APPLY PESTICIDES CORRECTLY
A GUIDE FOR COMMERCIAL APPLICATORS

REGULATORY PEST CONTROL

A study guide
for persons seeking State of Hawaii Department of Agriculture certification
in Commercial Applicator category 9 Regulatory Pest Control
to buy, use, or supervise the use of *restricted use* pesticides

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U.S. ENVIRONMENTAL PROTECTION AGENCY
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CONTENTS

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PREFACE

Federal regulations establish general and specific standards that you must meet before you can legally use certain pesticides. Your State will provide material which you may study to help you meet the *general* standards.

This guide contains information you must know to meet the *specific* national standards for applicators who are engaged in regulatory pest control. Because the guide was prepared to cover the entire Nation, some information important to your State may not be included. The State agency in charge of your training can provide the other materials you should study.

This guide will give you information about:

- characteristics of regulated pests, including how they spread and become established,
- regulatory pest control strategies and methods,
- laws and regulations affecting regulatory pest control,
- personal safety,
- environmental impact of regulatory pest control, and
- examples of some Federal-State cooperative programs for control of regulated pests.

INTRODUCTION

Destructive insects, diseases, weeds, and other pests are a constant threat to the Nation's crops, livestock, other agricultural resources, and public health. There are three main types of control for these pests:

- prevention—keeping a pest from becoming a problem,
- suppression—reducing pest numbers or damage to an acceptable level, and
- eradication—removing a pest completely from a crop, an area, or geographic location.

Regulatory pest control programs are designed to:

- prevent the entry of foreign pests into the United States,
- control any newly discovered outbreaks of foreign pests before they become widely established,
- prevent or reduce the spread of pests that become established,
- suppress periodic outbreaks of native pests or public health vectors too widespread for farmers, ranchers, and other local groups to handle by themselves.

The agency responsible for plant, animal, and other agricultural regulatory pest control at the Federal level is APHIS — the Animal and Plant Health Inspection Service — in the U.S. Department of Agriculture. Within APHIS are two basic units:

- Plant Protection and Quarantine Programs (PPQ), and
- Veterinary Services (VS).

PPQ's plant protection work involves five major functions:

- maintaining inspections at international ports of entry,
- conducting plant pest surveys,
- establishing and maintaining international and domestic plant pest quarantines,
- carrying out plant pest control operations, and
- conducting research and development on new methods of plant pest control.

VS's animal protection program has six major functions:

- maintaining animal and animal product inspection at international ports of entry,
- eradicating outbreaks of any foreign animal pests which get past the border defenses,
- fighting domestic animal diseases of economic and/or human health significance,
- continuing research and development on new control methods,
- assuring safe and effective veterinary medications, and
- providing for humane care of animals.

The Public Health Service (PHS) is another Federal agency involved in regulatory pest control. Its mission is the prevention of spread of human diseases and pests which carry human diseases (vectors). Vessels, aircraft, or other vehicles arriving at a U.S. port from a foreign port are subject to inspection by public health regulatory officials. The inspectors search for infestations of rodents, insects, or other pests; contaminated food or water; or any other unsanitary condition that must be controlled to prevent the introduction, transmission, or spread of communicable disease. Any vehicles which contain known vectors of those diseases must be treated with a pesticide at the port of entry.

Public Health regulatory officials also have the authority to conduct comprehensive management programs to eradicate escaped or established vectors of quarantined human diseases. State and local health departments usually work cooperatively with the Public Health Service to carry out these programs.

A third Federal agency involved in regulatory pest control is the Fish and Wildlife Service (FWS). One of its missions is to reduce the agricultural losses caused by wildlife and to protect human health and safety from threats posed by wildlife. FWS policy is to reduce levels of damage and not to eradicate any species. Most species of animals being regulated under the FWS control programs are protected by State or Federal laws and are excepted from protection only when causing damage.

Regulatory officials seeking pesticide certification in Category IX (Regulatory Pest Control) should be familiar with the general functions of PPQ, VS, PHS, and FWS.

Much regulatory work is performed cooperatively between States and APHIS, PHS, or FWS. Pest management programs are jointly planned, financed, and executed. State regulatory agencies are the principal cooperators, but State Experiment Stations, county and city agencies, universities, State and local public health agencies, Extension Services, and industry often participate. Work on State land and privately owned land is done under State authority.

REGULATED PESTS

The types of organisms which may become regulated pests include:

- insects,
- mites, ticks, and spiders,
- fungi, bacteria, viruses, mycoplasmas, parasitic seed plants, and nematodes,
- weeds,
- snails and slugs, and
- vertebrate pests such as birds, reptiles, amphibians, and mammals.

Federal, State, or local governments regulate a pest if it may interfere with:

- agricultural and material production, transit, storage, or use,
- human health, comfort, or leisure, or
- the life cycle of beneficial plants or animals.

Several criteria help to determine whether a pest should be regulated:

- The pest must pose a major threat—either actual or expected.
- Consideration must be given to whether there are any other control actions which would be reasonable, effective, and less disruptive.
- The regulatory objective must be obtainable.
- The economic or societal gains must outweigh the costs of regulation.

Pest Movement

Most pests move within the environment. "Natural spread" is the movement the pest makes without the help of man. Pests can move on their own, travel with their hosts, or be carried by air, water, soil, or animals. When man or his activities move a pest, "artificial spread" occurs. Most pests move long distances by being carried either in or on people, or in infested articles and host materials moved by people.

Regulatory pest control programs usually attempt to restrict or prevent both natural and artificial spread of pests.

Pest Introduction

Introduction is the entrance of a pest into an area where it is not presently established. The possibility of pest introduction into new areas has increased as the speed of transportation and the quantity and variety of commodities transported throughout the world have increased. The increased travel of people also increases the possibility of pest introduction into new areas. It is impossible to intercept every entry of potential pests. Fortunately, the introduction of an organism into an area does not always insure its establishment as a pest.

Pest Establishment

Establishment is the survival and reproduction of a pest colony in a new environment. In their native habitat, the population growth and adverse effects of potential pests are often limited by cultural or environmental conditions. These include disease, predators, parasites, and other factors. However, organisms introduced into a new habitat where those natural controls are absent may often multiply rapidly and become pests.

Ordinarily it is difficult for a pest to become established in a new area, because a complicated set of conditions must exist for the establishment to take place.

- Introduction must occur into a favorable environment — suitable climate, available host or nutrients, lack of effective natural enemies, and little natural resistance or competition.
- The pest, upon arrival in the new place, must be healthy. It must arrive in sufficient numbers to survive natural attrition and be able to reproduce.
- Some pests require specific conditions, such as alternating seasons or alternate hosts at different life stages. The new environment must provide these conditions in the correct sequence.

The more specific the pest's requirements are, the less likely it is that it will become established.

REGULATORY PEST CONTROL PROGRAMS

The best management strategy would be to control pest populations at the point of origin. Unfortunately, such control is not practiced in many countries and may not be possible or practical in some areas of the world. Therefore, the United States must protect its plants, animals, resources, and people from pests introduced from abroad.

To obtain effective control, pest management strategies should be flexible. Control is easier and less costly if implemented when pest populations occur in a limited area and are not well established. A specific management strategy should be designed for each pest species. The plan must be based upon a thorough knowledge of several interrelated factors:

- identification of the pest species, its biology and life cycle, the way it spreads, and its method of affecting man;
- identification of host species and their distribution;
- location of established infestations, their size and extent;
- identification of natural limiting factors such as climate, geographical barriers, parasites, and predators;
- identification of effective cultural, biological, mechanical-physical, and other nonchemical control methods;
- identification of effective chemical control agents, their various formulations, the best method for applying them, and their possible effects on the environment;
- determination of whether the societal or economic benefits to be gained through the control of the pest outweigh the monetary and environmental costs.

Regulatory officials should work closely with affected State and local groups to plan and carry out pest control programs. Safeguards should be taken to protect the health of people and domestic animals, crops, wildlife, and other environmental values. All programs involving chemical pesticides should be reviewed and critically studied for their impact on the environment.

Regulatory pest control programs are conducted to suppress, contain, or eradicate pests. Six major strategies are used in the management of regulated pests:

- prevention of entry (inspection and quarantine),
- survey and detection of pests,
- eradication of infestation,
- containment of infestation,
- retardation of spread, and
- reduction of pest impact on plant and animal hosts.

Quarantines

International and domestic pest quarantines are a key method for controlling the movement of pests. They govern the importing, exporting, and inter- and intrastate movement of:

- pests harmful to plants and animals,
- pests that are a threat to public health,
- plant and animal products and other materials that might harbor and spread such pests.

Domestic Quarantines

When a new and potentially destructive pest is found in the United States, emergency regulations are put into effect to prevent artificial spread. A formal quarantine is invoked if the pest cannot be eradicated quickly and artificial spread is likely to occur. Entire States or only parts of States may be under regulation. Regulated areas should be redefined as necessary to reflect changes in infestations. Areas remain under regulation until APHIS, PHS, and State officials determine that:

- the pest is no longer a menace,
- the pest is infesting an area too large for effective quarantine action, or
- no effective control technology is available.

International Quarantines

Quarantines may also be invoked to prevent introduction of foreign pests which are new to the United States or are not widespread here.

Ports-of-Entry Inspection

Agricultural quarantine inspection at U.S. ports of entry is the Nation's major line of defense against foreign pests that affect agriculture. Public Health regulatory officials at ports of entry are responsible for preventing the introduction of pest vectors and disease agents of importance to human health. These regulatory inspectors are stationed at all major air, sea, border, and offshore ports. They examine imported cargoes of plants and animals, and plant and animal products. Treatments or other management safeguards are sometimes necessary.

Cooperating closely with other Federal and State agencies, inspectors also look for "hitchhiking" pests on incoming carriers (aircraft, ships, and vehicles) and miscellaneous nonagricultural cargo. Customs inspectors examine incoming passengers' baggage and refer all agricultural items to inspectors who intercept those items that might spread insects, diseases, and other pests to the United States. Military personnel trained in entry requirements help inspect incoming military cargo at U.S. military bases.

Inspectors also work in foreign countries to preclear agricultural commodities for export to the United States. At the request and expense of foreign exporters, they inspect and supervise treatment of animals and plants to meet U.S. entry requirements.

Inspectors also certify U.S.-grown products to meet import requirements of other countries. This inspection helps U.S. exporters avoid the expense of having shipments refused entry abroad because of pest risk. It also helps prevent spread of U.S. pests in foreign countries.

Survey and Detection

Pest surveys provide essential information about both destructive and beneficial organisms. Information collected on pests should include:

- identification and habits,
- incidence (number of pests per unit area),
- distribution (location of the infestation and the boundaries of the infestation),
- hosts, and
- damage caused.

Data collected on beneficial organisms should include:

- identification,
- incidence,
- distribution,
- host or prey, and
- effectiveness.

Such information is sometimes collected with the use of biometric surveys. These are surveys conducted on relatively small, scientifically selected sites. Survey results are then statistically applied to a large sample area. They are similar to a Gallup or Harris opinion poll. Biometrically designed surveys are the fastest, most efficient method of detecting pest infestations, spread, and population. For example, a survey of this type used to detect Japanese beetle infestations in and around a major city might use only 5 traps per square mile compared to the usual 201 per square mile. This permits surveying a larger area — 1,500 square miles compared to the usual 80 square miles — with no decrease in efficiency.

Biometrics has been introduced into nearly every area of regulatory pest control work. Statistical methods provide fast, low-cost solutions to problems. Biometric surveys are commonly used:

- to detect pest introduction or establishment near ports of entry,
- to trace natural or artificial spread of into new areas,
- to measure the success of pest control programs, and
- to monitor pesticide use.

A biometric survey may not be useful in monitoring an eradication program. Because it indicates only approximate locations and numbers, it may not detect every individual population of the pest.

Regulatory survey and detection activities fall into three broad categories:

- "early detection" pest trapping,
- the Cooperative Plant Pest Survey and Detection Program, and
- surveys conducted before and after pest management programs.

Early Detection

Surveys, using blacklight and other trapping devices, help detect the presence of pests that are new to an area. Such surveys are conducted at ports of entry and at many other locations throughout the country. This early detection is essential to prevent the establishment and spread of pests. Eradication is much easier when infestations are discovered early.

Surveys around international airports and seaports detect foreign pests that have slipped through the quarantine barrier. Border States cooperate with APHIS and PHS to conduct these surveys. In other locations, the surveys are conducted by State and local regulatory agencies to detect the spread of pests from one area to another within the United States.

Cooperative Plant Pest Survey and Detection Program

This is a joint Federal-State program through which agricultural workers across the Nation provide up-to-date information on pest conditions in their localities. Cooperators include APHIS and all State agricultural agencies — State Extension Services, Agricultural Experiment Stations, agricultural college faculties, and State plant and animal regulatory services. Commercial organizations and many other agricultural workers also assist. The information collected is published and distributed nationwide in the weekly *Cooperative Plant Pest Report.* Included in the report are pest distribution maps, crop and livestock damage figures, and other technical data.

Pest Management Programs

Surveys are an integral part of pest management programs. Data on pest reproduction levels, population buildups, and pest spread are essential for planning quarantine and treatment activities. Detection surveys identify new areas of infestation. Delimiting surveys define the limits of the infestation. These surveys provide the information that is necessary for implementing any regulatory program. Evaluation surveys measure the results of control activities.

Eradication of Infestation

If a pest is newly introduced, the immediate objective usually is to eradicate it. The best time to do this is while the population is small, not widespread, and not well established. This is also the case when an infestation begins to spread to a new area. Eradication may be difficult or almost impossible after the population grows larger and infests a large area. Usually all available means are used to eradicate the pest. Many of these methods are described below under "Reducing or Preventing Pest Destruction."

Containment of Infestation

When eradication is not immediately possible because of environmental concerns or lack of technology, it is best to try to contain the infestation. Quarantines and any available control methods should be used while additional methods or environmental safeguards are being developed.

Retardation of Spread

When it is not possible or feasible to eradicate an established pest, the objective may be to slow the spread of infestation. The methods used may be the same as for eradication, but they usually are less intensive. Quarantines may be strengthened to reduce artificial spread.

Reducing or Preventing Pest Destruction

If the population of a regulated pest increases to a point where damage becomes a problem, intensified control efforts may be needed. Usually, this action is taken when the pests threaten high-value crops or livestock, recreational or residential areas, human health, or other valuable resources. Cultural, chemical, and other control measures are used to reduce the population to a point where the damage level is acceptable and available natural controls can operate.

The control program should take advantage of natural control factors such as climate and natural enemies of the pest. In addition, each pest management system should include the most effective and safest factors of one or more of the following techniques.

Resistant Varieties

Some types of plants and animals resist pests better than others. By using resistant types, we make the environment less favorable for pests. This makes it easier to control or eradicate the pests. For example, resistant varieties are used as part of regulatory pest control programs for burrowing nematode, a pest of citrus. Rootstocks of citrus species which show resistance to the burrowing nematode have been isolated and field tested. They will soon be available to commercial nurserymen.

Biological Control

Regulated pests which originate in other countries may be suppressed by importing natural enemies from their native environment. This technique is most common for insects, mites, and some weeds. Imported natural enemies may themselves become pests, so extensive studies must be made.

Predators and Parasites — Releasing more of a pest's natural enemies into the target area can increase pest control. Organisms known to attack pests in their native environment can be imported or reared in laboratories, and released in infested areas. No parasites or predators should be released until they are determined to be harmless to man, animals, plants, and other beneficial organisms.

Many kinds of parasites and predators of the gypsy moth 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 have not always been able to prevent serious outbreaks and resultant damage.

Sterile Males — Males of some pest 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. The release of sterile males is one of the primary techniques used in the regulatory pest control program for screwworms. The technique has been successfully applied in southeastern and southwestern United States, Puerto Rico, and the Virgin Islands. The continuous release of sterile males is the primary method used to create a barrier zone between the United States and Mexico to keep the screwworms from reentering the United States.

Pathogens — Bacteria, viruses, and fungi may be introduced into an infested area to control pests by causing disease. These disease agents, like parasites and predators, are often found in the pest's native environment and are imported or reared in the laboratory for release.

The use of pathogens is an important part of the regulatory pest control program for Japanese beetles. Japanese beetles are subject to attack by two bacteria which cause the fatal milky disease. Preparations containing spores of the contagious bacteria are produced commercially and released in infested areas. One treatment of grub-infested turf will usually insure establishment of the milky disease. However, several seasons may be required before the disease reaches its greatest effectiveness and before a reduction in beetle population is evident. The disease may need to be introduced again after several years.

Cultural Control

Planting, growing, harvesting, and tillage practices may help or harm pests. Other practices such as crop rotation, pasture rotation, time of planting, and use of trap crops also affect pests.

Crop Rotation — Taking infested fields out of production and fallowing or planting an alternate crop may deprive pests of host plants on which to feed and reproduce. Crop rotation is an important part of the regulatory pest control program for the golden nematode. Many farmers withhold their lands from potato, tomato, and other host crop production.

Pasture Rotation — Keeping livestock and other host animals out of infested pastures for specific time periods may deprive pests of food and keep them from completing their life cycle. Pasture rotation is an important practice in the regulatory pest control program for cattle fever ticks. Taking host animals out of infested pastures for at least 9 months will cause the ticks to starve to death.

Trap Crops — Primary or secondary host crops planted early may draw pests away from the main crop. Destruction of such crops breaks the reproductive cycle of the pest before the main crops are established. Trap crops are used in the regulatory pest control program for boll weevil. A crop of cotton is planted early in the season to attract the boll weevils. This early crop is destroyed or treated with a systemic insecticide to control the pests before the primary crop is established.

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. This technique is used in the regulatory pest control program for the pink bollworm. Planting dates for cotton are set by each State in cooperation with the growers. The planting date must be as late in the season as possible. For the method to be successful, all the growers in the area must comply. Planting is timed so that the first bolls form well after the peak of spring bollworm emergence.

Early Plowup — Plowing soon after harvest eliminates crop debris and other hosts that may provide food and shelter for new pest generations or overwintering pests. Early plowup may also prevent some weed pests from setting seed. This technique is part of the regulatory pest control program for witchweed. Witchweed-infested land planted to tobacco, vegetables, or other early harvested crops is plowed or disked after harvest. This destroys crabgrass (hosts) and any witchweed plants before they produce seed.

Fall or Spring Tillage — Cultivation at specific times may reduce pest populations by:

- destroying the pests directly,
- destroying host plants, or
- exposing the pests to sun, wind, and natural predators.

Cultivation is often used to control weed pests. Fall or spring tillage is part of the regulatory pest control program for grasshoppers. Working the cropland soil in fall or early spring reduces grasshopper numbers by burying the eggs so deeply that young grasshoppers cannot reach the surface after hatching or by exposing the eggs to the drying action of sun and wind.

Mechanical-Physical Control

Traps, barriers, gunning, and many types of attractants and repellents are all used in regulatory pest control. These methods are used extensively for controlling vertebrate pests. They are also used to survey for other pest species.

Traps — Traps are highly selective tools used in vertebrate pest control. Steel or leg-hold traps have been used traditionally, but may injure nontarget animals that are captured. Padding the jaws may reduce this problem. The "conibear" trap is more "humane" in that its victim is quickly killed. It has fairly wide application. Live traps are generally more humane than steel traps, but are more costly to operate and are less efficient (especially for the larger predators). The trap line must be checked daily so captured animals will not starve or die of dehydration.

Barriers — There are several types of barriers, but all are designed to prevent pests from passing through. These include fenced areas and barriers which cover openings, stop tunneling, and prevent gnawing. Materials used include sheet metal, hardware cloth, concrete, asbestos board, and similar materials. This kind of approach is especially effective in control of rodents in structures.

Gunning — Gunning, though highly selective, is expensive and time-consuming. It works best in combination with other methods. It will often take larger predators not controlled by traps or toxic devices. Aerial gunning for coyotes has become a highly effective control tool.

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

Repellents — Repellents include a great variety of devices aimed at keeping pests from doing damage. Automatic exploders, noisemakers, recordings of scare calls, ultrasonics, moving objects, lights, and electric fences are some of the repellents used regularly. The efficacy of some of these devices may be questionable and may be highly dependent on correct placement.

Sanitation

Removing sources of food and shelter helps to suppress some pests. Sanitation also serves as a deterrent to pest infestations. Sanitation is one of the major aspects of regulatory pest control of boll weevil. The aim is to reduce the number of boll weevils that survive after harvest and enter hibernation sites. Cotton stalks are destroyed early in the fall, as long before frost as possible. Other sanitation methods followed are:

- fields are cultivated cleanly,
- ditch banks are plowed and rows in the field are turned,
- weed clusters are removed,
- dense undergrowth is removed from nearby woods,
- litter around farm buildings is destroyed.

Sanitation is also important in the control of animal disease vectors. Fly control in and around barns and livestock pens, for example, is greatly aided by prompt manure removal and other sanitary techniques.

Chemical Control

Chemicals are generally the fastest way to control pests. In many instances, they are the only weapons available. Identification of the best pesticide for the job is an important responsibility for regulatory pest control officials. Often a single pesticide is sold in several formulations. The regulatory official should choose the formulation which will best meet the requirements for each situation.

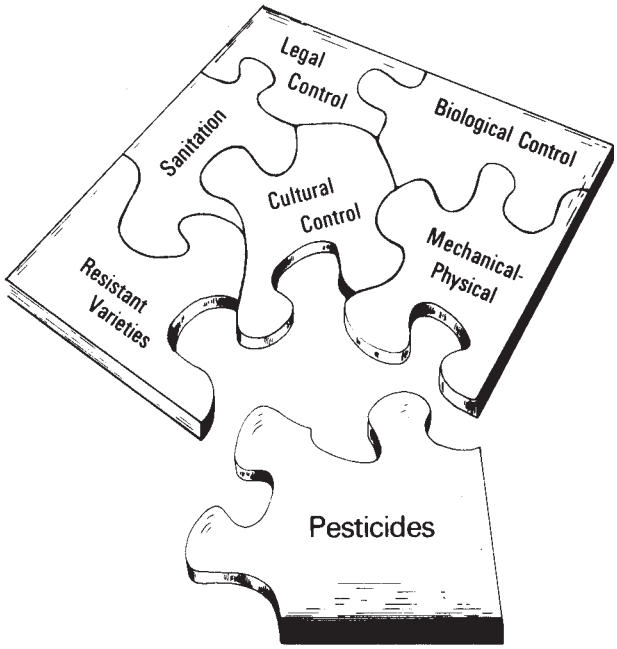
Considerations in making a choice should include:

- effectiveness against the pest,
- whether the product is registered for the intended use,
- the plant, animal, or surface to be treated,
- the application equipment available or proposed method of application,
- cost,
- the danger of drift and runoff.
- potential injury to applicator,
- presence of endangered species, if any,
- effect on nontarget organisms such as wildlife and humans, and
- type of environment the application must be made in — such as agricultural, forest, urban.

Integrated Pest Management

Integrated pest management (IPM) programs should be cooperative Federal-State-producer-industry undertakings. The objective is to develop

Integrated Control



and implement a pest control system using a combination of pest control techniques — resistant varieties, biological, cultural, mechanical-physical, sanitation, and chemical control methods. Advantages of the integrated approach may include more effective pest control, lower production costs, and reduced use of chemical pesticides. Regulatory agencies should cooperate with other Federal agencies, the Cooperative Extension Service, State experiment stations and universities, and local growers and ranchers to establish IPM programs and pilot projects.

SPECIALIZED APPLICATIONS

A variety of pesticides and pesticide application equipment are used in regulatory pest control programs. Many of the programs are carried out in cooperation with affected farmers, ranchers, or other local groups who often provide the application equipment and may make the applications. Other pest control work may be done by commercial applicators under contract to regulatory agencies.

Sometimes, however, regulatory pest control officials must apply pesticides. These applications may require the use of specialized equipment designed for efficient control of some regulated pests. Such areas of specialty include, but are not limited to:

- commodity fumigation,
- aerial application,
- vat-dipping and spray-dipping of livestock, and
- use of mechanical toxicant delivery systems.

Commodity Fumigation

Commodity fumigation is necessary for the treatment of infested commodities or other items that move from regulated areas. Because fumigation is a complex process, correct procedures vary according to the situation. The following, however, are some basic principles of fumigation.

Pests in Fumigated Commodities

The type of fumigation needed depends in part on:

- the kind of pest present, and
- the life cycle stage of the pest at the time of treatment.

If only adult pests are present and there is air space throughout the load, low dosages and short exposures are usually adequate. But if eggs, larvae, cysts, or pupae are present, higher dosages or longer exposure periods may be required.

Immature forms of some pests are more resistant to fumigation than adults are. Both dosage and exposure period usually must be increased:

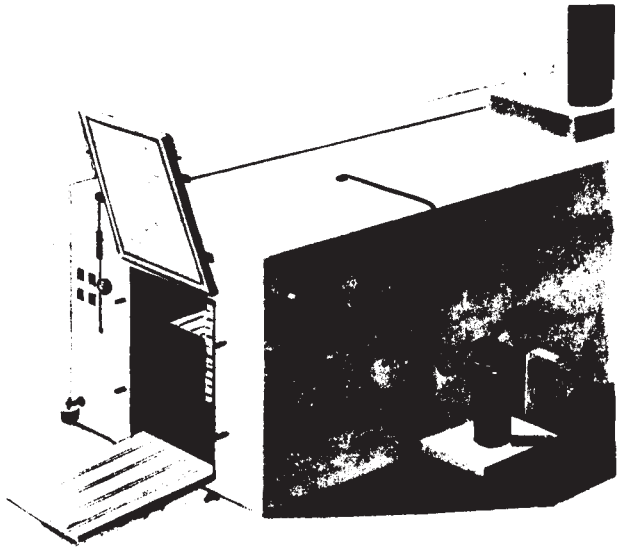
- when pests are embedded in commodities (such as the weevil in sweet potatoes and fruit flies in citrus), or
- when pests are in closely packed or dry, sorptive commodities (such as the granary weevil in flour).

Nature of Fumigated Commodities

Commodities or objects which require fumigation range from loosely packed and nonsorptive (such as scrap iron) to closely packed and highly sorptive (such as ground alfalfa hay). Loosely packed, nonsorptive materials allow gas to circulate easily throughout the load. Pests in all stages of development can be reached by the fumigant and may be relatively easy to kill. Pests in closely packed, highly sorptive materials are much harder to kill because the fumigants cannot circulate well. Closely packed materials have little air space for the gas to enter. Dry, highly sorptive commodities absorb the gas as it enters the mass. Fumigation treatments should be designed to allow for these factors.

Tightness of Fumigation Chamber

Many types of atmospheric-pressure fumigation chambers are used to fumigate commodities. All such chambers must be tightly sealed to be effective. The tightness of the seal cannot be judged visually. Use an approved method to determine whether chambers are tight enough.



Fumigation Chamber

Circulation

Many fumigants used to treat regulated pests require circulation. Circulation is necessary to prevent possible injury to the commodities, to comply with tolerances set by the Environmental Protection Agency, and to achieve maximum pest control. The gases must be mixed with air and circulated so that they quickly come in contact with all of the material to be treated. Without adequate circula-

tion, the gas would be trapped by the part of the load it contacted first.

There must be space above or below the load to allow air and gas to mix and circulate properly as the fumigant is introduced. Otherwise, gas concentrations will become too high at first.

Overloading and Underloading — Overloading of fumigation chambers prevents or slows the circulation of the gas. This may cause:

- uneven concentrations of gas,
- incomplete kill of pests, and
- increased injury to susceptible commodities.

Underloading disrupts the circulatory system. There will be too much gas in the area through which the flow passes and too little gas elsewhere in the chamber.

Nature of Commodities — Consider the nature of the commodities when arranging loads for fumigation. When you load dry, porous commodities such as hay, straw, and corncobs, leave a few inches of space between the load and side walls of the chamber. Whenever possible, leave space between tiers of bags, bales, etc. Products may be placed directly against the walls of the fumigation chamber if:

- they do not absorb gas rapidly, and
- they allow enough space between individual items to permit air to move downward freely.

Fully Loaded Chambers — Directions for fumigation usually assume that the chamber will be fully loaded. Using normal dosages to treat partial loads may cause illegal residues. Use appropriate size chambers whenever possible. Otherwise, add empty crates or other objects to simulate normal loads.

Personal Safety in Fumigant Application

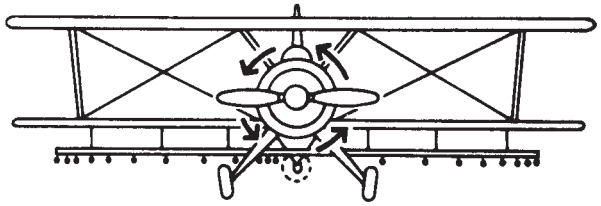
Most fumigants used in regulatory pest control are highly toxic to humans. Be careful to follow all label instructions for safety and protective clothing and equipment. Too much exposure to fumigants may make a person seem drunk. The signs and symptoms of fumigant poisoning are:

- poor coordination,
- slurring words,
- confusion, and
- sleepiness.

Repeated exposure to the fumigant methyl bromide, which is often used in regulatory pest control, can cause permanent internal injury without early signs or symptoms of poisoning. The operator may receive a fatal dose before any symptoms appear.

Aerial Application

Aircraft are generally used to disperse pesticide sprays, baits, dusts, granular formulations, and



some biological control agents over large areas. In large control programs, electronic systems may guide the aircraft and record the area treated. Regulatory pest control officials directly involved in aerial application of pesticides should be familiar with the information in the USDA/EPA manual "Aerial Application". It is available through State regulatory agencies and State Extension Services.

Selection of Aircraft

In selecting aircraft for a specific program, consider such factors as:

- the total acreage to be treated,
- the size of individual blocks,
- the time allotted for completion,
- available airstrips,
- ferry distances,
- the type of terrain, and
- the number of personnel available to manage the operation.

It is impractical to use large, fast aircraft on blocks less than 2 or 3 miles long. Small aircraft should not be used when the number required would congest the airstrip or when long ferry distances are involved.

Weather

Weather plays an important role in aerial application. Winds may carry pesticides away from the target area. High temperatures may cause fine sprays to evaporate or drift away without reaching the target. The best weather for aerial application of pesticide sprays and dusts is usually from dawn until mid-morning and in early evening.

During late spring, summer, and early fall, temperature inversions commonly occur in early morning. A temperature inversion exists in still air that:

- is coolest at ground level,
- gets warmer up to a certain height, and
- gets cooler from that point on up.

Do not attempt aerial application during a temperature inversion. Pesticide particles released into the cool air layer at ground level during an inversion have little upward movement. The slightest air movement can cause the particles to drift for great distances before they settle out.

Unless the program is an emergency, it is best not to apply sprays or dusts in the late evening. When evening applications are planned, it is important to know when it will be too dark to work safely. No pilot should take off with a load of pesticides unless he can complete the round trip before dark. Even though the airport may be lighted for safe landing after dark, the pilot must have time to complete the application in daylight.

An exception is the application of certain specialized chemicals to control winter-roosting starlings and blackbirds. Some of these compounds require cold temperatures and rain in order to be lethal. Also, they must be applied after dark when the birds are in the roost. Therefore, the use of these compounds is restricted to weather which would not be suitable for any other aerial pesticide applications.

Personal Safety in Aerial Application

Pilots, ground crew, and flagmen all need to avoid unnecessary contact with the pesticides being handled and applied. The onset of poisoning symptoms during flight could cause a serious accident. Aerial applicators should pay particular attention to safety and protective clothing and equipment precautions listed on the pesticide label. Pilots should not load or mix pesticides.

Vat-Dipping and Spray-Dipping of Livestock

Vat dipping is the only allowable method for treating sheep and goats for regulated pests. It is the preferred method for treating cattle, horses, and most other species of animals. Cattle and swine may be treated with a spray-dip machine. Use of engine-driven tank-type spray equipment with constant mechanical mixing of bath is generally not acceptable. Easily restrained horses and other specified animals may be treated this way in some cases. Hand-powered sprayings are not acceptable in regulatory pest control.

Pretreatment

Animals should be examined to determine if their physical condition is such that they can be safely treated. Otherwise, acute toxic reactions may result in losses. Divide the animals into groups according to age or size and treat each group separately. It may be necessary to handtreat young or weak animals. Whenever practical, delay treatment of young animals until they are 1 month old. Do not allow dams to nurse their young until after the dip has drained from udder and teats.

Rest the animals before treatment. Allow them to drink their fill of water so they will be less likely to drink the dip and be poisoned. Avoid rough handling of animals before, during, and after treatment. After driving animals to the treatment area, allow them to rest and cool off. Remove caked mud, excessive filth, or heavy accumulations of dust from animals. These coverings may keep the pesticide from reaching the pests.

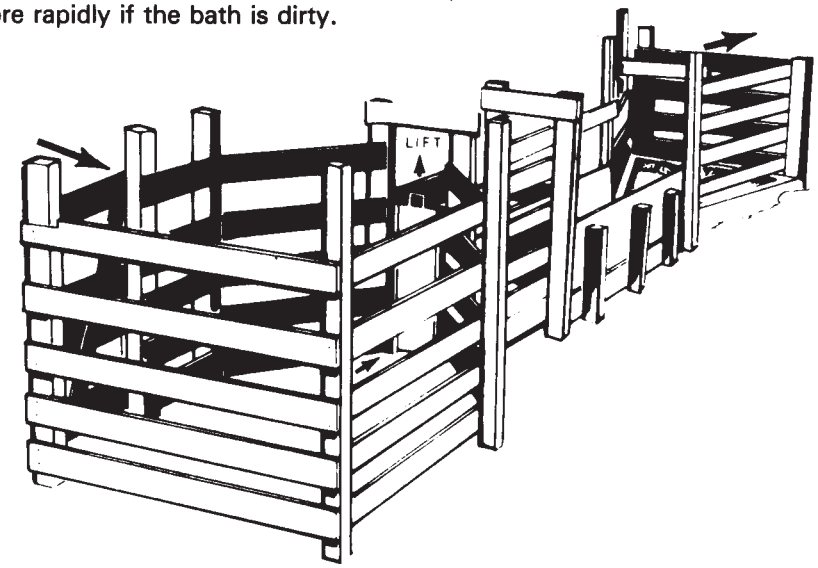
Vat Dip Treatment

Submerge each animal completely. Use a dipping fork to insure that the head is submerged at least once. The dipping fork is necessary to assure proper handling of the animals and to help protect

Large Vat for Cattle, Horses, Sheep, Goats

the operator from exposure to the pesticide. Do not dip animals that are wet with rain, snow, or ice. They will carry additional water into the vat and dilute the bath.

Keep the bath reasonably clean, because pesticides settle out more rapidly if the bath is dirty.



Small Vat for Sheep, Goats

Skim hair and other materials from the surface regularly. The amount of bottom sediment must be monitored. If it reaches 10 percent, empty and clean the vat. Be sure to follow APHIS guidelines for disposing of the vat contents.

The amount of pesticide added must be carefully measured according to the calibration instructions for the vat. Maintaining the proper concentration of pesticide in the vat is extremely important. Excessive concentration may poison or kill treated animals. Weak concentrations may not destroy all the pests. Never allow the bath volume to fall below the 7/8 level, because all replenishment ratios are based on this amount. The bath can be replenished as often as convenient at any point above the 7/8 level. Replenish the bath with a premixed solution of water and pesticide at the proper dosage.

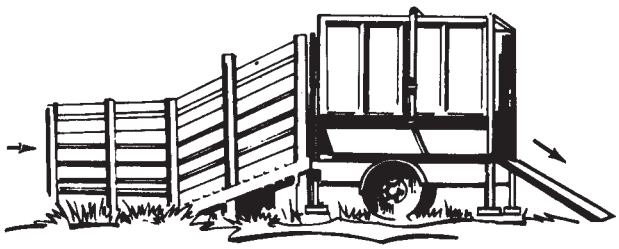
Mix the bath thoroughly:

- when it is first filled,
- each time it is replenished, and
- after any period of nonuse.

Spray-Dip Treatment

The principal advantage of the spray-dip over the dipping vat is that it is easy to move from farm to farm. Thus, it is useful in treating small herds when the owner does not have access to a dipping vat.

Spray-Dip Machine for Cattle



Ticks and scabies mites can be eradicated by treatment with a spray-dip machine if particular care is taken to assure complete wetting of the animal, including the head, face, inside of ears, brisket, underside, between the thighs, around the scrotum or udder, under the tail, and the switch of the tail. The spray-dip machine will not be effective unless its use is very carefully supervised.

Each animal should receive three 20-second bursts of spray with a few seconds pause between bursts to allow it to breathe. If necessary, the time spent in the machine may be increased to assure that all of the animal's skin is wet. Animals under

the age of 8 weeks should be given only two 10-second sprayings with an intermediate pause.

Replenishment and cleaning requirements for spray-dip machines are similar to those for dipping vats. Closely follow calibration instructions for the machine to assure proper dosages.

Posttreatment

Animals should be rested, fed, and watered after treatment. Do not allow the pesticide to drip on the feed or into the water. Hold the animals overnight before hauling or handling them. In hot weather, try to protect animals from direct exposure to the sun. In cold weather, give animals access to an open shed or windbreak. Keep animals on their feet until dry; if they lie down, they may freeze to the ground. After the pesticide has drained off, animals may be driven a short distance to warm them, but avoid vigorous exercise. Rain following treatment may wash off some of the pesticide and reduce the effectiveness of treatment.

Personal Safety in Vat-Dipping and Spray-Dipping

Operators dipping or spray-dipping livestock are at risk of harmful exposure to pesticides. The greatest hazard is that of being splashed by pesticides during mixing and treatment. All operators should wear enough protective clothing and equipment to avoid exposure to the pesticides. Follow the safety and protective clothing and equipment instructions on the label.

Mechancial Toxicant Delivery System

The M-44 is a mechanical device for delivering sodium cyanide. It was developed by the FWS specifically for the control of coyotes. It consists of:

- a case holder wrapped with fur, cloth, or wool,
- an ejector mechanism,
- a case loaded with 12 grains of sodium cyanide, and
- a 5- to 7-inch hollow stake.

The stake is driven into the ground, the ejector unit is cocked and placed in the stake, and the case holder containing the case of cyanide is screwed onto the ejector unit. A fetid bait, usually made from fish, brains, or blood, is carefully spread on the case holder. An animal attracted by the bait will try to pick up the baited case holder. The ejector mechanism is released when the animal pulls up on the case holder and the cyanide is forced into its mouth. On the basis of hundreds of recorded pulls, 71 percent of the animals were recovered. They were generally less than 50 yards from the M-44.

LAWS AND REGULATIONS AFFECTING REGULATORY PEST CONTROL

Legislative Authority

Federal Programs — APHIS

The Animal and Plant Health Inspection Service (APHIS) and the Federal agricultural regulatory pest control program are provided for by congressional acts. The acts provide the Secretary of Agriculture with authority to:

- establish quarantines and regulations against imports that are likely to carry agricultural pests not known to be present or widely distributed in the United States,
- establish quarantines and regulations to carry out cooperative Federal-State suppression, containment, or eradication measures against designated agricultural pests which become established in the United States, and
- provide exporters, on request, with certification that their plant and animal products meet import requirements of other countries.

Federal Programs — PHS

The Public Health Service (PHS) and the Federal public health regulatory pest control programs are provided for by congressional acts. The acts provide the Surgeon General with authority to:

- establish quarantines and regulations against imports and vessels likely to carry pests of public health importance not known to be present or widely distributed in the United States, and
- establish quarantines and regulations to carry out cooperative Federal-State suppression, containment, or eradication measures against designated pests of public health significance which become established in the United States.

Federal Programs — FWS

The Fish and Wildlife Service (FWS) and the Federal animal damage control program are provided for by congressional acts which provide the Secretary of the Interior with the authority to:

- develop and insure the use of ecologically sound, socially acceptable animal damage control activities, and
- assist in reducing conflicts between man and wildlife.

State and Local Programs

State regulatory pest control programs are provided for by authority of the individual State legislatures. Consult appropriate State statutes for details.

Pesticide Labels and Labeling

Regulatory pest control officials should know and understand:

- the general format and terminology of pesticide labels and labeling,
- basic instructions, warnings, terms, symbols, and other information commonly found on pesticide labels,
- the difference between general and restricted use classification,
- the penalties for misuse of pesticides under Federal and State laws.

Labeling Exemptions

Whenever possible, regulatory officials should choose a pesticide which has label directions that cover the intended use. However, some emergency situations in regulatory pest control may require the use of a pesticide in a manner inconsistent with its labeling. For example, a newly introduced pest may not be listed on any pesticide label. Or the product registered for use against the pest may not be registered for use on the crop or animal which the pest is attacking. Federal law authorizes the Environmental Protection Agency (EPA) Administrator to allow any Federal or State agency to alter label directions in emergencies. This is called a Section 18 exemption. Three types of exemptions are possible:

- specific exemption,
- quarantine-public health exemption, and
- crisis exemption.

Specific Exemption — Specific exemptions must be requested in writing by the head of the Federal agency or the Governor of the State involved, or by a designee. They are used when the pest problem is anticipated and there is enough time to apply for the exemption in writing.

Quarantine-Public Health Exemption — This type of exemption may be issued for Federal or State programs concerned with preventing the introduction or spread of a foreign pest of agricultural or public health importance into or throughout the United States. "Foreign pests" are those not known to be established in the United States but which threaten to become established or have recently become established. This exemption must

also be requested in writing by the head of a Federal agency, the Governor of a State, or a designee.

Crisis Exemption — A crisis exemption may be issued by the State or agency itself when an unpredicted outbreak of a pest occurs and the situation is so critical that there is no time to apply for a specific exemption. Such exemptions may not be granted for any pesticide which has been suspended or cancelled for the use in question. The State or agency issuing the crisis exemption should notify EPA by phone before issuing the exemption. Within 10 days of the issuance, EPA must be given written details of the crisis and any plans for further pesticide applications. If the applications will continue for more than 15 days, the issuing State or agency must apply for a specific exemption.

Registrations Sought by Regulatory Agencies

Regulatory agencies also may seek the registration of pesticides which are necessary for the safe and effective control of regulated pests but which may not be registered through normal channels. Two major types of registrations are available to regulatory agencies:

Special Local Needs State Registration — Most State regulatory agencies have the authority to issue "special local needs" registrations allowing the use of pesticides against pests which are found within the State. Such a registration may be granted only if no other pesticide is currently registered and available for that use. The pesticide to be registered must have a Federal tolerance established if crops or livestock will be treated and sold. This is often called a 24(c) registration. Complete regulations and guidelines for this registration are available from the EPA Pesticide Registration Division.

APHIS Treatment Manual Supplemental Labeling Registration — To allow flexibility in the use of pesticides against regulated pests, APHIS treatment manuals can be specified as part of the supplemental pesticide product labeling. The treatment manuals must carry complete instructions for the use being cited. EPA reviews the APHIS treatment manual for accuracy and completeness and then registers the manual as supplemental labeling. The pesticide label(s) contain a statement such as:

> "Also for use in accordance with the recommendations and instructions issued by the United States Department of Agriculture in the Animal and Plant Health Inspection Service treatment manuals for regulatory pest control programs on _____ (name of pest) _____ .
>
> To be used only by or under the direction of Federal/State regulatory pest control officials."

Residues in Food or Feed

Laws establish legal tolerance levels for pesticide residues in food and feed. Regulated pests in or on crops and livestock may have to be controlled with pesticides. To avoid illegal residues:

- use only chemicals registered for use on that crop or animal, and
- use them at the recommended dosage.

Follow use directions exactly. Be particularly sure to observe the interval between treatment and harvest, slaughter, or grazing. If a nonregistered pesticide must be applied under an emergency exemption, find out whether the treated crops or animals may still be sold for food or feed.

Pesticides to be applied on crops and livestock must be chosen with care. Some fumigants can build up residues in commodities after repeated applications. Some pesticides can affect chemical or physical properties of a commodity, including taste, odor, appearance, ripening rate, viability, and vitality. When treating storage areas and warehouses that house food and feed, use pesticides registered for such areas. Otherwise, you may contaminate the stored products.

ENVIRONMENTAL IMPACT

Chemical control of regulated pests need not be damaging to the environment. In most cases, it is beneficial. As a regulatory pest control official, one of your most important tasks is to assess the impact of your pesticide programs on the environment. Be sure to pass the information on to other regulatory agencies, other Federal and State agencies, and private industry. The information serves as a basis for developing new chemicals and methods of control that will avoid or minimize residue levels in the environment.

Pesticide Selection

Several pesticide products may be effective against the target pest. Choose the one that will cause the least damage to the environment while giving adequate control. If possible, select a pesticide and formulation that:

- will control the pest for the desired period of time and then break down into nontoxic byproducts, and
- can be applied to the target easily with little drift and runoff.

Domestic Animals

Keep nontarget animals and pets from coming in contact with regulatory pesticide applications. Do not allow dairy and meat animals, poultry, horses, sheep, goats, and other domestic animals to eat plants or drink water that are contaminated with pesticides. Take special precautions with baits or traps that might be attractive to nontarget animals and pets. In most instances, correct placement and timing will protect nontarget species.

Wildlife

Consider both the immediate and long-term effects on wildlife before making any application. Animals may be affected by pesticides either directly or indirectly. Incorrect application procedures could cause direct kills of susceptible nontarget fish, birds, mammals, and other wildlife. Indirect effects may result from repeated use of materials that build up in the food chain over time. This build-up may reduce the animals' ability to reproduce and may be fatal to predators at the top of the food chain.

Bees

Honeybees and other beneficial pollinators can be harmed by some pesticide applications. Careful planning and good communications between regulatory pest control officials and beekeepers can greatly reduce bee losses. Use these commonsense precautions:

- notify beekeepers before an application is to be made,
- choose a pesticide which minimizes toxicity to bees,
- when working near known hives, choose formulations and methods that are the least toxic to bees (aerial applications are more hazardous to bees than ground sprays),
- treat at dusk to avoid foraging bees and other pollinators,
- do not apply pesticides while target plants are in flower, and
- do not treat large areas or repeat applications at short intervals.

Sensitive Areas

Be especially careful when applying pesticides near or over areas where people live and work. Take special precautions to avoid accidental poisoning of humans or pets and to avoid contaminating such things as drinking water and swimming pools. If possible, choose formulations that do not leave unsightly residues. When you plan to apply pesticides or release biological agents in or near an urban area, consider informing the public beforehand.

PESTS

Federal and State regulatory agencies conduct programs:

- to control pests already established in the United States—both those which occur nationwide and those that are limited to certain sections of the country, and
- to prevent the entry of more than 1,300 species of foreign pests that are considered a significant threat.

Detailed information on the many regulated pests is available from the Public Health Service (PHS), Animal and Plant Health Inspection Service (APHIS), Fish and Wildlife Service (FWS), and State regulatory agencies.

Both APHIS and FWS cooperate with State regulatory agencies in control programs for many regulated pests. The following are some examples of current cooperative programs.

Many regulatory programs for control of pests in animals are not covered by the Federal pesticide laws. These programs, such as treatment of internal diseases, have not been included in this manual. However, control of animal diseases often involves the use of pesticides to control disease vectors. A few of those programs are listed here.

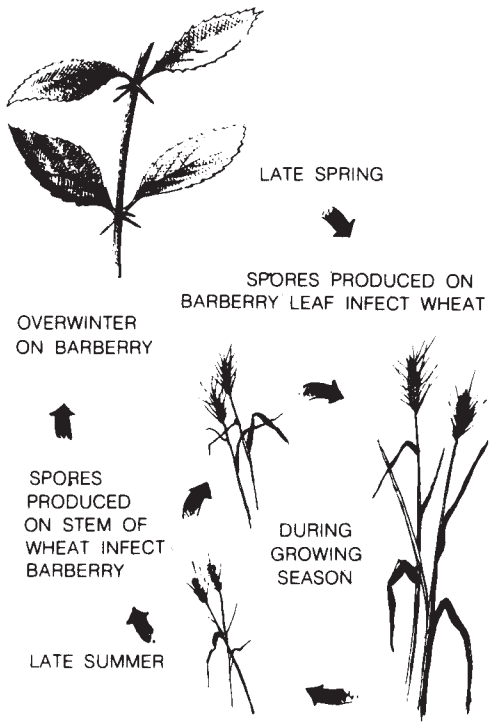
Regulatory pest control officials directly involved in controlling animal disease vectors, such as insects, mites, and ticks, should be familiar with the information in the USDA/EPA manual for certified applicators entitled "Agricultural Pest Control — Animal". Officials directly involved in use of disinfectants should be familiar with the information in the USDA/EPA manual for certified applicators entitled "Apply Pesticides Correctly: How To Use Antimicrobial Pesticides".

None of the current Public Health Service regulatory programs are Federal-State cooperative programs. Regulatory pest control officials directly involved in controlling pests of public health importance should consult Federal, State, and local officials for information on regulated public health pests in their region. They should also be familiar with information in the USDA/EPA manual for certified applicators entitled "Public Health Pest Control".

All three of these USDA/EPA manuals are available through State regulatory agencies and State Extension Services.

Barberry

Certain species of barberry bushes may be infected with the black stem rust, a fungus that causes a destructive disease that attacks wheat, oats, barley, rye, and some grasses. The disease takes food and water from host plants, reducing yield and quality.



BLACK STEM RUST OF WHEAT — DISEASE CYCLE

The cooperative eradication program in the Midwest consists of searching for and destroying rust-susceptible bushes. This destroys a vital link in the life cycle of the disease-causing fungus. Federal and State quarantines regulate the movement of susceptible species of barberry, preventing reestablishment of bushes in the eradication area. When an area is considered "barberry free", it is placed on a maintenance program — an informal, periodic inspection program. More than 97 percent of the original 1,073,000-square-mile infested area is now on such a program.

Blackbirds and Starlings

Blackbirds and starlings:

- pull winter wheat and early corn sprouts,
- consume and contaminate feed at livestock feedlots,
- are suspected to play a role in transmissible gastroenteritis (TGE) in hogs, and
- damage fall grain crops.

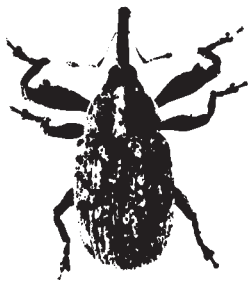
Starling

In addition, the organism that causes histoplasmosis, a disease of humans, grows in the accumulated droppings from their large winter roosts.

Control efforts to reduce these problems take the form of chemical and mechanical repellents and pesticides. The FWS has helped to develop and implement the use of several avicides.

Boll Weevil

The boll weevil is one of the world's most destructive insect pests and the major pest of cotton. Estimated cotton losses, plus the cost of the control work, exceed $300 million annually.



Control work began in the Big Bend region along the Texas-Mexico border, and in the El Paso area. Since then, control programs have been started in Texas' High Plains in cooperation with the State of Texas, the Plains Cotton Growers Association, and Mexico. Pesticides are applied in the fall to kill weevils before the diapause stage. Good pest management has increased control effectiveness with reduced use of pesticides. Methods in use include:

- cultural control,
- good sanitation,
- use of pesticides only when needed, and
- use of systemic insecticides in trap crops near hibernation sites.

Burrowing Nematode

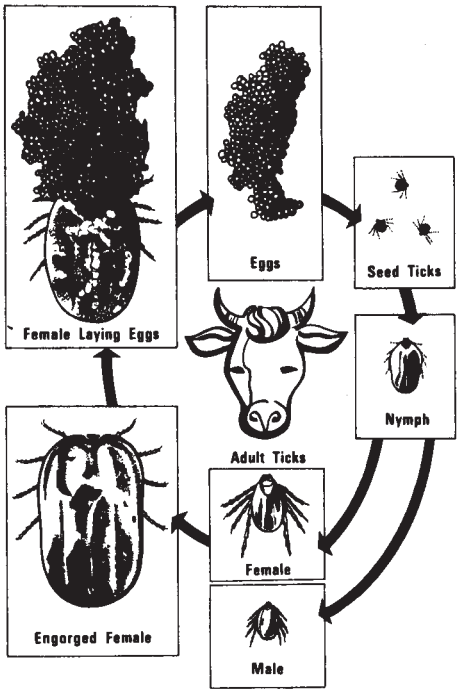
The burrowing nematode is an eelworm that lives in the soil. It attacks the roots of citrus, bananas, and many other tropical and subtropical plants. On citrus, the pest causes a degenerative disease known as spreading decline. Burrowing into the young rootlets, it feeds and reproduces on them. Destruction of rootlets causes trees to decline in vigor, reducing yield and quality of the fruit.

The U.S. Department of Agriculture joined the State of Florida in a cooperative control program. APHIS conducts surveys and makes laboratory analyses of the root samples collected; the State handles the control and regulatory work. A cooperative program has found a few citrus rootstocks with some resistance to the nematode. These rootstocks are commercially available.

Cattle Fever Ticks

Cattle fever ticks may spread a severe and often fatal cattle disease known as cattle tick fever,

THE LIFE CYCLE OF A CATTLE FEVER TICK

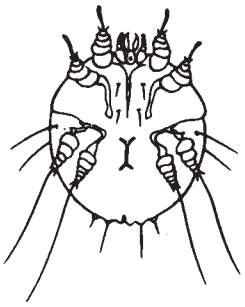


southern cattle fever, red water, splenic fever, or Texas fever. Cattle tick fever caused great losses to cattlemen each year before the tick was finally eradicated from the United States.

A Cooperative Federal-State quarantine at the Mexican border prevents the ticks from entering the United States on infested cattle or other hosts. Cattle crossing the border must be free from ticks and are given a precautionary dipping in an acaricide. Occasionally, infestations are found outside the quarantine zone. These are usually due to strays, smuggled animals, or movement of infested animals. These infestations are eradicated by systematic dipping of cattle and horses in the infested area for a period of 5 to 12 months. A single dip treatment should kill the ticks on an animal, but it does not prevent reinfestation by ticks still on the ground.

Cattle Scabies

Scabies is a contagious skin disease of cattle which may be caused by several types of mites. The disease is produced when tiny parasitic mites



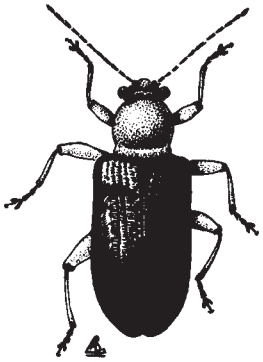
Scabies Mite

pierce the animal's skin to feed. A discharge from the wound oozes onto the surface of the skin and forms scabs or crusts. The affected areas may also become infected with bacteria. Cattle with scabies lick, rub, and scratch themselves to relieve intense itching. They lose weight and condition. Occasionally, animals die from heavy infestations of scabies mites.

A cooperative Federal-State eradication program has eliminated the disease from large sections of the United States. Outbreaks still occur in Southwestern, Western, and Midwestern States. The cooperative program involves State quarantines of infected feedlots or herds, supported as necessary by Federal quarantines. Infected or exposed cattle are dipped or spray-dipped with a miticide to kill the mites. Each outbreak must be reported and investigated to determine the origin of the infestation and any possible spread.

Cereal Leaf Beetle

The cereal leaf beetle is a destructive pest of wheat, oats, barley, and other small grains. Heavy feeding by the adults and larvae reduces crop yields and turns the plant yellowish-white.



A cooperative Federal-State program was started to help prevent spread, suppress populations, and reduce damage caused by the beetle in heavily infested areas. A Federal quarantine helped prevent long-range artificial spread. It was revoked, however, because of the natural spread of the flying insect. The regulatory effort has switched from the use of pesticides to biological controls. Parasites of the beetle's egg and larvae — tiny wasps known to attack the beetle in Europe — are being reared and released in infested areas. This is expected to reduce small grain losses and delay natural spread of the pest to the west. To detect any spread of the beetle, biometric surveys are conducted each year in the major small-grain-producing States west of the Mississippi River.

Citrus Blackfly

The citrus blackfly is one of the most destructive pests of citrus. Brief infestations can reduce citrus production by as much as 50 percent. Uncontrolled infestations can cause total crop failure within 2 years.

Federal, Texan, and Mexican regulatory officials have been jointly fighting a small but stubborn outbreak in the lower Rio Grande Valley in Texas and adjoining areas of Mexico. They are working to prevent a wholesale spread of citrus blackfly to this country. There are quarantines on each side of the border, and parasites are being released throughout the infested area of Texas and Mexico. Insecticides are used on any outbreak of citrus blackfly in the United States. Intensive surveys are conducted an-

nually in the citrus areas of both nations to detect any new infestations. Parasites have recently been released in Florida to eradicate small infestations there.

Equine Infectious Anemia

Equine infectious anemia (EIA), or swamp fever, is an infectious viral disease of horses, mules, and asses. The disease may be spread directly from animal to animal or through biting flies, biting lice, and mosquitoes. EIA has been reported in all sections of the United States. In 1976, more than 10,000 confirmed cases were reported. Control or eradication of the disease is now possible through:

- a specific test for the disease,
- quarantine and disposal of infected animals, and
- rigorous vector control.

A cooperative Federal-State regulatory program has been started to test horses, mules, and asses for the disease and to promote vector control in stables and pastures.

Giant African Snail

The giant African snail is a destructive agricultural and "suburban" pest. It damages crops, lawns, and ornamentals. In addition, it leaves unsightly slime trails and is a health hazard. In Hawaii, damage to crops and ornamentals and control work by homeowners amount to hundreds of thousands of dollars each year. An outbreak of the snail in Florida has been declared eradicated. Infested and adjacent properties were cleared of debris and treated with a molluscicide bait. Federal and Floridian regulatory officials conduct biometric surveys to detect any spread of the pest.

Golden Nematode

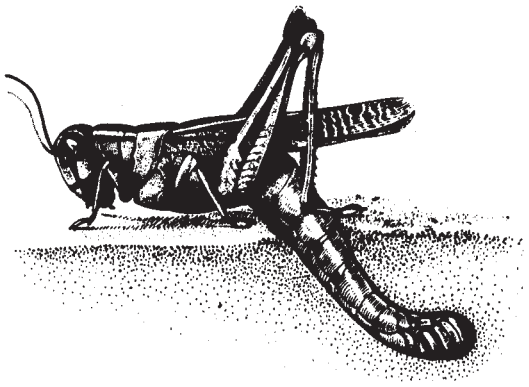
The golden nematode is one of the world's most damaging pests of potatoes. It also attacks tomatoes and eggplants. This tiny eelworm attacks plant roots, depriving them of food and water. Heavy infestations can reduce crop yields as much as 60 percent or more.

Since the pest was first discovered on Long Island, many infestations have been eradicated. Regulatory officials from New York State and APHIS are cooperating in an eradication program in the remaining areas of infestation. Much of the affected acreage has been removed from agricultural production through housing developments; the remainder has either been chemically treated or taken out of potato production (planted to nonhost crops).

A resistant variety of potato is showing promise in reduction of this pest. Chemical treatment is by soil fumigation, since the unhatched nematode is protected by both the shell of the egg and the tough, leathery cyst of the female. Two or three treatments are necessary to kill all the nematodes in the area. Biometric surveys are carried out in all major potato-growing areas of the United States to detect any infestations of the nematode. Recent outbreaks in several upstate New York counties have been detected and are being treated.

Grasshoppers

The grasshopper is one of the few native pests subject to a regulatory control program. Grasshoppers are found throughout the United States, but



usually are major pests only in the Midwestern and Western States. During serious outbreaks, they can completely devastate range and cropland.

Annual surveys throughout the Midwestern and Western States are used to evaluate grasshopper infestations. The results are distributed to farmers, ranchers, State officials, and other agricultural workers.

When outbreaks threaten rangeland, Federal regulatory officials join interested States in large-scale cooperative programs to suppress the grasshopper population. Aerial applications of insecticides are the main control method. In general, ultra low volume (ULV) insecticide sprays give the most satisfactory results.

Cultural control practices are a good supplement to the chemical control program in cropland areas. Working the soil in late fall or early spring helps to reduce grasshopper hatch. Altering planting date timing and sowing less susceptible crops are also

important when large outbreaks are predicted.

Natural biological controls can also be used. Some of the more important natural enemies of grasshoppers include: blister beetles, ground beetles, spiders, rodents, birds, and bacterial and fungal diseases.

Gypsy Moth

The gypsy moth is a highly destructive pest of forest and ornamental trees. Damage is caused by

the caterpillars (larvae) feeding on leaves. Repeated loss of leaves can kill hardwood trees; some softwoods do not survive a single attack. Weakened trees are subject to secondary attack by diseases and other insects.

For many years, Federal-State quarantine and control activities kept moths confined to New England, New York, and Pennsylvania. An eradication program was started in the infested area but was stopped because of pesticide residue problems.

The gypsy moth has been spreading rapidly and is now established throughout the Northeast. Small, isolated outbreaks have been found in other States. Recreational vehicles and mobile homes have been pinpointed as an important source of long-distance spread.

The present cooperative program consists mainly of:

- enforcement of Federal-State quarantines,
- control work at infested campgrounds and mobile home parks to minimize artificial spread,
- use of biological control (especially parasites, predators, and disease agents) in infested areas,
- use of chemical controls to suppress or eradicate new infestations, and
- nationwide surveys to detect spread into uninfested areas.

Hog Cholera

Hog cholera is an infectious, contagious viral disease that affects swine only. Before the United States eradication program was begun in 1962, hog cholera cost the swine industry $50 million annually.

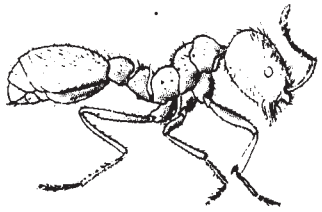
The cooperative Federal-State eradication program is based on:

- locating disease outbreaks through a detection and reporting system,
- containing the disease with State and Federal quarantines, and
- eliminating the virus by destroying infected and exposed swine herds.

One purpose of the quarantine is to control possible vectors of the virus. Suspected vectors are house flies, stable flies, and horse flies. Vector control techniques include cultural practices and sanitation programs as well as intensive insecticide use. Hog cholera is believed to have been eradicated from the United States as of 1977. However, the Federal-State cooperative program continues to survey intensively for new outbreaks.

Imported Fire Ant

The imported fire ant is a small, aggressive insect. When disturbed, it is quick to attack both people and animals. Its painful, burning sting causes blisters that take as long as 10 days to heal



and may develop infection. The ants' large mounds or nests (as high as 3 feet and an equal distance across) interfere with farming and ranching in rural areas and with use and maintenance of property in urban and suburban locations.

The cooperative program between infested Southeastern States and APHIS consists of:

- survey,
- control,
- quarantine, and
- monitoring activities.

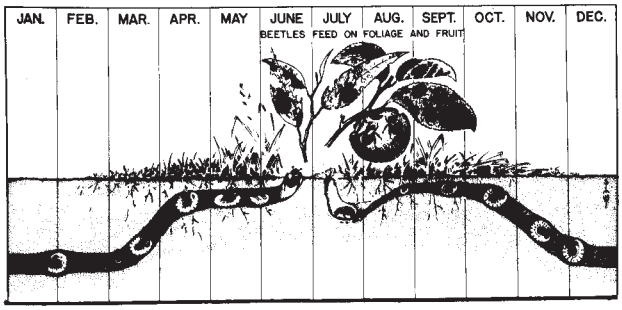
A specially developed bait, containing an insecticide, is used to kill the ants. It is usually applied by aircraft in spring and fall treatments. Federal regulatory officials join in control activities only

after State or local agencies request assistance.

Treatment programs are carefully planned to achieve control without treating estuaries, wildlife refuges, and other sensitive areas. To further protect the environment, monitoring is an integral part of this pest control program. After each treatment, samples are collected from selected sites and analyzed for the presence of insecticide residues. This program may be altered soon because of possible registration restrictions imposed on the insecticide bait currently in use.

Japanese Beetle

The Japanese beetle is a destructive lawn, garden, and agricultural pest. Adults feed on more than 275 kinds of plants, including grapes, peaches, apples, soybeans, and many ornamentals.



Life Cycle of the Japanese Beetle

The grubs (larvae) do extensive damage to turf in pastures, lawns, and golf courses. The infestation is limited mainly to States east of the Mississippi River. Isolated outbreaks have been discovered and eradicated in the Western States.

- Control involves:
  - eradicating isolated infestations, and
  - preventing artificial spread of the beetle.

Infestations near commercial and military airports are treated (as necessary) to prevent beetles from "hitchhiking" on departing aircraft.

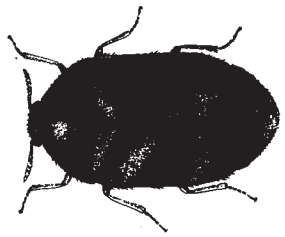
Control of the Japanese beetle can be accomplished by:

- applying chemical insecticides to the soil to kill the grubs,
- applying insecticidal sprays to foliage and other vegetation to suppress adult beetle populations, and
- applying biological agents such as milky spore disease to the soil to control the grubs.

Fluctuations in pest numbers and other factors may alter the regulatory control program for this pest.

Khapra Beetle

The khapra beetle is one of the world's most destructive pests of stored grain. When left undisturbed, an infestation can multiply rapidly and destroy an entire warehouse of grain.



All known infestations of the khapra beetle in the United States have been eradicated. No other country has ever eradicated khapra beetles after the pest became established. Eradication involved:

- extremely close cooperation among APHIS, the affected States, and Mexico, and
- development of new ways to fumigate grain storage facilities.

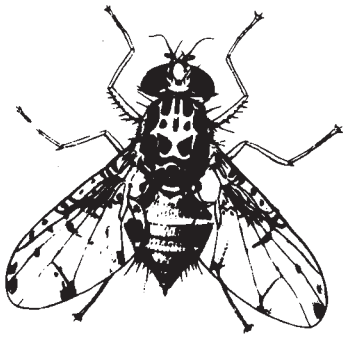
Control measures used against other storage pests are not effective against the khapra beetle. The larvae crawl into cracks and crevices and other protected places in infested structures, making them impossible to reach with space sprays. Only fumigants capable of deep penetration can combat the beetle. The dosages of these fumigants must be higher than amounts commonly used for grain sanitation.

A Federal-State-Mexican cooperative program conducts yearly surveys to detect any infestations of the pest. Special attention is given at ports-of-entry to shipments of imported grain products and other commodities that might harbor the beetle.

Mediterranean Fruit Fly

The Mediterranean fruit fly is a voracious pest, attacking more than 200 kinds of fruits and vegetables. Heavy infestations can result in complete crop loss. "Medfly" has been found in the United States on several occasions. Each time, it has been eradicated.

Intensive surveys are conducted annually in high-risk areas — principally Florida, California, Arizona, and Texas. When an infestation is found, an inten-



sive eradication program begins immediately. The control is usually an insecticide applied aerially or, in some cases, with ground equipment. Low volume concentrates or wettable powders are the formulations most often used. Aerial applications help maintain the treatment schedule, especially when large acreages are involved. Aerial applications may not be appropriate in urban areas. Sterile flies have recently been used to eradicate isolated Medfly infestations.

Mexican Fruit Fly

The Mexican fruit fly attacks citrus and other fruits. Larvae feed in the fruit, making it unfit for humans to eat. Heavy infestations can totally ruin a crop. The fly invades from Mexico and is found each year in the lower Rio Grande Valley.

A Federal quarantine helps to prevent spread from the Valley to noninfested areas of the United States. Fruit moving to citrus-producing areas from the quarantined areas in Texas must first be fumigated.

In Mexico, U.S. regulatory personnel help maintain road stations to intercept rail or automotive shipments of infested fruit moving north to border areas. They also supervise the fumigation of fruit for export to the United States.

Intensive surveys are maintained in Texas and California to detect fruit flies which may enter on contraband fruit. When the first fly is trapped, a control program begins in that area. In Baja California, large-scale releases of sterile male flies are made each year to prevent establishment of the pest in the United States.

Mormon Cricket

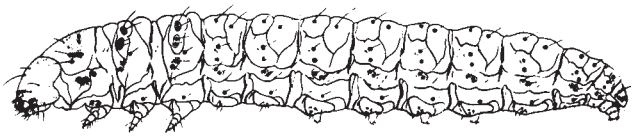
The Mormon cricket is another native pest subject to a suppression program. This large, wingless, long-horned grasshopper is a serious pest of range and cropland in 16 Midwestern and Western States. It attacks more than 250 species of range plants and all cultivated crops.

The cooperative Federal-State program is designed to keep cricket populations at a nondamaging level. All known infested areas are observed closely. At the first sign of population buildup, control work begins.

Mormon crickets can be most effectively controlled during migration. If the crickets migrate in bands, they should be controlled, Control work should begin soon after the crickets begin to migrate from the breeding areas. It should be completed before the females begin laying eggs. Chemical controls are usually baits or sprays applied by air or ground equipment.

Pink Bollworm

Pink bollworm larvae feed on cotton bolls, reducing yields and quality of lint, seed, and oil. Heavy infestations can result in complete loss of a crop.



The overwintering larvae hibernate within the seed and in old bolls left in the field, sometimes webbing in debris, soil cracks, etc. The pink bollworm has become established in the Southwestern United States and eastward to Texas and Louisiana. Much of the U.S. cotton crop still has not been infested.

Federal and State quarantines help prevent artificial spread of the pest. Surveys in noninfested cotton areas detect any extension of the generally in-

fested area and locate new infestations as soon as possible. Cultural controls, when properly carried out, are an effective and frequently used way to reduce or eliminate infestations. Planting dates should be as late as possible and harvest dates should be as early as possible. Stalks should be shredded and fields should be plowed to a depth of at least 6 inches before the pest has gone into its overwintering stage. Insecticide sprays may be used to supplement the cultural control program. Sterile male moths are being released in some areas to prevent establishment of bollworm populations.

Predators

Large predators, especially coyotes, can cause high losses to livestock. The FWS, working through cooperative State programs, is attempting to reduce damage levels. Control is aimed at reducing damage and not at eliminating predators. Integrated pest management methods used in these programs include trapping, M-44's, and aerial gunning.

Screwworms

Screwworms are the larvae (maggots) of the screwworm fly. They are a serious pest of warmblooded animals—livestock, pets, wildlife, and even humans. They closely resemble common blowfly maggots. But unlike blowfly maggots—which feed on dead or diseased tissue—screwworms consume the healthy flesh of the warmblooded animals they infest. They can seriously injure, maim, or kill infested animals. The larvae grow from nearly microscopic size to about one-half inch in length, and in the process greatly enlarge the wound. Screwworms caused great damage to livestock before they were eradicated from the United States.

The Federal-State cooperative control program is based on the release of millions of sexually sterilized screwworm flies into infested and barrier zones. When native fertile flies mate with sterile flies, they lay eggs that do not hatch. Thus, screwworm populations drop with each generation until eradication is achieved. The continuous release of sterile flies throughout the United States-Mexico border area creates a barrier zone against migrating screwworm flies which might reinfest the United States.

Sea Lampreys

Control of predatory sea lampreys is vital to reestablishing and maintaining valuable fish stocks in the Great Lakes. The objective of the control program is to suppress sea lamprey abundance to a level where they will not limit restoration of an optimum fishery.

The FWS destroys larval sea lamprey through periodic applications of selective pesticides to streams where they spawn. The FWS operates electric weirs (trapping devices) on eight Lake Superior streams to assess annual changes in the abundance of sea lamprey.

Venezuelan Equine Encephalitis

Venezuelan equine encephalitis (VEE) or horse sleeping sickness is a viral disease carried by mosquitoes and other bloodsucking pests. VEE is fatal to about 60 percent of all infected horses, mules, and related animals. Other warmblooded animals, including humans, are subject to low-grade infection. VEE is rarely fatal to humans.

VEE invaded the United States in the summer of 1971, crossing the U.S.-Mexican border into southern Texas. A cooperative Federal-State program brought the outbreak under control. The program consisted of quarantines, mass vaccination of horses, and pesticide applications to control mosquitoes and other vectors. The disease was eradicated late in 1971. A cooperative Federal-State program continues intensive surveillance to detect any outbreaks of VEE. The control of this disease is under the jurisdiction of both animal and public health regulatory officials.

West Indian Sugarcane Root Borer

The West Indian sugarcane root borer is a destructive pest of citrus and sugarcane. It also attacks many other commercial crops including seed corn, sweet potatoes, cotton, and peppers. Both adults and larvae of the pest damage citrus trees. Adults (beetles) feed on tender, young foliage. Larvae (grubs) girdle trees, tunnel into roots, and feed on rootlets. Larval damage can kill trees.

Federal regulatory officials and the State of Florida are cooperating in a program to prevent spread of the borer and reduce its damage. The work includes:

- State quarantines to regulate the movement of articles that might spread the pest,
- surveys to detect any new outbreaks or spread, and
- soil and foliage insecticide treatments in citrus groves to kill the larvae and beetles.

Fluctuation in pest numbers and other factors may alter the regulatory control program for this pest.

Witchweed

Witchweed is a parasitic seed plant that attacks the roots of corn, sorghum, sugarcane, and many other crops of the grass family. Heavy infestations can cause severe damage. This pest was first discovered in the United States in adjoining areas of North and South Carolina. A cooperative Federal-State control program has successfully confined it to those two States.

Under the program, Federal and State quarantines regulate the movement of articles that might spread the pest. Post-emergence applications of herbicides are made each season to keep witchweed plants from producing seed. Biometric and mail surveys in noninfested areas help detect unknown infestations.

The newest control technique involves injecting ethylene gas below the soil surface. The gas triggers germination of about 90 percent of the witchweed seeds. The resulting plants are destroyed in one of two ways:

- host plants are removed before treatment so the weed seedlings die from lack of food and water, or
- herbicides are used to kill the weeds before they produce seeds.

Recent advances in control technology, including a highly selective experimental herbicide, have made it feasible to start a witchweed eradication program.

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