical names and/or common names for the active ingredients. Inert ingredients need not be named, but the label must show what percent of the total contents they comprise.

### Chemical Name

The chemical name is a complex name which identifies the chemical components and structure of the pesticide. This name is almost always listed in the ingredient statement on the label. For example, the chemical name of atrazine is 2-chloro-4-ethylamino-6-isopropylamino-1,3,5-triazine.

### Common Name

Because pesticides have complex chemical names, many are given a shorter "common" name. Only common names which are officially accepted by the U. S. Environmental Protection Agency may be used in the ingredient statement on the pesticide label. The official common name may be followed by the chemical name in the list of active ingredients. For example, a label with the brand name Sevin 50% WP would read:

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

By purchasing pesticides according to the common or chemical names, you will always be certain of getting the right active ingredient.

### Type of Pesticide

The type of pesticide usually is listed on the front panel of the pesticide

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# Labels and Labeling

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label. This short statement usually indicates in general terms what the product will control. Examples:

- insecticide for control of certain insects on fruits, nuts, and ornamentals,
- soil fungicide,
- herbicide for the control of trees, brush, and weeds,
- algicide.

## Net Contents

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

## Name and Address of Manufacturer

The law requires the maker or distributor of a product to put the name and address of the company on the label. This is so you will know who made or sold the product.

## Registration and Establishment Numbers

These numbers are needed by the pesticide applicator in case of accidental poisoning, claims of misuse, or liability claims. They are also used by regulatory agencies in cases of misbranding, adulterated products and other regulatory actions.

### Registration Numbers

An EPA registration number must appear on pesticide labels (for example, EPA Reg. No. 3120-280). This indicates that the pesticide label has been approved by the federal government. In cases of special local needs, pesticide products may be approved by a state. These registrations are designated, for example, as EPA SLN No. KS-960001. In this case, SLN indicates "special local need" and KS means that the product is registered for use in Kansas.

### Establishment Numbers

The establishment number (for example, EPA Est: No. 5840-AZ-1) appears on either the pesticide label or

container. It identifies the facility that produced the product. In case something goes wrong, the facility that made the product can be traced.

## Signal Words and Symbols

Every label contains a signal word giving you a clue to how dangerous the product is to humans. Knowing the product's hazard helps you choose the proper precautionary measures for yourself, your workers, and other persons (or animals) which may be exposed.

The signal word must appear in large letters on the front panel of the pesticide label. It immediately follows the statement, "Keep Out of Reach of Children," which must appear on every pesticide label.

**DANGER**—This word signals you that the pesticide is highly toxic. A taste to a teaspoon taken by mouth could kill an average-sized adult. Any product which is highly toxic orally, dermally, or through inhalation or causes severe eye and skin burning will be labeled "DANGER."

All pesticides which are highly toxic orally, dermally, or through inhalation will also carry the word **POISON** printed in red and the skull and crossbones symbol.

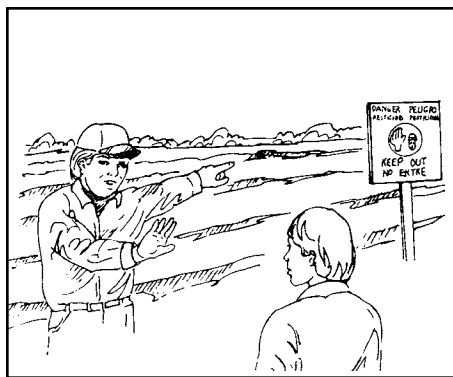
**WARNING**—This word signals you that the product is moderately toxic. As little as a teaspoon to a tablespoon by mouth could kill the average-sized adult. Any product which is moderately toxic orally, dermally, or through inhalation or causes moderate eye and skin irritation will be labeled **WARNING**.

**CAUTION**—This word signals you that the product is slightly toxic. An ounce to more than a pint taken by mouth could kill the average adult. Any product which is slightly toxic orally, dermally, or through inhalation or causes slight eye and skin irritation will be labeled **CAUTION**.

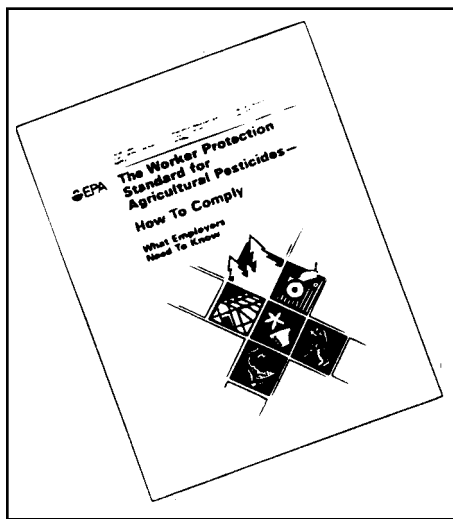
## Worker Protection Standard

The U.S. Environmental Protection Agency's Worker Protection Standard (as revised in 1992) must be complied with when pesticide products are used on agricultural establish-

# Labels and Labeling



Field Warning Sign



How to Comply

ments (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 decontamination 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 and/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 few very limited circumstances permitted by the WPS).

- Protecting pesticide handlers by giving them safety instruction 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 Standard 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 Services, pesticide dealers, the Government Printing Office, and other commercial sources.

## Precautionary Statements

All pesticide labels contain additional statements to help you decide the proper precautions to take to protect yourself, your helpers, and other persons (or domestic animals) which may be exposed. Sometimes these statements are listed under the heading, “Hazards to Humans and Domestic Animals.” They are composed of several sections.

## Route of Entry Statements

The statements which immediately follow the signal word, either on the front or side of the pesticide label, indicate which route or routes of entry (mouth, skin, lungs) you must particularly protect. Many pesticide products are hazardous by more than one route, so study these statements carefully. A “Danger” signal word followed by “May be fatal if swallowed or inhaled” gives you a far different warning than, “Danger: Corrosive—Causes eye damage and severe skin burns.”

Typical DANGER label statements include:

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# Labels and Labeling

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- Fatal if swallowed,
- Poisonous if inhaled,
- Extremely hazardous by skin contact—rapidly absorbed through skin,
- Corrosive—causes eye damage and severe skin burns.

These statements are not uniform on all labels, so many variations may be found. More than one or even all four precautions may be stated on the same label.

Typical WARNING label statements include:

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

Statements on a WARNING label may be exactly like those found on a DANGER label or a CAUTION label. Or they may be a combination of the two; for example, “harmful or fatal.” Many WARNING label precautionary statements simply drop the words “may” or “may be” from the caution statements. This leaves a stronger signal, which is in keeping with the moderate toxicity of products possessing a WARNING label.

Typical CAUTION label statements include:

- Harmful if swallowed,
- May be harmful if absorbed through the skin,
- May be harmful if inhaled,
- May irritate eyes, nose, throat, and skin.

These statements may vary considerably. They usually are more moderate than the statements found on a DANGER label, using “harmful” instead of “fatal” or “poisonous;” “irritant” instead of “corrosive;” and qualifying the warnings with “may” or “may be.” This is in keeping with the much lower toxicity of products possessing a CAUTION label.

## Specific Action Statements

These statements usually follow immediately after the route of entry statements. They recommend the specific action you should take to prevent poisoning accidents. These statements

are directly related to the toxicity of the pesticide product (signal word) and the route or routes of entry which must particularly be protected.

DANGER labels typically contain statements such as:

- Do not breathe vapors or spray mist,
- Do not get on skin or clothing,
- Do not get in eyes.

(You would not deliberately swallow the pesticide, so the “Do not swallow” statement is omitted.)

These statements correspond to the strongest statements in the “route of entry” section. For example, if the only reason a product has a DANGER label is because it can cause corrosive eye damage, the specific action statement might read: “Do not get in eyes. Avoid contact with skin and breathing vapors, dusts, or spray mists.” Most DANGER label products, however, are highly toxic through most or all of the entry routes, so several “Do not” statements will appear.

Typical WARNING labels combine specific action statements from DANGER and CAUTION labels. Depending on which route or routes are most likely to cause poisoning, the label might list “do not get on skin or in eyes,” but “avoid breathing vapors and spray mist.” This indicates that poisoning by inhalation of the pesticide is less likely than receiving skin or eye injury.

CAUTION labels generally contain specific action statements which are much milder than those on the DANGER label:

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

These statements indicate that the toxicity hazard is not as great.

The specific action statements help you prevent pesticide poisoning by taking the necessary precautions and wearing the correct protective clothing and equipment.

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# Labels and Labeling

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## Protective Clothing and Equipment Statements

Pesticide labels that fall under the Worker Protection Standards have very specific statements regarding personal protective equipment. However, many other labels carry no statement at all. You should follow all advice on protective clothing or equipment which appears on the label. However, the lack of any statement or the mention of only one piece of equipment does not rule out the need for additional protection.

A label, for example, might carry the statements: "Causes skin and eye irritation. Do not get in eyes, on skin or clothing. Wear goggles while handling." Even though the label does not specifically require them, you should wear a long-sleeved shirt, long-legged trousers, and gloves. You should consider wearing rubberized or waterproof clothing if you will be in prolonged contact or wet by an overhead spray application.

Some pesticide labels fully describe appropriate protective clothing and equipment. A few list the kinds of respirators which should be worn when handling and applying the product. Others require the use of a respirator but do not specify type or model to be used.

## Other Precautionary Statements

Labels often list other precautions to take while handling the product. These are self-explanatory:

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

These statements represent actions which a competent applicator will always follow. The absence of any or all of them from the label DOES NOT indicate that they need not be performed.

## Statement of Practical Treatment

These statements tell you the first aid treatments recommended in case of poisoning. Typical statements include:

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

All DANGER labels and some WARNING and CAUTION labels contain a note to physicians describing the appropriate medical procedures for poisoning emergencies and may identify an antidote.

## Environmental Hazards

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

## Endangered Species

In order to protect specific endangered species from adverse effects of pesticides, many product labels will change. They will include a statement directing users to obtain and abide by a special bulletin which identifies specific geographical areas where the pesticide may NOT be used. These actions are required by the Endangered Species Act. EPA will make the Endangered Species Bulletins available to users through county Extension agents, pesticide dealers, and at other outlets.

The U.S. Fish and Wildlife Services (FWS) is the final authority for the interpretation of the Endangered Species Act, particularly for geographic areas where certain pesticides may be used with certain safeguards or are



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# Labels and Labeling

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prohibited. Implementation of the endangered species labeling project will be phased in over several years.

At the time this manual went to press, EPA was still developing the details of this program. Any bulletins appearing prior to reference on the label will contain voluntary provisions.

## Special Toxicity Statements

If a particular pesticide is especially hazardous to wildlife, that will be stated on the label. For example:

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

These statements alert you to the special hazards that the use of the product may pose. They should help you choose the safest product for a particular job and remind you to take extra precautions.

## General Environmental Statements

Some of these statements appear on nearly every pesticide label. They are reminders of common sense actions to follow to avoid contaminating the environment. The absence of any or all of these statements DOES NOT indicate that you do not have to take adequate precautions.

Sometimes these statements follow a "specific toxicity statement" and provide practical steps to avoid harm to wildlife. Examples of general environmental statements include:

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

## Physical or Chemical Hazards

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

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

NOTE: Hazard statements (hazards to humans and domestic animals, environmental hazards, and physical-chemical hazards) are not located in the same place on all pesticide labels. Some newer labels group them in a box under the headings listed above. Other labels may list them on the front panel beneath the signal word. Still other labels list the hazards in paragraph form somewhere else on the label under headings such as "Note" or "Important." You should search the label for statements which will help you apply the pesticide more safely and knowledgeably.

## Classification Statement

Every pesticide will sooner or later be classified by the U. S. Environmental Protection Agency as either "general" or "restricted."

Any pesticide product which has been restricted must carry this statement in a prominent place at the top of the front panel of the pesticide label:

### RESTRICTED USE PESTICIDE

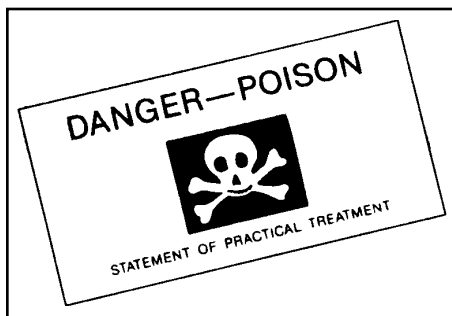
**For retail sale to and use only by certified applicators or persons under their direct supervision and only for those uses covered by the certified applicator's certification.**

NOTE: At this printing, EPA has not completed the classification of all pesticide products on the market. Therefore, the absence of a RESTRICTED USE statement does not necessarily indicate that the product has a low hazard level. Use the signal word and the precautionary statements to judge the toxicity hazard of all pesticide products.

## Reentry Statement

Some pesticide labels do not come under the Worker Protection Standards requirements (see above). This statement tells you how much time must pass before people can reenter

# Labels and Labeling



*Danger-Poison Symbol*

a treated area. These reentry intervals are set by both EPA and some states. Reentry intervals set by states are not always listed on the label; it is your responsibility to determine if one has been set. It is illegal to ignore reentry intervals.

The minimum legal protective clothing for reentry following agricultural and other outdoor treatments is:

- long-sleeved shirt,
- long-legged trousers or coveralls,
- hat,
- sturdy shoes with socks.

Gloves are suggested. For early reentry in enclosed areas, a respirator may be necessary.

The reentry statement may be printed in a box under the heading "Reentry" or it may be in a section with a title such as "Important," "Note," or "General Information."

If no reentry statement appears on the label or is set by your state, then you must wait at least until sprays are dried or dusts have settled before reentering or allowing others to reenter a treated area. That is the minimum reentry interval.

## Storage and Disposal

All pesticide labels contain general instructions for the appropriate storage and disposal of the pesticide and its container. State and local laws vary considerably, so specific instructions usually are not included. Typical statements include:

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

- Do not reuse bag. Burn or bury in a safe place.

One or more of these statements may appear on a pesticide label. You should try to determine the best storage and disposal procedures for your operation and location. These statements may appear in a special section of the label titled "Storage and Disposal" or under headings such as "Important," "Note," or "General Instructions."

## Bulk Storage

Bulk storage of pesticides is becoming a more common practice. There are special concerns with storing large volumes of pesticides in individual containers such as:

- fire and explosion hazards,
- spills-ruptured/leaking tanks,
- runoff environmental contamination,
- security.

The 1985 Kansas Legislature passed regulations to assure safe and proper bulk storage of pesticides. Following are some key points of the regulations.

- Controlled are facilities for storage of pesticides in non-mobile containers of undivided quantities greater than 50 gallons liquid or 100 pounds dry weight.
- Non-mobile bulk pesticide storage tanks must be equipped with an effective means of secondary containment.
- The capacity of the secondary containment must be at least 10 percent greater than the capacity of the largest tank within the secondary containment.
- Bulk pesticide storage facilities must be kept under lock and the power supply must have a master switch which is also kept under lock.
- Any facility constructed after May 1, 1985 must be in compliance with this law before it can be used.
- Additional storage, mixing/loading, and wash facility regulations have been proposed

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# Labels and Labeling

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by EPA. These new regulations may be enacted in the near future. For information on the status of regulations, contact the Plant Health Division, Kansas Department of Agriculture at 913-296-2263.

## Directions For Use

The instructions on how to use the pesticide are an important part of the label for you. This is the best way you can find out the right way to apply the product.

The use instructions will tell you:

- the pests which the manufacturer claims the product will control,
- the crop, animal, or site the product is intended to protect,
- in what form the product should be applied,
- how much to use,
- how often to apply,
- mixing directions,
- compatibility with other often-used products,
- phytotoxicity and other possible injury or staining problems,
- how the material works,
- where the material should be applied,
- when it should be applied,
- other special information.

Labels for agricultural pesticides often list the least number of days which must pass between the last pesticide application and harvest of crops, or slaughter, or grazing of livestock. These are intervals set by EPA to allow time for the pesticide to break down in the environment. This prevents illegal residues on food, feed, or animal products and possible poisoning of grazing animals. This information may appear as a chart or it may be listed after application directions for the target crop or animal.

## Label Terminology

Many terms are used on the label to describe when and how to use pesticides. They also are found in leaflets and bulletins that you may get from your local Cooperative Extension agent, land-grant university, or

other agencies. Your understanding of these terms will help you get the best results from pesticides.

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

**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 or pests have emerged.

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

**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, specific 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; also, the oral treatment of an animal with a liquid.

**Foliar**—application to the leaves of plants.

**In-furrow**—application to the furrow in which a plant is planted.

**Over-the-top**—application over the top of the growing crop.

**Pour-on**—pouring the pesticide along the mid-line 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 the pesticide with the soil.

**Soil injection**—application beneath the soil surface.

**Spot treatment**—application to a small area.

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# Labels and Labeling

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## Reading the Label

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

- whether it is the pesticide you need for the job,
- whether the pesticide can be used safely under the application conditions.

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

- what safety equipment is required for WPS,
- what protective equipment you should use,
- what the pesticide can be mixed with (compatibility),
- how much pesticide to use,
- the mixing procedure.

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

- what safety measures you should follow,
- where the pesticide can be used (livestock, crops, structures, etc.),

- when to apply the pesticide (including the waiting period for crops and animals),
- how to apply the pesticide,
- whether there are any restrictions for use of the pesticide.

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

- where and how to store the pesticide,
- how to decontaminate and dispose of the pesticide container,
- where to dispose of surplus pesticides.

## Pesticide Label Examples

Examples of three kinds of pesticide labels are shown on the following pages. These are:

- A herbicide label—Sinbar,
- An insecticide label—Capture: (Restricted label), and
- A fungicide label—Daconil Ultrex



# SINBAR®

## HERBICIDE

### WETTABLE POWDER

**ACTIVE INGREDIENT**

Terbacil [3-tert-butyl-5-chloro-6-methyluracil] ..... 80%

**INERT INGREDIENTS** ..... 20%

TOTAL ..... 100%

EPA Reg. No. 352-317

**KEEP OUT OF REACH OF CHILDREN****CAUTION****PRECAUTIONARY STATEMENTS****HAZARDS TO HUMANS AND DOMESTIC ANIMALS****CAUTION !** MAY IRRITATE EYES, NOSE, THROAT, AND SKIN.

Avoid breathing dust or spray mist. Avoid contact with skin, eyes, and clothing.

**STATEMENT OF PRACTICAL TREATMENT****If in eyes:** Flush with plenty of water; get medical attention if irritation persists.**If on skin:** Flush with plenty of soap and water.**For medical emergencies involving this product, call toll free 1-800-441-3637.****PERSONAL PROTECTIVE EQUIPMENT***Applicators and other handlers must wear:*

Long-sleeved shirt and long pants.

Waterproof gloves.

Shoes plus socks.

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

**USER SAFETY RECOMMENDATIONS****USERS SHOULD:** Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.**ENVIRONMENTAL HAZARDS**

Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters.

**IMPORTANT**

Injury to or loss of desirable trees or other plants may result from failure to observe the following:

Do not apply (except as recommended for crop use), or drain or flush equipment on or near desirable trees or other plants, or on areas where their roots may extend, or in locations where the chemical may be washed or moved into contact with their roots. Do not use on lawns, walks, driveways, tennis courts, or similar areas. Do not use in home planting of fruits, nuts or other crops nor in apple, peach or pecan orchards interplanted with other trees or desirable plants. Prevent drift of dry powder or spray to desirable plants. Do not contaminate any body of water. Keep from contact with fertilizers, insecticides, fungicides, and seeds. Thoroughly clean all traces of "Sinbar" from application equipment immediately after use. Flush tank, pump, hoses, and boom with several changes of water removing nozzle tips and screens (clean these parts separately).

**GENERAL INFORMATION**

Du Pont "Sinbar" Herbicide is a wettable powder to be mixed in water and applied as a spray for selective weed control in alfalfa, apples, peaches, blueberries, caneberries, mint, pecans and sugarcane. It is non-volatile, non-flammable, and non-corrosive to equipment.

"Sinbar" controls susceptible weeds for an extended period of time; the degree of control and duration of effect will vary with the amount of chemical applied, soil texture, rainfall and other conditions. Soils high in clay or organic matter require higher dosages

than soil low in clay or organic matter to obtain equivalent herbicide performance. Moisture is required to activate the chemical; best results occur if rainfall (or sprinkler irrigation) occurs within 2 weeks of application.

Observe all cautions and limitations on labeling of all products used in mixtures.

## DIRECTIONS FOR USE

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

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

### **AGRICULTURAL USE REQUIREMENTS**

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 12 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls.
- Waterproof gloves.
- Shoes plus socks.

Du Pont "Sinbar" Herbicide should be used only in accordance with recommendations on this label, or in separate published Du Pont recommendations available through local dealers.

Du Pont will not be responsible for losses or damages resulting from use of this product in any manner not specifically recommended by Du Pont. User assumes all risk associated with such non-recommended use.

Do not use in Kern County, California.

## SELECTIVE USE IN CROPS

### **WEED CONTROL**

Best results are obtained if application is made shortly before or shortly after weed growth begins; if dense growth is present, remove tops and spray the ground. Control of perennial grasses may be improved by cultivation prior to treatment; otherwise, avoid working the soil as long as weed control continues or else effectiveness of the treatment may be reduced. For alfalfa, the soil should not be disturbed. See "Crops" section for recommended use rates for specific crops.

"Sinbar", at rates of 1/2 to 1 1/2 lbs. per acre (alfalfa), controls annual weeds including species of chickweed, henbit, lambsquarters, mustard, tansymustard, crabgrass, and foxtail, and such weeds as downy brome (cheatgrass), marehail, peppergrass, prickly lettuce, shepherdspurse, snowed, ryegrass, wild barley, and yellow rocket. Treatment will not control established perennial bindweeds, johnsongrass and Canada thistle.

Rates of 1 to 4 lbs. per acre control johnsongrass seedlings and annual weeds including species of chickweed, clover, crabgrass, crotalaria, seedling dandelion, fiddleneck, foxtail, henbit, knotweed, lambsquarters, mustard, nightshade, panicum, plantain, pigweed, purslane, ragweed, sandbur (sandspur), signalgrass (Brachiaria), smartweed, and wild geranium and such weeds as American burnweed (fireweed), Erechtites hieracifolia, barnyardgrass (watergrass), bluegrass (Poa annual), China lettuce, crowfootgrass, dogfennel, Flora's paintbrush, Florida pusley, guineagrass, horseweed, jimsonweed, junglerice, natalgrass, and orchardgrass. In addition, treatment usually provides partial control of species of groundsel, horsenettle, quackgrass, red sorrel, and yellow nutsedge.

Rates of 2 to 4 lbs. per acre (blueberries) control weeds including species of cinquefoil, hawkweed and such weeds as annual sedge, perennial ryegrass, quackgrass, redroot (Lachnanthes caroliniana), and red sorrel.

### **EQUIPMENT-- SPRAY VOLUMES AND PRESSURES**

Do not apply this product through any type of irrigation system.

Apply with a fixed-boom power sprayer properly calibrated to a constant speed and rate of delivery. Use sufficient water (minimum 20 gals. per acre) to provide thorough and uniform coverage of the ground. On alfalfa, mint and sugarcane, preemergence broadcast applications may be made by aircraft (5 to 10 gals. spray per acre).

Continuous agitation in the spray tank is required to keep the material in suspension. Avoid overlapping, and shut off spray booms while starting, turning, slowing or stopping, or injury to the crop may result.

### **SPRAY PREPARATION**

Mix proper amount of "Sinbar" into necessary volume of water.

### **USE RATES**

All dosages of "Sinbar" are expressed as broadcast rates; for band treatment, use proportionately less. Where a range of dosages is given, use the lower rate on coarse textured soils (low in clay or organic matter) and the higher rate on fine textured soils (high in clay or organic matter).

### **SOIL LIMITATIONS**

Crop injury may result from failure to observe the following: Unless otherwise directed, do not use on sand, loamy sand or gravelly soils, nor on soils low in organic matter (less than 1%).

### **REPLANTING**

Unless otherwise directed, do not replant treated areas to any crop within 2 years after last application as injury to subsequent crops may result.

## CROPS

### ALFALFA

Treat only stands established for 1 year or more. Do not use on alfalfa-grass mixtures or other mixed stands. Do not use with surfactants.

Do not apply on snow covered or frozen ground, as injury to the crop or poor weed control may result.

#### U.S. (EXCEPT NORTHEAST)

Make a single application of 1/2 to 1 1/2 lbs. per acre in the fall after plants become dormant or in the spring before new growth starts. For semi-dormant and non-dormant varieties, apply in fall or winter after last cutting or in the spring before new growth starts. Apply before or after emergence of weeds but before they are 2" tall or across.

Do not apply to established stands after new growth starts in the spring, as injury to the crop may result. Do not use in California south of Interstate 80.

#### NORTHEAST

Apply "Sinbar" at the rate of 3/4 to 1 1/2 lbs per acre (ground application only) to alfalfa that is dormant (fall through winter) or in the spring before initial new growth exceeds 2 inches in height or to stubble after cutting, following hay removal and before regrowth exceeds 2 inches in height. Two applications may be made per crop year, but should be at least 60 days apart and should not exceed a total of 2 1/4 pounds.

For winter annual weeds and early germinating summer annuals, applications of "Sinbar" during dormancy or before new spring growth exceeds 2 inches in height provides the best results. Late germinating annual grasses and broadleaf weeds are best controlled with an after cutting treatment. Where an early application is made for control of winter annual weeds and early germinating summer annuals but where late germinating grasses and broadleaves are expected to be a problem, a second application (after cutting) may be applied for improved results.

Temporary yellowing may occur when applications are made to new alfalfa growth.

### APPLES, PEACHES

Use "Sinbar" alone, or apply as a tank mixture with Du Pont "Karmex" DF Herbicide. Make a single band or broadcast application as a directed spray; avoid contact of foliage and fruit with spray or mist. Apply either in the spring or after harvest in the fall before weeds emerge or during early seedling stage of weed growth. Where complete weed control to harvest is desired, additional weed control measures may be required during the growing season.

Where crop is grown under furrow irrigation or under raised-berm flood irrigation (trees 4" to 6" above waterline), apply only as a band treatment. Do not treat trees planted in the bottom of irrigation furrows or trees grown under flat flood or basin irrigation, and do not use on eroded areas where subsoil or tree roots are exposed, as injury to trees may result. Do not graze or feed forage from treated areas to livestock.

"Sinbar" Alone--Use only under trees established in the orchard for at least 3 years.

#### Lbs. "Sinbar" Per Acre

Soil Texture	1 to 2%	More Than 2%
Description	Organic Matter	Organic Matter
Sandy loam	2	3
Loam, silt loam, silt	2 1/2	3 1/2
Clay loam, clay	3	4

"Sinbar" + "Karmex" DF-- Use only under trees established in the orchard for at least 2 years.

#### Lbs. "Sinbar" + "Karmex" DF Per Acre

Soil Texture	1 to 2%	More Than 2%
Description	Organic Matter	Organic Matter
Sandy loam	1 + 1	1 1/2 + 1 1/2
Loam, silt loam, silt	1 1/2 + 1 1/2	2 + 2
Clay loam, clay	2 + 2	2 + 2

### ASPARAGUS

**Direct Seeded**--Plant seed 1 1/2 inches deep in coarse soils and 1 inch deep in fine soils. During planting operation, spray activated charcoal (such as Aqua NuChar<sup>1</sup> or Gro-Safe<sup>2</sup>) as a 1 inch band on soil surface directly over rows at a rate of 300 lbs. per acre (broadcast basis equivalent to 15 lbs. per acre where row spacing is 20 inches). Follow with "Sinbar" as a single spray at 1 to 2 lbs. per acre. Use the lower rate on coarser soils and the higher rate on finer soils.

**Established Beds**--Apply 1 1/2 to 3 lbs. "Sinbar" per acre prior to spear emergence. Application may be made immediately after clean cutting. Use the lower rate on coarser soils and the higher rate on finer soils. Do not apply more than 3 lbs. per acre.

Apply before weeds emerge or to small weeds (1/2 to 2 inches tall or across).

High organic soils absorb "Sinbar" so that it is substantially inactivated as a soil residual herbicide. On these soils, weed control is provided by postemergence foliar uptake only. Apply up to 3 lbs. "Sinbar" per acre and a maximum of 2 applications per year.

**Note:** Do not use on areas where subsoil or roots are exposed. Do not use on plants that are diseased or lacking in vigor, as injury to the crop may result. Do not harvest within 5 days after application. Treated areas may be planted to asparagus one year after application. Otherwise, do not replant to any other crop within two years after last application.

<sup>1</sup> Aqua NuChar - Registered trademark of Westvaco Corp.

<sup>2</sup> Gro-Safe - Registered trademark of ICI Americas, Inc.

### BLUEBERRIES

Treat only plantings established for 1 year or more. Make a single band or broadcast application to ground beneath bushes; avoid contact of foliage and fruit with spray or mist. Apply either in the spring or after harvest in the fall before weeds emerge or during early seeding stage of weed growth. Do not use on eroded areas where subsoil or roots are

exposed, nor on plants that are diseased or lacking in vigor, as injury to the plants may result. Treated areas may be planted to blueberries one year after last application.

U.S.

**Lbs. "Sinbar" in Min. 25 Gals. Water Per Acre**

<b>Soil Texture</b>	<b>1 to 3%</b>	<b>More Than 3%</b>
	<b>Organic Matter</b>	<b>Organic Matter</b>
Sand, Loamy		
Sand	Do not use	2
Sandy Loam, Loam,		
Silt Loam,	2	3
Silt, Sandy Clay,		
Sandy Clay Loam,		
Silty Clay, Silty	3	4
Clay Loam, Clay,		
Clay Loam	4	4

### MAINE, MARYLAND, NEW JERSEY

Apply as directed above, or, for broader spectrum weed control apply as a tank mix with "Karmex" DF:

**Lbs. "Sinbar" + "Karmex" DF Per Acre**

<b>Soil Texture</b>	<b>1 to 3%</b>	<b>More Than 3%</b>
	<b>Organic Matter</b>	<b>Organic Matter</b>
Sand, Loamy Sand	Do Not Use	2 + 2
Sandy Loam	2 + 2	2-1/2 + 2
Loam, Silt Loam,		
Silt, Sandy Clay,	2-1/2 + 2	3 + 2
Sandy Clay Loam		
Silty Clay,		
Silty Clay Loam,	3 + 2	3 + 2
Clay, Clay Loam		

Do not replant areas treated with "Sinbar" + "Karmex" DF to crops other than blueberries within two years after application, as injury to those crops may result.

### CANE BERRIES

**(Blackberries, Boysenberries, Dewberries, Loganberries, Raspberries, Youngberries)**--Treat only plantings established for 1 year or more. Make a single band or broadcast application of 1 to 2 lbs. per acre in a minimum of 20 gals. of water to the soil beneath the canes in the fall or early spring before fruitset and before weeds emerge or during the early stage or weed growth. Do not spray foliage nor use on eroded areas where subsoil or roots are exposed, nor apply to plants that are diseased or lacking vigor as injury to the plant may result. Treated areas may be planted to mint, alfalfa, blueberries, apples or peaches 1 year after last treatment. Do not replant to other crops within 2 years of last application. Do not apply within 70 days before harvest.

### MINT (Peppermint, Spearmint)

**Preemergence Application:** Make a single broadcast application of 1 to 2 lbs. per acre before mint emerges.

**Midwest:** Apply in the spring just after the last cultivation.

### Pacific Northwest:

**West of Cascade Mountains**--Apply in spring or fall after last cultivation.

**East of Cascade Mountains**--Apply any time after the first settling rain in the fall, but not when ground is frozen. If moisture is inadequate to activate the chemical, irrigation by sprinkler must follow fall or winter treatment as soon as soil thaws in the spring (or promptly after spring treatment) or poor weed control may result.

**Weeds Controlled in Mint (Pacific Northwest):** Weeds controlled by "Sinbar" at 1 to 2 lbs per acre in the Pacific Northwest are dogfennel, nightshade, henbit, chickweed, tansy-mustard, annual pepperweed, shepherds purse, mustard (Jim Hill) and filaree. Weeds partially controlled or suppressed by "Sinbar" are Russian thistle, nutsedge, annual bluegrass, barnyardgrass, knotweed, vetch, lambsquarters, downy brome, quackgrass and false flax.

### Postemergence Application (Midwest and Pacific Northwest):

Apply 1 to 1-1/2 lbs. per acre before weeds are 2" tall (or across) and grasses are 1" tall (or across). Add 1/2 to 1 pt. surfactant to each 25 gals. of spray; non-phytotoxic superior-type spray oil may be substituted at the rate of 1 gal. per acre. If preemergence treatment has not been applied, a second post-emergence application may be made but do not exceed 2 lbs. total per acre per season. Do not apply within 60 days of harvest.

**Preemergence + Postemergence:** Apply as directed above. Do not apply more than 2 lbs. total per acre per season; do not apply within 60 days of harvest.

**Note:** For either newly planted roots or established mint, soil must be well prepared before preemergence application. Crop injury and/or poor weed control may result if application is made to ground which is cloddy or compacted, resulting in exposed or improperly covered roots. Do not apply to newly planted roots that are diseased or lacking in vigor, nor on thinly covered or exposed subsoil areas as injury to the crop may result. Use of insecticides in fields where "Sinbar" is applied may result in injury to the mint; observe use limitations on insecticide labels. Treated areas may be planted to mint one year after last application.

### PECANS

Use "Sinbar" alone, or apply as a tank mixture with Du Pont "Karmex" DF Herbicide. Use only under trees established in the grove for at least 1 year. Make a single band or broadcast application as a directed spray, using 30 gals. (min.) of water per acre. Avoid contact of foliage and nut with spray or mist. Apply in the spring before weeds emerge or during the early seedling stage of weed growth.

### Lbs. Product Per Acre

<b>Soil Texture</b>	<b>"Sinbar"</b>		<b>Tank Mixture</b>
	<b>Alone</b>	<b>-OR-</b>	<b>"Sinbar + "Karmex" DF</b>
Sandy loam	2		1 1/2 + 1 1/2
Loam, silt loam,			
silt	2 1/2		1 3/4 + 1 3/4
Clay loam, clay	3		2 + 2

Do not use on eroded areas where subsoil or roots are exposed, nor on trees that are diseased or lacking in vigor or on trees planted in irrigation furrows as injury to the trees may result. Do not graze or feed forage from treated areas to livestock.



## SUGARCANE

Because sugarcane varieties vary in their resistance to herbicides, determine tolerance to "Sinbar" prior to adoption as field practice to prevent possible crop injury. Do not use on varieties which are known to be susceptible to herbicide, such as 48-103 (Louisiana), 50-28 (Texas), 53-263 (Hawaii) or P.R. 1048 (Puerto Rico). Do not use where cane is grown on thinly covered sub-soils or rocky areas as injury to cane may result. Do not replant treated areas to any crop other than sugarcane or pineapple within 2 years after last application as injury to subsequent crops may result.

**Louisiana**--For best control of seedling johnsongrass; apply broadcast at 2 lbs. per acre in the fall after planting and before cane emerges; repeat application at same rate in the early spring before weeds emerge. Alternatively, for control of most seedling weeds in fall-planted or stubble cane not treated in the fall with "Sinbar", apply broadcast in the spring at 4 lbs. per acre. Use 1/3 of above broadcast rates when band-treating 1/3 of the area.

As a layby treatment immediately after last cultivation, apply 1/2 lb. per acre in a 30" band as a directed spray to row middles; do not apply over top of cane as injury to the crop may result.

**Texas**--Apply broadcast at 1 to 2 lbs. per acre in the fall to stubble cane or to plant cane before emergence; repeat application at same rate in early spring. Use 1/3 of above broadcast rates when band-treating 1/3 of the area.

**Hawaii**--Make a single preemergence broadcast application of 1 to 2 1/2 lbs. per acre on plant or ratoon cane before cane emerges. Longevity of control is enhanced if application is made during the relatively dry season (March through October).

**Puerto Rico**--Make a single preemergence broadcast application of 1 to 2-1/2 lbs. per acre on plant cane only.

### STORAGE AND DISPOSAL

**STORAGE:** Store product in original container only, away from other pesticides, fertilizer, food, or feed.

**PRODUCT DISPOSAL:** Do not contaminate water, food, or feed by storage or disposal. Wastes resulting from use of this product may be disposed of on site or at an approved waste disposal facility.

**CONTAINER DISPOSAL:** Completely empty bag into application equipment. Then dispose of empty bag in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

### NOTICE OF WARRANTY

Du Pont warrants that this product conforms to the chemical description on the label thereof and is reasonably fit for the purposes stated on such label only when used in accordance with the directions under normal use conditions. It is impossible to eliminate all risks inherently associated with the use of this product. Crop injury, ineffectiveness, or other unintended consequences may result because of such factors as weather conditions, presence of other materials, or the manner of use or application, all of which are beyond the control of Du Pont. In no case shall Du Pont be liable for consequential, special or indirect damages resulting from the use or handling of this product. All such risks shall be assumed by the buyer. DU PONT MAKES NO WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE NOR ANY OTHER EXPRESS OR IMPLIED WARRANTY EXCEPT AS STATED ABOVE.

**AG - 7691 9103 9/30/93**

**RESTRICTED USE PESTICIDE**

**Toxic to fish and aquatic organisms.**  
For retail sale to and use only by certified applicators, or persons under their direct supervision and only for the uses covered by the certified applicator's certification.



**2 EC  
Insecticide/Miticide**

EPA Reg. No. 279-3069

EPA Est. 279-

<b>Active Ingredient:</b>	<b>By Wt.</b>
Bifenthrin: (2 methyl[1,1'-biphenyl]-3-yl) methyl 3-(2-chloro-3,3,3-trifluoro-1-propenyl)- 2,2-dimethyl-cyclopropanecarboxylate* .....	<b>25.1%</b>
<b>Inert Ingredients:**</b> .....	<b>74.9%</b>
	<b>100.0%</b>

\*Cis isomers 97% minimum, trans isomers 3% maximum.  
\*\*Contains xylene range aromatic solvents.  
This product contains 2 pounds active ingredient per gallon.  
U.S. Patent No. 4,238,505

**KEEP OUT OF REACH OF CHILDREN  
WARNING  
AVISO**

This label must be in the possession of the user at the time of application.  
Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

See other panels for additional precautionary information.

FMC Corporation  
Agricultural Chemical Group  
Philadelphia PA 19103

**STATEMENT OF PRACTICAL TREATMENT**

**If swallowed:** Get medical attention. Call a Poison Control Center or physician promptly for advice. Describe Precautionary Statements and Note to Physician on the label. Do not induce vomiting unless advised by a physician or qualified medical advisor. Do not give anything by mouth to an unconscious person.

**If inhaled:** Remove victim to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. Get medical attention.

**If on Skin:** Wash with plenty of soap and water. Get medical attention.

**If in Eyes:** Flush with plenty of water. Call a physician if irritation persists.

**Note to Physician:**

Pesticide Hotline (800) 858-7378. This product is a pyrethroid. If large amounts have been ingested, the stomach and intestines should be evacuated. Treatment is symptomatic and supportive. Digestible fats, oils, or alcohol may increase absorption and so should be avoided.

**For Emergency Assistance Call (800) 331-3148.**

**PRECAUTIONARY STATEMENTS  
Hazards to Humans (and Domestic Animals)**

**Warning**

May be fatal if swallowed. Harmful if inhaled, or absorbed through skin. Causes moderate eye irritation. Avoid breathing vapor or spray mist. Avoid contact with skin, eyes 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 E on an EPA chemical resistance category selection chart.

**Handlers who may be exposed to the dilute through application or other tasks must wear:** long-sleeved shirt and long pants, chemical-resistant gloves, such as Barrier Laminate or Nitrile Rubber or Neoprene Rubber or Viton, and shoes plus socks.

**Handlers who may be exposed to the concentrate through mixing, loading, application or other tasks must wear:** long-sleeved shirt and long pants, chemical-resistant gloves, such as Barrier Laminate or Nitrile Rubber or Neoprene Rubber or Viton, shoes plus socks, and protective eyewear.

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

**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.

**Environmental Hazards**

This pesticide is extremely toxic to fish and aquatic invertebrates. Use with care when applying in areas adjacent to any body of water. Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not make applications when weather conditions favor drift from treated areas. Drift and runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. Do not contaminate water when disposing of equipment washwaters.

This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area.

The use of bifenthrin is prohibited in areas that may result in exposure of endangered species to bifenthrin. Prior to use in a particular county contact the local extension service for procedures and precautions to use to protect endangered species.

## Physical/Chemical Hazards

Do not use or store near heat or open flame.

## 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.

**Resistance.** Some insects are known to develop resistance to products used repeatedly for control. Because the development of resistance cannot be predicted, the use of this product should conform to resistance management strategies established for the use area. Consult your local or state agricultural authorities for details.

If resistance to this product develops in your area, this product, or other products with a similar mode of action, may not provide adequate control. If poor performance cannot be attributed to improper application or extreme weather conditions, a resistant strain of insect may be present. If you experience difficulty with control and resistance is a reasonable cause, immediately consult your local company representative or agricultural advisor for the best alternative method of control for your area.

## AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 12 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is: Coveralls, Chemical-resistant gloves, such as Barrier Laminate or Nitrile Rubber or Neoprene Rubber or Viton, and Shoes plus socks.

## STORAGE AND DISPOSAL

### Pesticide Storage

Do not freeze. Do not store below 40° F. If crystals are observed, warm material to above 60° F by placing container in warm location. Shake or roll container periodically to redissolve solids.

Keep out of reach of children and animals. Store in original containers only. Store in a cool, dry place and avoid excess heat. Carefully open containers. After partial use, replace lids and close tightly. Do not put concentrate or dilute material into food or drink containers. Do not contaminate other pesticides, fertilizers, water, food, or feed by storage or disposal.

In case of spill, avoid contact, isolate area and keep out animals and unprotected persons. Confine spills. Call FMC: 1-(800)-331-3148.

To confine spill: If liquid, dike surrounding area or absorb with sand, cat litter or commercial clay. If dry material, cover to prevent dispersal. Place damaged package in a holding container. Identify contents.

### Pesticide Disposal

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

### Container Disposal

Metal or Plastic Container: 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. Do not cut or weld metal containers.

U-Turn® Container: Do not rinse container. Do not empty remaining formulated product. Do not break seals. Return intact to point of purchase.

## Chemigation Use Directions

Apply this product only through sprinkler including center pivot, lateral move, end tow, side (wheel) roll, traveler, big gun, solid set, or hand move irrigation systems. Do not apply this product through any other type of irrigation system. Do not connect an irrigation system (including greenhouse systems) used for pesticide application to a public water system.

For LEPA irrigation a minimum of 0.5 inch of water per acre is recommended. Where non-emulsified oils are used as the diluent, 1 to 2 pints per acre is recommended.

Crop injury, lack of effectiveness, or illegal residues in the crop can result from non-uniform distribution of treated water. If you have questions about calibration, you should contact State Extension Service specialists, equipment manufacturers, or other experts. A person knowledgeable of the chemigation system and responsible for its operation, or under the supervision of the responsible person, shall shut the system down and make necessary adjustments should the need arise. Failure to cease application during a mechanical stoppage may result in undesirable residues to adjacent areas.

The system must contain a functional check valve, vacuum relief valve, and low pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.

The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.

The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.

The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.

The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.

Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock.

Do not apply when wind speed favors drift beyond the area intended for treatment.

Capture® 2 EC insecticide/miticide should be applied continuously for the duration of the water application. Capture 2 EC should be diluted in sufficient volume to ensure accurate application over the area to be treated. When using chemigation, a minimum of 0.5 inch per acre of irrigation water is recommended. Agitation generally is not required when a suitable diluent is used. A diluent test should be conducted to ensure that phase separation will not occur during dilution and application. Failure to achieve a uniform dilution throughout the time of application may result in undesirable residues or less than desirable control.

## Rotational Crops

Rotational crops may be planted no sooner than 30 days after last application. Straw may not be used for food or feed.

## Tank-Mixture

Capture 2 EC Insecticide/Miticide may be applied in tank mixtures with other products approved for use on Field Corn (Grain and Silage), Popcorn, and Field Corn Grown For Seed, but should not be applied in tank mixtures containing clay-based fungicides. Observe all restrictions and precautions which appear on the labels of these products. Test for compatibility of products before mixing.

## Application Instructions

Rate of application is variable according to pest pressure, timing of sprays, and field scouting. Use lower rates under light to moderate infestations; higher rates under heavy insect pressure and for mite control. Arid climates generally require higher rates.

# Field Corn (Grain and Silage), Popcorn, Field Corn Grown For Seed

For use in Colorado, Kansas, Nebraska, New Mexico, Oklahoma, and Texas

CROP	PEST	DOSAGE		REMARKS
		LB AI/A	FL OZ/A	
Corn	European Corn Borer Southwestern Corn Borer Western Bean Cutworm Corn Earworm Corn Rootworm Adults Banks Grass Mite Twospotted Spider Mite Carmine Mite	0.08-0.10	5.1-6.4	<p><b>General:</b> Apply in a minimum of 2 gallons of finished spray per acre by aircraft or in a minimum of 10 gallons per acre with ground equipment. When applying by air, 1-2 quarts of emulsified oil may be substituted for 1-2 quarts of water in the finished spray. Thorough coverage is essential to achieve control.</p> <p><b>To control ear-attacking pests:</b> Apply Capture 2 EC just before silking and repeat as necessary to maintain control. Do not apply more than 0.2 lb ai/A after ear formation.</p> <p><b>Southwestern Corn Borer, European Corn Borer:</b> Make 2 applications for corn borer control with the initial application at or shortly before egg hatch.</p> <p><b>For control of other insect pests:</b> Apply when pests first appear and repeat as necessary.</p> <p><b>For mite control in Kansas, Colorado and Nebraska:</b> Apply for Banks Grass Mite when leaves on the lower one-third of the plant are starting to yellow from mite damage and colonies are becoming established on ear zone leaves. Apply for Twospotted Spider Mite control when colonies first form, before a heavy widespread mite infestation exists. Apply in a minimum of 2 gallons of finished spray per acre by aircraft or in a minimum of 10 gallons per acre with ground equipment. When applying by air, 1 quart of emulsified oil may be substituted for 1 quart of water in the finished spray. Thorough coverage is essential to achieve control. Chemigation not recommended in the states of Kansas and Nebraska.</p> <p><b>For mite control in Texas, New Mexico, and Oklahoma Use of Capture 2 EC on corn is prohibited in all coastal counties of Texas:</b> Early Management/Low Population Level: Apply for Banks Grass Mite control in Eastern New Mexico, Western Oklahoma, and the Texas High/South Plains when colonies first form prior to leaf damage or discoloration and before dispersal above the bottom third of the plant.</p> <p>In South Texas, for Banks Grass Mite, Twospotted Spider Mite, and Carmine Mite control: Apply when colonies first form prior to leaf damage or discoloration and before widespread mite dispersal throughout the canopy.</p> <p>Repeat as necessary to maintain control. For mid to late season infestations, higher rates and shorter application intervals will be necessary for heavier initial populations and corn under heat or drought stress.</p> <p>Apply in a minimum of 5 gallons of finished spray per acre by aircraft or in a minimum of 10 gallons per acre with ground equipment. When applying by air, 2 quarts of emulsified vegetable or petroleum oil should be substituted for 2 quarts of water in the finished spray. When applying by ground, 1 to 2 quarts of emulsified oil should be substituted for 1 to 2 quarts of water in the finished spray. Thorough coverage is essential to achieve optimum initial and residual control.</p>

Do not apply more than 0.2 pound active per acre per season.  
Do not apply within 30 days of harvest.

Do not graze livestock in treated areas or cut treated crops for feed within 30 days of the last application.

### Spray Drift Precautions—Corn

All aerial and ground application equipment must be properly maintained and calibrated using appropriate carriers.

OBSERVE THE FOLLOWING PRECAUTIONS WHEN SPRAYING IN THE VICINITY OF AQUATIC AREAS SUCH AS LAKES; RESERVOIRS; RIVERS; PERMANENT STREAMS, MARSHES OR NATURAL PONDS; ESTUARIES AND COMMERCIAL FISH FARM PONDS.

Do not apply by ground equipment within 25 feet, or by air within 150 feet of lakes; reservoirs, rivers, permanent streams, marshes or natural ponds, estuaries, and commercial fish farm ponds.

Use of ultra low volume (ULV) application on corn is prohibited.

Do not make aerial or ground applications during temperature inversions or if heavy rainfall is imminent. Inversions are characterized by stable air and increasing temperatures with height above the ground. Mist or fog may indicate the presence of an inversion in humid areas. The applicator may detect the presence of an inversion by producing smoke and observing a smoke layer near the ground surface.

Make aerial or ground applications when the wind velocity favors on target product deposition (approximately 3 to 10 mph). Do not apply when wind velocity exceeds 15 mph. Avoid applications when wind gusts approach 15 mph. Inclusion of a compatible drift reducing agent is encouraged.

For aerial applications, the spray boom should be mounted on the aircraft so as to minimize drift caused by wingtip or rotor vortices. The minimum practical boom length should be used and must not exceed 75% of wing span or rotor diameter.

Risk of exposure to sensitive aquatic areas can be reduced by avoiding applications when wind direction is toward the aquatic area.

Do not cultivate within 10' of the aquatic area so as to allow growth of a vegetative filter strip.

Use the largest droplet size consistent with good pest control. Formation of very small droplets may be minimized by appropriate nozzle selection, by orienting nozzles away from the air stream as much as possible. Do not apply at spray boom pressure greater than 45 p. s. i.

Spray should be released at the lowest height consistent with pest control and flight safety. Applications more than 10 feet above the crop canopy should be avoided.

Low humidity and high temperatures increase the evaporation rate of spray droplets and therefore the likelihood of increased spray drift to aquatic areas. Avoid spraying during conditions of low humidity and/or high temperature.

### Dealers Should Sell in Original Packages Only.

**Terms of Sale or Use:** On purchase of this product buyer and user agree to the following conditions:

**Warranty:** FMC makes no warranty, expressed or implied, concerning the use of this product other than indicated on the label. Except as so warranted, the product is sold as is. Buyer and user assume all risk of use and/or handling and/or storage of this material when such use and/or handling and/or storage is contrary to label instructions.

**Directions and Recommendations:** Follow directions carefully. Timing and method of application, weather and crop conditions, mixture with other chemicals not specifically recommended and other influencing factors in the use of this product are beyond the control of the seller and are assumed by the buyer at his own risk.

**Use of Product:** FMC's recommendations for the use of this product are based upon tests believed to be reliable. The use of this product being beyond the control of the manufacturer, no guarantee, expressed or implied, is made as to the effects of such or the results to be obtained if not used in accordance with directions or established safe practice.

**Damages:** Buyer's or user's exclusive remedy for damages for breach of warranty or negligence shall be limited to direct damages not exceeding the purchase price paid and shall not include incidental or consequential damages.

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**Net Contents:**

**SPECIMEN LABEL**

**ISK**BIOSCIENCES™

**Daconil Ultrex™**

 **Turf Care®**  
**Turf and Ornamental Fungicide**  
(82% Water Dispersible Granules)

<b>Active Ingredient:</b> Chlorothalonil (tetrachloroisophthalonitrile) .....	82.5%
<b>Inert Ingredients:</b> .....	17.5%
<b>Total:</b> .....	100.0%

**Keep Out of Reach of Children**  
**DANGER—PELIGRO**

See side panel for additional precautionary statements.

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

**ISK Biosciences Corporation**  
5966 Heisley Road  
P.O. Box 8000  
Mentor, Ohio 44061-8000

DACONIL ULTREX is a Trademark of  
ISK Biosciences Corporation.

TURF CARE is a Registered Trademark  
of ISK Biosciences Corporation.

EPA Reg. No. 50534-202  
EPA Est. No. 37429-GA-2

2425-1052-9157-9401

## Precautionary Statements

### Hazards to Humans and Domestic Animals

#### DANGER

Corrosive. Causes irreversible eye damage. Harmful if absorbed through skin. May be a potential skin sensitizer.

DO NOT get in eyes or on clothing. Harmful if inhaled. Avoid breathing dust or spray mist. Avoid prolonged contact with skin. Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals.

DO NOT take internally.

**Note to User:** This product may produce mild bronchial irritation and temporary irritation of the skin characterized by redness or rash on exposed skin areas. Affected persons should consult a physician.

#### FIRST AID:

**If swallowed:** Call a physician or Poison Control Center. Drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. DO NOT induce vomiting or give anything by mouth to an unconscious person.

**If in eyes:** Immediately flush eyes with plenty of water and continue for 15 minutes. Seek medical attention for eyes immediately.

**If inhaled:** Remove victim to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. Get medical attention.

**If on skin:** Wash with plenty of soap and water. Get medical attention.

**Note to physician:** Persons having temporary irritation may respond to treatment with antihistamines or steroid creams and/or systemic steroids.

#### Personal Protective Equipment (PPE):

WPS USES: Applicators and other handlers who handle this pesticide for any use covered by the Worker Protection Standard (40 CFR Part 170) – in general, agricultural-plant uses are covered – must wear: long-sleeved shirt and long pants, waterproof gloves, shoes plus socks, protective eye wear, and a dust/mist filtering respirator (MSHA/NIOSH approval number prefix TC-21C). For exposures in enclosed areas, applicators and other handlers must wear a respirator with either an organic vapor-removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval number prefix TC-23C), or a canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G).

NON-WPS USES: Applicators and other handlers who handle this pesticide for any use NOT covered by the Worker Protection Standard (40 CFR Part 170) – in general, only agricultural-plant uses are covered – must wear: long-sleeved shirt and long pants, waterproof gloves, shoes plus socks, and protective eyewear.

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

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

#### 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.

#### Environmental Hazards

This product is toxic to fish, aquatic invertebrates, and marine/estuarine organisms. Runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. DO NOT apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. DO NOT contaminate water when disposing of equipment washwaters. DO NOT apply when weather conditions favor drift from treated areas. Apply only to areas specified on label.

#### Directions for Use

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

DO NOT apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

#### AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. **The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.**

DO NOT enter or allow worker entry into treated areas during the restricted entry interval (REI) of **48 hours**.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is: coveralls, waterproof gloves, shoes plus socks, and protective eyewear.

DO NOT combine DACONIL ULTREX in the spray tank with pesticides, surfactants or fertilizers, unless your prior use has shown the combination physically compatible, effective and noninjurious under your conditions of use. DO NOT combine DACONIL ULTREX with Dipel 4L, Foil, Triton AG-98, Triton B-1956, Latron B-1956 or Latron AG-98 as phytotoxicity may result from the combination when applied to some species on this label.

Dipel is a registered trademark of Abbott Laboratories. Foil is a registered trademark of Ecogen Corporation. Triton AG-98, Triton B-1956, Latron B-1956 and Latron AG-98 are trademarks of Rohm and Haas Company.

The required amount of DACONIL ULTREX should be added slowly into the spray tank during filling. With concentrate sprays, pre-mix the required amount of DACONIL ULTREX in a clean container and add to the spray tank as it is being filled. Keep agitator running when filling spray tank and during spray operations.

#### Golf Course Fairways, Lawns & Other Turfgrasses:

Apply DACONIL ULTREX in 30 to 40 gallons of water per acre. Begin applications when conditions favor disease development and repeat applications as long as these conditions persist. Under severe disease conditions use the highest rate and shortest interval corresponding with the application schedule selected from the table below.

DO NOT mow or water after treatment until spray deposited on turfgrass is thoroughly dry; DACONIL ULTREX should always be used in conjunction with good turf management practices.

Diseases Controlled*	Interval of Application	Application Rate Per Acre
1. Dollar spot	7-10 days 14-21 days	2.5 to 5 lb 5 to 9.1 lb
2. Leaf spot, Melting-out, Brown blight	7-10 days 14-21 days	5 lb 5 to 9.1 lb
3. Brown patch	7-14 days	5 to 9.1 lb
4. Gray leaf spot	7-10 days	5 to 10 lb
5. Red thread	7-10 days	5 to 15 lb
6. Anthracnose	7-14 days	5 to 15 lb

a/ Low rate is not effective on intensively mowed turfgrasses such as golf course tees and greens.

#### Golf Course Tees, Greens and Ornamental Turfgrass:

Apply DACONIL ULTREX in an adequate amount of water to provide complete coverage. This amount may vary from 90 to 450 gallons per acre. See below for suggested rates and timing. Under severe disease conditions, use the high rate and apply on a 7 day schedule.

Diseases Controlled*	Interval of Application	Rate: Pounds Per Acre	
		Before Disease Occurs	After Disease Has Occurred
1. Dollar spot	7-14 days	5-10	10-20
2. Brown patch	7-14 days	5-10	10-20
3. Leaf spots, Melting-out	7-10 days	5-10	10-20
4. Gray leaf spot	7-10 days	5-10	10-20
5. Red thread	7-10 days	5-15	15-20
6. Anthracnose	7-14 days	7.5-15	–
7. Copper spot	7-10 days	10-15	15-20
8. Stem rust (bluegrass)	7-14 days	10-15	15-20
9. DICHONDRA Leaf spot (California only)	7-14 days	10-15	15-20

\*Diseases listed are caused by fungi, some of which are named as follows:

1. Dollar spot: *Sclerotinia homeocarpa*; *Lanzia* or *Moellerodiscus* spp.
2. Brown patch: *Rhizoctonia solani*, *R. zeae*, *R. cerealis*
3. Leaf spots, Melting-out, Brown blight: *Drechslera* spp. (including *D. poae*, *D. siccans*), *Bipolaris sorokiniana*, *Curvularia* spp.
4. Gray leaf spot: *Pyricularia grisea*, *P. oryzae*
5. Red thread: *Laetisaria fuciformis*
6. Anthracnose: *Colletotrichum graminicola*
7. Copper spot: *Gloeocercospora sorghi*
8. Stem rust: *Puccinia graminis*
9. Dichondra leaf spot: *Alternaria* spp.

Gray snow mold caused by *Typhula* spp. – Apply in sufficient water to obtain adequate coverage (90 to 450 gallons per acre). Apply 13.6 to 27.2 pounds of DACONIL ULTREX per acre of turf area. Application must be made before snow cover in autumn. Use the higher rate if turf layer remains frozen prior to snow cover. If snow cover is intermittent or lacking during the winter, re-apply DACONIL ULTREX at 13.6 pounds per acre at monthly intervals until gray snow mold conditions no longer prevail. In areas where pink snow mold (Geriachia or Fusarium patch) is likely to occur,

apply DACONIL ULTREX at 13.6 pounds per acre in combination with products containing either benomyl at 44 ounces active ingredient per acre, or iprodione at 88 ounces active ingredient per acre of turf area. Read and observe all label directions for products containing these active ingredients.

**Fusarium (Gerlachia) Patch:** For control of Fusarium patch only in areas where snow cover is intermittent or lacking during the winter, apply 13.6 to 24 pounds of DACONIL ULTREX per acre of turf area. Begin applications in late autumn and re-apply at 21 to 28 day intervals until conditions favorable for Fusarium patch no longer prevail.

**Algal Scum:** For prevention of algal scum on turfgrasses caused by cyanobacteria of the genus Lyngbia, apply DACONIL ULTREX at the rate of 5 to 10 pounds per acre on a 7 to 14 day schedule. Under severe scum conditions use the high rate and apply on a 7 day schedule. When algal scum is well established, every attempt should be made to dry out the afflicted area. Once dry, spiking or verticutting should be done to enhance turfgrass recovery in conjunction with DACONIL ULTREX applications at the rate of 10 to 20 pounds per acre on a 7 to 14 day schedule. Several applications of DACONIL ULTREX at the high rate may be necessary for turfgrass recovery. Only a preventive spray program with DACONIL ULTREX will prevent a recurrence of the algae when environmental conditions are favorable for algal growth.

### Ornamental Plants:

Apply DACONIL ULTREX at a rate of 1.4 pounds per 100 gallons of water unless other directions are given in the tables below. Apply in a spray to run-off, when conditions are favorable for disease development. Repeat applications at 7 to 14 day intervals until conditions are no longer favorable. During periods when conditions favor severe disease incidence, generally cloudy or wet weather, apply DACONIL ULTREX at 7 day intervals. DACONIL ULTREX should be applied to plants when both foliage and flowers are dry, or nearly dry.

DO NOT combine DACONIL ULTREX in the spray tank with pesticides, surfactants or fertilizers, unless your prior use has shown the combination to be physically compatible, effective and noninjurious under your conditions of use.

DACONIL ULTREX may be used in greenhouses. DO NOT use mistblowers or high pressure spray equipment when making applications of DACONIL ULTREX in greenhouses.

Use of DACONIL ULTREX is recommended for control of fungal diseases referred to by numbers in parentheses following each ornamental. Ornamentals listed on this label have been tested and found to tolerate applications of DACONIL ULTREX at the recommended rates. The user should test for possible phytotoxic responses, using recommended rates on ornamental plants on a small area prior to commercial use. Applications made during bloom may damage flowers and/or fruits.

**Fruits and other structures which may be borne on treated plants MUST NOT BE EATEN.**

## Ornamentals Recommended for Treatment With DACONIL ULTREX

### BROADLEAF SHRUBS AND TREES

Andromeda (Pieris) (4)	Holly (1)
Ash (Fraxinus) (1)	Lilac (5)
Aspen (1)	Magnolia (1)
Azalea (1.2.4)	Maple (1)
Buckeye, Horsechestnut (1)	Mountain Laurel (1)
Cherry-Laurel (1)	Oak (red group only) (1.7)
Crabapple (1.6.8)	Oregon-Grape (Mahonia) (6)
Dogwood (1)	Photinia (1)
Eucalyptus (3)	Poplar (1)
Euonymus (1)	Privet (Ligustrum) (1)
Firethorn (Pyracantha) (1)	Rhododendron (1.2.4)
Flowering Almond (1.2)	Sand Cherry (1.2)
Flowering Cherry (1.2)	Sequoia (1)
Flowering Peach (1.2)	Spiraea (1)
Flowering Plum (1.2)	Sycamore, Planetree (1)
Flowering Quince (1.2)	Viburnum (5)
Hawthorn (1.6)	Wainut (Juglans) (1)

### FLOWERING PLANTS\* and BULBS

Arabian Violet (2)	Iris (1.2)
Begonia (1)	Lily (1)
Camellia (2)	Marigold (1)
Carnation (1.2)	Narcissus (1)
Chrysanthemum (1.2)	Pansy (1)
Crocus (1)	Petunia (1.4)
Daffodil (1)	Phlox (1)
Daisy (1)	Poinsettia b/ (1)
Geranium (1.6)	Rose c/ (1)
Gladiolus (1.2)	Statice (1)
Hollyhock (6)	Tulip (1)
Hydrangea (foliage only) (1.6)	Zinnia (1.5)

a/ Avoid applications during bloom period on plants where flower injury is unacceptable.

b/ Discontinue applications prior to bract formation: phytotoxicity is possible on the bracts.

c/ Use 1 pound per 100 gallons of water.

### FOLIAGE PLANTS

Aglaonema (1)	Ming aralia (1)
Areca palm (1)	Oyster plant (Rhoeo) (1)
Artemesia (1)	Pachysandra (1)
Boston fern (1)	Parlor palm
Dumbcane (Dffenbachia) (1)	(Chamaedorea) (1)
Dracaena (1)	Peperomia (1)
Fatsia (Aralia) (1)	Philodendron (1.4)
Ficus (1)	Prayer plant (Maranta) (1)
Florida Ruffle Fern (1)	Syngonium (1)
Leatherleaf Fern (1)	Zebra plant (Aphelandra) (1)
Lipstick plant (1)	

d/ Use 2.5 pounds of DACONIL ULTREX per 100 gallons of water.

## Diseases Controlled with DACONIL ULTREX

### 1. Leafspots/Foliar Blights:

Actinopelte leafspot	Fabraea (Entomosporium) leafspot
Alternaria leafspot/ leaf blight	Fusarium leafspot
Anthrachnose	Gloeosporium black leafspot
Anthrachnose leaf blotch, spot	Ink spot (Drechslera)
Anthrachnose (Discula) blight	Marssonina leafspot
Ascochyta blight	Monilinia blossom blight, twig blight
Bipolaris (Helminthosporium) leafspot	Mycosphaerella ray blight
Botrytis leafspot, leaf blight	Myrothecium leafspot, brown rot
Cephalosporium leafspot	Nematostoma leaf blight
Cercospora leafspot	Phyllosticta leafspot
Cercosporidium leafspot	Ramularia leafspot
Corynespora leafspot	Rhizoctonia web blight
Coryneum blight (shothole)	Septoria leafspot
Curvularia leafspot	Sphaeropsis leafspot
Cylindrosporium leafspot	Stagonospora leaf scorch
Dactylaria leafspot	Tan leafspot (Curvularia)
Didymellina leafspot	Volutella leaf blight
Drechslera leafspot	

### 2. Flower spots/blights:

Botrytis flower spot, flower blight	Ovulinia flower blight
Curvularia flower spot	Rhizopus blossom blight
Monilinia blossom blight	Sclerotinia flower blight

### 3. Cylindrocadium stem canker

### 4. Phytophthora leaf blight, dieback

### 5. Powdery mildews:

Erysiphe cichoracearum	Microsphaera spp.
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### 6. Rusts:

Gymnosporangium spp.	Puccinia spp.
Pucciniastrum hydrangeae	

### 7. Taphrina blister

### 8. Scab (Venturia inaequalis)

The following ornamental plant species which have been tested with DACONIL ULTREX at recommended rates did not exhibit phytotoxicity:

Botanical Name	Common Name
Aechmea fasciata	Aechmea
Araucaria heterophylla	Norfolk Island Pine
Asplenium nidus	Birdnest Fern
Bougainvillea spp.	Bougainvillea
Caladium spp.	Caladium
Calathea makoyana	Peacock plant
Calistephus chinensis	Aster
Carissa grandiflora	Natal plum
Clerodendron thomsonae	Bleeding Heart
Codiaeum spp.	Croton
Cordylone terminalis	Ti Plant
Crassula argentea	Jade Plant
Cyrthodium falcatum	Holly Leaf Fern

Dironaea muscipula	Venus Fly Trap
Dizygotheca elegantissima	False Aralia
Epipremnum aureum	Golden Pothos, Scindapsus
Episcia cupreata	Flame Violet
Fittonia spp.	Silver-nerve Plant
Gerbera jamesonii	Gerbera Daisy
Gynura sarmentosa	Purple Passion Vine
Gypsophila paniculata	Baby's Breath
Hoya spp.	Wax Plant
Ilex cornuta	Chinese Holly
Ilex crenata	Japanese Holly
Impatiens spp.	Impatiens
Pilea cadierei	Aluminum Plant
Platynerium spp.	Staghorn Fern
Sansevieria trifasciata "Hahnii"	Birdsnest Sansevieria
Toimea menziesii	Piggy-back Plant
Yucca elephantipes	Spineless Yucca
Zygocactus truncatus	Christmas Cactus

**NOTE:** DO NOT apply DACONIL ULTREX to either green or variegated Pittosporum or to Schefflera, as multiple applications have been demonstrated to cause phytotoxic responses.

**Conifers:** Apply DACONIL ULTREX in sufficient water and with proper calibration to obtain uniform coverage of tree canopy. Application with ground equipment is preferable to aerial application because ground applications generally give better coverage of the tree canopy. If application with ground equipment is not feasible, DACONIL ULTREX may be applied with aircraft using at least 20 gallons per acre. When concentrate sprays are used or when treating non-bearing or immature trees, the lower rate of DACONIL ULTREX listed may be used. DO NOT allow livestock to graze in treated areas. The following spray volumes are recommended as gallons of spray per acre:

	Dilute	Concentrate
Forest stands	Not used	10 to 20 (aircraft)
Christmas trees	100	10 to 50 (aircraft or ground equipment)
Nursery beds	100	5 to 10 (ground equipment only)

Diseases Controlled	DACONIL ULTREX Rate Per		Application Directions
	Acre	100 GAL*	
Swiss needlecast	2.5 to 5.0 lb	2.5 to 5.0 lb	Single application technique. In Christmas tree plantations or forest stands make one application in the spring when new shoot growth is 1/2 to 2 inches in length.
Sclerotieris canker (pines), Swiss needlecast (Douglas-fir)	1.25 to 2.5 lb	1.25 to 2.5 lb	Make the first application in spring when new shoot growth is 1/2 to 2 inches in length. Make additional applications at 3 to 4 week intervals until conditions no longer favor disease development.
Sirococcus tip blight	1.8 to 3.2 lb	1.8 to 3.2 lb	For use in nursery beds, apply the highest rate specified on a 3 week schedule.
Rhizosphaera needlecast (spruces), Scirrhia brown spot (pines)	5.0 lb	5.0 lb	
Cyclaneusma and Lophodermium needlecasts (pines)	2.5 to 5.0 lb	2.5 to 5.0 lb	Apply in early spring prior to budbreak. Repeat applications at approximately 6 to 8 week intervals, until spore release ceases in late fall. Apply monthly during periods of frequent rainfall, and where Lophodermium infections occur during dormancy (Pacific Northwest). During drought periods, applications may be suspended, then resumed upon next occurrence of needle wetness.
Rhabdochline needlecast (Douglas-fir)	1.4 to 2.5 lb	1.4 to 2.5 lb	Apply at budbreak and repeat at 3 to 4 week intervals until needles are fully elongated and conditions no longer favor disease development. In plantations of mixed provenance, or when irregular budbreak occurs, apply weekly until all trees have broken bud, then every 3 to 4 weeks as specified above. In nursery beds, use the high rate on a 3 week schedule.
Botrytis seedling blight Phoma twig blight	1.4 to 2.5 lb	1.4 to 2.5 lb	Begin applications in nursery beds when seedlings are 4 inches tall and when cool, moist conditions favor disease development. Make additional applications at 7 to 14 day intervals as long as disease favorable conditions persist.

\*Volumetric rates to be used only with full dilute spray volume specified on this label.

## Application and Calibration Techniques for Sprinkler Irrigation

Apply this product only through center pivot, motorized lateral move, solid set or portable (wheel move, side roll, end tow, or hand move) irrigation system(s). DO NOT apply this product through any other type of irrigation system. DO NOT use DACONIL ULTREX through sprinkler irrigation equipment on golf courses.

Crop injury, lack of effectiveness, or illegal pesticide residues in the crop can result from non-uniform distribution of treated water.

If you have questions about calibration, you should contact State Extension Service specialists, equipment manufacturers or other experts.

DO NOT apply this product through irrigation systems connected to a public water system. 'Public water system' means a system for the provision to the public of piped water for human consumption if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days per year.

Controls for both irrigation water and pesticide injection systems must be functionally interlocked, so as to automatically terminate pesticide injection when the irrigation water pump motor stops. A person knowledgeable of the irrigation system and responsible for its operation shall be present so as to discontinue pesticide injection and make necessary adjustments, should the need arise.

The irrigation water pipeline must be fitted with a functional, automatic, quick-closing check valve to prevent the flow of treated irrigation water back toward the water source. The pipeline must also be fitted with a vacuum relief valve and low pressure drain, located between the irrigation water pump and the check valve, to prevent back-siphoning of treated irrigation water into the water source.

**Always inject DACONIL ULTREX into irrigation water after it discharges from the irrigation pump and after it passes through the check valve. Never inject pesticides into the intake line on the suction side of the pump.**

Pesticide injection equipment must be fitted with a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump. Interlock this valve to the power system, so as to prevent fluid from being withdrawn from the chemical supply tank when the irrigation system is either automatically or manually turned off.

The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump. The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.

Spray mixture in the chemical supply tank must be agitated at all times, otherwise settling and uneven application may occur. DO NOT apply when wind speed favors drift beyond the area intended for treatment.

Posting of areas to be chemigated is required when 1) any part of a treated area is within 300 feet of sensitive areas such as residential areas, labor camps, businesses, day care centers, hospitals, in-patient clinics, nursing homes or any public areas such as schools, parks, playgrounds, or other public facilities not including public roads, or 2) when the chemigated area is open to the public.

Posting must conform to the following requirements. Treated areas shall be posted with signs at all usual points of entry and along likely routes of approach from the listed sensitive areas. When there are no usual points of entry, signs must be posted in the corners of the treated areas and in any other location affording maximum visibility to sensitive areas. The printed side of the sign should face away from the treated area towards the sensitive area. The signs shall be printed in English. Signs must be posted prior to application and must remain posted until foliage has dried and soil surface water has disappeared. Signs may remain in place indefinitely as long as they are composed of materials to prevent deterioration and maintain legibility for the duration of the posting period.

All words shall consist of letters at least 2-1/2 inches tall, and all letters and the symbol shall be a color which sharply contrasts with their immediate background. At the top of the sign shall be the words KEEP OUT, followed by an octagonal stop sign symbol at least 8 inches in diameter containing the word STOP. Below the symbol shall be the words PESTICIDES IN IRRIGATION WATER.

This sign is in addition to any sign posted to comply with the Worker Protection Standard.

DACONIL ULTREX may be used through two basic types of sprinkler irrigation systems as outlined in Sections A and B below. Determine which type of system is in place, then refer to the appropriate directions provided for each type.

### A. Center Pivot, Motorized Lateral Move and Traveling Gun Irrigation Equipment

For injection of pesticides, these continuously moving systems must use a positive displacement injection pump, of either diaphragm or piston type, constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock and capable of injection at pressures approximately 2-3 times those encountered within the irrigation water line. Venturi applicator units cannot be used on these systems.

Thoroughly mix recommended amount of DACONIL ULTREX for acreage to be covered into same amount of water used during calibration and inject into system continuously for one revolution or run. Mixture in the chemical supply tank must be continuously agitated during the injection run. Shut off injection equipment after one revolution or run, but continue to operate irrigation system until DACONIL ULTREX has been cleared from last sprinkler head.

### B. Solid Set and Portable (Wheel Move, Side Roll, End Tow, or Hand Move) Irrigation Equipment

With stationary systems, an effectively designed in-line venturi applicator unit is preferred which is constructed of materials that are compatible with pesticides; however, a positive-displacement pump can also be used.

Determine acreage covered by sprinkler. Fill tank of injection equipment with water and adjust flow to use contents over a thirty to forty-five minute period. Mix desired amount of DACONIL ULTREX for acreage to be covered with water so that the total mixture of DACONIL ULTREX plus water in the injection tank is equal to the quantity of water used during calibration, and operate entire system at normal pressures recommended by the manufacturer of injection equipment used, for amount of time established during calibration. Agitation is recommended. DACONIL ULTREX can be injected at the beginning or end of the irrigation cycle or as a separate application. Stop injection equipment after treatment is completed and continue to operate irrigation system until DACONIL ULTREX has been cleared from last sprinkler head.

## Storage and Disposal

DO NOT contaminate water, food or feed by storage or disposal. Open dumping is prohibited.

**Storage:** Store in a dry place.

**Pesticide Disposal:** Pesticide wastes are toxic. Improper disposal of excess pesticide, pesticide spray or rinsate is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

**Container Disposal:** Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.



## Warranty and Limitation of Damages

Seller warrants to those persons lawfully acquiring title to this product that at the time of the first sale of this product by seller that this product conformed to its chemical description and was reasonably fit for the purposes stated on the label when used in accordance with Seller's directions under normal conditions of use and Buyers and users of this product assume the risk of any use contrary to such directions. SELLER MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY, INCLUDING ANY OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS OR OF MERCHANTABILITY, AND NO AGENT OF SELLER IS AUTHORIZED TO DO SO. In no event shall Seller's liability for any breach of warranty exceed the purchase price of the material as to which a claim is made.

Buyers and users of this product are responsible for all loss or damage from use or handling of this product which results from conditions beyond the control of Seller, including, but not limited to, incompatibility with other products unless otherwise expressly provided in the Directions for Use of this product, weather conditions, cultural practices, moisture conditions or other environmental conditions outside of the ranges that are generally recognized as being conducive to good agricultural and/or horticultural practices.

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# Labels and Labeling


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## Study Questions

1. (36) The ingredient statement on the label must list:
  - a) what the package is made out of
  - b) each active pesticide ingredient and its percentage
  - c) the percentage of the total that is made up by the inert ingredients
  - d) b and c above.
2. (37) An establishment number is needed:
  - a) so you will know where to order more product next year
  - b) in case something goes wrong, the facility which made it can be traced
  - c) to identify the truckers who haul the chemicals
  - d) so you can send any you do not use back to the company.
3. (38) Route of entry statements on the label refers to:
  - a) how the chemical was routed from the manufacturer to the dealer
  - b) the routes you must take when you take the product to the point of application
  - c) how the pesticide may enter your body (mouth, skin, lungs)
  - d) none of the above.
4. (39) Typical CAUTION label statements include:
  - a) harmful if swallowed
  - b) may be harmful if inhaled
  - c) may be harmful to eyes, nose, throat and skin
  - d) all the above.
5. (40) Statement of practical treatment:
  - a) tells you how to use the product
  - b) tells how roughly to handle the package
  - c) tells you the first aid treatments recommended in case of poisoning
  - d) all of the above.
6. (41) Every pesticide will eventually be classified:
  - a) as "general" or "restricted" use
  - b) as a herbicide
  - c) as safe or dangerous
  - d) for use in the home or use in the garden.
7. (42) Which of the following are special concerns with bulk storage of pesticides?
  - a) fire and explosion
  - b) spills—ruptured / leaking tanks
  - c) runoff and environmental contamination
  - d) all the above.
8. (43) How is the best way to find out how to apply a pesticide product correctly?
  - a) talk to a neighbor
  - b) talk to the manufacturer
  - c) talk to a Cooperative Extension Service person
  - d) read the label.



The environment is our surroundings and its many forms of life, water, air, soil, plants, and wildlife are important parts. Because pesticides can be pollutants, you must use them correctly to prevent harm to the environment. You should be aware of how pesticide contamination can affect our natural resources. By knowing and following good application practices, you can protect the environment and yourself and be a responsible pesticide applicator.

## Potential Hazards

When pesticides are used in a way other than as directed on the label, they can:

- injure nontarget plants and animals,
- leave harmful residues, and
- move from the application site into the surrounding environment,
- move into the groundwater and surface waters.

## Direct Kill of Nontarget Plants and Animals

Pesticides which are improperly applied can kill nontarget organisms. Drift from the target area may injure fish, birds, other wildlife, and sensitive plants. Drift of herbicides can damage nearby crops, forests, or landscape plantings. Poorly timed applications can kill bees and other pollinators which are working in the area. Or you may kill beneficial parasites and predators that help control pests.

Runoff from treated areas can kill fish and other aquatic animals and plants in nearby ponds, streams, and lakes. Aquatic life also can be killed by careless tank filling or draining and by rinsing or discarding used containers along or in waterways.

Pesticides can harm other wildlife, too. Even tiny amounts of pesticide may kill them or destroy their source of food. Pesticides applied over large areas, such as in mosquito, biting fly, and forestry pest control, must be chosen with great care to avoid poi-

soning nontarget plants and animals in the area.

Ask for help in choosing the safest pesticide for the job. Injury or death to nontarget plants and animals can lead to lawsuits, fines, and loss of your applicator certification.

## Long-Term Effects

Pesticides can be harmful in the environment even if they do not cause direct kills of nontarget plants and animals. Some pesticides can build up in the bodies of animals (including humans). These are called accumulative pesticides. The chemicals may be stored in an animal's body until they are harmful to it or to the meat-eater which feeds on it. Long-term effects may include eggs that will not hatch and young that will not develop normally. Most accumulative pesticides are chlorinated hydrocarbons and have had VERY limited uses in the United States for over the last 20 years.

Some pesticides stay in the environment without change for long periods of time. These are persistent pesticides. Persistent pesticides which are not stored by animal tissues are often harmless to the environment. They may stay on or in the soil and give long-term pest control without repeated applications. Sometimes, these pesticides injure sensitive plants planted in the treated soil.

Pesticides which break down quickly in the environment to form harmless materials are called nonpersistent. These pesticides are often broken down easily by microorganisms or sunlight. Most organophosphate and carbamate insecticides are nonpersistent.

## Pesticide Movement

Pesticides which move away from the target area are problems in the environment. Highly volatile pesticides such as 2,4-D esters can move great distances as invisible vapor in the air and injure nontarget plants. Dusts, aerosols, and fogs can easily drift away from the target area with air currents. Any application that

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# Protecting the Environment

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produces fine dust or spray particles may result in drift.

Pesticides move off target in other ways also. They may be carried off target by rain and runoff water. They may leach through the soil to areas nearby or to ground water below.

Whenever you are applying a pesticide, select the pesticide, the formulation, and the application equipment which will most likely result in an application which stays on target.

## Contamination of Soils

Pesticides which move off target onto soil or which persist in soil may limit the use of that soil. Agricultural, ornamental, turf, and forestry crops may be killed or contaminated if planted on the site. Residential, grazing, and recreational uses of the soil may be impossible if the soil contains pesticide residues. The pesticide label will list crop rotation limits and other growing restrictions.

## Contamination of Air

The movement of pesticides in the air cannot be controlled. The polluted air creates a hazard for people, animals, or plants that come into contact with it. Pesticides in the air may settle onto water, crops, livestock, trees, parks, or houses. Provide adequate spacing or a buffer zone when applying pesticides near sensitive areas. Keep in mind that the wind can carry pesticide particles or droplets many miles off target.

### Prevention of contamination of air within a structure

#### *Outside Applications*

1. Request the consumer to close all windows and shut off air conditioning when treating the yard or around the perimeter of the house.
2. Make sure applications do not enter air ducts or plenums.

#### *Inside Applications*

1. Be aware of how easily some pesticides move offsite in the air currents created by ventilation systems and by forced-air heating and cooling systems.

2. Apply pesticides close to the floor whenever possible to decrease the chances of drift in air currents.
3. Ventilate dwellings or animal structures after application even if there is no odor. Provide adequate ventilation for crawl spaces when applicable.

## Contamination of Surface Water

Water is necessary for all life. Humans and animals need clean water for drinking and bathing. Most fish and other aquatic animals and plants can survive only slight contamination of their water environment.

Farmers, ranchers, horticulturists, foresters, and turf growers need uncontaminated water for their livestock and for irrigation. Polluted water can injure the plants or animals directly or cause illegal residues in the food, feed, poultry, or livestock products.

Pesticides get into water in many ways. Sometimes they are applied directly to the water to control aquatic pests. Pesticide contamination of water occurs most often when pesticides reach the water through carelessness or misuse of pesticides.

## Contamination of Groundwater

Groundwater is by far the largest water resource in Kansas. Pumped from thousands of wells, it is used by virtually every person in Kansas every day. A few of the uses of groundwater include drinking, cooking, irrigation (including lawns), municipal, industrial, recreational (e.g. swimming pools) and many other uses.

In general, the sources of groundwater include water from rain (and other precipitation), lakes, streams, ponds, etc., which slowly leaches through the surface soil and accumulates in the underlying sand and gravel layers. Such layers may be only a few feet from the soil surface and others are several hundred feet below. These groundwater collection layers are called aquifers and can be thought of as underground lakes.

There are many potential sources of groundwater contamination. Some of these include industrial and municipal wastes, livestock and human waste septic systems, pesticide use, and various microbes. Fortunately, as the water slowly leaches through the soil, most (if not all) of these contaminants are removed through chemical and microbiological actions in the soil. However, aquifers which are only a few feet below the soil surface are being found contaminated with a variety of chemicals—including pesticides. Studies are presently intensifying to determine the extent of groundwater contamination.

Pesticides are essential chemical tools used in the production, transportation, and storage of food, feed, and fiber. They are also vital in pest control related to food preparation and serving, and in health and recreation related situations. It is extremely important that pesticide users recognize the importance of properly handling pesticides to avoid surface water and soil contamination with these chemicals.

## **Minimizing Groundwater Contamination**

Pesticide contamination of groundwater is a public concern. Contamination results from two types of sources—point and non-point.

### ***Point Source Contamination***

Point source contamination results from localized spills or accidents, which is to say, the contamination can be traced back to an identifiable area. Point source contamination accounts for large doses being introduced into groundwater and, as a result, poses the greatest risk of rendering the water unfit for drinking.

Spills and other mishaps which occur during the handling and mixing of pesticides are a major contributing factor. There are several steps we can take to minimize contamination.

Wells are a direct conduit to the groundwater and extra care should be taken at these sites when handling pesticides. In addition, many wells

are not adequately sealed which increases the risk of contamination in the event of a spill. Mix pesticides at least 200 feet from a well. Using a nurse-tank as a water source helps avoid these problems. Prevent back-siphoning into the well. Keep the end of the filler hose above the water level of the tank at all times. Anti-backflow devices for hoses can be purchased from irrigation and spray equipment suppliers. Clean up spills, especially near wells and other water supplies.

Additional practices which help prevent point source contamination include triple-rinsing and the proper disposal of pesticide containers and excess pesticides.

### ***Non-point Source Contamination***

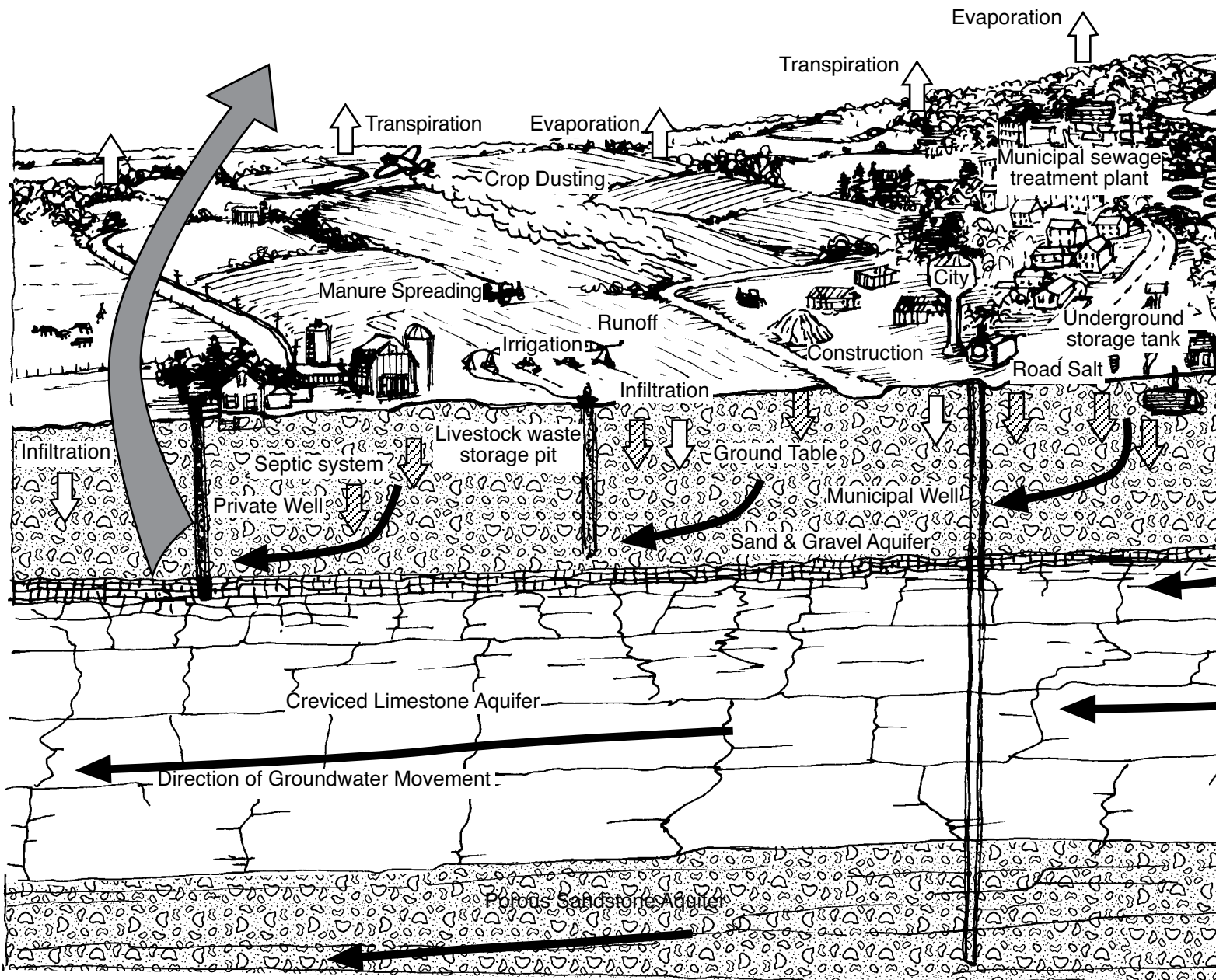
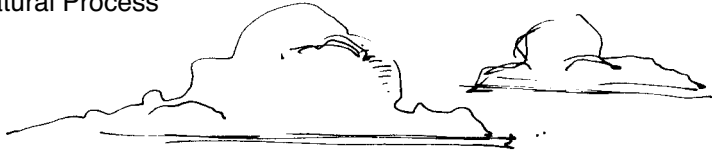
Contamination which occurs from non-point sources cannot be traced back to a specific location or event. Examples of non-point source contamination would include the leaching of pesticides through the normal course of pesticide use, or pesticides carried in surface runoff as a result of soil erosion. The extent of non-point source contamination is dependent upon pesticide (herbicide, insecticide, fungicide), soil type, geological factors, production management, and weather factors.

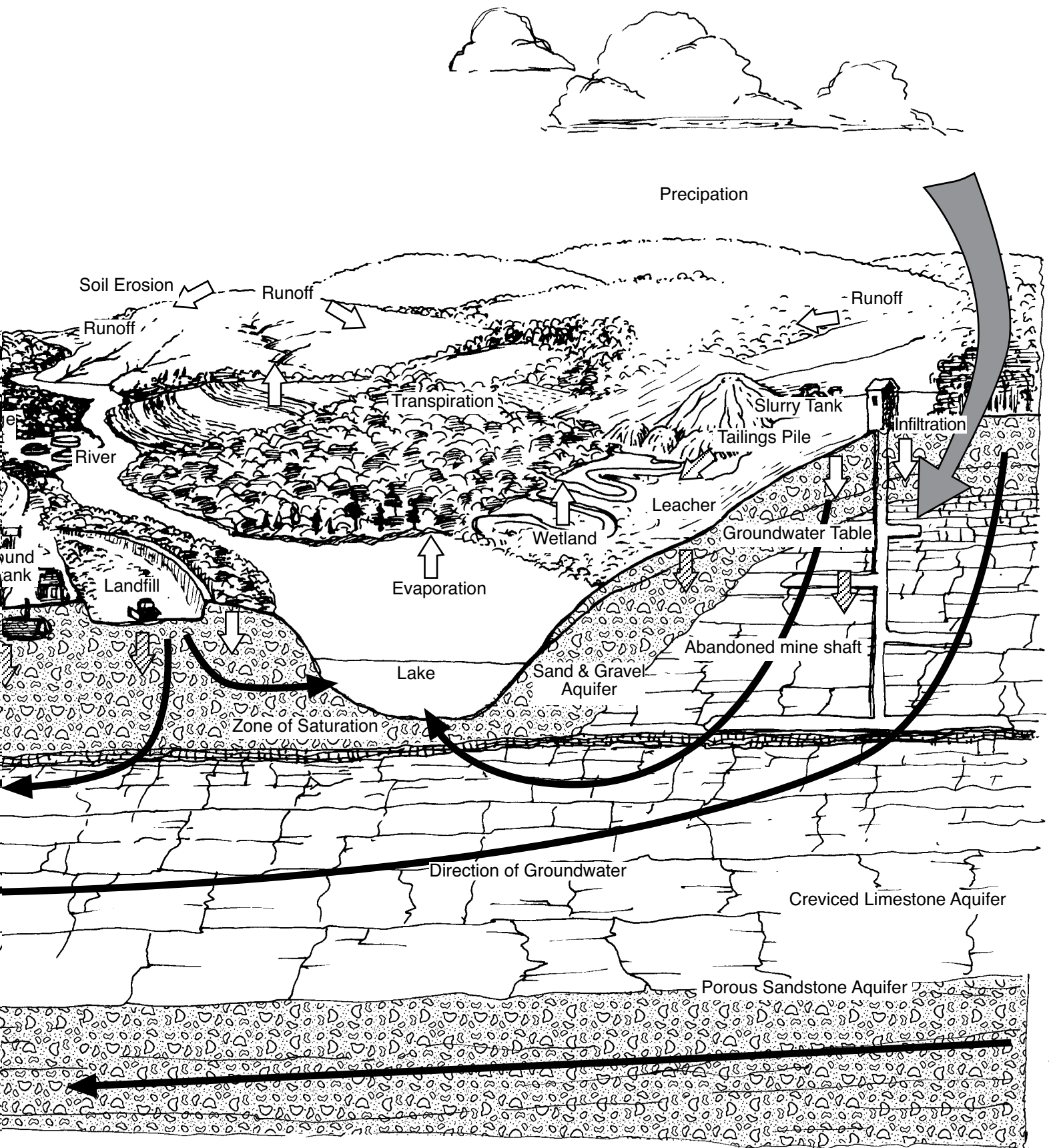
There are several practices which minimize non-point source contamination. Apply the proper amount of pesticide for the crop, pest and site. Read the label to determine what the minimum use rate is. Proper sprayer calibration assures application uniformity and more effective control. The amount of product can also be reduced by using band applications instead of broadcast treatments. These practices not only reduce the potential for groundwater contamination but also decrease the chance of crop injury, residual problems and make control more economical.

In choosing a herbicide, less mobile, short residual products are less likely to leach to the water table. Crop and herbicide rotation also reduces risk as a result of using different herbicides each year.

# Groundwater and Land Use in the Water Cycle

- ← Direction of Groundwater Movement
- ↓ Human Induced Impacts on Groundwater
- ↓ Natural Process





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# Protecting the Environment

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It is also helpful to identify high risk areas. The greatest risk for contamination exists where the groundwater table is close to the soil surface. In addition, herbicides are more likely to contaminate groundwater when applications are made to coarse textured soils low in organic matter. High pH soils also present concerns because some herbicides leach more readily under these conditions. Extra care should be taken when any of these situations exist.

## **Prevention of water contamination in wells, cisterns, and other water sources.**

When filling a tank with water be sure to keep the water pipe or hose above the level of the pesticide mixture. This prevents contamination of the hose and keeps pesticides from back-siphoning into the water source. You are required by the Kansas Department of Health and Environment (KDHE) to use an anti-back flow device when filling from a public water supply. This may be a fixed air gap or an anti-back flow device. Contact KDHE for a copy of the requirements and approved devices.

Avoid mixing, loading or storing pesticides in areas where a spill, leak or overflow could allow pesticide to get into water sources. Locate mix-load sites and equipment cleaning sites at least 200 feet from surface water or from direct links to groundwater. Use containment pads or install dikes or other barriers, or grade soil to divert any potential spills.

Locate pesticide storage facilities at least 100 feet from wells, springs, sinkholes, and other sites that directly link to groundwater to prevent their contamination from runoff or fire-fighting water.

## **Potential Benefits**

Pesticides can help the environment when they are used carefully and wisely. For years they have been used to control pests which are harmful to humans. With the help of pesticides, we produce food, feed, and fiber. Forests, ornamentals, buildings, and turfgrass plantings can be protected. Diseases, insects, and other plant pests can be greatly reduced. There can be higher yields and better crop quality using less land to produce more food products.

Pesticides can be used to enhance outdoor activities in parks and camping areas. Fly and mosquito control programs give relief from the annoying pests. Aquatic pest control programs help keep lakes and waterways usable for swimming, boating, and fishing.

Pesticides protect livestock and domestic animals from harmful and annoying pests. The quantity and quality of livestock products—milk, eggs, meat, wool, and leather—are improved when pests are controlled.

Herbicides help keep rights-of-way clear of weeds. Highways, runways, train tracks, and utility rights-of-way must be weed-free to allow safe, unobstructed traffic flow. Barnyards, warehouses, utility lines, and other similar areas are safer when herbicides are used to keep weeds out.

By selecting pesticides wisely and applying them correctly, the responsible pesticide applicator can use these chemicals for the benefit of the environment.



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# Protecting the Environment

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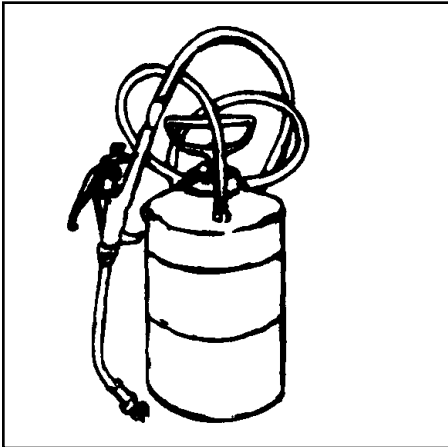
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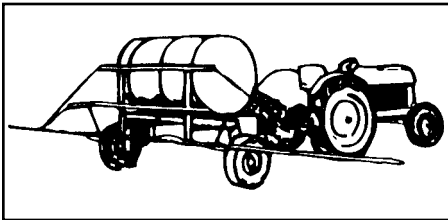
## Study Questions

1. (59) A pesticide which breaks down quickly in the environment is called:
  - a) persistent
  - b) non-persistent
  - c) a fumigant
  - d) an avicide.
2. (60) Contaminated or polluted water by pesticides:
  - a) can injure plants and animals directly
  - b) is of no concern to pesticide applicators
  - c) will clear up without anyone knowing
  - d) none of the above.
3. (61) When minimizing ground-water contamination, the two major sources are:
  - a) rain and snow-melt sources
  - b) leaching and sink-hole sources
  - c) point and non-point sources
  - d) train and truck accidents.
4. (64) Pesticides:
  - a) should never be used in the environment
  - b) can help the environment when they are used carefully and wisely
  - c) can not harm the environment
  - d) are so toxic there is no way to use them carefully or wisely.

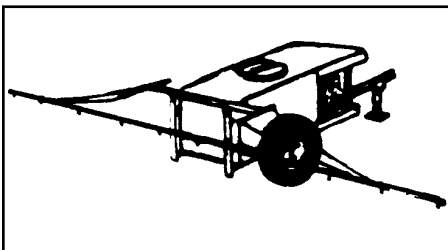
# Application Equipment



Portable Sprayer



Low Pressure Sprayer



High Pressure Sprayer

The pesticide application equipment you use is important to the success of your pest control job. You must first select the right kind of application equipment. Then, you must use it correctly to suit your needs and take good care of it. These things are true whether you use hand-carried, tractor-drawn, self-propelled or aircraft-mounted equipment. Here are some things you should know about choosing, using, and caring for equipment.

## Sprayers

Your sprayer should be designed to do the job you want to do. It should be durable and convenient to fill, operate, and clean.

### Hand Sprayers

Hand sprayers are used for small jobs. Use them in restricted areas where a power unit would not work.

#### Advantages :

- economical,
- simple, and
- easy to use, clean, and store.

#### Limitation :

- frequent lack of good agitation and screening for wetttable powders. Keep WP's in suspension by shaking the sprayer.

### Low Pressure Hydraulic Sprayers

These sprayers deliver low to moderate volume at 15 to 50 psi. Most are used for treating field and forage crops, pastures, fencerows, and structures. They also may apply fertilizer-pesticide mixtures.

#### Advantages :

- medium to large tanks,
- low cost, and
- light weight.

#### Limitations:

- low-gallonage output may limit their use when high volume is required, for example, liquid fertilizer applications,
- low pressure limits versatility, and
- agitation system may be of limited capacity.

### High Pressure Sprayers

These are designed to deliver medium volumes at high pressure. They are used to spray fruits, vegetables, trees, landscape plants, and livestock. When fitted with the correct pressure regulators, they can also be used at low pressures. Applications usually are made at high gallonages (100 gallons or more per acre above 100 psi). Even though very large tanks are used, they may need to be filled often.

#### Advantages:

- well built,
- usually have mechanical agitation, and
- last a long time even when using abrasive solutions.

#### Limitations:

- high cost,
- large amounts of water, power, and fuel needed,
- high tire loads, and
- high pressure capability which makes a spray that drifts easily.

### Air Blast Sprayers

These units use a high-speed, fan-driven air stream to break the nozzle output into fine drops which move with the air stream to the target. The air is directed to either one or both sides as the sprayer moves forward. These sprayers are used in applying pesticides to landscape plants, fruits, and vegetables, and for biting fly control. Most air blast sprayers can be adapted to apply either high or low volumes of spray. These sprayers should not normally be used to apply herbicides or for field broadcast applications.

#### Advantages:

- good coverage and penetration,
- low pump pressures, and
- mechanical agitation.

#### Limitations:

- drift hazards,
- chance of overdosages,
- difficult to use in small areas, and
- hard to confine discharge to limited target areas.

# Application Equipment

## Ultra-Low-Volume (ULV) Sprayers

ULV's deliver undiluted pesticides from the air, on the ground, or in buildings.

### Advantages:

- no water is normally needed, and
- equal control with less gallonage.

### Limitations:

- does not provide for thorough wetting,
- hazards of using high concentrates,
- chance of overdosage, and
- small number of pesticides labeled for use in this manner.

## Nozzles

Agricultural chemical spraying is becoming increasingly sophisticated and precise. Chemicals used by farmers today are designed for specific needs and require different nozzles to be applied properly.

The difference in nozzle styles is important because it is the nozzle that actually dispenses thousands of chemical and fertilizer dollars. Labels on these products may or may not contain information about the kind of spray nozzle that should be used.

Kansas applicators use five basic types of spray nozzles: the flat fan, even flat fan, hollow cone, solid cone, and flooding spray.

Each has a specific use, distinctive spray distribution, and operating requirement. Nozzle styles are summarized according to recommended uses, distinctive spray distributions, and operating requirements in Table 1, "Nozzle Styles," and in Table 2, "Nozzle Operations."

## Questions to Consider

It is not easy to make specific nozzle recommendations because many questions must be considered.

- What kind of chemical will be sprayed: herbicide, insecticide, fungicide?
- What is the chemical's formulation: wettable powder, flowable, emulsifiable concentrate?

- When is the chemical used: pre-plant incorporated, preemerge, postemerge?
- Is spray drift a problem?
- What will carry the chemical: water, liquid fertilizer?
- Will two or more chemicals be used in combination?
- What kind of sprayer will be used in the application: air-plane, ground sprayer, floater, kit attached to some other farm implement?
- What pressure range is desired?
- What speed will sprayer operate?
- What is nozzle spacing on boom?

## Nozzle Selection Procedure

Refer to Table 1, Nozzle Styles, to determine the proper nozzle pattern for the intended use and particular sprayer. Then you can select the correct size of nozzle to ensure proper chemical distribution.

### Step 1.

Determine the sprayer application volume in gallons per acre (gpa) from the pesticide label or printed recommendations. The application volume is the gallons of carrier (water, fertilizer) plus the amount of chemical formulation applied per treated acre.

### Step 2.

Select an appropriate ground speed in miles per hour (mph) according to existing field conditions. The actual speed should be measured as part of the calibration procedure.

### Step 3.

Determine the spray width per nozzle (w) in inches.

For boom spraying, w = the nozzle spacing.

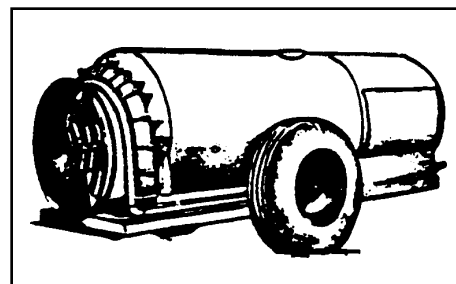
For band spraying, w = band width.

For foliar applications, such as row-crop spraying from drop pipes or direct spraying.

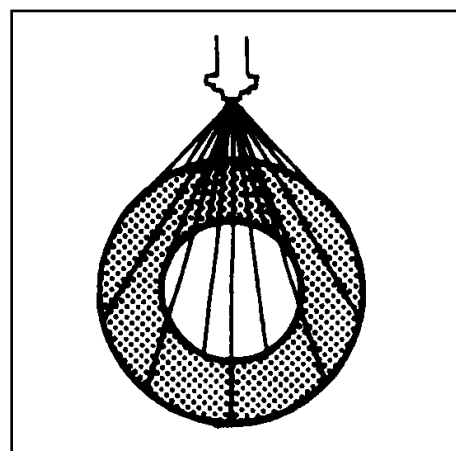
$$w = \frac{\text{row spacing}}{\text{number of nozzles per row}}$$

### Step 4.

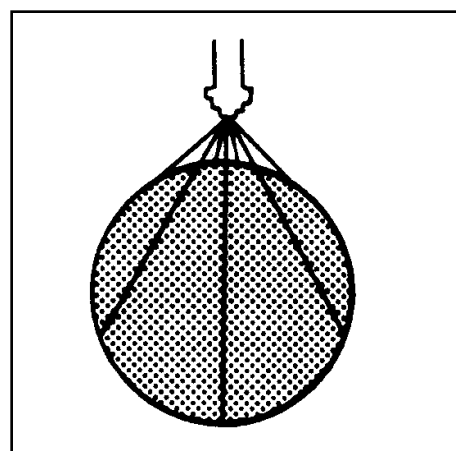
Determine the output required for each nozzle by using a manufacturer's catalog or this equation:



*Air Blast Sprayer*













*Hollow Cone Spray*



*Solid Cone Spray*

# Application Equipment

**Table 1. Nozzle Styles**

Nozzle Style	Suggested Use	Recommended Pressure (psi)	Comments	Single Distribution Pattern
Flat Spray	Weed and brush control	10–30; never exceed 40	Reasonably coarse spray in a fan-type pattern that will overlap along a spray boom. Wider operating pressure ranges may be used with certain "wide range" flat fan nozzle tips.	Bell Shaped 
Even Spray	Band application of preemergence and postemergence	15–30; never exceed 40	Fan-type pattern that gives a uniform volume of spray	Rectangular Shaped 
Cone	Insecticides and fungicides (foliar applications).	60 and above	Circular fan-type pattern giving good penetration of sprayed surfaces.	Hollow Cone  Solid Cone 
Flooding Spray	Preemergence and postemergence herbicides where drift is hazardous	8–20 for maximum drift control; never exceed 40	Coarse fan-type pattern. Sprays wide surface yet can be sprayed close to surface. Nozzle spacing should be 60 inches or less for herbicide applications.	Flooding Spray 
Raindrop	Preemergence and postemergence herbicides where drift control is needed. (Aerial and ground applications.)	20–60 psi	Produces very large drops in a hollow cone pattern.	Hollow Cone 
Whirl Jet	Herbicide incorporation kits	5–20 psi	Produces medium size drops in a hollow cone pattern with typical fan angles up to 140°.	Hollow Cone 
Raindrop Flat Fan	Weed and brush control	10–40 psi	Special drift reduction fan-type nozzle.	Bell Shaped 
Drift-guard Flat Fan	Weed and brush control	10–40 psi	Special drift reduction fan-type nozzle.	Bell Shaped 
Turbo-flood Shaped	Preemergence and postemergence herbicides where drift is a factor.	10–40 psi	Special drift reduction flooding-type nozzle with improved distribution uniformity.	Wide Angle Bell 

# Application Equipment

**Table 2. Nozzle Operation**

Type	Recommended			Boom	Orientation	Recom- Spray Overlap
	Spray Angle	Pressure (psi)	Spacing (inches)	Height (inches)		
Flat Spray,	60°	10–30	20	21–23	Vertical	30–50%
Raindrop Flat	73°	10–30	20	20–22		
Fan, Drift-guard	80°	10–30	20	17–19	Vertical	Never
Flat Fan	110°	10–30	30	13–15		
Even Spray	80°	15–30	Row Spacing	5"= 8" band	Vertical	Never
				6"= 10" band		
				7"= 12" band		
				8"= 14" band		
Cone	40°–110°	60 and above	As required for adequate foliar application.			
Flooding Spray,	100°–145°	8–20	40	12–15	Spray discharged 30°–45° from horizontal	100%
Turbo-flood	100°–145, 100°–145°	8–20	60 120	18–22 36–45		
Raindrop	80°–140°	20–60	20	15–30	Spray discharged 30°–45° from horizontal	50–100%
	80°–140°	20–60	30	16–31		
Whirl Jet	120°–140°	5–20	30	10–11	Spray discharged 30°–45° from horizontal	80–160%
	120°–140°	5–20	40	14–15		

$$\text{gpm} = \frac{\text{gpa} \times \text{mph} \times \text{w}}{5940^*}$$

gpm = individual nozzle output in gallons per minute

gpa = label requirements in gallons per acre

mph = speed of applicator in miles per hour

w = width in inches sprayed per nozzle as determined in step 3

\*Using 6,000 instead of 5,940 makes the calculation easier and results in an error of only 1 percent.

### Step 5.

Select a nozzle size from the manufacturer's catalog that will give the gpm output when operating at the desired pressure.

You can purchase nozzles in many materials. Here are the main features of each kind.

#### Brass:

- inexpensive,
- wear quickly from abrasion,

#### Stainless steel:

- will not corrode,
- resists abrasion, especially if it is hardened.

#### Nylon :

- resists corrosion and abrasion,
- some solvents may cause swelling of older nylon compounds,
- available in color coding for easy identification.

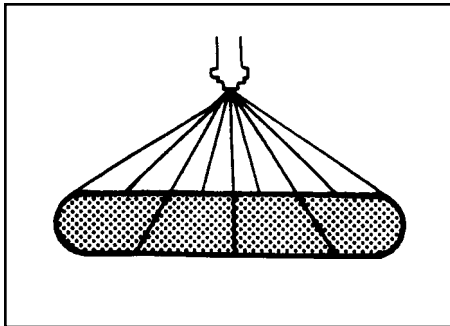
New combination nozzles featuring stainless steel orifice inserts in injection molded nylon bodies offer the advantages of both stainless steel and nylon at a reasonable price.

The formulation of the pesticide being sprayed determines the material of which the nozzle can be made. Brass nozzle tips should not be used with wettable powder or other abrasive formulations. The relative costs of materials are summarized in the following figure:

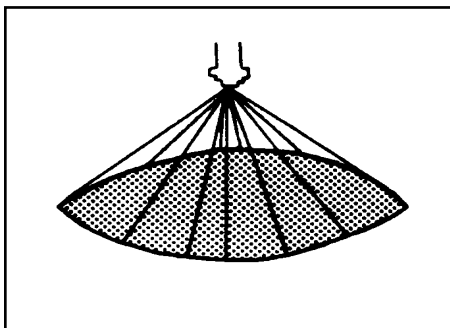
# Application Equipment

**Nozzle Material**  
(Delavan LF-3-80° with Wettable Powder)

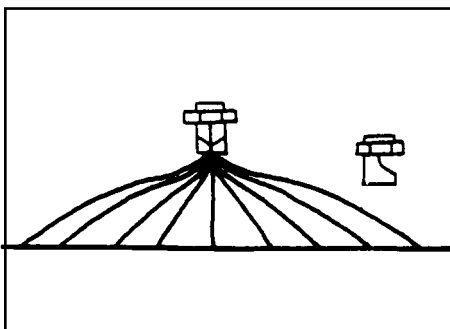
Material	Life (hrs)	Initial Cost Factor	Actual Cost/Hr. Factor
Brass	100	1.0	1.0
Nylon	400	1.0	0.25
Stainless Steel	500	3.1	0.62
Hardened Stainless Steel	1500	3.5	0.23



*Even Spray*



*Flat Spray*



*Flooding Spray*

## Check Nozzles Often

Keep nozzles in good working condition. For most boom applications, select nozzles of uniform type and size.

Nozzle caps should not be overtightened. Adjust nozzle height and spacing to suit the target. Follow the nozzle manufacturer's instructions and the pesticide label. Allow for crop or weed height if necessary. Check each nozzle for uniform flow using water and a jar marked in ounces.

With the sprayer running, hold a jar under each nozzle and time how long it takes to fill the jar. There should be no more than 10 percent variation among all the nozzles. Replace any nozzle tips that discharge more than + or - 5 percent specified by the nozzle manufacturer when new.

Replace any nozzles having faulty spray patterns. A good check is to spray on asphalt pavement or bare ground moving slow enough to get the area thoroughly wet. Watch for streaks as you increase speed or as spray dries.

Clean nozzles with a toothbrush or wooden toothpick only. A nail or pocket knife can damage the nozzle tip and ruin the spray pattern.

## Operation and Maintenance

Always read and follow the operator's manuals for all your spray equipment. They will tell you exactly how to use and care for it. After each use, rinse out the entire system. Remove and clean nozzles, nozzle screens, and strainers, and complete any maintenance required. Check for leaks in lines, valves, seals, and tank both after filling with water and during running.

Be alert for nozzle clogging and changes in nozzle patterns. If nozzles clog or other trouble occurs in the field, be careful not to contaminate yourself while correcting the problem. Shut off the sprayer and move it to the edge of the field before dismounting. Wear protective clothing while making repairs.

Clean the sprayer thoroughly when changing chemicals or before storing. Contamination from the previous chemical can injure your crop or react with the new chemical to decrease its effectiveness. Refer to Table 3 for recommended cleaning solutions and methods.

The following steps are suggested for a thorough cleaning. Spray and mix/load equipment should have been thoroughly rinsed with clean water and the rinsate applied to a field area prior to the cleaning process. Additional precautions may be necessary for certain chemicals.

1. Choose a cleaning area so that the discharge will not contaminate streams or water supplies. Keep children, pets, and livestock away from puddles.
2. Hose down the inside of the tank and fill it about half full. Then flush the cleaning water out through the nozzles by operating the sprayer.
3. Repeat step 2.
4. Select the proper cleaning solution and follow instructions from those in Table 3.
5. Flush the sprayer one final time with clean water.
6. Remove the nozzle tips and screens and clean them with kerosene or a detergent solution. Nozzle tips should be dried and

# Application Equipment

**Table 3. Cleaning Solutions and Methods for Cleaning Sprayers**

Pesticide Used	25 Gallon Cleaning Solution	2.5 Gallon Cleaning Solution	Instructions
Hormone herbicides, amine formulations (2,4-D, dicamba, MCPA)	1 qt. household ammonia	½ cup household ammonia	Thoroughly agitate, flush small amount through system, and let remainder stand in sprayer over night. Flush and rinse.
	or	or	
	1 lb. washing soda (sal soda)	3 Tbsp washing soda (sal soda)	Same as above, except let stand for at least 2 hours.
	or	or	
	2 lbs. trisodium phosphate	¼ lb. trisodium phosphate	
	or	or	
	½ lb. fine activated charcoal and ½ cup powder detergent	2 Tbsp fine activated charcoal and 1–2 oz powder detergent	Agitate, operate sprayer for 2 minutes, let remainder stand for 10 minutes, then flush through sprayer. Rinse.
Hormone herbicides, ester formulations (2,4-D, brush killers, [MCPA])	1 lb. washing soda + 1 gal kerosene + ¼ lb powder detergent <sup>1</sup>	4 oz. washing soda + 1½ cups kerosene + 1 Tbsp powder detergent	Rinse inside of tank and flush small amount through sprayer. Let stand for 2 hrs. Flush and Rinse.
Other herbicides (atrazine, simazine, alachlor)	¼ lb powder detergent <sup>1</sup>	1 Tbsp powder detergent <sup>1</sup>	Rinse with clean water before and after using sudsy solutions.
Insecticides <sup>2</sup> and/or fungicides	¼ lb powder detergent <sup>1</sup>	1 Tbsp powder detergent <sup>1</sup>	Agitate, flush, and rinse.

<sup>1</sup> Liquid detergent may be substituted for powder detergent; mix at a rate to make a sudsy solution.

<sup>2</sup> Organophosphate and carbamate insecticides may be detoxified by adding household ammonia to the cleaning solution (1 qt./25 gallons or ½ cup/2.5 gallons.)

stored in a dry place or may be stored in light oil or diesel fuel.

7. If the sprayer is to be stored, fill tank almost full with clean water. Add a small amount of new light oil to the tank. Coat the system by pumping tank contents out through nozzles or handgun. Drain the pump and plug its openings or fill the pump with light oil or antifreeze. Remove nozzles and nozzle screens and store in light oil or diesel fuel.

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# Application Equipment

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## Dusters and Granular Applicators

### Hand Dusters

Like hand sprayers, hand dusters can be used around homes and in gardens. They may consist of a squeeze bulb, bellows, tube, or shaker, a sliding tube, or a fan powdered by a hand crack.

#### Advantages:

- the pesticide is ready to apply, and
- good penetration in confined spaces.

#### Limitations:

- high cost for pesticide,
- hard to get good foliar coverage, and
- dust is subject to drifting.

### Power Dusters

Power dusters use a powered fan or blower to propel the dust to the target. They range from knapsack or backpack types to those mounted on or pulled by tractors. Their capacity in area treated per hour compares favorably with some sprayers.

#### Advantages:

- simply built,
- easy to maintain, and
- low in cost.

#### Limitations:

- drift hazards,
- high cost of pesticide, and
- application may be less uniform than with sprays.

### Selecting a Duster

Look for a power duster that is easy to clean. It should give a uniform application rate as the hopper is emptied. Look for both hand and power dusters that keep the dust cloud well away from the user.

### Granular Applicators

These include hand-carried knapsack and spinning disk types for broadcast coverage, mounted equipment for applying bands over the row in row crops, and mounted or tractor-drawn machines for broadcast coverage.

#### Advantages :

- eliminates mixing,
- minimizes drift, and
- is less hazardous to applicator.

#### Limitations :

- high cost for pesticide,
- limited use against some pests because granules won't stick to most plants,
- need to calibrate for each granular formulation, and
- poor lateral distribution, especially on side slope.

### Selecting a Granular Applicator

Choose a granular applicator that is easy to clean and fill. It should have mechanical agitation over the outlet holes. This will prevent bridging and keep flow rate constant. Application should stop when drive stops even if outlets are still open.

### Use and Maintenance

Both dusters and granular applicators are speed-sensitive, so maintain uniform speed. Do not travel too fast for ground conditions. Bouncing equipment will cause the application rate to vary. Stay out of any dust cloud that may form. Watch banders to see that band width stays the same. Small height changes due to changing soil conditions may cause rapid changes in band width.

Clean equipment as directed by the operator's manual.

### Controlling Drift

Drift is one of the major problems facing the application of agricultural chemicals. In addition to the potential damage to non-target areas, drift tends to reduce the effectiveness of chemicals and waste money. Drift is generally inconsistent with pesticide labeling and is a violation of state and federal laws. There are two different types of drift.

#### Vapor Drift

Vapor drift occurs when a chemical vaporizes after being applied to the target area. The vapors are then carried to another area where damage may occur. The amount of vaporization that occurs depends largely on the temperature and formulation



# Application Equipment

of the chemical being used. Volatile ester formulations vaporize rapidly in temperatures as low as 65°F, while the “low volatile” esters resist vaporization up to 85 to 100°F. The amine formulations are referred to as “non-volatile.” Thus, by choosing the correct herbicide formulations, the dangers of vapor drift can be reduced substantially.

### Physical Drift

Physical drift is the actual movement of spray particles away from the target area. Many factors affect physical drift, but one of the most important is droplet size. Small droplets fall through the air much more slowly, so they are carried farther by air movement. The particle may be trapped in a temperature inversion and carried for a great distance if weather conditions are unfavorable. In addition, evaporation has a greater effect on the smaller droplet, which in turn slows the settling rate and creates still more opportunity for drift. The end result is that the carrier in some of the smaller particles evaporates completely before reaching the ground.

All nozzles produce a wide range of droplet sizes and the very small, drift-prone particles cannot be eliminated completely. However, there are several things that can be done to minimize unwanted physical drift.

First of all, use adequate amounts of carrier, usually 15 to 20 gallons per acre. This has several benefits from the standpoint of drift control. With lower concentrations, more drift droplets will be necessary to produce ill effects. In addition, more carrier means larger nozzles, which in turn usually produce larger droplets. Although this will increase the number of refills, the added carrier may also improve coverage and increase the effectiveness of the chemicals.

Avoid high pressures. A higher pressure creates a finer spray, which is more subject to drift. Forty psi should be considered maximum pressure for flat fan, even fan, and flooding nozzle tips. For maximum drift control with

flooding nozzle tips, operate within the 8 to 20 psi pressure range (see Table 1).

Use a flooding or drift reduction nozzle where practical. They produce larger droplets and operate at lower pressure than the equivalent tapered fan nozzle. Special low drift hollow cone, flat fan, and flooding nozzles are claimed to greatly reduce the number of fine particles.

Numerous drift-reducing spray additives are available today, although their effectiveness generally has not been thoroughly tested. Foams and invert emulsions also have potential, although special equipment is usually required.

**Extreme care should be exercised to avoid drift away from the target area. Either physical drift or vapor drift can cause damage and expose the applicator to civil liability and possible criminal charges. Variables and their effect on physical drift are summarized in Table 4.**

**Table 4. Effects of Variables on Physical Drift**

<b>Helps Reduce Drift</b>	<b>Variable</b>	<b>Causes More Drift</b>
Lower	<b>Boom Height</b>	Higher
Lower	<b>Wind Speed</b>	Higher
Larger	<b>Droplet Size</b>	Smaller
Lower	<b>Pressure</b>	Higher
Larger	<b>Orifice Size</b>	Smaller
Low Pressure Flat Fan	<b>Nozzle Type</b>	Flat Fan or Cone
Flooding	<b>Nozzle Type</b>	Flat Fan or Cone
Raindrop	<b>Nozzle Type</b>	Flat Fan or Cone
Higher	<b>Relative Humidity</b>	Lower
Higher	<b>Viscosity</b>	Lower
Lower	<b>Volatility</b>	Higher

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# Application Equipment

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## Study Questions

1. (66) What must you do in terms of application equipment?
  - a) see your banker
  - b) make a purchase before the price goes up
  - c) select the right kind of equipment
  - d) talk with a neighbor.
2. (67) The letters, "ULV" stand for:
  - a) unusually large volume
  - b) ultimate land value
  - c) ultra low volume
  - d) unlimited livestock versatility.
3. (69) Spray nozzles are made out of:
  - a) brass
  - b) stainless steel
  - c) nylon
  - d) all the above.
4. (70) When you change chemicals in your sprayer, you should:
  - a) clean the sprayer thoroughly
  - b) just fill the tank with the new chemical and continue to spray
  - c) put the new chemical in before the tank is empty to avoid getting air in the lines
  - d) let the sprayer sit for two days to let it dry out.
5. (72) Advantages of a power duster are:
  - a) no drift hazard of the dust
  - b) pesticides are inexpensive to buy
  - c) simply built, easy to maintain and low in cost
  - d) always provide complete coverage.
6. (73) To help reduce physical drift, use adequate amounts of carrier, \_\_\_\_\_ gallons per acre.
  - a) 5 to 10
  - b) 15 to 20
  - c) 25 to 30
  - d) 35 to 40

# Calibration

## Equipment

Calibration is simply a process to adjust application equipment to apply the desired rate of pesticide. This process is needed to ensure that each pesticide is applied as directed on the label. Too much pesticide is dangerous; too little will not do a good job.

Accurate calibration is the only way to know how much chemical is being applied.

Failure to calibrate a sprayer can injure crops, create hazardous situations, and cost money in wasted chemical. In addition to calibrating the sprayer at the start of the season, it should be recalibrated every few days of use. Tests have shown that wettable powders can wear nozzle tips enough to increase the discharge rate by 20 percent after spraying for only 10 hours. Also, some brand new nozzles show a tendency to “wear in” and increase discharge by a few percent during the first hour or two.

Before calibrating, check the sprayer carefully. Be sure nozzle tips are clean. Is pressure holding constant?

When the sprayer is operating properly, proceed to calibrate. There are many techniques for calibrating a sprayer, but they are all based on determining the volume of chemical applied to a measured area. The choice between calibration methods will depend on the type of equipment to be calibrated as well as personal preference. Use these or any other method, but CALIBRATE.

### Calibrating Lawn and Garden Equipment

Before applying a pesticide, completely read the label on the pesticide container and follow its recommendations and safety precautions. Check the mechanical condition of the application equipment for tight connections and cleanliness.

Calibration of liquid hand sprayers may be accomplished with relative

ease. When spraying, either hold the nozzle at a steady, constant height and spray back and forth in swaths or swing the nozzle back and forth at a uniform speed in a sweeping, overlapping motion. A uniform walking speed must be maintained during application.

This calibration procedure is only for spraying ground areas. When spraying trees, shrubs, bushes, etc., use the recommended concentration (i.e., tablespoons per gallon) and spray until foliage is wetted.

1. Measure and mark an area of known size on a concrete or asphalt surface (i.e., 10 ft × 10 ft = 100 ft<sup>2</sup> or 20 ft × 25 ft = 500 ft<sup>2</sup>). Using water, practice spraying the area. Observe the evaporating water. Areas of excessive or deficient application rates will be apparent. By adjusting the spraying technique, one should be able to obtain a uniform distribution over the marked area.
2. Fill the sprayer with water to a marked level, spray the area using the refined technique from 1, and measure the amount of water that has to be added to return the water to the marked level. The application rate can then be easily computed.

*Example:*

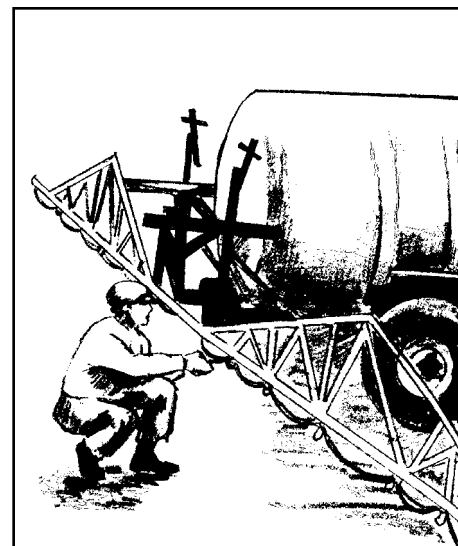
measure area = 20 ft × 25 ft = 500 ft<sup>2</sup>

water sprayed = 0.75 gallon

application rate = 0.75 gallon/500 ft<sup>2</sup>

or 1.5 gallon/1000 ft<sup>2</sup>

3. Recommendations on the label are sometimes given only in pounds (or quarts) of product per acre rather than in ounces per 1000 ft<sup>2</sup>, so the following conversions may be useful:  
dry products - oz/1000 ft<sup>2</sup> = recommended lb/A × 0.37  
liquid products - oz/1000 ft<sup>2</sup> = recommended qt/A × 0.73
4. Determine the proper amount of pesticide and add it to the water in the tank by:



# Calibration

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## Equipment

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$$\text{oz pest./tank} = \frac{\text{GT} \times \text{OP}}{\text{G}/1000 \text{ ft}^2}$$

where:

GT = Gallons per tankful

OP = oz pesticide per 1000 ft<sup>2</sup>

G/1000 ft<sup>2</sup> = Gallons applied per 1000 ft<sup>2</sup>

The oz pesticide/tank represents the amount of pesticide formulation to mix with a full sprayer tank.

*Example:*

For a 3 gallon tank capacity, application rate from 2 above of 1.5 gallons 1000 ft<sup>2</sup> and a recommended rate of 4 lbs dry material per acre.

*First:*

$$\begin{aligned} \text{oz}/1000 \text{ ft}^2 &= 1b/A \times 0.37 \\ &= 4 \times 0.37 = 1.5 \text{ oz}/1000 \text{ ft}^2 \end{aligned}$$

*Then:*

$$\begin{aligned} \text{oz pest./tank} &= \frac{\text{GT} \times \text{OP}}{\text{G}/1000 \text{ ft}^2} \\ &= \frac{(3 \text{ gal})(1.05 \text{ oz}/1000 \text{ ft}^2)}{(1.5 \text{ gal}/1000 \text{ ft}^2)} \\ &= 3 \text{ oz}/\text{tank} \end{aligned}$$

Avoid spraying near sensitive plants. Check weather conditions and spray when wind speed is low to prevent drift. Do not use a higher pressure than needed. If for any reason you have a surplus pesticide, dispose of it according to label directions. After application, clean the sprayer thoroughly.

Calibration of granular applicators is also possible, but is less safe as we must use the chemical to be applied in the calibration process. Except for the orifice or metering gate setting, ground speed is the most significant factor affecting the application rate. To obtain the most uniform application, cover the area twice with the second application at right angles to the first.

1. Read the pesticide label to determine the application rate, and set the machine as recommended by the operator's manual for a starting setting. Set gate openings from one direction only, such as from "closed" to "open," to eliminate variation in setting.

2. Fill the hopper with the pesticide to an easily determined level designated by a mark drawn across the tank with a rule and marking pen.
3. Apply to a known area within the total acreage to be treated.
4. Refill the hopper to the mark, weighing container before and after filling to determine the amount used.
5. The application rate can now be easily calculated.

*Example:*

$$\begin{aligned} \text{swath area} &= 5 \text{ ft wide} \times \\ &\quad 100 \text{ ft long} = 500 \text{ ft}^2 \\ \text{amount applied} &= 1 \text{ lb} \\ \text{application rate} &= 1 \text{ lb}/500 \text{ ft}^2 \\ &\quad \text{or } 2 \text{ lbs}/1000 \text{ ft}^2 \end{aligned}$$

or if the recommendation is given in pounds per acre:

*Example:*

$$\begin{aligned} \text{swath area} &= 5 \text{ ft wide} \times \\ &\quad 100 \text{ ft long} = 500 \text{ ft}^2 \\ \text{amount applied} &= 1 \text{ lb} \\ 1 \text{ acre} &= 43,560 \text{ ft}^2 \end{aligned}$$

*First:*

$$\begin{aligned} &\frac{\text{distance traveled (ft)} \times \\ &\quad \text{swath width (ft)}}{43,560 \text{ ft}^2/\text{A}} \\ &= \frac{5 \text{ ft} \times 100 \text{ ft}}{43,560} \\ &= 0.011 \text{ A} \end{aligned}$$

*Then:*

$$\begin{aligned} \text{application} &= \frac{\text{amount used (pounds)}}{\text{acres covered}} \\ &= 1 \text{ lb}/0.011 \text{ A} \\ &= 87 \text{ lbs}/\text{A} \end{aligned}$$

6. If the application rate determined in 5 is not the desired rate, readjust the applicator setting and repeat 2 to 5 until the desired rate is obtained.

Granular formulations may differ in density, granule size, carrier used, etc. Be sure that you calibrate for each different formulation and be alert to changes in application rate. A good practice is to mark off the hoppers in a specific measure, such as quarts, and check the amount used at each filling against the area covered.

# Calibration Equipment

## Field Sprayers

To apply a pesticide evenly and accurately, the sprayer must move at a constant speed and operate at a constant pressure. Each nozzle must be clean and at the right height. All nozzles must be of the correct type and size for the job. Each nozzle in the system must deliver its rated amount.

## Measured Course and Banding

1. Measure off a distance of  $\frac{1}{8}$  mile (660 feet or 40 rods). It is best to run the test in the field that will be sprayed, since sinkage in a soft field can change travel speed.
2. Start with a full spray tank, and be sure to eliminate air pockets in the pump, lines, and tank. Water (or the usual carrier) will usually do for calibration, but if you are using a chemical that changes the viscosity of the carrier, you should use the chemical as it will be sprayed.
3. Spray the  $\frac{1}{8}$ -mile strip, using the gear and throttle setting that you will use while spraying. You should run the engine well into the governed rpm range so that the governor can hold the speed constant.
4. Measure carefully the amount of water needed to refill the tank. Again, be careful to eliminate air pockets in the tank.
5. Calculate the application rate as follows:

*Broadcast*—

$$\frac{\text{Gallons Used} \times 66}{\text{Swath width in ft.}} = \frac{\text{Gallons per treated acre}}{\text{treated acre}}$$

*Banding*—

$$\frac{\text{Gallons Used} \times 66}{\text{Band width in ft.}} = \frac{\text{Gallons per treated acre}}{\text{treated acre}} \times \text{Number of bands}$$

6. Divide tank capacity by gallons per acre determined in Step 5. This gives the number of acres covered by one tankful of spray.
7. To determine the amount of chemical to add to each tank, multiply the recommended rate of application by the number of acres covered per tankful.

## Calibration Jar

1. With the unit stationary, operate the sprayer at the same pressure that will be used in the field. Use clean water for calibration unless you are using a chemical that changes the viscosity of the water. Hold a 1-quart jar under each nozzle and measure the number of seconds needed to fill the jar.
2. Calculate the flow rate of each nozzle by the formula:

$$\text{G.P.M.} = \frac{15}{S}$$

Where :

G.P.M. = Gallons per minute delivered by nozzle

S = Number of seconds needed to fill quart jar

Large nozzle tips with high flow rates may require use of a 5-gallon bucket in place of the quart jar. If using a 5-gallon bucket, the formula in setup 2 becomes:

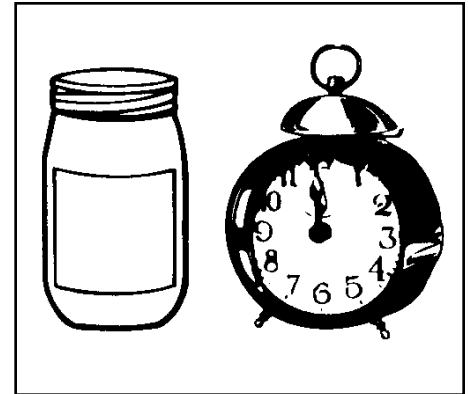
$$\text{G.P.M.} = \frac{300}{S}$$

Where :

G.P.M. = Gallons per minute

S = Number of seconds needed to fill 5-gallon bucket

3. Average the nozzle flow rates as determined in Step 2. Compare the flow rate of each individual nozzle tip with the average. Any tip that has flow rate more than  $\pm 5\%$  different than the average should be replaced. If the average flow rate differs from the factory specifications for new tips by more than  $\pm 5\%$ , then the entire set of nozzle tips should be replaced.
4. Measure a distance of 176 feet and time the tractor over that distance while operating at the same gear and rpm that will be used in the field. If possible, do this in the actual field to be sprayed so the sinkage will be constant.
5. Determine the speed of the unit in miles per hour from the formula:



*Check Fill-time*

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# Calibration

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## Equipment

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$$\text{MPH} = \frac{120}{T}$$

Where:

MPH = Speed of tractor in miles per hour

T = Number of seconds needed to travel 176 feet

Some examples may be found in the table on page 80.

6. Now, determine the application rate from the formula:

$$\text{G.P.A.} = \frac{\text{G.P.M.} \times 5,940}{\text{MPH} \times W}$$

Where:

G.P.A. = Application rate in gallons per acre (treated area)

G.P.M. = Gallons per minute delivered by nozzle

MPH = Speed in miles per hour

W = Width

(a) For broadcast spraying, W is nozzle spacing in inches

(b) For band spraying, W is band width in inches

7. Divide tank capacity by the gallons per acre determined in step 6. This gives the number of acres covered by one tankful of spray.
8. To determine the amount of chemical to add to each tank, multiply the recommended rate of application by the number of acres covered per tankful.

### Calibration Nomograph

The nomograph eliminates the calculations usually required to calibrate a sprayer. Needed are a quart jar, funnel, tape measure, watch with a sweep second hand, pencil and a straight edge. This procedure is not adapted to sprayers with ground driven, positive displacement pumps. The only other requirement is that the speed, nozzle spacing, and nozzle flow rate fall within the limits shown on the scales of the graph.

#### Procedure

1. Operate the sprayer standing still with plain water (or the usual carrier) in the tank. Use the normal engine speed and pressure settings. Use a funnel to catch the flow from one nozzle in a quart jar. Determine the length of time (in

seconds) needed to fill the quart jar. Repeat this for all nozzles and average the results. Replace any nozzles that vary more than  $\pm 5\%$  from the average.

2. Measure a distance of 176 feet, and determine the length of time (in seconds) needed to cover the 176 feet distance. This should be done with the same gear and throttle setting as will be used for spraying. If possible, do this in the field that will be sprayed so that sinkage will be nearly constant.
3. Measure the swath width of each nozzle. For boom spraying where the total area is covered, this is the nozzle spacing in inches. For band spraying, this is the band width in inches.
4. Now, refer to the nomograph on page 74. Draw a straight line from the "seconds to travel 176 feet" to the "nozzle spacing in inches."
5. Locate the point where your first line crosses the pivot line. Draw second straight line from that point to the "seconds to fill quart jar" using the average determined in Step 1.
6. Read "Gallons per Acre" from the appropriate scale.

#### Example

(Shown in dashed lines)

A field crop sprayer is equipped with nozzles that fill a quart jar in 50 seconds at the usual spraying pressure. The sprayer covers the distance of 176 feet in 24 seconds. Nozzle spacing is 20 inches. When operated under these conditions, the sprayer will deliver 17.8 gallons per acre.

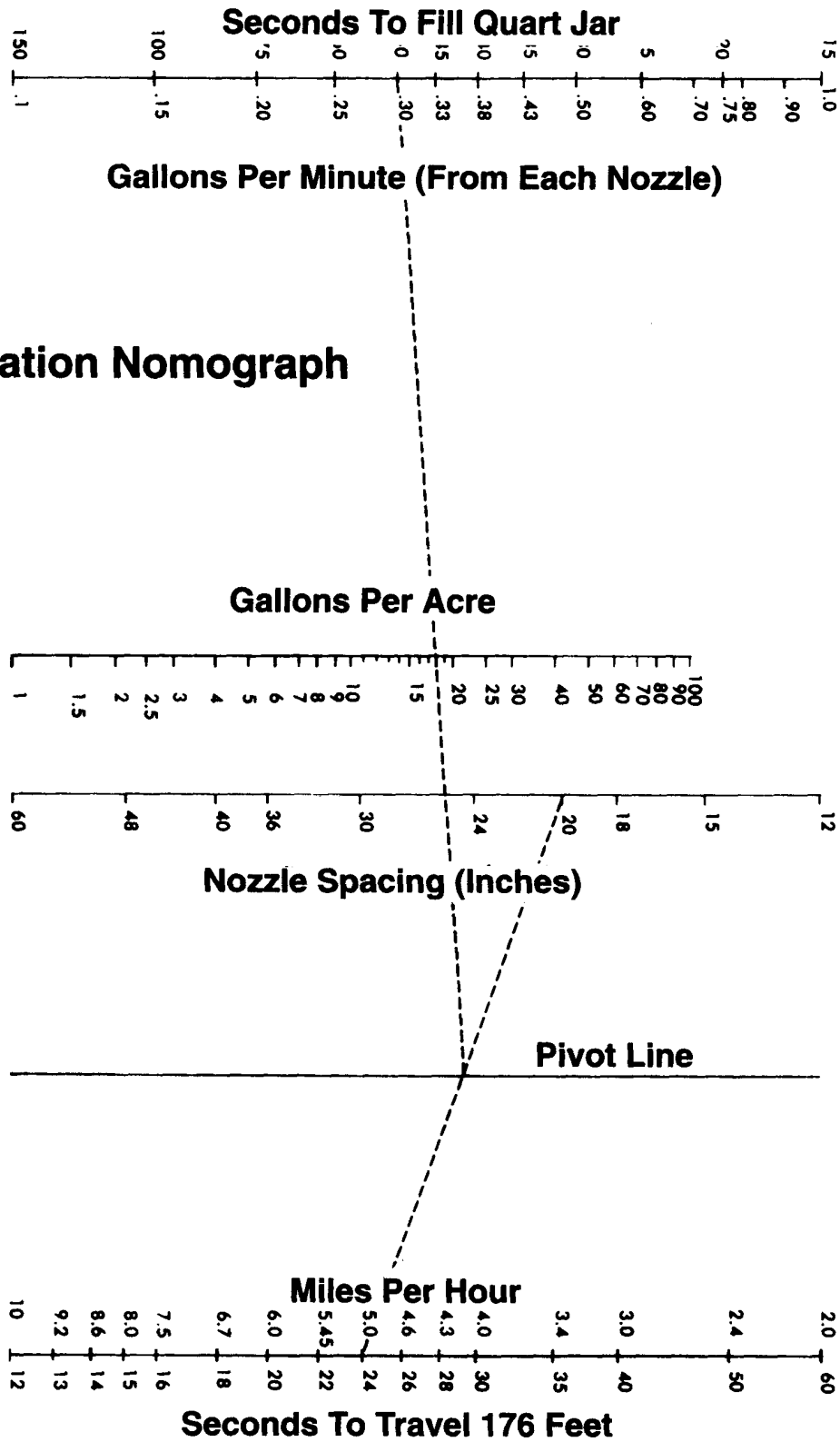
**Note:** For a more thorough discussion of sprayer components, nozzle selection and calibration, refer to Extension Bulletins FM-13, "Understanding Your Sprayer," and AF-20, "Selecting the Right Sprayer Nozzle."

### Adjusting Your Sprayer

If the sprayer is delivering more or less spray than the label directs, you can change the rate three ways:

# Calibration Equipment

## Calibration Nomograph



# Calibration

## Equipment

### Field Speed Determination

Time required to drive 176 feet (seconds)	Speed (miles per hour)
60	2
40	3
30	4
24	5
20	6
17	7

- Change the pressure. Lower pressure means less spray delivered; higher pressure means more spray delivered. This is not a good method, because a pressure change may change the nozzle pattern and droplet size. Pressure must be increased 4 times to double the output.
- Change the speed of your sprayer. Slower speed means more spray delivered, faster speed means less spray delivered. This method is practical for small changes in delivery rate. If you drive half as fast, you double the delivery rate.
- Change the nozzle tips to change the amount delivered. The larger the hole in the tip, the more spray delivered. This is the best method for making major changes in the delivery rate of sprayers. Always select proper nozzles for the job. Use the manufacturer's performance charts to make the selection.

After making a change, recalibrate to make sure the rate is correct.

### Determining the Correct Dosage

Next, the correct amount of pesticide to put in the tank to apply the correct dosage must be determined. To do this, you need to know two more facts:

1. How much the sprayer tank holds.
2. The amount of formulation to be used per unit of area. This will be given on the label.

Suppose the tank holds 200 gallons of spray. The directions say to apply one pint of formulation on each acre, and the sprayer applies 20 gallons per acre. First find the number of acres one tank load will spray. Divide 200 gallons by 20.

$$\frac{200 \text{ gallons per tankful}}{20 \text{ gallons per acre}} = 10 \text{ acres per tankful}$$

To find the amount of formulation to add to the tank for spraying 10 acres with one pint per acre, multiply 1 pint by 10.

$$1 \text{ pint per acre} \times 10 \text{ acres per tankful} = 10 \text{ pints per tankful.}$$

Suppose the formulation of a pesticide is a 50 percent wettable powder and you want to apply  $\frac{1}{2}$  pound of active ingredient per acre. In this example the tank will cover 10 acres.

Find how many pounds of formulation are needed to apply  $\frac{1}{2}$  pound of active ingredient per acre. There is  $\frac{1}{2}$  pound of active ingredient in 1 pound of 50 percent wettable powder formulation. So 1 pound of formulation is needed for each acre your sprayer will cover.

$$1 \text{ pound per acre} \times 10 \text{ acres per tankful} = 10 \text{ pounds per tankful.}$$

Add the 10 pounds of wettable powder to a small amount of water in a clean bucket. Stir until it is mixed well and add this mixture (called a slurry) to the partly filled tank. Remember to operate the sprayer's agitator while adding the slurry and filling the tank.

## Granular Application Calibration

Granular chemicals for weed or insect control must be applied with precision. This is particularly true of pre-emergence herbicides and soil insecticides.

Both herbicides and insecticides may be broadcast before planting or applied after planting. It is common, however, to apply those chemicals in a band over the row by attaching applicators to the planter. This reduces the amount of material used and thus lowers costs.

## Check and Maintain Ground Speed

Speed should be checked carefully in the field where the chemicals will be applied. One method is to set markers 176 feet apart and check the time (in seconds) required to drive between them. Make each check with a running start. To determine the speed in miles per hour, divide 120 by the traveling time in seconds. Some examples are given in the table at left.



# Calibration

## Equipment

Once the field speed has been established and checked, keep the speed uniform during the application.

Even though granular applicators use a rotating agitator that varies with ground speed, the flow of the granules through the outlet hole is not necessarily proportional to speed. It is not uncommon to find a 100 percent variation in the application rate with a speed change of 1 mile per hour.

The factors that affect application rate can vary from one day to the next or from one field to another. For this reason, check the application rate often so the necessary adjustments to obtain the proper application rate can be made.

### Field Check of Application Rate

Once the applicators have been set according to the operator's manual, make a field check for each hopper. This can be done in several ways. One method is to make a round or two in the field with the seed boxes removed from the planter. Paper, plastic, or cloth bags can be used for collecting the granules from each hopper. The granules collected can be weighed or checked with a calibrated measure. Repeat this process until the desired rate is obtained from each hopper.

Another method that is less accurate but still acceptable is to proceed with the planting and check the exact amount dispensed through each hopper. The disadvantage of this method is the possibility of not having the proper application rate on the calibrating rows.

The table at right shows the number of feet of row in 1 acre, and the pounds per acre to equal 1 ounce per 1,000-foot row. The table can be used to check calibration.

#### Example 1

It is desired to apply a granular insecticide with units mounted on a 6-row 30-inch planter. The insecticide calls for 6 to 8 ounces per 1,000 feet of row. Four passes were made across a quarter section and the operator refilled all the hoppers. Refilled, they held a total of 20 pounds of insecticide. Is this within the allowable range?

*Solution:*

The total row length covered is:  
 $4 \text{ passes} \times 6 \text{ rows} \times 2,650 \text{ feet} = 63,360 \text{ feet}$ , so the application rate is:

$$20 \text{ pounds} \times \frac{16 \text{ ounces/pound}}{63.36 \text{ thousand feet}} = 5.05 \text{ oz./1,000 ft.}$$

The application rate is too low, so the applicator should be readjusted.

#### Example 2

An applicator refilled the granular hoppers after finishing a 9-acre field and found that 75 pounds of granules had been applied. The label calls for 5 to 7 ounces per 1,000 feet of row and the applicator is using 24-inch rows. Is this within the allowable range?

*Solution:*

The application rate in lbs/acre is:  
 $\frac{75 \text{ pounds}}{9 \text{ acres}} = 8.33 \text{ lbs/acre}$

From the table, 1 oz./1,000 ft. = 1.36 lb./ac, so the row application rate was:

$$\frac{8.33 \text{ lb/ac}}{1.36 \text{ lb/ac}} = 6.125 \text{ oz./1,000 ft.}$$

The application rate was acceptable.

#### Example 3

A patch of weeds about 80 feet in diameter needs to be treated for a noxious weed. The granular herbicide being used should be applied at the rate of 2 pounds per square rod. How much should be broadcast on this area?

*Solution:*

1 rod = 16.5 feet, so one sq. rod =  
 $272 \text{ sq. ft.}$

The area of a circle is:  
 $A = 3.14 \times r \times r$ , where r is the radius of the circle.

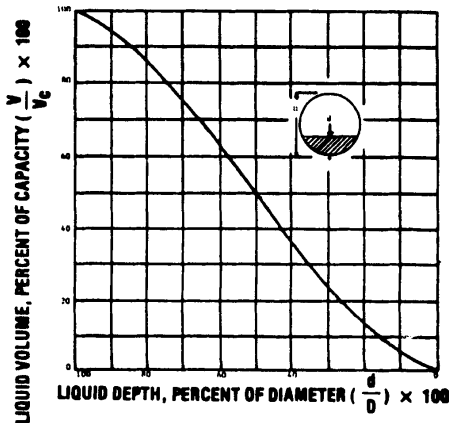
In this case,  $r = 40'$ , so:  
 $A = 3.14 \times 40 \times 40 = 5,024 \text{ square feet}$ ,  
 or  
 $\frac{5,024 \text{ sq. ft.}}{272 \text{ sq. ft./sq. rod}} = 18.5 \text{ sq. rd.}$

So, the total amount applied should be:  
 $2 \text{ lbs./sq. rd.} \times 18.5 \text{ sq. rd.} = 37 \text{ lbs.}$

### Checking Calibration

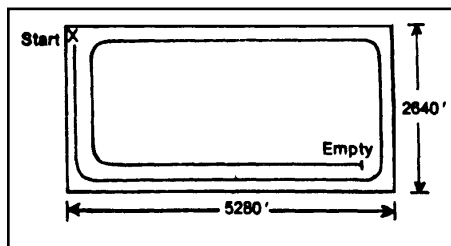
Row per Spacing Row	Feet of Row in 1 Acre	lbs/Acre to Equal 1 oz. 1,000 ft. of Row
40	13,068	.82
36	14,520	.91
30	17,424	1.09
24	21,780	1.36
20	26,136	1.63

# Calibration Equipment



Depth-volume relationship for cylindrical tank.

Depth-Volume Graph



Example 1

## Volume and Area Determinations

### Determining Volume

Volume of a Cylinder =  $3.1416 \times \text{radius} \times \text{radius} \times \text{length}$ .

Volume of a Cone =  $1.0472 \times \text{radius} \times \text{radius} \times \text{height}$  (i.e. round hopper bottom).

Volume of a Pyramid =  $\text{length of base} \times \text{width of base} \times \frac{1}{3} \text{ of the height}$  (i.e. square hopper bottom).

### Volume Conversion Factors

- 1 gallon = 231 cubic inches.
- 7.48 gallons = 1 cubic foot
- 62.4 pounds of water = 1 cubic foot
- 8.336 pounds of water = 1 gallon
- 1 gallon = 0.1337 cubic foot
- 27 cubic feet = 1 cubic yard

### Determining Field Areas

Area of a Rectangle =  $\text{length} \times \text{width}$

Area of Right Triangle =  $\frac{1}{2} \times \text{length} \times \text{width}$

Area of a Circle =  $3.14 \times \text{radius} \times \text{radius}$

### Area Conversion Factors

- Acres =  $\text{sq. ft.} / 43,560$
- miles =  $\text{ft.} / 5,280$
- miles =  $\text{rods} / 320$
- rods =  $\text{ft.} / 16.5$

### Useful Conversions

MPH  $\times$  ft/min / 88

$$\text{Acres/Hour} = \frac{\text{MPH} \times \text{swath width(ft)}}{8.25}$$

$$\text{Acres/Minute} = \frac{\text{MPH} \times \text{swath width(ft)}}{495}$$

### Example:

A 20 foot sprayer traveling 6 MPH covers 14.5 acres/hour. A 100 MPH airplane with a 50 foot swath covers 10.1 acres/minute.

- 3 teaspoons = 1 tablespoon
- 2 tablespoons = 1 fluid ounce
- 8 fluid ounces = 1 cup
- 2 cups = 1 pint
- 2 pints = 1 quart
- 4 quarts = 1 gallon
- 1 pint = 473 milliliters
- 1 gallon = 3,785 milliliters
- 1 pound = .454 kilograms
- 1 liter of water weighs 1 kilogram
- 1,000 milliliters = 1 liter
- 1,000 grams = 1 kilogram

## How much is in the tank?

Cylindrical spray tanks are often mounted horizontally, but unless the tank has a capacity scale taped to it, it is hard to calculate how much liquid is left in the tank.

The first question is "What is the total capacity of the tank?" The volume of a cylindrical tank is:

$$V = 3.1416 \times R \times R \times L$$

This assumes the end of the tank is square, not oval or spherical. For example, if the tank diameter is 36 inches and the length is 48 inches, the volume is:

$$V = 3.1416 \times 18 \times 18 \times 48 = 48,858 \text{ cubic inches.}$$

Since 1 gallon contains 231 cubic inches, the tank capacity in gallons is:

$$\frac{48,858}{231} = 211.5 \text{ gallons}$$

Now, if the tank is only partially filled, how much does it contain? To determine this, with the tank level, measure the depth of the liquid, then consult the graph. Considering the same tank (36"  $\times$  48") as above, assume the liquid depth is 9 inches. Then,  $d/D \times 100$  becomes  $9/36 \times 100$  or 25. Reading up from the bottom axis, then over, the graph indicates that the tank is 20 percent full, or 20 percent  $\times$  211.5 gallons equals 42.3 gallons.

### Example 1

An operator filled a 300-gallon spray tank and started spraying a half section. He ran out in the middle of the second round. Swath width is 30 feet. How many gallons per acre are being applied?

### Solution:

First, calculate the area sprayed. In this case, the top and bottom strips are 5,280 feet long, while the end strips are  $2,640 - 90 = 2,550$  feet long.

Thus, the areas sprayed are:

Top:	$30' \times 5,280' = 158,400$
Bottom:	$60' \times 5,280' = 316,800$
Left:	$60' \times 2,550' = 153,000$
Right:	$30' \times 2,550' = 76,500$
TOTAL	704,700 ft <sup>2</sup>

# Calibration

## Equipment

Now to convert square feet to acres:

$$\frac{704,700 \text{ ft}}{43,560 \text{ ft/acre}} = 16.18 \text{ acres}$$

So the application rate is:

$$\frac{300 \text{ gallons}}{16.18 \text{ acres}} = 18.5 \text{ gallons/acre}$$

### Example 2

A creek runs through an 80 acre field, cutting a large corner off. The east and west boundaries are  $\frac{1}{2}$  mile and  $\frac{1}{8}$  mile long, and the south fence is  $\frac{1}{4}$  mile long. The creek is nearly straight. A 25' wide sprayer makes 30 passes, starting at the west edge, and about 340 gallons of spray is used. What is the application rate?

### Solution:

To solve the problem, first divide the sprayed area into two regions, a rectangle and a triangle.

### Rectangle (Region 1)

$$\text{Area} = 30 \text{ passes} \times 25' \times 660' = 495,000 \text{ ft}^2 \left(\frac{1}{8} \text{ mile} = 660 \text{ feet}\right)$$

### Triangle (Region 2)

$$\text{Area} = \frac{1}{2} \times W \times L$$

$$\text{Now, } Z = \frac{1}{2} - \frac{1}{8} = \frac{3}{8} \text{ mile} = 1,980'$$

$$W = 750'$$

Since the creek is nearly straight: L is the same proportion of Z as W is to  $\frac{1}{4}$  mile. Thus,

$$L = \frac{W}{\frac{1}{4} \text{ mile}} \times Z$$

or

$$L = \frac{750}{1,320} \times 1,980 = 1,125'$$

So Area =  $\frac{1}{2} \times 750 \times 1,125 = 421,875 \text{ ft}^2$  and the total area sprayed is:

$$495,000 + 421,875 = 916,875 \text{ ft}^2$$

or

$$\frac{916,875 \text{ ft}^2}{43,560 \text{ ft}^2/\text{acre}} = 21.0 \text{ acres}$$

Since 340 gallons were used, the application rate is:

$$\frac{340 \text{ gal.}}{21.0 \text{ acre}} = 16.2 \text{ gallons/acre}$$

### Example 3

A sprayer with a 30 foot boom starts spraying a  $\frac{1}{4}$  section sized cen-

ter pivot irrigated field. At the end of the third round, about 320 gallons of spray has been used. What is the application rate?

### Solution:

A 90 feet wide strip was sprayed around the outside of the circle, so we can calculate the total area of the circle, then subtract the area that has not yet been sprayed.

Total area of circle:

$$A = 3.14 \times 1,320 \times 1,320 = 5,471,136 \text{ ft}^2$$

or

$$\frac{5,471,136 \text{ ft}^2}{43,560 \text{ ft}^2/\text{ac}} = 125.6 \text{ acres}$$

Area not yet sprayed

$$r = 1,320 - 90 = 1,230'$$

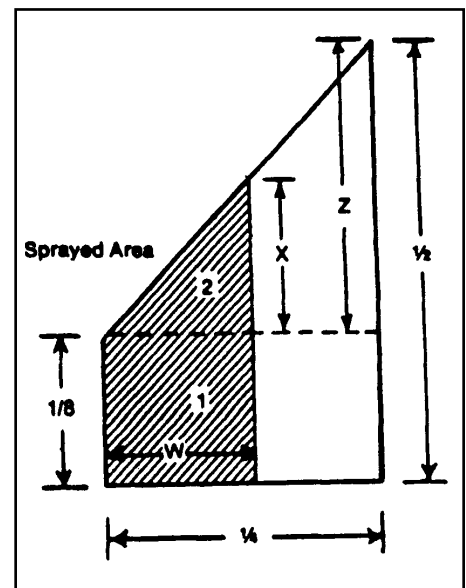
$$A = 3.14 \times 1,230 \times 1,230 = 4,750,506 \text{ ft}^2$$

or

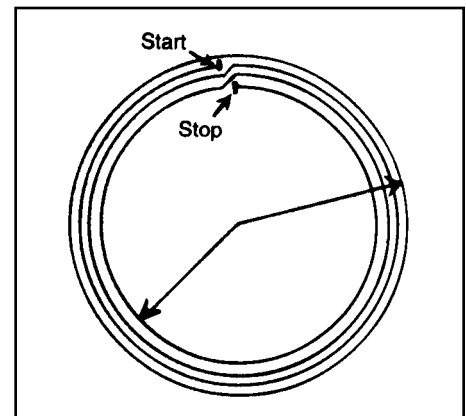
$$\frac{4,750,506 \text{ ft}^2}{43,560 \text{ ft}^2/\text{ac}} = 109.1 \text{ acres}$$

So, the area that has been sprayed is  $125.6 - 109.1 = 16.5$  acres, and the application rate is:

$$\frac{320 \text{ gallons}}{16.5 \text{ acres}} = 19.4 \text{ gallons/acre}$$



Example 2



Example 3

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# Calibration Equipment

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## Study Questions

1. (75) Accurate calibration of a sprayer:
  - a) is done at the factory
  - b) is the only way to know how much chemical is being applied
  - c) only needs to be done every three years
  - d) can be done while you wait for the tank to fill up between loads.
2. (76) To apply a pesticide evenly and accurately, the sprayer must:
  - a) move at a constant speed
  - b) have a constant pressure
  - c) have only the correct size and type of nozzle
  - d) all of the above.
3. (78) The following can be used to adjust a sprayer to deliver more or less spray:
  - a) change the pressure
  - b) change the speed
  - c) change the nozzle tips
  - d) all the above.
4. (80) When calibrating a granular applicator, the speed should be checked:
  - a) on hard ground in the barn yard
  - b) along the shoulder of the roadway
  - c) in the field where they will be applied
  - d) in the most convenient location.

## Laws and Regulations

In Kansas, a pesticide business must be licensed. Any individual, business, association of persons, or corporation who applies pesticides for compensation on or to the property of another is required to obtain a Kansas Pesticide Business License. It is unlawful to advertise, offer for sale, sell or perform any service for the control of a pest on the property of another or apply a pesticide on the property of another within this state without a pesticide business license. Pesticide businesses must employ a commercial applicator who is certified in each category and subcategory in which application work is performed prior to becoming licensed.

Commercial applications of pesticides have, for certification purposes, been separated into the following categories/subcategories, depending on what reason the pesticides are used:

1. *Agricultural Pest Control*—in the production of agricultural crops and animals.
  - a. *Agricultural Plant Pest Control*—in producing agricultural crops and for grasslands and non-crop agricultural lands.
  - b. *Agricultural Animal Pest Control*—on animals and to places on or in which animals are confined. (Doctors of Veterinary Medicine engaged in the business of applying pesticides for hire, publicly holding themselves out as pesticide applicators, are included in this category)
  - c. *Agricultural Wildlife Damage Control*—in rangeland and agricultural areas.
2. *Forest Pest Control*—in forests, forest nurseries, and forest seed-producing areas.
3. *Ornamental and Turf Pest Control*—to control pests in the maintenance and production of ornamental trees, shrubs, flowers and turf.
  - a. *Ornamental Pest Control*—in the maintenance and pro-

duction of ornamental trees, shrubs, and flowers.

- b. *Turf Pest Control*—in the maintenance and production of turf.
  - c. *Interior Landscape Pest Control*—in the production and maintenance of houseplants and other indoor ornamental plants kept or located within structures occupied by humans including, but not limited to houses, apartments, offices, shopping malls.
4. *Seed Treatment*—on seeds.
  5. *Aquatic Pest Control*—purposefully applied to standing or running water, excluding applicators engaged in public health related activities included in category 8 below.
  6. *Right-of-Way Pest Control*—in the maintenance of public roads, electric powerlines, pipelines, railway right-of-way or other similar areas, excluding applicators engaged in regulatory activities included in category 9.
  7. *Industrial, Institutional, Structural and Health Related Pest Control*—in, on, or around food handling establishments, human dwellings, institutions such as schools and hospitals, industrial establishments, including warehouses and grain elevators, and any other structures and adjacent areas, public or private; and for the protection of stored, processed, or manufactured products.
    - a. *Wood Destroying Pest Control*—in the control of termites, powder post beetles, wood borers, wood rot fungus and any other wood destroying pest.
    - b. *Stored Products Pest Control*—for the control of pests in stored grain and food products.
    - c. *Industrial Weed Control*—for control of weeds in industrial areas.
    - d. *Health Related Pest Control*—in health programs for



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# Laws and Regulations

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- the management and control of pests having medical and public health importance.
- e. Structural Pest Control—for control of pests in structures; human dwellings, institutions, schools, hospitals, industrial establishments; those applications not covered by wood-destroying or stored product pest control.
8. *Public Health Pest Control*—federal, state, or other governmental employees in public health programs for the management and control of pests having medical and public health importance.
  9. *Regulatory Pest Control*—federal, state, or other governmental employees who use or supervise the use of restricted use pesticides in the control of federal or state regulated pests.
    - a. Noxious Weed Control—in the control of weed pests regulated under the Kansas Noxious Weed Law.
    - b. Regulated Pest Control—in the control of federal or state regulated pests not covered in subcategory (a) above.
  10. *Demonstration and Research Pest Control*—this category includes:
    - a. individuals who demonstrate to the public the proper use and techniques of application of restricted use pesticides or supervise such demonstrations;
    - b. persons conducting field research with pesticides and, in doing so, use or supervise the use of restricted use pesticides.
3. A certified commercial applicator who is not employed by or otherwise acting for a licensed business is required to prepare a written statement of work performed for each application of restricted use pesticides made by him/her or made under his/her supervision. Each such statement must set forth the following:
    1. Name and address of commercial applicator;
    2. Name and address of owner or operator of property treated;
    3. The name of each pest to be controlled;
    4. Date and location of the application of the pesticide;
    5. Complete brand or product name of each pesticide used;
    6. EPA Registration number;
    7. Quantity of pesticide used;
    8. Total area to which the pesticide is applied;
    9. The concentration or rate of pesticide applied, when applicable;
    10. Signature of the individual who performed or supervised the application;
    11. Wind direction and velocity, when applicable;
    12. Expiration date of all guarantees, if any are given;
    13. If the pesticide was applied at less than label rate, this must be conspicuously stated; and
    14. For additional required records, see (b) under the Required Records section below.

Such records must be maintained for three (3) years after such application of pesticide, and shall be available upon request of the Kansas Department of Agriculture.

## Responsibilities of Certified Applicators

1. A certified applicator is to have his/her certificate or pocket card in possession when applying a restricted use pesticide.
2. A certified commercial applicator is required to notify the Kansas Department of Agriculture of any change in mailing address—such notification is to be made by the tenth of the month following the month during which the change occurred.
4. A non-certified person applying a restricted use pesticide must be under the supervision of a certified commercial applicator. This supervision requires that both persons are stationed at and work

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## Laws and Regulations

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from the same business address and that the certified commercial applicator provide the non-certified applicator with detailed instructions in the handling and application of the pesticide being used. The certified commercial applicator must be available to the non-certified applicator by telephone, 2-way radio or other comparable means of communication during the time the restricted use pesticide is being applied. The certified commercial applicator shall be physically present, when such presence is required by the pesticide label. The certified commercial applicator shall be prepared to verify that the requirements were met, if requested to do so by an authorized representative of the Kansas Department of Agriculture. Uncertified applicators in wood-destroying, ornamental, turf or interior landscape pest control may not commercially apply any pesticide unless they are registered pest control technicians or if either a certified applicator or registered pest control technician is physically present.

### Required Records

The Kansas Pesticide Law requires each pesticide business to maintain certain kinds of records of all (both restricted use and general use pesticides) commercial applications. These requirements as stated in the law are as follows:

- (a) Each pesticide business shall present to each customer for whom he or she performs a pest control service involving the application of pesticides a written statement of services or contract setting forth the following information:
  1. Business name and address of the pesticide business;
  2. Name and address of the customer; (All addresses should include the street address or rural route)
  3. The name of each pest to be controlled;
  4. Date and location of the application of the pesticide;
  5. Complete brand or product name of each pesticide used;
  6. EPA Registration number;
  7. Quantity of pesticide used;
  8. Total area to which the pesticide is applied;
  9. The concentration or rate of pesticide applied, when applicable;
  10. Signature of the individual who performed or supervised the application;
  11. Wind direction and velocity, when applicable;
  12. Expiration date of all guarantees, if any are given;
  13. If the pesticide was applied at less than label rate, this must be conspicuously stated.
- (b) Whenever the service involving the application of pesticides is performed for the purpose of controlling termites, powder post beetles, wood borers, wood rot fungus or any other wood destroying pest; the following information shall be included in addition to that required under subsection (a);
  - (1) The conditions under which retreatments, if any are to be made;
  - (2) the approximate date or dates of inspection, for any to be made after the original application of the pesticides; and
  - (3) a diagram of the structure to be treated, showing the location of visible evidence of active and inactive infestations by any wood destroying pest or pests for which the treatment is proposed; where a partial or spot treatment is to be made, this diagram shall also show the area or areas of the structure which are to be treated.
  - (4) If the treatment is not complete, conspicuously state that a "LIMITED TREATMENT," "PARTIAL TREATMENT" or "SPOT TREATMENT" was made.

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- (c) The required written statement of services or contract for services involving the application of pesticides may be incorporated into any business form used by the pesticide business licensee.
  - (d) The pesticide business licensee shall retain a copy of each written statement of services or contract in his files for three (3) years from the expiration date of any written statement of services or contract. Each pesticide business licensee shall make available to the Secretary of the Kansas Department of Agriculture upon request:
    - (1) A copy of any written statement of services or contract;
    - (2) Records of all pesticide applications during any specified period;
    - (3) Records of all employees who performed any service involving, or in conjunction with, the application of pesticides; and
    - (4) Any other requested information.
- on the label registered under the Kansas agricultural chemical act and /or by the environmental protection agency; or
  - 5. knowingly use ineffective or improper methods of materials; or
  - 6. knowingly operate faulty, unsafe, or if registration is required, unregistered equipment, or operate any equipment in a negligent manner; or
  - 7. refuse to neglect to keep and maintain records required by this act or refuse or neglect to make records available when and as required by this act; or
  - 8. make false or fraudulent records, invoices or reports; or
  - 9. make any misrepresentation or defraud any member of the public; or
  - 10. use any method or material without regard to public health, safety or welfare.

## Prohibited Actions

All pesticides must have a label. The label includes instructions for use, storage and disposal of containers. The label, together with any literature to which it refers, has the force of law. It is unlawful to detach, alter, deface, or destroy the label.

The following is a partial list of Unlawful Acts specified under the Kansas Pesticide Law. It shall be unlawful for any person to:

- 1. Use pesticides in a manner which is inconsistent with such pesticide's label or labeling; or
- 2. discard or store any pesticide or pesticide container in such a manner as to cause injury to humans, vegetation, crops, livestock, wildlife, pollinating insects or waterways and wildlife therein; or
- 3. make false or fraudulent claims through any media, misrepresenting the effect of material or methods to be utilized; or
- 4. make a pesticide recommendation or use not in accordance with the directions for use shown

## Penalties

Violations of the provisions listed above may incur a civil penalty in an amount not less than \$100 nor more than \$5,000 for each violation and, in the case of a continuing violation, every day such violation continues, shall be deemed a separate violation.

Any commercial applicator violating the provisions of the Kansas Pesticide Law and Regulations may be deemed guilty of a class A misdemeanor.

## Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as Amended

Pesticides are regulated by both state and federal laws. Certification as it exists today was first created in 1972 when the U.S. Congress passed a law which is called FIFRA (by its initials). This law covers the registration of all pesticides, including their classification as restricted. FIFRA requires that applicators meet certain competency requirements to use restricted pesticides. It also provides for



civil penalties up to \$5,000 for each offense and criminal penalties up to \$25,000, or one year in prison, or both, for persons who do not obey the law. Use inconsistent with the label is a violation of FIFRA.

In general all pesticides must be registered by EPA. FIFRA and related rules and regulations set forth the requirements for registration. These requirements are quite complex and need not be discussed here other than to point out that EPA will not register a pesticide unless the agency is satisfied that the use of the pesticide as specified by the label will not cause undue harm to man or the environment. Pesticides must be reregistered periodically, and EPA must make the same kind of judgment on a reregistration that it does on an original registration. EPA may cancel the registration of a pesticide if information becomes available to show that the material poses an undue risk to man or the environment.

There are some exceptions to the registration requirement, but those exceptions do not generally affect the availability or use of a pesticide in agriculture. An unregistered pesticide may be made available for (1) experimental use under a temporary permit especially if the experimental use is needed to develop information to support an application for registration, and (2) emergency use upon application by the Kansas Department of Agriculture for a Section 18 permit.

### Related Regulations

Shipment of pesticides and other dangerous substances across state lines is regulated by the Federal Department of Transportation (DOT).

If you haul pesticides between states, you should know that:

- (a) they must be in their original packages. Each package must meet DOT standards.
- (b) the vehicle must have a correct sign. Manufacturers must put the correct warning signs on each package.
- (c) the pesticides may not be hauled in the same vehicle with food products.

- (d) you must contact DOT immediately after each accident:
  - (a) when someone is killed,
  - (b) when someone is injured badly enough to go to a hospital, or
  - (c) when damage is more than \$50,000.
- (e) you must tell DOT about all spills during shipment.

State and local laws may require you to take additional precautions. Specific Fish and Game laws govern the use of such pesticides as 1080, sodium cyanide, fumigants and others used in vertebrate damage control.

Disposal of pesticide waste is regulated in Kansas by the Department of Health and Environment. To avoid the expense and regulatory problems associated with pesticide waste, every effort should be made to avoid producing it. Excess pesticide solutions and diluted rinse solutions should be collected and appropriately used in subsequent spray mixtures. Liquid pesticide containers should be properly rinsed (use the triple rinse method or equivalent) so that they can be disposed of as solid waste or recycled.

For regulatory purposes, pesticide wastes are classified as hazardous, small quantity hazardous, or non-hazardous. What must be done with pesticide waste depends upon its classification. Questions concerning the classification and required disposal methods for certain kinds of waste should be directed to the Kansas Department of Health and Environment. Applicators are responsible for determining whether or not they produce hazardous waste. Basically, the EPA considers a waste to be hazardous if it is ignitable, reactive, corrosive or toxic, or if it is listed among 400 or more substances the EPA has determined to be hazardous.

### Residues

The pesticide that stays in or on raw farm products or processed foods is called a residue. EPA sets residue tolerances under regulations authorized by the Federal Food, Drug, and Cosmetic Act. A tolerance is the

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concentration of a pesticide that is judged safe for human use. Residues in processed foods are considered to be food additives and are regulated as such.

Tolerances are expressed in “parts per million” (ppm). One ppm equals one part (by weight) of pesticide for each million parts of farm or food product. Using pounds as a measure, 50 ppm would be 50 pounds of pesticide in a million pounds of the product. The same pesticide may have a different tolerance on different products. It might be 5 ppm on grapes and 25 ppm on apples.

If too much residue is found on a farm or food product, the product may be seized or condemned.

The label will tell you how many days before harvest the pesticide may be applied. Follow the label exactly to be sure you are not breaking the law and to be sure dangerous levels of pesticide residues are not consumed.

## Common Pesticide Misuses

The common misuses involving pesticides start with poor planning. The “more is better” syndrome has no place in choosing the rate to apply. Adherence to pesticide label rates specified for the crop, soil, and pesticide combination provides higher probability that the pesticide will work as desired without crop damage, illegal residues or environmental hazard. Improper mixes of different pesticides are sometimes chosen in an attempt to “kill two birds with one stone.” Unless the pesticide label has instructions for a specific mix, the applicator assumes responsibility. Common errors include use of excessive rates in the combination, improper carrier, incompatibility of formulations, and inappropriate timing of application for a component pesticide.

Pesticide misuse commonly results from poor management decisions in spray application, use of inadequate safety equipment, and use of improperly maintained or designed sprayer equipment. Use of pesticide products

inconsistent with their individual labels is a violation of the pesticide law.

## Common Law Rules Governing the Use of Pesticides

In addition to all the state and federal statutes and regulations governing the use of pesticides, farmers and commercial pesticide applicators may be held liable for improper use of pesticides under common law. For centuries, Anglo-American law has held that you have the right to enjoy the use of your property without undue interference from your neighbors. This common law right has been reaffirmed by court actions throughout our history and is not based on specific acts of legislators or the Congress. However, statutes within each state define and limit common law rights.

Under common law, you may protect your property from trespass by another. Trespass includes the drift of a pesticide from a person’s property to that of his neighbor. If pesticide drifts onto a neighbor’s property and causes damage, he/she has cause for a suit and recovery of damages. If the drift is enhanced by your negligence, his/her case against you is strengthened. Any act or omission that creates an unreasonable risk of harm to another constitutes negligence.

Under some circumstances, use of pesticides may constitute a nuisance, even when no trespass can be established. Spraying a golf course may create a public nuisance if, for example, the odor drifts over an adjoining urban community. In such a case, only a public official or a class action suit may seek an injunction against continued spraying. Or the spraying may constitute a private nuisance where only a neighbor may feel an invasion of his/her enjoyment of his land. Here, he/she may seek an injunction against further spraying and perhaps seek damages as well.

Under common law strict liability is imposed on any activity known to

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be abnormally dangerous. In some states, use of pesticides is subject to the strict liability rules (liability without fault). Kansas is not one of these strict liability states. However, the Supreme Court has stated that applicators are required to exercise "a high degree of care, not liability without fault," in keeping chemical pesticides from causing damage to others. A high degree of care requires one to exercise "reasonable precautions," given the nature and location of his business, to prevent his actions from harming others.

Phrases such as "high degree of care" and "reasonable precautions" are tough to define and give lower courts a wide degree of discretion in determining whether an applicator is to be held responsible for damages. Legal scholars have found that except for unusual circumstances, the injured plaintiff will almost always win if he can establish two things:

- (1) That the drifted or misapplied chemical caused the injury, AND
- (2) The plaintiff was damaged.

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## Study Questions

1. (86) How long must an applicator maintain application records?
  - a) 6 months
  - b) 1 year
  - c) 3 years
  - d) 5 years.
2. (87) When must a certified applicator be physically present while supervising an application by a non-certified applicator?
  - a) Mondays and Fridays
  - b) from 10:00 a.m. until 3:00 p.m
  - c) when the application costs over \$500
  - d) when such presence is required by the pesticide label.
3. (88) Under the Kansas Pesticide Use Law:
  - a) it is unlawful to spray after sundown
  - b) it is unlawful to spray a neighbor's property for no pay
  - c) it is unlawful to detach, alter, deface or destroy the label
  - d) it is unlawful to treat for certain pests after September 31.
4. (89) In general, all pesticides must be registered by:
  - a) Kansas Department of Health and Environment
  - b) U.S. Environmental Protection Agency
  - c) Kansas Department of Transportation
  - d) Kansas Water Resource Board.
5. (90) The residue concentration of a pesticide on food or feed judged to be safe for human use is called a:
  - a) tolerance
  - b) residue
  - c) amount
  - d) none of the above.
6. (91) In court actions under common law, strict liability such phrases as "high degree of care:"
  - a) mean the same to all persons
  - b) are never used
  - c) are easy to define and lock the courts into narrow actions
  - d) are tough to define and give courts a wide degree of action.



Pesticides are designed to poison pests. Unfortunately, many pesticides are also poisonous to people. Many people in all walks of life have pesticide residues in their bodies. Pesticide applicators and their families are regularly exposed to far greater than normal contact with pesticides. Therefore, it is important to do everything possible to keep exposure to an absolute minimum.

You also want to protect your workers and other people from pesticide injuries. Most pesticide accidents result from careless practices or lack of knowledge about safe handling of pesticides. The time you spend to learn about and to use safe procedures is an investment in the health and safety of you, your family, and others.

## Protecting Your Body

Some pesticides are so highly toxic that accidental exposure to them without proper protection can sicken or kill humans. Other pesticides are much less toxic; large exposures to these poisons would be necessary to cause illness. Even slightly toxic pesticides can irritate the nose, throat, eyes, and skin of some people. You should know how to protect yourself, your workers, and other persons from harmful exposure to the pesticides you are applying.

Pesticides can enter the body in three major ways:

- through the mouth (orally),
- through the skin and eyes (dermally),
- through the lungs (by inhalation).

People may be poisoned without realizing the seriousness of the exposure—especially if pesticides enter through the skin and lungs.

**Oral poisoning** can be caused by:

- not washing hands before eating, drinking, smoking, or chewing,
- mistaking the pesticide for food or drink,
- accidentally applying pesticides to food,

- carelessly splashing pesticide into the mouth.

**Dermal poisoning** can be caused by:

- not washing hands after handling pesticides or their containers,
- splashing or spraying pesticides on unprotected skin or eyes,
- wearing pesticide-contaminated clothing (including boots and gloves),
- applying pesticides in windy weather,
- wearing inadequate protective clothing and equipment during mixing or application.

**Inhalation poisoning** can be caused by:

- prolonged exposure to pesticides in closed or poorly ventilated spaces,
- accidentally breathing vapors from fumigants and other toxic pesticides,
- breathing fumes, dust, or mist during application without appropriate protective equipment,
- inhaling fumes present immediately after a pesticide is applied (reentering the area too soon),
- not having a good seal on your respirator or using an old or inadequate cartridge or canister.

People can be exposed to pesticides in two major ways:

- acute exposure, and
- chronic exposure.

**Acute exposure** is a single incident of exposure to a pesticide. Usually the symptoms of poisoning begin quickly and leave little doubt about the cause of the illness. Acute exposure is usually due to an accident such as:

- splashing a pesticide into the mouth,
- spilling or spraying a pesticide onto your clothing, or
- being contaminated by broken equipment.

**Chronic exposure** is repeated exposure to pesticides over a period of time. Chronic exposure may go unnoticed since some pesticides may persist in the body for a long time without any obvious signs or symptoms of poisoning. If you continue to be

# Pesticide Safety

exposed to these pesticides, residues in your body may increase. An additional risk is that even low-level chronic exposure may lead to serious illness. Chronic exposure most often occurs in the work-place because of:

- faulty or inadequate protective clothing or equipment,
- early reentry,
- inadequate cleanup of clothing and body, or
- contaminated working conditions.

## What You Should Wear

To prevent pesticides from entering the body, you must wear protective clothing and equipment. You should follow all advice on protective clothing or equipment which appears on the label. However, the lack of any statement or the mention of only one piece of equipment does not rule out the need for additional protection. No safety recommendations can cover all situations. Your common sense and knowledge of pesticide toxicity should help you assess the hazard and select the kind of protection you need.

### Protective Clothing

#### Body Covering

Protective clothing should be clean, dry, free of holes and tears, and cover as much skin as possible. Always wear long-sleeved coveralls or long-sleeved shirts and pants. Tuck shirts into pants and cover the waist area with an apron for added protection.

Clothing should be made from tightly woven fabric and have collars and cuffs that fit snugly when buttoned. Waterproof and/or disposable coveralls are now available and offer good protection.

Wear pant legs outside to prevent pesticides from seeping into boots or shoes. Wear long sleeves outside gloves; however, if you are working above your head, tuck sleeves inside.

#### Gloves

When you handle concentrated or highly toxic pesticides, wear gloves. For liquid formulations, liquid-proof neoprene gloves are best. They should be long enough to protect the wrist.

Gloves should not be lined with a fabric. The lining absorbs chemicals and is hard to clean. For most jobs, sleeves should be outside of the gloves to keep pesticides from running down the sleeves and into the gloves. But if you will be working with your hands and arms overhead, put the gloves outside of the sleeves.

#### Hat

Wear something to protect your head. A wide-brimmed hat will help keep pesticides off your neck, eyes, mouth, and face. Most special coveralls have an attached protective hood. Hats should not have a cloth or leather sweatband. They should be easy to clean or disposable. When you will be exposed to liquid pesticides, wear a liquid-proof hat. Plastic "hard hats" with plastic sweatbands are liquid-proof and are cool in hot weather.

#### Shoes and Boots

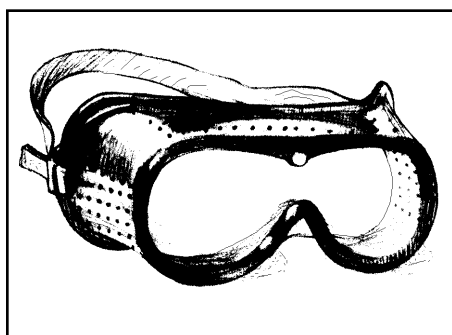
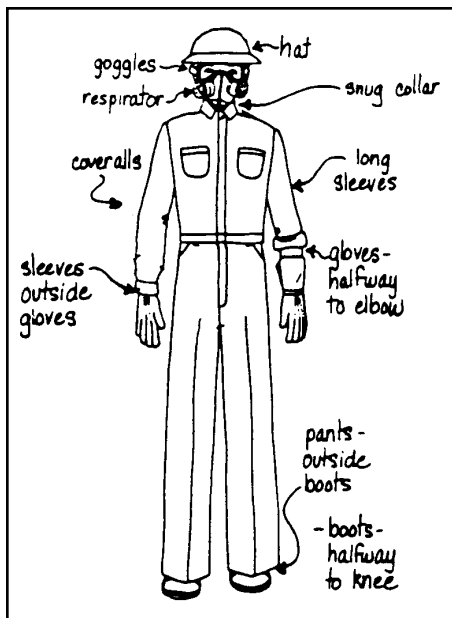
Sturdy shoes and socks are sufficient for some pesticide applications. Neoprene or rubber boots are a wise precaution with many pesticide applications because canvas, cloth, and leather shoes can readily absorb pesticides. If you will be handling liquid concentrates or highly toxic pesticides (those with "DANGER" on the label), neoprene or rubber boots are necessary. Wear unlined boots with trouser legs outside the boots so the pesticide will not run down the leg and collect in the boot.

#### Goggles or Face Shield

Wear goggles or a face shield when there is any chance of getting pesticide in your eyes. Eyes readily absorb pesticides and the temporary blindness caused by an accident may delay or prevent self-treatment. You can wear goggles alone or with a respirator.

#### Protective Clothing for Fumigant Application

When handling or applying fumigants, be sure to check the label for directions on how to best protect yourself. If the label does not give specific instructions, then you should wear at least gloves, shoes



or boots, and a long-sleeved shirt and long-legged trousers made from tightly woven fabric. Some fumigants readily penetrate rubber, neoprene, and leather. These fumigants may be trapped inside the gloves, boots, or liquid-proof suit and cause severe skin irritation or lead to poisoning through skin absorption. The labels on these fumigants will specify the appropriate protective clothing to be worn while handling them.

### Care of Clothing

#### *Laundering Clothing Contaminated with Pesticides*

Research has shown that pesticide residues are transferred to other clothing in the wash load—so always wash contaminated clothes separately. Know what pesticide was used, its toxicity level, and formulation so you can use the appropriate treatment. One machine washing may be sufficient to remove some diluted, water soluble, less toxic pesticides. However, up to three launderings are recommended when removing residue from the less water soluble, more concentrated or more dangerous chemicals. Emulsifiable concentrate formulations are more difficult to remove. Discard clothing contaminated with highly toxic, concentrated chemicals.

Always prerinse contaminated clothes before washing by hosing garments outdoors, soaking in a suitable container, or use the prerinse cycle with agitation in an automatic washing machine. A detergent is not necessary at this stage. Prerinse is especially helpful in removing wettable powder formulations.

Wash no more than three or four pieces of clothing at a time using the highest water level setting, regular 10 to 12 minute cycle, and hot water (140°F). The lower the water temperature, the less pesticide is removed. If your hot water heat thermostat is set at a lower temperature, you should reset it before washing.

Use the recommended amounts of any good laundry detergent, remembering to increase the amount if your machine exceeds a 16-gallon water

fill. The amount of detergent suggested on the box is for 16 gallons of water, and the high fill setting on many of today's large capacity machines can use up to 24 or 26 gallons. Heavy duty liquid detergents are known for their oil-removing ability, so they would be the best choice for removing oil-based pesticides.

Although bleach and ammonia are useful laundry aids at times, the usual amounts used in laundering do not help remove pesticide residue. Either can be used if you wish, but not together. NEVER MIX BLEACH AND AMMONIA. They can react with each other to form a potentially fatal gas.

If necessary, launder contaminated clothing two or three times with lots of water to thoroughly flush the fabric. It is not necessary to dry them between washings.

Since pesticides could remain in the washer and contaminate subsequent loads, it is essential to clean the machine by filling it with hot water containing a detergent, and running it through a complete cycle.

To avoid any possibility of residues collecting in the dryer, line drying is recommended for the clothes. An added benefit of this practice is that many pesticides break down when exposed to sunlight.

### Protective Equipment

The respiratory tract—the lungs and other parts of the breathing system—is much more absorbent than the skin. You must wear an approved respiratory device when the label directs you to do so. Even if the label does not require it, you should always wear a respiratory protective device:

- if the pesticide you are mixing or applying has a label precautionary statement such as “do not breathe vapors or spray mist,” or “harmful or fatal if inhaled,”
- during calibration and adjusting of equipment if you are using pesticides with the above precautionary statements,
- if you will be exposed to a pesticide for a long time,

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- if you are working in an enclosed area.

If you still have trouble breathing while wearing a respiratory device, see your physician to find out whether you have a respiratory problem.

## *Cartridge Respirator*

You should wear this kind of respirator when you will be intermittently exposed to a pesticide.

The inhaled air is drawn through both a fiber filter pad and a cartridge to absorb pesticide vapors. Most harmful vapors, gases, and particles are removed. These half-face masks cover the mouth and nose. To cover the eyes also, use one that is combined with goggles, or wear separate goggles.



Cartridge Respirator



Canister Respirator



Supplied-Air Respirator



Self-contained Breathing Apparatus

## *Canister Respirator (Gas Mask)*

You should wear this kind of respirator when you will be continuously exposed to a pesticide.

The canister has longer-lasting absorbent material and filters than the cartridge respirator. Gas masks usually provide full-face protection. Neither cartridge nor canister respirators will protect you from high concentrations of vapor, and neither kind is effective when the oxygen supply is low; for example, during fumigation inside buildings, railroad cars, holds of ships, or grain bins.

## *Supplied-Air Respirator*

You may use this kind of respirator when mixing or applying pesticides:

- when the oxygen supply is low,
- when you are exposed to high concentrations of highly toxic pesticides.

You must work close to a supply of clean air, since this type of respirator works by pumping clean air through a hose to the face mask.

## *Self-Contained Breathing Apparatus*

You should wear this kind of respirator under the same conditions as the supplied-air respirator. It does about the same thing. The difference is that you carry cylinders of air or oxygen with you, usually on your back. This lets you move more freely and over a wider area than you can

with a supplied-air respirator. Seek training from competent instructors before using self-contained breathing equipment. These devices contain a limited air supply, which may be used up even more quickly in high temperatures or with excessive exertion.

## *Positive Pressure Respirator*

Both chemical cartridge and chemical canister respirators rely on the wearer's ability to draw air through the filters in normal breathing. To be effective, these "negative-pressure" respirators must be tightly sealed to the face. A positive-pressure respirator uses a lightweight blower to draw the contaminated air through the filter. It forces the clean air into a loose-fitting helmet-like head covering. The outflow prevents contaminants from entering the helmet. The filtered air circulates over the head, neck, and upper body of the applicator, providing some cooling.

Positive-pressure respirators are available as lightweight backpacks, or they may be mounted on or in application equipment where the power is supplied by the vehicle's electrical systems. Some vehicle-mounted units provide cool filtered air to the applicator.

## *Respiratory Devices for Use With Fumigants*

Fumigants are gases. They pose the greatest hazard of poisoning through inhalation. Exposure to even small concentrations of the fumigant as a gas can cause severe injury and death. Special precautions are necessary during handling and application. Use a supplied-air respirator, or at least a canister respirator with an organic vapor canister. Wear a respirator during application and reentry if any exposure to the fumigant gas is likely. In closed areas, such as bins, vaults, and chambers there may be insufficient oxygen to sustain life. Use supplied-air respirators or a self-contained breathing apparatus and never work alone.

## *Selection and Maintenance*

Use only those respirators which carry a seal of approval for pesti-



cide use from the National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA). Read the manufacturer's instructions on the use and care of any respirator and its parts before you use it.

A negative-pressure respirator must fit the face well. Long sideburns, a beard, or glasses may prevent an adequate seal.

When applying pesticides, change filters, cartridges, or canisters if you have trouble breathing, if you smell pesticides, or after a maximum of 8 hours of use. Remove and discard filters, cartridges, and canisters and wash the facepiece with detergent and water, rinse it, and dry it with a clean cloth. Store it in a clean, dry place away from the pesticides.

The useful life of a cartridge or canister depends on:

- the amount of absorbent material it contains,
- the concentration of contaminants in the air,
- the breathing rate of the wearer,
- the temperature and humidity.

Operation and maintenance requirements for positive-pressure respirators are similar to those for cartridge and canister respirators. The filter has a longer working life than those in cartridges or canisters, but it should be replaced after about 150 hours of use or when the amount of air being supplied to the applicator drops noticeably. The exposed parts of these respirators also need to be washed and dried after each use.

## Special Handling Precautions

- If possible, clothing worn when applying pesticides should be saved for that use only.
- If clothing gets contaminated when working with pesticides, change immediately. Don't wait until you've finished the job.
- Always wear rubber gloves when handling and rinsing clothes contaminated with pesticides.
- Wash hats, gloves and boots daily. Always wear clean clothes daily.
- Empty pockets and cuffs of any pesticide granules outdoors, discarding them in a safe manner. Granules left in clothing could dissolve into the wash water and not be completely resolved during the wash cycle.
- Keep contaminated clothing in containers separate from the regular family laundry and always wash separately.
- Test gloves for leaks by filling them with water and gently squeezing.
- Wash contaminated clothing as soon as possible after each wearing. The longer they stand, the harder it is to remove the chemicals.
- Wash goggles and face shield at least once a day.
- If clothes have become contaminated with concentrated, highly toxic pesticides, destroy them by burial. Washing will not make them safe to wear. A recent research study found that cotton denim fabric swatches contaminated with an undiluted methyl parathion emulsifiable concentrate solution still contained a considerable amount even after 10 washings. However, three launderings removed nearly all traces of a diluted field strength methyl parathion solution.
- Burial is the preferred method of disposing of heavily contaminated clothing. Burning is not a satisfactory solution because of the danger of pesticide residue being carried some distance by the smoke.
- Bury contaminated clothing at least 18 inches deep in open fields, but only in locations where surface and subsurface water will not be polluted. Don't use sites where animals, such as hogs, might uncover them while rooting or digging.

# Pesticide Safety

## Protective Clothing and Equipment Guide

Formulation	Label Signal Word		
	CAUTION	WARNING	DANGER
Dry	Long-legged trousers and long-sleeved shirt; shoes and socks	Long-legged trousers and long-sleeved shirt; shoes and socks; wide-brimmed hat.	Long-legged trousers and long-sleeved shirt; shoes and socks; hat; gloves; cartridge or cannister respirator if dusts in air or if label precautionary statement says: "Poisonous or fatal if inhaled."
Liquid (when mixing)	Long-legged trousers; long sleeved shirt; shoes and socks; wide-brimmed hat.	Long-legged trousers and long-sleeved shirt; shoes and socks; wide-brimmed hat; rubber gloves. Goggles if required by label precautionary statement. Cartridge or canister respirator if label precautionary statement says: "Do not breathe vapors or spray mists." or "Poisonous if inhaled."	Long-legged trousers and long-sleeved shirt; rubber boots; wide-brimmed hat; rubber gloves, goggles or face shield. Canister respirator if label precautionary statement says: "Do not breathe vapors or spray mists," or "Poisonous if inhaled."
Liquid (prolonged exposure to spray, or application in enclosed area)	Long-legged trousers and long-sleeved shirt, boots, rubber gloves, waterproof wide brimmed hat, cartridge respirator.	Water-repellent, long-legged trousers and long-sleeved shirt, rubber boots, rubber gloves, rubber apron, waterproof wide-brimmed hat, face shield, cartridge or canister respirator.	Waterproof suit, rubber boots, rubber gloves, waterproof hood or wide-brimmed hat, face shield canister respirator.

## Personal Cleanup

Any time you spill a pesticide on yourself, wash immediately. When you finish working with pesticides or pesticide-contaminated equipment, take a shower. Wash your body and hair thoroughly with detergent and water. Work clothing should be changed daily. Place used clothing away from your other clothes and away from the family laundry. The pesticides remaining on your work clothes could injure persons who touch them. Do not allow children or pets to play in them. Be sure that the person who will be laundering your work clothes knows of the potential danger. Do not launder work clothes with the family laundry. Run the washing machine through one cycle with only detergent after washing pesticide work clothes. Do not wash contaminated gloves, boots, respirators, or other equipment in streams or ponds. The pesticides could poison aquatic life or harm people, livestock, or wildlife.

## Reentering Treated Areas

Unprotected persons should not enter an area immediately after a pesticide application. The waiting period is called the reentry interval. Workers not wearing proper protective clothing must always wait at least until sprays have dried or dusts have settled before entering an area treated with any pesticide. Some highly toxic carbamate and organophosphate pesticides have specific reentry times set by law. These times must be listed on the pesticide label.

If you are in charge of a pesticide application, you should warn workers and other people that an area has been treated with pesticides. The only exceptions are mosquito abatement and related public pest control programs, and livestock and other animal treatments.

## Handling Pesticides Safely

### Transportation of Pesticides

You are responsible for the safe transport of pesticides in your possession. The safest way to haul pesticides

is in the back of a truck. Secure all containers to prevent breakage and spillage. Keep the pesticides away from food, feed, livestock, pets, and passengers. Pesticides should be transported only in correctly labeled containers. Be sure to keep paper and cardboard packages dry. If any pesticide is spilled in or from the vehicle, clean it up right away using correct cleanup procedures. Do not leave pesticides unattended. You are responsible if accidents occur.

### Pesticide Storage

Regulations addressing storage, mix/load, wash facilities have been proposed by EPA. Contact the Pesticide and Fertilizer Program, Kansas Department of Agriculture at 785-296-3786 for current information.

As soon as pesticides arrive, store them in a designated place. The storage area should be in a cool, dry, well-ventilated and well-lighted room or building that is insulated to prevent freezing or overheating. Be sure that the area is fireproof, with a concrete floor. Keep the area locked to prevent entry by children and other unauthorized persons and post warning signs on doors and windows.

The area should be supplied with detergent, hand cleaner, and water; absorbent materials, such as absorbent clay, sawdust, and paper to soak up spills; a shovel, broom, and dustpan; and a fire extinguisher rated for ABC fires.

The storage building or area should be located away from where people and animals live. This will avoid or minimize harm to them in case of fire or flooding.

Store all pesticides in the original containers. Do not store them near food, feed, seed, or animals. Store paper containers off the floor. Check every container for leaks or breaks. If one is leaking, position the containers so the hole is on the top. Then transfer the contents to a container that has held exactly the same pesticide. If one is not available, use a clean container of similar construction and label it correctly. In cases where paper con-

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# Pesticide Safety

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tainers are punctured, place them in a heavy, clear-plastic bag. Clean up any spills. Keep an up-to-date inventory of the pesticides you have.

## Mixing and Loading Pesticides

Studies have shown that pesticide applicators are most often exposed to harmful amounts of pesticides when handling concentrates.

Workers involved in mixing and loading undiluted highly toxic pesticides are exposed to a high risk of accidental poisoning. Pouring concentrates from one container to another is the most hazardous activity.

### Safety Guidelines

By observing some simple precautions, you can reduce the risks involved in this part of your job. It is important to keep livestock, pets, and people out of the mixing and loading area. Do not work alone when using highly toxic pesticides. Choose a place with good light and ventilation. Be particularly careful not to mix or load pesticides at night or indoors unless lighting and ventilation are adequate.

Before handling a pesticide container, put on protective clothing and equipment. Each time you use a pesticide, read the directions. Do this before you open the container. This is essential—directions, including amounts and methods, often change.

Do not tear paper containers to open them. Use a sharp knife. Clean the knife afterwards, and do not use it for other purposes. When pouring a pesticide from the container, keep the container and pesticide below eye level. This will help avoid a splash or spill on your goggles or protective clothing.

If you splash or spill a pesticide while mixing or loading, stop right away and remove contaminated clothing. Immediately wash thoroughly with detergent and water. Then, clean up the spill.

When mixing pesticides, measure carefully. Use only the amount called for on the label and mix only the volume you plan to use.

When loading pesticides, stand so the wind does not blow them toward your body. To prevent spills, close containers after each use.

### Closed Handling Systems

Closed handling systems can reduce the applicator's exposure to concentrated pesticides. A closed handling system is a series of interconnected equipment which allows the applicator to remove a pesticide from its original container, rinse the empty container, and transfer the pesticide and rinse solution to the spray tank without contacting the pesticide.

Closed system handling has several advantages and disadvantages.

#### Advantages:

- increased applicator safety,
- less need for protective clothing and equipment (waterproof clothing and respirators can be uncomfortable, especially in hot weather),
- reduction of spills,
- more accurate measurement. This reduces overdosing and under dosing and may result in savings to the applicator.

#### Disadvantages:

- equipment may be cumbersome,
- equipment is not usable with all pesticide containers because of variations in drum openings, shapes, and sizes,
- many steps involved in the system
- all must be done in proper sequence.

The systems now available are designed to remove the pesticide concentrate from the original container in one of two ways:

- gravity,
- suction.

Gravity systems are sometimes called "punch and drain" systems. The unopened pesticide container is inserted into a chamber, which is then sealed. A punch cuts a large opening in the container, allowing all the material to drain into the mixing tank. A water nozzle attached to the punch sprays the inside of the container to rinse it thoroughly. The rinse water also drains into the mixing tank. The

rinsed container is then removed for disposal. A limitation of this system is that only full container quantities can be used. It is not possible to use part of the pesticide in a container and store the rest.

Suction systems use a pump to remove the pesticide through a probe inserted into the container. Some containers are equipped with built-in probes. The pesticide is transferred to the mixing tank by hose and pipe. When the container is empty, it and the transfer system are rinsed with water. The rinse water is added to the mixing tank.

To allow the use of only part of the pesticide in the container, the system must have a way to measure the amount of pesticide suctioned into the mixing pan, and must allow the probe to remain in the container until all the pesticide is used and the container and probe can be rinsed. Some probes have a breakaway head which allows the head to stay and the probe to be withdrawn and reused.

In some systems, it is not possible to reseal partially emptied containers. Another disadvantage of suction systems is that highly viscous pesticides (those which pour like molasses) are difficult to move by suction.

Two techniques have been developed for handling dry concentrates. One is a dosed handling system similar to those used for liquid formulations. The other is soluble packaging. Soluble bags or containers allow an applicator to put the entire package (pesticide and container) into the tank. The container dissolves in the solvent in the tank. Disadvantages of soluble packaging include the risk of releasing the concentrate if the packaging is exposed to water during shipping and the possibility of "splashback" as containers are added to the tank.

## **Pesticide Application**

The safety of yourself and others should be a major concern during any pesticide application. Follow all label directions carefully, and observe these basic safety guidelines.

Wear the correct protective clothing and equipment. Wear waterproof clothing if you will be working in drift, spray or runoff. Do not wipe your gloves on your clothing; this will contaminate your clothing and may soak through to your skin. Never eat, drink, smoke, or chew while handling or applying pesticides. Wash your face and hands thoroughly first. If you feel ill, do not try to finish the job. Get out of the area fast and get help.

If you will be working outdoors, choose application equipment, formulations, and additives that will minimize drift and runoff. Do not apply pesticides during or just before expected high winds or heavy rains. Try to spray downwind from sensitive areas such as beehives, residential areas, waterways, and nontarget crops and livestock.

If you are working indoors, be sure you have adequate ventilation or wear a supplied-air respirator. Be sure that nontarget food and feed, toys, and pets are removed from the area to be treated. Failure to do this is a misuse of the pesticide. Choose application techniques, equipment, and formulations that minimize exposure to persons and non-target animals who may have to reenter treated areas to live or work.

To prevent spillage and possible poisonings, check all application equipment for leaking hoses, pumps, or connections; and plugged, worn, or dripping nozzles. Do not blow out clogged nozzles, hoses, or lines with your mouth. Do not allow children, pets, or unauthorized persons to touch application equipment or pesticide containers or to enter storage areas. Correctly calibrate your equipment before use. Try to use all the pesticide in your tank or hopper. If you have some left over, use it for other labeled uses.

Before application, you must clear the area of all unprotected persons. By law, the application of a pesticide—either directly or through drift—must not expose workers or other persons.

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# Pesticide Safety

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## Cleaning Equipment

Never leave pesticide equipment at the application site. When the tank or hopper is empty, return the equipment to the area designated for equipment cleanup. Mixing, loading, and application equipment must be cleaned as soon as you finish using it. Clean both the inside and outside, including nozzles. Only trained persons should do this job. They should wear correct protective clothing.

Have a special procedure for cleaning equipment. A designated cleaning location ought to have a wash rack or concentrate apron with a sump to catch contaminated wash water.

If at all possible, reuse sump collections when mixing compatible spray solutions. If necessary contaminated sump collections should be disposed of as you would other pesticides. Keep drainage out of water supplies and streams.

Equipment sometimes must be repaired before it is completely cleaned. Warn the person doing the repairs of the potential hazards.

## Disposal

### Pesticides

The best way to solve the problem of pesticide waste disposal is to simply avoid producing any. Excess pesticides should be properly collected, labeled and temporarily stored for use in another spray mixture. Rinse solutions should also be collected and used as diluent in subsequent tank mixes. Pesticide inventories should be carefully managed so that old or useless pesticide products do not accumulate. All pesticides or pesticide solutions should be stored according to label directions.

### Containers

Do not leave pesticides or pesticide containers at the application site. Never give pesticide containers to children to play with or adults to use. Leftover pesticides should be kept in tightly closed containers in your storage facility.

Always triple rinse empty containers of liquid pesticides as follows:

1. Empty the container into the tank. Let it drain an extra 30 seconds.
2. Fill it one-fifth to one-fourth full of water.
3. Replace the closure and rotate the container. Invert the container so the rinse reaches all the inside surfaces.
4. Drain the rinse water from the container into the tank. Let the container drain for 30 seconds.
5. Repeat steps 2 through 4 at least two more times for a total of three rinses. Remember to empty each rinse solution into the tank.

### *Burnable Containers*

- You may burn small numbers of them if permitted by state and local regulations unless prohibited by the label.
- You may take them to a landfill operating under state permit for pesticide disposal.

### *Nonburnable Containers (metal, plastic, or glass)*

- Rinse the containers three times.
- Many large containers in good shape can be reused by your supplier. Return them to your supplier, a pesticide manufacturer or formulator, or a drum reconditioner.
- You can send or take them to a place that will recycle them as scrap metal or dispose of them for you.
- Properly rinsed containers may be crushed and buried in a sanitary landfill. Follow state and local standards.
- If it is not possible to rinse containers, contact the Department of Health and Environment for assistance.

### **Hazardous Waste**

When a pesticide waste is produced it is important that it be properly disposed of according to state and federal laws. Four options are available with preference in the order listed:

1. Reuse according to the label instructions. The Kansas Department of Agriculture, Pesticide and Fertilizer Program (785-296-3786) can provide assistance concerning label instructions.
2. Return the unused pesticide to the manufacturer or distributor for reprocessing. This should be done only after obtaining their approval. Transportation must be in accordance with all applicable U.S. Department of Transportation regulations. The pesticides should also be left in the original containers unless they are leaking. Assistance for shipment of pesticides include the U.S. Department of Transportation (785-267-7288) and the U.S. Environmental Protection Agency (913-551-7030).
3. Hazardous wastes in quantities exceeding the minimum exemption limit must be disposed by a permitted hazardous waste disposal facility.
4. Small quantity hazardous and non-hazardous wastes can be disposed at the county sanitary landfill depending upon the quantity and type of pesticide. However, before transporting any pesticide wastes to a sanitary landfill, you must contact the Kansas Department of Health and Environment (785-296-1600).

In order to determine if any of your wastes are considered hazardous and to what extent you are regulated, contact the Kansas Department of Health and Environment. They have prepared a booklet entitled, *A Guide to Pesticide Waste Disposal in Kansas*, which provides information on this subject. The booklet may be obtained by calling 785-296-1600, or by writing: Department of Health and Environment, Bureau of Waste Management, 1000 S.W. Jackson, Suite 320, Topeka, Kansas 66612.

## Cleanup of Pesticide Spills

### Minor Spills

Keep people away from spilled chemicals. Rope off the area and flag

it to warn people. Do not leave unless someone is there to confine the spill and warn of the danger. If the pesticide was spilled on anyone, wash it off immediately.

Confine the spill. If it starts to spread, dike it up with sand or soil. Use absorbent material such as soil, sawdust, or an absorbent clay to soak up the spill. Shovel all contaminated material into a leak-proof container for disposal. Dispose of it as you would a pesticide waste. Do not hose down the area, because this spreads the chemical. Always work carefully and do not hurry.

Do not let anyone except properly trained persons enter the area until the spill is completely cleaned up.

### Major Spills

The cleanup of a major spill may be too difficult for you to handle, or you may not be sure of what to do. In either case, keep people away, give first aid if needed, and confine the spill. Then call Chemtrec, the local fire department, and state pesticide authorities for help.

Chemtrec stands for Chemical Transportation Emergency Center, a public service of the Manufacturing Chemicals Association. Its offices are located in Washington, D.C. Chemtrec provides immediate advice for those at the scene of emergencies.

Chemtrec operates 24 hours a day, seven days a week, to receive calls for emergency assistance. For help in chemical emergencies involving spills, leaks, fire, or explosions, call toll-free 800-424-9300 day or night. This number is for emergencies only.

If a major pesticide spill occurs on a highway, have someone call the highway patrol or the sheriff for help. (Carry these phone numbers with you.) Do not leave until responsible help arrives.

## Cleanup Notification of Pesticide Spills

### Minor Spills

Generally speaking, a minor spill is one involving 1 quart or approximately 2 pounds or less of pesticide

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concentrate. However, common sense must be used in determining how much action you as an individual take regarding pesticide spills. For example, 1 quart of a highly toxic insecticide requires more expertise and precautions in handling clean-up and disposal than does 1 quart of low toxicity herbicide.

Keeping the product toxicity in mind, a general procedure for cleaning up a minor spill would be to use an absorbent, such as pet litter, cover with bleach, and scrub the area with detergent. Then follow label statements for disposal, or telephone the State Department of Health and Environment, 785-296-1600, or the State Department of Agriculture, 785-296-3786, for further instructions on disposal.

### ***Pesticide Spill Phone Numbers***

1. Local Poison Control Center:
2. County Extension Agent:
3. Local Police Department:  
City, County, State
4. Local Fire Department:
5. Civil Defense:
6. Department of Emergency Management: 785-296-3176, or 800-905-7521.
7. Department of Health and Environment: 785-296-1600.
8. Kansas Department of Agriculture: 785-296-3786.

Before authorities arrive, get a copy of the pesticide label and if possible determine the toxicity of the pesticide involved. Information from the label can be very helpful to the doctor.

### **Major Spills**

Pesticide spills caused by commercial spray rigs, aerial spray planes, and large pesticide containers may be too big to be handled by one person. There are certain procedures one should follow to notify the proper authorities.

All spills should be reported by telephone to the Kansas Division of Emergency Management, 785-296-3176. If contact cannot be made, you should notify the local authorities such as the police department, fire department or civil defense office.

If there are individuals who have been exposed to the spilled pesticide, the local poison control center should be notified. Every effort should be taken to keep other people from being exposed to the spill until local authorities can assume responsibility at the site.

For all problems, accidents, or incidents that occur, you should have a list of the phone numbers of these authorities available and accessible.

### ***Pesticide Regulatory Agencies***

Department of Emergency Management: 785-296-3176, or 800-905-7521.

Department of Health and Environment: 785-296-3786.

Kansas Department of Agriculture: 785-296-3786.

U.S. Environmental Protection Agency Region VII Office: 913-551-7030.

## **First Aid and Pesticide Poisoning Recognition**

### **First Aid**

Get medical advice quickly if you or any of your fellow workers 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.

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 poison before you call for emergency help. Apply artificial respiration if the victim is not breathing.

Read the first aid instructions on the pesticide label, if possible. Follow those instructions. Do not become exposed to poisoning yourself while you are trying to help. Take the pesticide container or the label to the physician. Do not carry the pesticide container in the passenger space of a car or truck.



## *Poison on skin:*

- Act quickly.
- Remove contaminated clothing and drench skin with water.
- Cleanse skin and hair thoroughly with detergent and water.
- Dry victim and wrap in blanket.

## *Chemical burn on skin:*

- Wash with large quantities of running water.
- Remove contaminated clothing.
- Cover burned area immediately with loose, clean, soft cloth.
- Do not apply ointments, greases, powders or other drugs in first aid treatment of burns.

## *Poison in eye:*

- Wash eye quickly but gently.
- Hold eyelid open and wash with gentle stream of clean running water.
- Wash for 15 minutes or more.
- Do not use chemicals or drugs in the wash water. They may increase the extent of injury.

## *Inhaled poison:*

- Carry victim to fresh air immediately.
- Open all doors and windows so no one else will be poisoned.
- Loosen tight clothing.

Apply artificial respiration if breathing has stopped or if the victim's skin is blue. If patient is in an enclosed area, do not enter without proper protective clothing and equipment. If proper protection is not available, call for emergency equipment from your fire department.

## *Poison 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 label.

## *Procedure for inducing vomiting:*

- Position victim face down or kneeling forward. Do not allow victim to lie on his/her back, because the vomitus could enter the lungs and do additional damage.

- Put finger or the blunt end of a spoon at the back of victim's throat or give syrup of ipecac.
- Collect some of the vomitus for the physician if you do not know what the poison is.
- 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 severe damage to the lungs if inhaled during vomiting.

## **Pesticide Poisoning Recognition**

Pesticides can poison humans as well as the target pests. Some pesticides are highly toxic to humans; only a few drops in the mouth or on the skin can cause severe injury. Other pesticides are less toxic, but over-exposure to them will cause injury. You should know the kinds of injury most likely to be caused by the pesticides you use.

A symptom is any bit of evidence that you are sick. It is something abnormal that you feel. Examples of symptoms are headache, dizziness, profuse sweating, weakness and nausea. A sign is evidence of an abnormality or disorder as observed by a physician. Examples of signs are vomiting, salivation, fever, declining mental alertness, and convulsions. Symptoms reported by a patient and signs observed by the doctor are used in diagnosis of a pesticide poisoning.

Pesticides in the same chemical group cause the same type of poisoning. The illness may vary from mild to severe depending upon the

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pesticide, the amount of pesticide and length of time the pesticide is in contact with the body, and other factors. Pesticide poisonings may occur by accidental ingestion, skin contact and/or by inhalation. Contact your doctor immediately if you or your co-worker have symptoms or signs of pesticide poisonings which occur after using a pesticide. Take the label of the pesticide with you when you go to the doctor.

Most chemical manufacturers are equipped to provide emergency information on their products. Manufacturers may be contacted through CHEMTREC. For help in a Chemical Emergency Involving a Spill, Leak, Fire, or Exposure, Call Day or Night CHEMTREC, (800) 424-9300.

Below are frequent symptoms and signs of pesticide poisonings.

## *Dithiocarbamates and Thiocarbamates*

These classes of chemicals include many fungicides and herbicides. Fungicides of the group include thiram, ferbam, maneb, and zineb. Herbicides of this group include butylate, vernolate, and EPTC.

**Toxicology:** Although these chemicals are similar, they are metabolized differently by animals and effects on human health are also different. Thiram and ferbam irritate the skin and mucous membrane. Maneb and zineb degrade in the environment and in animal tissues to a compound that apparently causes cancer in laboratory animals. Thiocarbamate herbicides are moderately irritating to skin and eyes but do not appear to be highly toxic.

**Symptoms and Signs:** Skin irritation may result from contact with thiram and ferbam. Swallowing large amounts of one of these pesticides may produce nausea, vomiting and diarrhea. If excessive amounts of spray or dust are inhaled, maneb, zineb and some herbicides irritate the skin and cause itching, sneezing and cough.

## *Herbicides*

### *Phenoxy Compounds*

Herbicides in this group include 2,4-D and 2,4-DB.

**Toxicology:** Some of the phenoxy acids, salts, and esters are moderately irritating to skin, eyes, and respiratory and stomach linings. These compounds are absorbed through the gut wall, lungs, and skin. Excretion in the urine occurs within hours, or at most, days. Given in large doses to experimental animals, 2,4-D causes vomiting, diarrhea, weight loss, ulcers of the mouth and pharynx, and toxic injury to the liver, kidneys, and central nervous systems.

**Symptoms and Signs:** Phenoxy compounds are moderately irritating to skin and mucous membranes. Inhalation of sprays may cause burning sensations in the chest and coughing may result. Swallowing of very large amounts has produced fever, hyperventilation and sweating.

### *Nitrophenolic and Nitrocresolic Herbicides*

Herbicides in this group include dinitrophenol, dinitrocresol, and dinoseb. Combinations widely used include dinoseb + naptalam and sodium salts of dinoseb + naptalam.

**Toxicology:** These materials are highly toxic to man and animals. Most nitrophenols and nitrocresols are absorbed through the stomach, skin, and lungs when fine droplets are inhaled. These chemicals are toxic to the liver, kidney and nervous system.

**Symptoms and Signs:** Profuse sweating, headache and thirst are common early symptoms of poisoning. Signs of poisoning include fever, unconsciousness and convulsions.

### *Paraquat and Diquat*

Herbicides and products in this group include paraquat (Gramoxone, Paraquat, Ortho Paraquat) and diquat (Ortho Diquat).

**Toxicity:** These chemicals injure the skin, nails, cornea, liver, kidney, and linings of the gastrointestinal and

respiratory tracts. Contact with the concentrate may cause irritation and fissuring of the skin of the hands, and cracking and sometimes loss of the fingernails. When absorbed in ingestion, paraquat damages the liver and kidney. Diquat appears less likely than paraquat to cause death.

**Symptoms and Signs:** Pain, nausea, vomiting and diarrhea are the earliest symptoms of injury and signs following ingestion of paraquat. Diquat ingestion results in intense nausea, vomiting, and diarrhea. Other signs signal severe poisoning by paraquat or diquat.

### *Insecticides*

#### *Organophosphates*

Some common examples are parathion, methyl parathion, DiSyston, Phosdrin, and Counter. These pesticides poison insects and other animals by binding with a chemical in the bloodstream. This chemical, an enzyme, must be present for the normal transmission of nerve impulses from the nerve fibers to the body tissues. Some loss of this enzyme can occur before symptoms and signs of poisoning appear. When the insecticide is present in sufficient dosage, the enzyme "cholinesterase" becomes "tied up." This allows accumulation of acetylcholine (the substance that allows for the transmission of impulses at various junctions), and a "short-circuit" results. The nerves continue to send messages to certain muscles. This is reflected in muscle twitchings and weakness. It also impairs nerve transmission in the brain causing disturbances in one's vision, sense of balance, muscular control and respiratory drive.

Organophosphates are absorbed by breathing, swallowing, and skin. Signs and symptoms of poisoning may develop rapidly in some cases, and more gradually in others. To a degree, toxicity depends on the rate that insecticides are broken down in the body. Symptoms of acute poisoning usually develop within 4 hours of contact; signs and symptoms devel-

oping later than 12 hours following exposure are not apt to be the result of organophosphate poisoning. Early symptoms include headache, dizziness, and weakness. Blurred vision or "pinpoint" vision may occur; eyes may water, drooling or watering at the mouth, abdominal cramps, diarrhea, and sweating may also occur. In advanced cases, fits and unconsciousness, lack of bowel control and respiratory depression may be experienced. Even though the patient may be near death at this stage of poisoning, he/she may be saved if proper medical treatment is applied quickly and continued for a long enough period of time.

You should be alert to the early signs and symptoms of poisoning. Other illnesses may cause symptoms similar to those described here. If any of these signs or symptoms appear, shortly after contact with these pesticides, call your doctor and advise him/her of the nature of the pesticide involved. A copy of the label should be taken along when going to the doctor. Remember the importance of immediately and completely removing contaminated clothing. By so doing, you may prevent additional pesticide exposure and minimize injury.

#### *Carbamate Insecticides*

Highly toxic ones include Temik, Vydate, Furadan, Methomyl (Lannate, Nudrin). Insecticides of this class also cause inhibition of the cholinesterase enzyme in a manner similar to organophosphates. A victim of carbamate poisoning often tends to recover after exposure. Carbamates are absorbed by inhaling, swallowing, and skin exposure. Signs and symptoms of poisoning are similar to those of phosphate poisoning. These include diarrhea, nausea, vomiting, abdominal pain, profuse sweating, salivation and blurred vision. Temporary paralysis of the extremities has been reported. Most reported illnesses have not exceeded a few hours and the prognosis is usually better than with organophosphate poisonings.

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# Pesticide Safety

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## *Chlorinated Hydrocarbons*

Examples are: Endosulfan (Thiodan), toxaphene and lindane. EPA has sharply curtailed use of many of these products. Others, however, are still active ingredients of various home and garden products and some agricultural pest control uses. The exact mode of action of these compounds is not known. In general, they act on the central nervous system to stimulate or depress. This results in behavior changes, sensory and equilibrium disturbances, involuntary muscle activity, and depression of vital centers, particularly those controlling respiration. Symptoms have been reported as soon as 30 minutes after massive exposure, but generally they develop more slowly. If maximum symptoms are not reached within a few hours after acute exposure, another diagnosis or complicating feature must be sought.

## *Pyrethrins and Pyrethroids*

Several hundred of these products are available. Many are packaged for household or garden lawn type uses. Commonly these products contain pyrethrins or a pyrethroid with a synergist such as pipronyl butoxide. Common pyrethroids are allethrin,

bioresmethrin, cypermethrin, decamethrin, permethrin, fenvalerate, tetramethrin and resmethrin. These compounds rapidly paralyze the insect nervous systems, making them famous for the quick knockdown action. Toxicity to mammals, however, is rare. Oral LD50 values of these compounds are several hundred or thousand milligrams per kilogram of body weight. Symptoms and signs of over-exposure include a stuffy, runny nose and scratchy throat from inhalation of partially purified pyrethrin extract. Asthmatic wheezing may be precipitated by exposure of predisposed individuals. A sudden bronchial spasm, swelling of mouth and larynx mucous membranes and shock have been reported with pyrethrin inhalation. On rare occasion, nervousness, irritability and tremors have been reported in persons who have breathed large amounts of pyrethrins. Hydrocarbon propellants in bug bomb products present a risk of heartbeat irregularities if inhaled to excess. Hydrocarbons used as solvents in spray products, are likely to result in cough, fever or chest pain if these liquids are inadvertently aspirated.

## Study Questions

1. (93) Exposure to pesticides may be:
  - a) acute
  - b) chronic
  - c) both of the above
  - d) none of the above.
2. (94) Neoprene or rubber boots are necessary when handling liquid concentrates which have \_\_\_\_\_ warning on the label:
  - a) Caution
  - b) Warning
  - c) Danger
  - d) use care.
3. (95) Which pesticide formulation is more difficult to remove by laundering?
  - a) dusts
  - b) soluble powders
  - c) wettable powders
  - d) emulsifiable concentrates.
4. (96) When you are intermittently exposed to pesticide fumes you should wear a:
  - a) canister respirator
  - b) cartridge respirator
  - c) supplied air respirator
  - d) self-contained breathing apparatus.
5. (97) When should you change filters and cartridges on your respirator?
  - a) if you have trouble breathing
  - b) if you smell pesticides
  - c) after a maximum of 8 hours of use
  - d) all the above.
6. (99) As soon as pesticides arrive for storage you should:
  - a) store them in the designated place
  - b) mark them with an "X" for storage
  - c) remove the label so it will not get lost
  - d) pack them in an absorbent material.
7. (100) Closed handling systems are designed to remove pesticide concentrate from the original container by:
  - a) gravity
  - b) suction
  - c) high pressure
  - d) a and b above.
8. (101) Before applying a pesticide, you must:
  - a) be paid for the job
  - b) clear the area of all unprotected persons
  - c) get the neighbor's approval
  - d) be sure the treated surface will dry within 30 minutes.
9. (102) The best way to solve the problem of pesticide waste disposal is:
  - a) dump it out along the road
  - b) pour it out in back of the shed
  - c) simply avoid producing any
  - d) bury it on the neighbor's property.
10. (103) In the case of minor pesticide spills, you should:
  - a) keep people away
  - b) confine the spill
  - c) dispose of it as you would pesticide waste
  - d) all the above.
11. (104) The initial effort to help a poisoned victim is:
  - a) respiration
  - b) transfusion
  - c) first aid
  - d) circulation.
12. (105) In the case of poison in the eye, you should:
  - a) keep the eye closed for 30 minutes
  - b) wash the eye quickly for 15 minutes with running water
  - c) put your goggles on to keep dust and dirt out
  - d) cover the eye with black cloth to keep all light out
  - e) all the above.

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# Terms Used in Pest Control

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## Other Terms Used in Pest Control

Some of these words have several meanings. Those given here are the ones that relate to pest control.

**Abrasion:** The process of wearing away by rubbing.

**Abscission:** The separation of fruit, leaves, or stems from a plant.

**Absorption:** The process by which a chemical is taken into plants, animals, or minerals. Compare with adsorption.

**Activator:** A chemical added to a pesticide to increase its activity.

**Adherence:** Sticking to a surface.

**Adsorption:** The process by which chemicals are held on the surface of a mineral or soil particle. Compare with absorption.

**Adulterated:** Any pesticide whose strength or purity falls below the quality stated on its label. Also, a food, feed, or product that contains illegal pesticide residues.

**Aerobic:** Living in the air. The opposite of anaerobic.

**Aerosol:** An extremely fine mist or fog consisting of solid or liquid particles suspended in air. Also, certain formulations used to produce a fine mist or smoke.

**Agitation:** The process of stirring or mixing in a sprayer.

**Alkaloids:** Chemicals present in some plants. Some are used as pesticides.

**Anaerobic:** Living in the absence of air. The opposite of aerobic.

**Animal Sign:** The evidences of an animal's presence in an area.

**Antagonism:** The loss of activity of a chemical when exposed to another chemical.

**Antibiotic:** A substance which is used to control pest microorganisms.

**Antidote:** A practical treatment for poisoning, including first aid.

**Aqueous:** A term used to indicate the presence of water in a solution.

**Arsenicals:** Pesticides containing arsenic.

**Aseptic:** Free of disease-causing organisms.

**Bait Shyness:** The tendency for rodents, birds, or other pests to avoid a poisoned bait.

**Bipyridyliums:** A group of synthetic organic pesticides which includes the herbicide paraquat.

**Botanical Pesticide:** A pesticide made from plants. Also called plant-derived pesticides.

**Broadleaf Weeds:** Plants with broad, rounded, or flattened leaves.

**Brush Control:** Control of woody plants.

**Carbamate:** A synthetic organic pesticide containing carbon, hydrogen, nitrogen, and sulfur.

**Carcinogenic:** Can cause cancer.

**Carrier:** The inert liquid or solid material added to an active ingredient to prepare a pesticide formulation.

**Causal Organism:** The organism (pathogen) that produces a specific disease.

**Chemosterilant:** A chemical that can prevent reproduction.

**Chlorinated Hydrocarbon:** A synthetic organic pesticide that contains chlorine, carbon, and hydrogen. Same as organochlorine.

**Chlorosis:** The yellowing of a plant's green tissue.

**Cholinesterase:** A chemical catalyst (enzyme) found in animals that helps regulate the activity of nerve impulses.

**Concentration:** The amount of active ingredient in a given volume or weight of formulation.

**Contaminate:** To make impure or to pollute.

**Corrosion:** The process of wearing away by chemical means.

**Crucifers:** Plants belonging to the mustard family, such as mustard, cabbage, turnip, and radish.

**Cucurbits:** Plants belonging to the gourd family, such as pumpkin, cucumber, and squash.

**Deciduous Plants:** Perennial plants that lose their leaves during the winter.

**Deflocculating Agent:** A material added to a suspension to prevent settling.

**Degradation:** The process by which a chemical is reduced to a less complex form.

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## Terms Used in Pest Control

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**Dermal:** Of the skin; through or by the skin.

**Dermal Toxicity:** Ability of a chemical to cause injury when absorbed through the skin.

**Diluent:** Any liquid or solid material used to dilute or carry an active ingredient.

**Dilute:** To make thinner by adding water, another liquid, or a solid.

**Dispersing Agent:** A material that reduces the attraction between particles.

**Dormant:** State in which growth of seeds or other plant organs stops temporarily.

**Dose, Dosage:** Quantity of a pesticide applied.

**Emulsifier:** A chemical which aids in suspending one liquid in another.

**Emulsion:** A mixture in which one liquid is suspended as tiny drops in another liquid, such as oil in water.

**Fungistat:** A chemical that keeps fungi from growing.

**GPA:** Gallons per acre.

**GPM:** Gallons per minute.

**Growth Stages of Cereal crops:**

(1) Tillering—when additional shoots are developing from the flower buds.

(2) Jointing—when stem internodes begin elongating rapidly.

(3) Booting—when upper leaf sheath swells due to the growth of developing spike or panicle. (4) Heading—when seed head is emerging from the upper leaf sheath.

**Hard (water):** Water containing soluble salts of calcium and magnesium and sometimes iron.

**Herbaceous Plant:** A plant that does not develop woody tissue.

**Hydrogen-Ion Concentration:** A measure of acidity or alkalinity, expressed in terms of the pH of the solution. For example, a pH of 7 is neutral, from 1 to 7 is acid, and from 7 to 14 is alkaline.

**Immune:** Not susceptible to a disease or poison.

**Impermeable:** Cannot be penetrated. Semipermeable means that some substances can pass through and others cannot.

**Lactation:** The production of milk by an animal, or the period during

which an animal is producing milk.

**LC<sub>50</sub>:** The concentration of an active ingredient in air which is expected to cause death in 50 percent of the test animals so treated. A means of expressing the toxicity of a compound present in air as dust, mist, gas, or vapor. It is generally expressed as micrograms per liter as a dust or mist but in the case of a gas or vapor as parts per million (ppm).

**LD<sub>50</sub>:** The dose of an active ingredient taken by mouth or absorbed by the skin which is expected to cause death in 50 percent of the test animals so treated. If a chemical has an LD50 of 10 milligrams per kilogram (mg/kg) it is more toxic than one having an LD50 of 100 mg/kg.

**Leaching:** Movement of a substance downward or out of the soil as the result of water movement.

**Mammals:** Warm-blooded animals that nourish their young with milk. Their skin is more or less covered with hair.

**Miscible Liquids:** Two or more liquids that can be mixed and will remain mixed under normal conditions.

**MPH:** Miles per hour.

**Mutagenic:** Can produce genetic change.

**Necrosis:** Localized death of living tissue such as the death of a certain area of a leaf.

**Necrotic:** Showing varying degrees of dead areas or spots.

**Nitrophenols:** Synthetic organic pesticides containing carbon, hydrogen, nitrogen, and oxygen.

**Noxious Weed:** A plant defined as being especially undesirable or troublesome.

**Oral:** Of the mouth; through or by the mouth.

**Oral Toxicity:** Ability of a pesticide to cause injury when taken by mouth.

**Organic Compounds:** Chemicals that contain carbon.

**Organochlorine:** Same as chlorinated hydrocarbon.

**Organophosphate:** A synthetic organic pesticide containing carbon, hydrogen, and phosphorus; parathion and malathion are two examples.

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# Terms Used in Pest Control

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**Ovicide:** A chemical that destroys eggs.

**Pathogen:** Any disease-producing organism.

**Penetration:** The act of entering or ability to enter.

**Phytotoxic:** Harmful to plants.

**Pollutant:** An agent or chemical that makes something impure or dirty.

**PPB:** Parts per billion. A way to express the concentration of chemicals in foods, plants, and animals. One part per billion equals 1 pound in 500,000 tons.

**PPM:** Parts per million. A way to express the concentration of chemicals in foods, plants, and animals. One part per million equals 1 pound in 500 tons.

**Predator:** Any animal that destroys or eats other animals.

**Propellant:** Liquid in self-pressurized pesticide products that forces the active ingredient from the container.

**PSI:** Pounds per square inch.

**Pubescent:** Having hairy leaves or stems.

**RPM:** Revolutions per minute.

**Safener:** A chemical added to a pesticide to keep it from injuring plants.

**Seed Protectant:** A chemical applied to seed before planting to protect seeds and new seedlings from disease and insects.

**Soil Sterilant:** A chemical that prevents the growth of all plants and animals in the soil. Soil sterilization may be temporary or permanent, depending on the chemical.

**Soluble:** Will dissolve in a liquid.

**Solution:** Mixture of one or more substances in another in which all ingredients are completely dissolved.

**Solvent:** A liquid which will dissolve a substance to form a solution.

**Spreader:** A chemical which increases the area that a given volume of liquid will cover on a solid or on another liquid.

**Sticker:** A material added to a pesticide to increase its adherence.

**Surfactant:** A chemical which increases the emulsifying, dispersing, spreading and wetting properties of a pesticide product.

**Susceptible:** Capable of being diseased or poisoned; not immune.

**Susceptible Species:** A plant or animal that is poisoned by moderate amounts of a pesticide.

**Suspension:** Finely divided solid particles mixed in a liquid.

**Synergism:** The joint action of two or more pesticides that is greater than the sum of their activity when used alone.

**Target Pest:** The pest at which a particular pesticide or other control method is directed.

**Tolerance:** (1) The ability of a living thing to withstand adverse conditions, such as pest attacks, weather extremes, or pesticides.

(2) The amount of pesticide that may safely remain in or on raw farm products at time of sale.

**Toxicant:** A poisonous chemical.

**Trade Name:** Same as brand name.

**Vapor Pressure:** The property which causes a chemical to evaporate. The lower the vapor pressure, the more easily it will evaporate.

**Vector:** A carrier, such as an insect, that transmits a pathogen.

**Viscosity:** A property of liquids that determines whether they flow readily. Viscosity usually increases when temperature decreases.

**Volatile:** Evaporates at ordinary temperatures when exposed to air.

**Wetting Agent:** A chemical which causes a liquid to contact surfaces more thoroughly.



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**NOTES:**

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## ANSWERS TO STUDY QUESTIONS

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