Home Grounds & Animals

2023 Pest Management Guide

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Keys to the Proper Use of Pesticides

1. Read the label on each pesticide container before each use. Follow the printed instructions to the letter; heed all cautions and warnings; note precautions about residues.
2. Store pesticides in the containers in which you bought them. Put them where children and animals cannot get to them - preferably locked-up and away from food, feed, seed, and other materials that may become harmful if contaminated.
3. Dispose of empty pesticide containers properly.

See your physician if symptoms of illness occur during or after the use of pesticides.

Disclaimer

Commercial products are named in this publication for informational purposes only. Virginia Cooperative Extension does not endorse these products and does not intend discrimination against other products which also may be suitable.

NOTICE:

Because pesticide labels can change rapidly, you should read the label directions carefully before buying and using any pesticides.

Regardless of the information provided here, you should always follow the latest product label when using any pesticide. If you have any doubt, please contact your local Extension agent, VDACS pesticide investigator, or pesticide dealer for the latest information on pesticide label changes.

See Chapter 1 - Regulations and Basic Information **for pesticide handling information.**

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How to Use this Pest Management Guide for Home Grounds and Animals

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Daniel Frank, Director, Virginia Tech Pesticide Programs

This 2023 Virginia Pest Management Guide provides the latest recommendations for controlling diseases, insects, and weeds for home grounds and animals. Also available in this guide is information about prevention and nonchemical control as alternatives to chemical control or as part of an integrated pest management approach. The chemical controls in this guide are based on the latest pesticide label information at the time of writing. Since pesticide labels continuously change, read the label directions carefully before buying and using any pesticide. Regardless of the information provided here, always follow the latest product label instructions when using any pesticide.

Help Is as Close as the Local Extension Office

https://ext.vt.edu/offices.html – or in the blue (government) pages of your telephone directory.

Virginia Tech and Virginia State University are Virginia's land-grant universities. The land-grant universities were created to benefit each state through research and educational resources. To provide this opportunity to everyone in the United States, the land-grant university system was extended to localities through outreach programs, established as the Cooperative Extension Service in 1914.

The unique Cooperative Extension partnership that exists between the USDA, the commonwealth, and your home town means that individuals, families, businesses, institutions, and the community can find answers to many pest management questions through a local Extension agent.

How this Guide Is Designed

This guide includes an overview of best management practices associated with home grounds and animals. We include information and advice about non-chemical controls of insects and diseases such as: using resistant plants or companion plants to reduce pest attacks; how to incorporate beneficial insects, animals, and other organisms into a pest management plan to fight off harmful organisms; and mechanical ways to control pests that include using weed blocking textiles and mulches in vegetable or ornamental plantings. Information on labeled chemical controls for specific pests is also included if no alternative solutions provide enough weed and pest control. See page 1-5 Integrated Pest Management for more information. Pay special attention to recommendations related to the type of application equipment and personal protective equipment for the applicator. There are also warnings associated with specific chemicals, especially as they relate to fish, other wildlife, pets and pollinators.

This guide includes nonchemical and chemical control recommendations for pests in outdoor recreation areas, wood products and households. The animal chapters of this guide cover external parasites of dogs and cats, outline Virginia regulations in dealing with nuisance and wild animals, and discuss management options for these nuisance animals.

Each chapter also provides recommendations on when to hire a professional pest control firm. The end of this chapter has some advice on selecting a pest control company. Many pest control jobs require equipment, permits, or chemicals that are not available to homeowners.

Getting to the Right Place in the Guide

First, identify the problem. Most of the concerns addressed by this guide involve plants. What type of plant has the problem? Each plant's problem should be approached differently—such as, never apply chemical recommendations for ornamentals to edible crops. See the vegetable or fruit sections of this guide for recommendations regarding pest problems on edible crops.

It is hard to determine the significance of a pest until the pest is clearly identified. It is also difficult to control the pest without a proper identification. It is easy to recognize a fly or dandelion. With a self-help book or other reference it is also simple to identify many other insects and weeds. However, other pests can be difficult to identify. This is especially true for the organisms and conditions that cause plant diseases. Some plant diseases aren't even caused by living organisms. For example, some plant injuries or damages are caused by nonliving, or abiotic conditions, such as air pollution, chemicals, heat, drought, excess water, cold, or poor site selection.

Extension agents can help identify the cause of home garden problems and prescribe a control. If the problem is especially hard to identify, the Extension agent has the resources of Virginia Tech and Virginia State University to provide assistance. A specimen can be sent to Blacksburg for identification. After identifying a pest problem, the next step is to control it.

How Important Is Your Pest Problem?

A pest is anything that causes a nuisance, blight or annoyance. Examples of annoyances associated with pests include: the discomfort caused by a pet's fleas; the destruction of food supply by pantry pests; the overgrowth of weeds in the lawn and garden; the loss of a favorite shade tree to blight; the health hazards associated with ticks; or the structural damage to a home caused by wood-infesting insects.

Is the pest problem worth controlling? Annoyances vary in their importance. Damage to a home is critical because it can be quite expensive and even dangerous. This kind of pest problem demands a quick, effective control. Other pest-related annoyances are not as important because they might not be as costly or dangerous. Low-priority problems don't always demand a quick and effective control. Some can even be ignored or eliminated by replacing the host plant. First evaluate how important the pest problem is, and if it is worth the effort and expense to control.

How Do You Choose a Pest Control Option?

When considering a pest control option, follow these important rules.

- Control a pest only when it is causing, or is expected to cause, more damage than is reasonable to accept.
- Use a control strategy that reduces the pest numbers to an acceptable level.
- Cause as little harm as possible to everything except the pest.

Avoiding Harmful Effects

Pest control involves more than simply identifying a pest and using a control measure. The treatment site, whether it is outdoors or inside a structure, usually contains other living organisms, such as people, animals, and plants, as well as the non-living surroundings, such as air, water, structures, objects and surfaces. All of these could be affected by pest control measures. It is important to consider the possible effects on the entire environment where the pest exists. Otherwise, pest control efforts could cause harm or create new pest problems. Use good judgment, and when pesticides are part of the strategy, rely on the pesticide labeling.

Pest control strategies can be disruptive. The actions of one organism or component sharing the site can affect the actions and well being of many others. When the balance is disrupted, certain organisms may be destroyed or reduced in number, and others—sometimes the pests—may dominate.

Who Should Apply the Control?

Decide who is going to control the pest problem. Is the job simple enough to tackle at home, or is it better for a professional to handle? The next section is about hiring contractors for pest control management. Even avid do-it-yourselfers should consider hiring a professional if the job involves controlling wood infesting pests in a home or spraying trees. Many pest control options require special equipment and knowledge. Some pest control projects are too complicated and can be unsuccessful for the home gardener, resulting in a project that is far more expensive than originally estimated. In these situations, hiring a professional is best.

How to Choose a Pest Control Company

Termites chomp away at your house. Roaches infest the kitchen. Mouse droppings dot a dresser drawer. Gypsy moths eat trees in the front yard. The lawn needs a major overhaul. There is a hornets' nest in the walls. These are serious pest management problems that demand a professional applicator. But how can one be sure that the pest control company will do a good job?

Here are some questions to ask:

Does the company have a good track record?

Research this answer carefully. Ask neighbors and friends if they were satisfied with the service they received from a given company. Call the Better Business Bureau, Sheriff's Office, the Virginia Department of Agriculture and Consumer Services

(VDACS) - Office of Consumer Affairs or the VDACS Office of Pesticide Services, listed in the reference tables later in the chapter, to check if they have received any complaints about the company.

Does the company have insurance? What kind of insurance? Can the salesperson show some documentation to prove the company is insured?

Contractor's general liability insurance, including insurance for sudden and accidental pollution, gives the homeowner some protection should an accident occur while pesticides are applied. Contractor workers' compensation insurance can also help protect the homeowner, should an employee of the contractor be injured while working in your home.

In Virginia, pest control companies are required to carry liability insurance. Never contract with a company that is not insured.

Is the company licensed?

In Virginia, all pest control companies are required to carry a pesticide business license. All employees are required to be trained and certified as either registered technicians or commercial applicators. In addition, these applicators are required to be recertified every two years. The law requires that a certified commercial applicator be available to supervise the application of pesticides in a home. This direct supervision requirement means that the supervisor must be in direct contact with the applicator, but the supervisor does not have to be on site.

Ask the company manager and the applicator to show you both their pesticide business license and their current pesticide applicator's certificate before signing the contract.

Is the company affiliated with a professional association?

As a member of a professional association, these companies can keep up-to-date on the latest information on pest control methods, safety, training, research and regulation. Most associations also have a code of ethics that members agree to abide by. The fact that a company chooses to affiliate itself with a professional association is evidence that they are concerned about quality and professionalism in their work.

For pest control operators (PCOs) or exterminators, professional associations include the National Pest Management Association, the Virginia Pest Management Association, and several regional groups. Lawn care companies also belong to many local and regional associations. The national and state associations affiliated with these groups are the Professional Lawn Care Network (PLANET) and the Virginia Turfgrass Council (VTC). The Virginia Nursery and Landscape Association is also affiliated with many landscape firms who apply pesticides for hire in Virginia. The addresses of these groups are listed in the reference tables later in the chapter.

Does the company stand behind its work? What assurances does the company make?

Think twice about dealing with a company unwilling to stand behind its work. The homeowner also has a role in this. For example, in the case of termite control treatments, a guarantee could be invalidated if the homeowner makes structural changes to the treated building without notifying the pest control company. In addition, many companies require an annual inspection or maintenance contract to keep the guarantee valid. Read the contract's fine print and ask questions.

Is the company willing and able to discuss the treatment plan?

Selecting a pest control service is just as important as selecting other professional services. Look for the same high degree of competence expected from a doctor or lawyer. The company should inspect the premises and outline a recommended control program, including: what pests are to be controlled; the extent of the infestation; what pesticide formulations will be used in your home and why; what methods will be used in the application; and any available alternative control methods. The control program should also outline any special instructions the homeowner should follow to reduce exposure to the treatment, such as vacating the house, emptying cupboards, removing pets, when it is safe to reenter the home, and what the homeowner can do to minimize pest problems in the future.

Contracts should be developed jointly with the customer. Any safety concerns should be noted and reflected in the choice of pesticides to be used. These concerns should include the health of the residing occupants (including allergies), the age of the occupants (such as infants and the elderly), or whether or not pets reside on the premises. Get bids from two or three different companies, and judge by value, not price. What appears to be a bargain may merit a second look. Don't always settle on the lowest bid. Look for quality.

After hiring a company, continue to monitor the work closely and evaluate results. If there is any reason to believe that something has gone wrong with the pesticide application, contact the company and discuss it with them. If the solution is unsatisfactory and continued negotiation does not work, contact the VDACS Office of Pesticide Services for help. They are listed in the reference tables later in the chapter. Document everything, ask detailed questions, and remain vigilant. Misunderstandings and poor communication about the outcome of a job can end up in court or cause great distress. Understand all the details before signing the contract, especially those concerning the risks of using pesticides.

Human risk is related to the toxicity of the pesticide versus the potential for exposure. Just because a pesticide is being sprayed doesn't mean there is a great risk for harm if exposure is minimized. Know what is being done to minimize this risk before committing to the treatment. Ask your contractor to share the product labeling information and Safety Data Sheets (SDSs) on the chemicals being used. If the contractor refuses, look elsewhere for service.

What about Integrated Pest Management (IPM)?

Stephanie Blevins Wycoff, Extension Associate, Virginia Tech Pesticide Programs
Daniel Frank, Director, Virginia Tech Pesticide Programs

Integrated Pest Management (IPM) combines several pest control tactics into a single plan to reduce pests and their damage to an acceptable level. Using many different tactics to control a pest problem causes the least disruption to the living organisms and non-living surroundings at the treatment site. Relying only on pesticides for pest control can cause pests to develop resistance to pesticides, can cause outbreaks of other pests, and can harm surfaces and non-target organisms. With some types of pests, only using pesticides achieves very poor control.

To solve pest problems, you should:

- Identify the pest or pests and determine whether control is warranted for each;
- Determine pest control goals;
- Know what control tactics are available;
- Evaluate the benefits and risks of each tactic or combination of tactics;
- Choose the most effective strategy that causes the least harm to people and the environment;
- Use each tactic in the strategy correctly; and
- Observe local, state, and federal regulations that apply to the situation.

The best strategy for each situation depends on the type of pest and the control needed.

Can You Take Advantage of Natural Controls?

Some natural forces act on all organisms, causing the populations to rise and fall. These natural forces act independently of humans and may help or hinder pest control. It might not be possible to alter the action of natural forces on a pest population. Be aware of the influence of natural forces and take advantage of them when possible. Natural forces that affect pest populations include climate, natural enemies, natural barriers, availability of shelter, and food and water supplies.

Climate

Weather conditions, especially temperature, day length, and humidity, affect pest activity and rate of reproduction. Rain, freezing temperatures, drought, or other adverse weather conditions may kill or suppress pests. Climate also affects pests indirectly by influencing growth and development of their hosts. For example, the population buildup of plant-eating pests can be related to the growth of its host plants. Unusual weather conditions can change normal patterns, which can lead to an increase or decrease in potential pest damage.

Natural Enemies

Birds, reptiles, amphibians, fish, and mammals feed on some pests and help keep populations down. Many predatory and parasitic insects and insect-like species feed on other organisms, some of which are pests. Pathogens often suppress pest populations. Creating a backyard environment that attracts beneficial insects and other natural enemies can help control pests on desirable plants.

Geographic Barriers

Mountains and large bodies of water restrict the spread of many pests. Other landscape features can have similar effects.

Food and Water Supply

Pest populations thrive only if their food and water supply lasts. Once the food source is gone, the pests die or become inactive. The life cycle of all living organisms depends on access to water.

Shelter

The availability of shelter can affect some pest populations. Overwintering sites and hiding spots are important for some pests. Rocks and logs in a garden are a good example of where pests, like slugs and snails, may find a safe haven from the sun and predators.

What Are Applied Controls?

Unfortunately, natural controls do not always control pests quickly or completely enough to prevent injury or damage. At these times, other control measures are necessary. Those available include:

• host resistance,

• biological control,

• cultural control,

• mechanical control,

• sanitation, and

• chemical control.

Host resistance: Some plants, animals, and structures resist pest attacks better than others. Some varieties of plants, wood, and animals are resistant to certain pests. Using resistant species and varieties, when available, helps control pest populations.

Host resistance works in three ways.

• Chemicals in the host repel the pest or prevent the pest from completing its life cycle.

• The host is more vigorous or tolerant than other varieties, and less likely to be damaged by pest attacks.

• The host has physical characteristics that make it more difficult to attack.

Biological control: A pest's natural enemies, like parasites, predators, and pathogens, can be used against it. Biological control may be supplemented by legally releasing, or enhancing the environment favoring the growth of, a pest's natural enemies in the target area. This might include creating habitats that favor predators or competitors not harmful to desirable host plants and animals. Biological control usually does not eradicate a pest, and the degree of control can change. There is a time lag between a pest population's increase and a corresponding increase in natural control. Under proper conditions, sufficient control can protect threatened plants or animals. Biological control also includes biologically altering the pest. This can include producing and releasing large numbers of sterile males; the use of sex attractants, called pheromones; or juvenile hormones. Pheromones can be used to monitor pest populations. Pheromones placed in a trap can attract insects in a sample area so that pest numbers are more easily estimated. Pheromones can also be a control tool. A manufactured copy of the pheromone that a female insect uses to attract males can be used to confuse males and prevent mating, leading to lower numbers of pests. Applying juvenile hormones to an area can reduce pest numbers by keeping immature pests from becoming reproducing adults.

Cultural control: Changing the environment, the condition of the host plant or animal, or the behavior of the pest can prevent or suppress an infestation. Cultural controls disrupt the normal relationship between the pest and the host plant or animal and make the pest less likely to survive, grow or reproduce. Common cultural practices include rotating crops, cultivating the soil, varying the time of planting and harvesting, planting trap crops, adjusting row width, and pruning, thinning and fertilizing cultivated plants.

Mechanical control: Adding physical controls to the environment, the host plant or animal, and/or the pest can help prevent or suppress an infestation. Mechanical controls include traps, screens, barriers, fences, nets, radiation, and electricity. Lights, heat, and refrigeration can alter the environment enough to suppress or eradicate some pest populations. Altering the amount of water, including humidity, can control some pests, especially insects and disease agents.

Sanitation: Keeping an area clean can help prevent and suppress some pests by removing the pests or removing their sources of food and shelter. Improve cleanliness, eliminate pest harborage, and increase the frequency of garbage pickup to reduce urban and industrial pests. Good manure management practices can prevent pests that attack domestic animals. Removing crop residues, and decontaminating equipment and other possible carriers before allowing them to enter a pest-free area or leave an infested area can reduce the carryover of agricultural pests from one planting to the next. The proper design of food-handling areas reduces access and shelter for many pests.

Chemical control: It is common practice to use pesticides to kill, repel, or prevent pests from causing damage. Chemicals that regulate plant growth or remove foliage are also classified as pesticides. Disinfectants and other common household chemicals may be classified as pesticides as well. Depending on the pest, pesticides can be the fastest way to control pests. In some instances, they are the only tactics available.

For additional information on IPM, please see:

An Introduction to Integrated Pest Management https://www.pubs.ext.vt.edu/ENTO/ENTO-365/ENTO-365.html.

Safe and Effective Use of Pesticides for Home Grounds and Animals

Stephanie Blevins Wycoff, Extension Associate, Virginia Tech Pesticide Programs
Daniel Frank, Director, Virginia Tech Pesticide Programs

Many of the control recommendations in this guide are chemical because they have been shown through research to work in a safe, effective, and efficient manner. Pest control recommendations are ever changing, which is evident in some sections of this guide where alternative controls have been added as research shows they can work under Virginia conditions. The authors will continue to add alternative controls to this guide as this information becomes available from research results produced by Virginia Tech, Virginia State, and other nearby test sites.

Although pesticides are a controversial subject and are often viewed in a negative light by the general public, they do have their place in pest management. Those of us who condemn all uses of pesticides, and those who quickly decide to apply these chemicals without consideration of alternatives are guilty of not weighing the issue properly. There are situations where pesticides are necessary. There are just as many cases where they don't need to be used as a "magic cure-all." This is especially true around the home. In many cases, home pest problems can be solved without the use of pesticides.

The rest of this section is directed toward the safe and proper use of pesticides for those who have weighed the information so far and decided to use a chemical control. There are sections on the label concerning environmental hazards and prevention of exposure, as well as how to safely handle pesticides and deal with emergency situations. In addition, there are a number of tables and sources listed to help you employ these chemicals safely and efficiently. If there is any piece of advice that you should remember from using this guide, it is to **read the pesticide label**. The label is the key to the proper and safe use of all pesticide products.

The Pesticide Label

If you decide to use a pesticide, you will most likely purchase these chemicals from a local outlet. Before you go to this outlet, please make sure you are prepared. You should already know what pest you are trying to control, how you are going to apply a pesticide *(the types of equipment and methods available to you for application),* and have established how important it is to control the pest.

With these factors in mind, you can go to your supplier and either ask for help or scan the shelves for the proper control. If you ask for help, make sure you read the product label carefully before you buy the chemical and not just go on the word of a clerk. There have been many situations where a person asked for advice at the store and came home with the wrong chemical. This is especially critical when you are shopping for a pesticide to apply on plants grown for food. Read the product label before you buy the pesticide to make sure you can use the chemical to control your pest problem. Is the product labeled for your crop or animal? If not, you cannot use it legally or safely. Read carefully for when to apply, how much to apply, and what type of equipment is needed to apply the chemical.

For further information on pesticide labels, refer to: https://www.pubs.ext.vt.edu/ENTO/ENTO-390/ENTO-390.html.

What Formulation Is Best for Your Situation?

Pesticide products are sold as concentrated formulations, which require mixing before use, and as ready-to-use formulations. Concentrates are generally less expensive per treatment than ready-to-use formulations, but present other problems. Examples of concentrates include wettable powders (W or WP), emulsifiable concentrates (E or EC), soluble powders (SP), and flowables (F). Do you have the means to mix, pour, and apply a concentrate safely? If you buy too much, which is usually the case with most homeowners using concentrates, keep in mind that you might have to store any remaining concentrate at your home. If you store many pesticides longer than a few years, they will deteriorate and lose their effectiveness (yet still be toxic). Are you prepared to possibly pay to have your chemical disposed of through a hazardous waste service, or wait until a Pesticide Collection Program comes to your area? If you throw the waste chemical into the garbage you could create a hazard to others and the environment.

Other formulations are sold ready-to-use. These can be applied directly without mixing and include: solutions (S), aerosols (A), dusts (D), pellets (P), granules (G), and baits (B). You should purchase only enough pesticide to use in one season. Look for products with reduced packaging that are low in toxicity, present few hazards to the environment, and which allow you to use them without having to handle, store, or dispose of concentrates. In addition, pick products which won't require you to purchase expensive application equipment in order to apply them. Some products are now sold in single dose packaging, which eliminates the problem of storing excess pesticide concentrates.

What Are the Parts of the Product Label?

The most important piece of information available to you is the pesticide product label. It is a legal document and is required to list all pertinent information about the product. You should become familiar with the different parts of the pesticide label. The information below corresponds to the numbers on the sample label to follow.

1) **Product Name:** includes the name of the manufacturer (ChemCo), the product name (NoPest), and the function of the product (Insect Killer).

2) **Ingredient Statement:** includes the amount of active ingredient by percent (8.0%) of the total product and identifies the ingredients by common name (deltathion) and chemical name (1,2 phospho-(5)-4-chloromethane).

3) **Toxicity Signal Word:** identifies the toxicity signal word (WARNING) which indicates that this product is moderately toxic to humans exposed to the chemical.

4) **EPA Registration Number** (999-000) is a code number that identifies the product by number according to EPA's product registration database. The first number (999) is specific to the company and the second (000) identifies the product. This number is very helpful when identifying the product if other parts of the label become unreadable.

5) **Precautionary Statements:**

   Hazards to Humans and Domestic Animals: warns the users how to protect themselves, what the hazards are to the eyes, the skin, the respiratory system, or if swallowed. The label also prescribes first aid measures and information for a physician (Note to Physician). This information should be provided to your doctor if you are poisoned.

   Environmental Hazards: warns the user about potential hazards to wildlife, to water from runoff and leaching, and to air from drift.

   Physical or Chemical Hazards: warns the user that the product is flammable and may cause a fire if not handled properly.

6.) **Directions for Use:** indicate it is a violation of Federal (and State) law to use the product in a manner inconsistent with its label directions. Violation can mean fines and criminal penalties. It can also mean possible civil law suits from injured parties. Use directions also tell you how much to use, on what pest, and on what crops. These statements are critical since the product cannot be used on any other crops, especially food crops. Also, the rates are very specific to the product. They should be followed closely. The label also warns you not to apply the product to unusual varieties including several named in a special note. Application on these varieties could injure or kill these plants.

7) **Storage and Disposal:** indicates how to properly store the product and how to handle the product for disposal.

8) Provides the **name and address of the manufacturer** and the **EPA Establishment Number** (EPA Est. No. 999-VA-1) which is important if the product is defective. It indicates which facility produced the product. Some products also include a lot number on the label.

SPECIAL NOTE: The EPA has added a "bee advisory box" to pesticide labels. An example of this box follows the sample label. Applicators should use extra caution to avoid exposing beneficial insects, such as the honey bee, to pesticides. Applying pesticides to blooming plants or allowing pesticides to drift to areas where pollinators feed or live is illegal and should be avoided. Our pollinators are in crisis, and impacting their habitats and food sources with pesticides is part of the cause. Use common sense when using pesticides around all non-target organisms.

ChemCo NoPest Insect Killer 1

Makes up to 8 Gallons Spray

Controls: Aphids, Mites, Thrips, Mealybugs, Whiteflies, Scale, and many other listed pests on Roses, Flowers, Ornamentals, Shrubs, and Trees.

Active Ingredients: Deltathion (1,2 phospho-(5)-4-chloromethane) **8.0%**

Inert Ingredients: .... 2 .... **92.0%**

KEEP OUT OF REACH OF CHILDREN

WARNING 3

Net Contents 8 FL. OZ. 4 **EPA Reg. No. 999-000**

Precautionary Statements 5

HAZARDS TO HUMANS & DOMESTIC ANIMALS

WARNING: Applicator should wear long-sleeved shirt, long pants, goggles, chemical-resistant gloves, socks, and shoes. Causes eye irritation. Do not get in eyes. Avoid contact with skin or clothing. Harmfull if swallowed. Avoid breathing vapor or spray mist. Wash thoroughly after handling. In case of eye contact, immediately flush eyes with fresh water for 15 minutes and get medical attention. If swallowed, promptly drink a large quantity of water and induce vomiting. Get medical attention immediately.

Note to Physician: Emergency Information–call (800) 555-5555 This product contains a cholinesterase inhibitor. If signs and symptoms of cholinesterase inhibition are present, atropine is antidotal. 2-PAM may also be given in conjunction with atropine.

ENVIRONMENTAL HAZARDS: This pesticide is toxic to fish. Use with care when applying in areas adjacent to any body of wʃater. Keep out of lakes, ponds, and streams. Do not apply when weather conditions favor runoff or drift from treated areas. Do not contaminate water by cleaning equipment or disposal of wastes.

PHYSICAL OR CHEMICAL HAZARDS: Flammable. Keep away from heat or open flame.

6 **DIRECTIONS FOR USE:** It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

READ ENTIRE LABEL. USE STRICTLY IN ACCORDANCE WITH LABEL PRECAUTIONS AND DIRECTIONS.

HOW TO USE: Mix thoroughly and spray entire plant, covering both upper and lower leaf surfaces. This product is designed for outdoor use only by home gardeners. It has not been tested on rare unusual varieties; therefore, when these plants are present, it is advisable to test on a few plants before spraying large numbers. **Do not apply to plants to be used for food or feed. Rate to apply – Aphids and Grasshoppers on Roses, Flowers, Shrubs, and Trees as Listed:** Apply 2 TBSP. (1 fl. oz.) to 1 gal. water. Spray as aphids appear. Repeat if infestation occurs.

All other Listed Pests on Roses, Flowers Shrubs, and Trees as Listed: Apply 3 TBSP (1.5 fl. oz.) to 1 gal water. Spray when insects or mites are present or feeding damage is first noticed. Repeat if reinfestation occurs. For Mealybugs, Flower Thrips, Whiteflies, Mites, Scales, and other hard to control pests, spray 2-3 times about 7-10 days apart. Clean sprayer after each use by flushing with water. Do not use household bleach as a cleaning agent.

CONTROLS: Aphids, Bagworms, Beet Armyworm, Birch Leafminer, Budworms, Grasshoppers, Gypsy Moth (larvae), Holly Leafminer, Lacebugs, Leafrollers, Leafhoppers, Mealybugs, Sawflies, Scales (crawlers), Stinkbugs, Thrips, Tent Caterpillars, Two-spotted Spear Mites, Whiteflies.

PLANTS: Ageratum, Alyssum, Arborvitae, Aster, Azalea, Birch, Boston Ivy, Bottlebrush, Clendula, Camellia, Cottonwood, Crapemyrtle, Marigold, Oak, Petunia, Pyracantha, Rose, Snapdragon, Spruce, Stock, Yew, Zinnia.

NOTE: Do not apply to American Elm, Flowering Crabapple, Sugar Maple, Red Maple, Redbud, Begonia, and Weigela as foliage injury may occur.

STORAGE AND DISPOSAL: Keep pesticide in original container. Do not put concentrate or dilute into food or drink containers. Do not contaminate food or foodstuffs. Do not store diluted spray. Do not reuse empty container. Wrap container and put in trash collection. 7

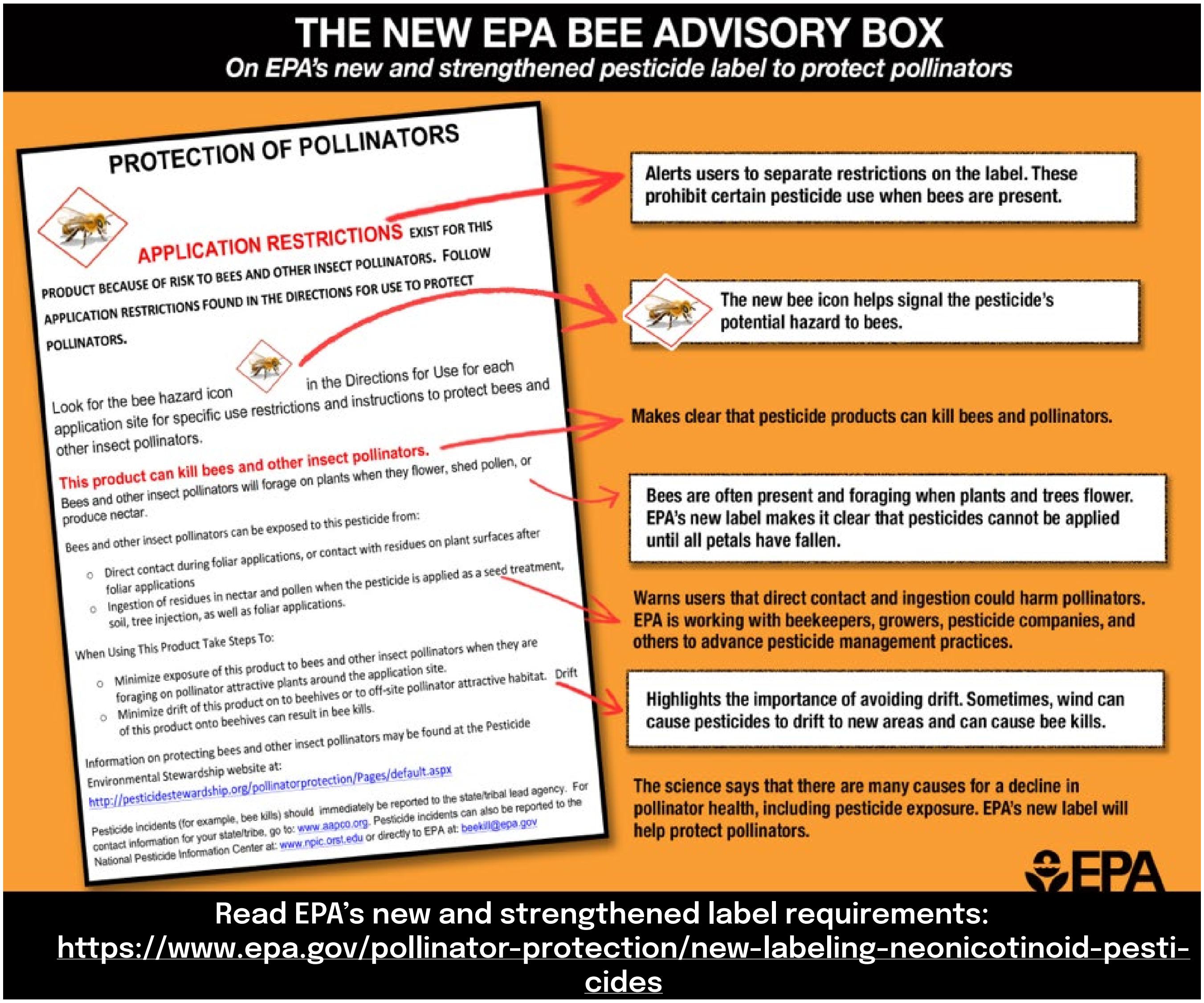
NOTICE: Buyer assumes all responsibility for safety and use not in accordance with directions.

ChemCo, Inc.
123 South Main Street
New Kenzee, VA 24000-0011
Product 1234 Made in the USA
Form 12300-E
EPA Reg. No. 999-000
EPA Est. No. 999-VA-1 8

2018©

SAMPLE ONLY

THE INFORMATION PRINTED IN THIS EXAMPLE SHOULD NOT BE USED IN PLACE OF THE INFORMATION PRINTED ON THE ACTUAL PESTICIDE LABEL.


THE NEW EPA BEE ADVISORY BOX
On EPA's new and strengthened pesticide label to protect pollinators
PROTECTION OF POLLINATORS
APPLICATION RESTRICTIONS EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.
Look for the bee hazard icon in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.
This product can kill bees and other insect pollinators.
Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.
Bees and other insect pollinators can be exposed to this pesticide from:
Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications
Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.
When Using This Product Take Steps To:
Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives can result in bee kills.
Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at:
http://pesticidestewardship.org/pollinatorprotection/Pages/default.aspx
Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency. For contact information for your state/tribe, go to: www.aapco.org. Pesticide incidents can also be reported to the National Pesticide Information Center at: www.npic.orst.edu or directly to EPA at: beekill@epa.gov
Alerts users to separate restrictions on the label. These prohibit certain pesticide use when bees are present.
The new bee icon helps signal the pesticide's potential hazard to bees.
Makes clear that pesticide products can kill bees and pollinators.
Bees are often present and foraging when plants and trees flower. EPA's new label makes it clear that pesticides cannot be applied until all petals have fallen.
Warns users that direct contact and ingestion could harm pollinators. EPA is working with beekeepers, growers, pesticide companies, and others to advance pesticide management practices.
Highlights the importance of avoiding drift. Sometimes, wind can cause pesticides to drift to new areas and can cause bee kills.
The science says that there are many causes for a decline in pollinator health, including pesticide exposure. EPA's new label will help protect pollinators.
EPA
Read EPA's new and strengthened label requirements:
https://www.epa.gov/pollinator-protection/new-labeling-neonicotinoid-pesticides

Environmental Considerations

Water Quality

Protecting our water resources is very important. Both surface and groundwater can be vulnerable to contamination from pesticides and fertilizers.

Ground Water

Ground water supplies are held in and move through geological formations called aquifers. Your home most likely sits over a local aquifer which supplies drinking water to you and your neighbors through your well or public water authority. In Virginia, about 90% of rural residents depend on groundwater from these aquifers for drinking water.

Careless use of pesticides and fertilizers can contaminate ground water by leaching (seeping) into the soil and eventually coming into contact with the water table. If a pesticide is persistent (lasts more than one season in the environment), is highly water soluble, or is highly toxic, it can reach the ground water and contaminate it. This is especially possible if the soils in your area are sandy or gravely in nature. In some areas of Virginia, geologic strata make the aquifers more vulnerable. These strata include the sandy areas of the coastal plains of eastern Virginia, the limestone *(Karst)* soils of the Blue Ridge Mountains of western Virginia, and the shale soils in the Highlands of southwestern Virginia. Other conditions which make ground water more vulnerable are excessive rainfall, irrigation, sinkholes, old wells, and other conduits to the aquifer. Even more dangerous are hot spots (point sources) caused by pesticide spills, backsiphoning*, careless mixing, improper storage, and illegal disposal. Hot spots are the leading cause of groundwater contamination from pesticides. The pesticide label will indicate if the pesticide you select is especially hazardous in these situations. In addition, you should take special precautions to limit the use of pesticides and even more importantly the excessive use of fertilizers. Fertilizers have been found in much greater amounts in water supplies than pesticides.

**Backsiphoning happens when a pesticide is pulled back into a water source where a fill hose is allowed to come into contact with the mix water in a spray tank. Homeowners should make sure that their spigots have a backflow preventer attached to prevent this potential problem. These devices are available at your local hardware store for less than $25.00. More importantly, make sure that there is an air gap present at all times between your water source and the spray tank or container you are filling!*

Surface Water

Another hazard of pesticide and fertilizer use is the potential for runoff into surface waters. Surface waters are known to recharge the groundwater in some aquifers. Therefore, contaminated surface water can be a threat to both surface and underground water resources.

Some pesticide and fertilizer products have greater potential for runoff than other products. If you apply a pesticide or fertilizer before a rain, or if you water your lawn or garden heavily just after an application, there is a good chance you are going to wash off the pesticide or fertilizer you just applied. Again, choose your chemical wisely; the product label and the charts at the end of this section will indicate whether a particular chemical poses a risk to water resources. Limit your use of chemicals only to the necessary amounts to do the job. Be even more cautious if you live near a stream or lake. In many subdivisions and urban areas, storm drains empty directly into nearby bodies of water. Any runoff from your property is likely to follow these storm drains to a local river or lake.

Farmers along the Chesapeake Bay area employ grass filter strips and planted buffer zones to reduce runoff. The turf areas on your property act in a similar manner and can be very effective in preventing many harmful chemicals from running off your property. By properly maintaining these areas or by planting new areas on your property, you too can employ similar protection to the water resources in your area. Contact your local water conservation district or Extension office for help with applying these methods to your property.

Air Quality

Pesticides can drift if applied under windy conditions or directed into the air. Pesticide drift is illegal and can be quite harmful to the plants, animals, people, and surfaces it contacts. For example, if you spray your lawn with 2,4-D or other phenoxy herbicides and these materials drift into a neighbor's yard or your garden, they can be quite damaging to desirable plants. Plants such as grapes, tomato, tobacco, ornamentals, flowers, garden vegetables, and fruit trees can be badly damaged by drift from these pesticides. Other herbicides also have the potential to cause extensive damage to non-target plants. Drift of insecticides and other toxic chemicals can poison animals and people. Some of the carriers and the pesticides themselves can also damage the surfaces they contact. Contact with painted surfaces, such as those on automobiles, can result in expensive damage. Contact with children's toys, swimming pools, and pet dishes all present exposure hazards to people and pets.

Drift onto walkways can be tracked into homes and adjacent areas, or can come into contact with bare feet. There have been cases where herbicides were allowed to drift onto a sidewalk (from a spot application) and later tracked into nearby turf areas. Weeks later a path of dead grass appeared where the chemical was tracked into the adjacent lawn.

Soils

The soil isn't just the substrate holding your plants in the ground. The soil is a very active environment which can play an important role in the breakdown of many chemicals. Nutrients important to the growth of plants are broken down in the soil to usable elements. The soil environment also holds and breaks down many pesticides. However, too much of a particular chemical can contaminate the soil environment to an extent where it is no longer alive. In other cases, chemicals can move through the soil and damage nearby trees and other desirable plants. The soil/water environment allows chemicals to travel through the soil. Again, follow all label directions, add organic material to your soils to encourage biodegradation of pesticides and other chemicals, and reduce your pesticide use by employing alternative controls.

Non-Target Organisms

Pesticides can be quite harmful to non-target animals and plants. We mentioned the potential damage to many plants earlier. Animals, both wild and domestic, can be harmed by careless pesticide use. Your backyard is home to many wild birds and animals. Many pesticides, especially insecticides, can directly and indirectly kill these animals. Birds in particular are very susceptible to pesticide poisoning. Careless use of some granular insecticides has been known to kill large numbers of birds in one feeding. If you use granules, make sure you incorporate them into the soil by watering or burying them. Birds can also be poisoned when they come into contact with treated surfaces or by eating treated food sources. Avoid spraying ripened fruit or flowers; cover plants with netting to prevent birds from contacting or eating treated plants. Birds can also feed on poisoned insects or lose these sources of food when they are killed by insecticides. Applications of herbicides can change wildlife habitats to where they are no longer habitable. Be careful when applying all pesticides and consider the impact of these chemicals on wildlife.

Other non-target organisms such as fish, bees, and beneficial invertebrates (insects, earthworms, etc.) are also susceptible to poisoning from pesticides. By eliminating beneficial organisms, your pest control problem can actually get worse. Consider alternatives and keep your pesticide applications to a minimum. For more information on the impact of certain pesticides on wildlife and other non-target organisms, refer to the reference tables at the end of this section of the guide.

Pets and other domestic animals are just as vulnerable to pesticides. Be careful when applying flea and tick controls on pets to avoid overexposing them to these chemicals. Be cautious with repeated applications of organophosphate and carbamate insecticides. The label will indicate which products contain these chemicals or may warn you that these products are cholinesterase inhibitors. Overuse of these chemicals can chronically poison your pet because they affect the animal's nervous system; they can inhibit an enzyme in an animal's (including humans) nervous system that is required to allow the system to work properly. Ask your veterinarian for advice and read the label to avoid this potential problem. Also make sure that your pet isn't exposed to other pesticide applications around your property, especially while your animal is being treated for fleas and ticks.

If you have a question about pesticide poisoning of pets or other domestic animals, please contact your veterinarian. This is your most reliable source. The veterinarian may contact other sources for you. Be careful about using Internet sources or other unknown sources of information, especially regarding treatment. Another reliable source of toxicological information is the ASPCA Animal Poison Control Center at (888) 426-4435. A charge may apply. See https://www.aspca.org/pet-care/animal-poison-control for details.

For assistance with wildlife poisonings or protection, contact your local Virginia Game Commission official.

Preventing Human Exposure and Poisonings

We have discussed the many precautions necessary to protect the environment and non-target organisms. The most vulnerable organism associated with pesticide use is yourself—the applicator. The person applying pesticides has the potential to come into contact with concentrated formulations when handling these chemicals. Even if you use less concentrated forms, you still can contact these materials in a much larger amount than when they are released into the environment. It is for this reason that you must be especially careful to prevent contact. Remember, there is no hazard associated with pesticide use if you are not exposed to the chemical itself. Even with highly toxic pesticides, applicators can reduce their hazard to very low levels by preventing exposure.

The Dose Makes the Poison

The potential for a pesticide to cause injury depends on several factors:

Toxicity of the Active Ingredient

Toxicity is the measure of the inherent ability of a chemical to produce injury. Some pesticides, such as pyrethrins, have low human toxicity while others, such as parathion, are highly toxic.

A pesticide's toxicity is listed on the product label according to a three-tiered signal word rating system. Most consumer chemicals are rated as low to moderate toxicity. Labels using the signal word "CAUTION" are rated as low toxicity pesticides. Those using the "WARNING" signal word are moderately toxic, and those using the "DANGER" signal word are highly toxic or highly corrosive. Avoid using any pesticide marketed for agricultural or commercial use. These chemicals are marketed for farm use and usually are concentrates formulated to be mixed for application on large acreage. For these reasons, mixing these products can be hazardous. Some chemicals may use the "DANGER-POISON" signal word with a red skull with crossbones, which means they can be extremely hazardous. Consumers are not equipped to handle these pesticides. Acute toxicity is based on the following ratings:

Table 1.1 - Toxicity Categories

Product Signal Word	Toxicity Category	Oral LD50 (mg/kg)[1]	Probable Adult Lethal Dose
DANGER/DANGER-POISON	highly toxic	0-50	a few drops to 1 teaspoon
WARNING	moderately toxic	50-500	1 - 2 teaspoons
CAUTION	slightly toxic	500-5000	1 ounce - 1 pint (pound)
CAUTION	almost non-toxic	more than 5000	1 pint (pound)

[1]The amount in milligrams of chemical per kilogram of body weight to kill 50% of the test organisms in a toxicity test (usually white male rats) when administered orally (ingested).

The greater the dose of a specific chemical (the amount absorbed), the greater the risk of injury. Dose is dependent on the absolute amount of the pesticide absorbed relative to the weight of the person. Therefore, small amounts of a pesticide might produce illness in a small child while the same dose of the same chemical in an adult might be relatively harmless.

For further information on toxicity, refer to: https://www.pubs.ext.vt.edu/ENTO/ENTO-389/ENTO-389.html.

Route of Absorption

Swallowing a pesticide usually creates the most serious problem. In practice, however, the most common route of absorption of pesticides is through the skin (dermal). The most toxic pesticides have resulted in death when absorbed through this route of exposure. This is why it is very important to wear protective clothing.

Duration of Exposure

In general, the longer you are exposed to a pesticide, the higher the level in the body. There is a point at which an equilibrium will develop between the intake and the output (the level will no longer continue to increase). This point may be either above or below the known toxic level.

Physical and Chemical Properties

The distribution and rates of breakdown of pesticides in the environment can significantly alter the likelihood that injury might occur.

Population at Risk

Persons who run the greatest risk of poisoning are those whose exposure is highest, such as users who handle or apply pesticides. However, the general public also faces the possibility of exposure.

Avoiding Exposure

Exposure is the key to creating a hazard with any toxin. Pesticides are no different. Without exposure you can't be poisoned. So avoiding exposure is the most important thing pesticide applicators can do to protect themselves. To protect yourself, you should wear protective clothing and limit your handling of pesticides as much as possible. Purchasing formulations which pose less risk in handling are worth the extra expense over a formulation which is harder to handle. Using a "measure and pour spout" device, now available in many garden centers, is a way to avoid exposure when measuring and pouring concentrates—the most hazardous stage for applicators. **Before using any device of this type for pesticide application, make sure it works properly**. Some types are prone to leaking. Test the device with water before using pesticides. If it leaks, return it to the place of purchase.

To protect yourself, you should wear the following protective clothing and equipment:

Eye Protection

You should wear chemical splash-proof goggles anytime you are mixing pesticides or where spray can come into contact with your eyes. Your eyes are extremely vulnerable to pesticide exposure. Most chemicals are eye irritants. You can purchase a pair of these types of goggles at most hardware stores. The cost is under $10.00.

Gloves

You should never handle a pesticide without using a pair of **unlined** chemical-resistant gloves. Gloves should be resistant to chemical permeation (chemical entering through the glove surfaces). Look for gloves made of nitrile or neoprene that will cover the upper forearms. Dispose of nitrile and neoprene gloves after one week of use. If you can't find these types of gloves, purchase a similar pair of vinyl gloves. Dispose of vinyl gloves after each use, because they can be permeated by chemical residues very easily. **Do not use** cloth or leather gloves. **Do not use** natural rubber or latex rubber gloves unless it is an emergency situation. Chemicals can penetrate rubber gloves within a very short period of time and some people have allergic reactions to latex. A good set of chemical-resistant gloves can be purchased at most hardware stores for less than $10.00 per pair.

Clothing

For most pesticides **marketed for home use**, you don't need any special clothing. However, you should read the label carefully to confirm this point. At minimum, **always** wear a long-sleeved shirt, long pants, socks, and shoes. You should **never** apply a pesticide in typical summer attire such as shorts and T-shirt. Remember, most pesticide exposure is through the skin. You should protect your skin at all costs. If you use coveralls, make sure they are approved for chemical use. If they are cloth, make sure you launder them after each use. Never wash these items in the same load as your regular family wash; they must be laundered separately (see specific instructions below).

Boots

You should wear chemical-resistant boots (preferably neoprene pull-over boots) anytime you must walk through sprayed areas or where concentrate or spray can come in contact with your shoes or feet. You should **not** wear leather or cloth shoes because if they become contaminated, these items **cannot** be cleaned to rid them of pesticide residues.

Other Devices

If you are mixing concentrates, you should consider using an apron. Aprons made of nitrile, neoprene, or vinyl provide an extra measure of protection when mixing and can prevent contamination of clothing you might need to wear for a long period during application.

A Word About Respirators:

Although professional applicators routinely use respirators to protect themselves, mostly because they work with pesticides daily, they are usually trained in the use of these devices. Respirators do not all fit the same. In addition, they must be properly stored and maintained to work well. If you have a beard, they will not offer the level of protection needed. Most home use pesticides do not call for respirator use. If the pesticide you are using indicates you should use a respirator, it might **not** be a chemical designed for consumer use. **Do not use pesticides designed for agricultural and commercial use around your home. You are asking for trouble if you do!**

Again, remember these recommendations are general in nature. Please read the pesticide label to determine the type of protective devices you need to wear.

Cleaning Up Yourself and Your Pesticide Contaminated Clothing After an Application

Wash Yourself Thoroughly to Remove Residues from Your Skin

After using a pesticide, you should take steps to decontaminate yourself. Rinse off your shoes and gloves. Remove them and your contaminated clothing in a mud room or garage and clean up immediately. Put your contaminated clothing in a plastic garbage bag. Be sure to mark this bag and seal it to prevent others from coming into contact with the contaminated items. If you spilled concentrates or heavily soaked your clothes with dilute pesticides, you should throw them in the garbage using the same bag. Otherwise, the bag of clothing should be set aside for later laundering—**separately from your family wash.**

You should immediately shower and shampoo thoroughly. Use plenty of hot water and soap. Dry off and take the towel you use to dry with to the laundry for washing as well (don't leave it in the bathroom for others to use!). Go back outside to check if you put everything away properly, including your boots, gloves, aprons, and goggles. These items should also be cleaned properly before you store them or use them again. Make sure you wear chemical-resistant gloves when handling and cleaning these items. Wash any areas of your skin or clothing after cleaning these items if they come in contact with the contaminated items or wash water.

Laundering Your Pesticide-Contaminated Clothing

Introducing pesticide-contaminated clothing into your family laundry presents a special hazard to you and the other members of your household. The pesticides on these pieces of clothing can be transferred to other clothing during the washing process. Please follow the instructions below carefully to prevent exposing you or your family to pesticide residues in the laundry.

Laundering Information for Pesticide-Contaminated Clothing - Before laundering, read the pesticide label to determine which chemicals are more toxic. Clothing contaminated with highly toxic and concentrated pesticides must be handled extremely carefully because pesticides are easily absorbed through skin. Hazards are less pronounced when handling clothing exposed to moderate or low-toxicity pesticides.

Discard any clothes that have been completely saturated with concentrated pesticides.

Laundering Recommendations (Cotton or Denim Fabric) - Wash contaminated clothing separately from the family wash. Pesticide residues are transferred from contaminated clothing to other clothing when they are laundered together.

Pre-rinsing contaminated clothing before washing will help remove pesticide particles from the fabric. Pre-rinsing can be done by:

1) Pre-soaking in a suitable container prior to washing to dislodge the particles;
2) Pre-rinsing with agitation in an automatic washing machine, and;
3) Spraying/hosing garments outdoors.

Clothing worn while using low-toxicity pesticides may be effectively laundered in one machine washing. It is strongly recommended that multiple washings be used on clothing contaminated with pesticides to draw out excess residues. Always wear chemical-resistant gloves when **handling contaminated clothing** to prevent pesticide absorption into the body.

Washing in hot water removes more pesticide from the clothing than in other water temperatures. Avoid cold water washing. Although cold water washing might save energy, cold water temperatures are relatively ineffective in removing pesticides from clothing.

Laundry detergents, whether phosphate, carbonate, or heavy-duty liquids, are similarly effective in removing emulsifiable concentrate pesticide formulations. Emulsifiable concentrate formulations are oil-based, and heavy-duty liquid detergents are known for their oil-removing ability.

Laundry additives, such as bleach or ammonia, do not contribute to the removal of pesticide residues. Either of these additives may be used, if desired, but caution must be used. Bleach should never be added to or mixed with ammonia, because they react together to form a **very toxic chlorine gas**. **Do not mix ammonia and bleach**.

If several garments have become contaminated, wash only one or two garments in a single load. Wash garments contaminated by the same pesticide(s) together. Launder using a full water level to allow the water to thoroughly flush the fabric.

Clothing exposed to pesticides should be laundered the same day. This is especially true with highly toxic or concentrated pesticides. It is much easier to remove pesticides from clothing by daily laundering than attempting to remove residues that have accumulated over a period of time.

Pesticide carry-over to subsequent laundry loads is possible because the washing machine is likely to retain residues. It is important to rinse the washing machine with an "empty load," using hot water and the same detergent, machine settings, and cycles used after laundering contaminated clothing.

Line-drying is recommended for these items. Although heat from an automatic dryer might create additional chemical breakdown of pesticide residues, many pesticides break down when exposed to sunlight. This also eliminates the possibility of residues collecting in the dryer.

Laundering Recommendations (Vinyl-coated Fabric, Neoprene, or Rubber) - Laundering this type of outer protective clothing is different from other types. It should be pan-washed in warm water (less than 110˚F) using a good detergent. Double or triple washing of heavily contaminated outer protective clothing is desirable. Rinse through two water changes and hang up to air dry. Outer protective clothing should be washed after each exposure or use.

Gloves must be thoroughly pan-washed inside and out using a good detergent with several rinses. Remember, gloves must be clean inside because they will be in contact with your skin. Wash **chemical-resistant boots** similarly to gloves.

Respirators require special care. Wash inside with a cloth, detergent, and warm water. Change filters according to instructions on the original container. Keep the respirator in a plastic bag, original container, or some other suitable container when it is not being used. Keep the respirator properly adjusted to your face. Filters and prefilters should be kept sealed in a plastic bag when not in use. Filters should be changed regularly according to ratings and amount of use.

Goggles should be washed with a mild detergent so as not to scratch the lenses.

Give all of your protective clothing and equipment the best of care. They may save your life.

Chemical Emergencies

What happens if you spill a pesticide?

Every pesticide spill situation varies, but there are some basic procedures you can follow to protect you and your family if a spill emergency occurs. Spills occur due to breakage of glass containers, tipping open containers during mixing and handling, and sometimes from poor storage conditions. Avoid these situations and you will avoid most spill emergencies.

Some measures you can take to reduce the hazards of a spill include:

• Review your pest control priorities to determine if you need to use or store a pesticide in the first place.

• Don’t buy large containers or glass containers that break easily.

• Avoid liquid formulations if possible.

• Use ready-to-use products to avoid storing or handling concentrates.

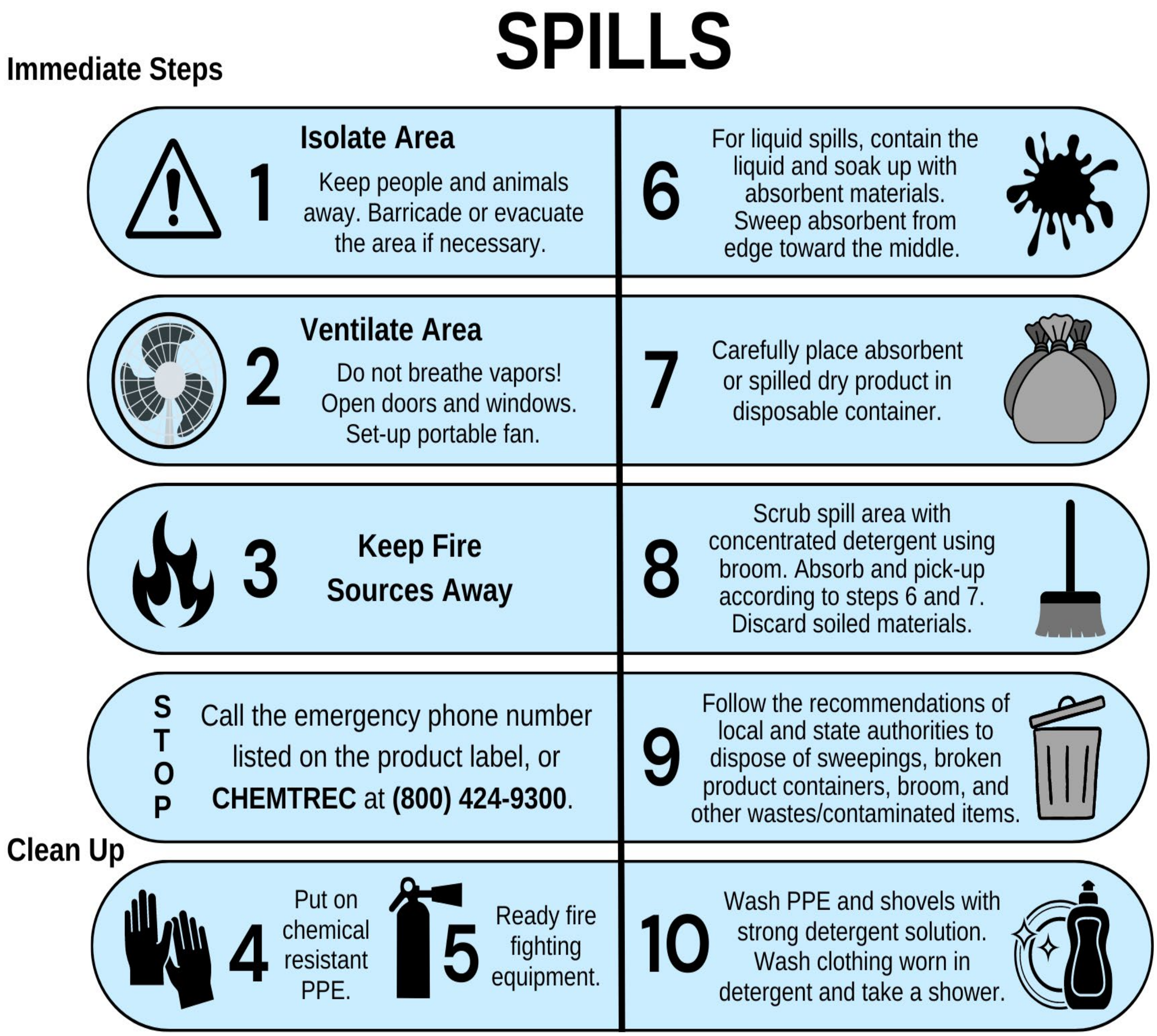
• Don’t store pesticides in your living areas or where vapors from a spill can enter your home in some way.

• Don’t place containers where they will be easily knocked onto the floor and broken.

• Don’t store pesticides where heat or cold will cause chemicals to react or rupture containers.

• Don’t store containers where they will become wet or damaged.

The following diagram provides a 10-step process that works for most home and garden chemicals. If you have any doubts, contact the chemical manufacturer, your local Extension agent, or the groups listed in the Virginia Pesticide Information Directory (to follow).



Chemical Spill Kit

Here is a list of supplies you will need to handle most chemical spills. Try to keep these items handy if you store pesticides in your home.

- chemical resistant gloves *[2 pairs made from nitrile or neoprene—if you can't get these, rubber or vinyl will work but be careful since some chemicals can permeate (dissolve and enter through the glove surfaces) these materials easily]*
- chemical resistant boots (*1 pair made from neoprene rubber, or vinyl—again be careful about permeation)*
- absorbent material (*1 large bag of kitty litter or other commercially available absorbent)*
- detergent *[strong household type such as Tide or All will work; trisodium phosphate (TSP) will work more effectively but be careful because this material can burn you]*
- disposable pail *(a 5-gallon bucket will work—this is a good place to store most of the items in a spill kit)*
- disposable plastic bags *(2 heavy-duty garden type bags)*
- broom (*household type with natural bristles)*
- scoop or shovel
- fire extinguisher [*10 lb.—rated for chemical fires (A B & C type fires)]*

What happens if you or a member of your family is exposed to or poisoned by a pesticide?

Pesticide poisonings can occur through careless handling, through accidental ingestion, and by contact with treated surfaces, containers, and application equipment. Many accidents can be prevented by careful handling, storage, and selection of safer products. Never store or leave pesticides where children, uninformed adults, or pets can contact them. Never leave a sprayer unattended or allow others to enter a treated area until the sprayed area is safe to reenter according to the label instructions.

Follow these directions if an exposure occurs

- **Follow the first aid recommendations on the label.** Often quick action on the scene can do more to help a victim than can be done by waiting for emergency personnel to arrive. Remember, the first aid instructions are usually directed to the layman at the scene. Your response to these recommendations could save a life or prevent long-term injury. This is especially important when chemicals splash into the eyes—fast action to rinse out an eye during the first 15-20 minutes can prevent possible permanent damage. One word of caution—be careful to avoid exposure to yourself when handling a poisoned victim.
- **Call your physician immediately.** If your family physician is not available, the patient should be taken to the nearest hospital emergency room along with the container of the poisoning agent (pesticide container with the intact label). Make sure you put the container in a plastic bag and warn all emergency personnel of the situation to protect them from possible exposure to the pesticide on the victim, the container, or at the site.
- If necessary, the physician will call the nearest poison control center for further information on the suspected poisoning agent, treatment, and prognosis.
- **If you have questions specific to a possible poisoning, you can call a Poison Control Center for information. Please refer to the list below for Poison Control Centers and other emergency contacts.**

Poison Information and Treatment Resources For Virginians

Regional Poison Control Centers

Provide 24-hour information and consultation services by Poison Information Specialists and board-certified Medical Toxicologists. Located in hospitals equipped for all toxicologic (poison) emergencies.

CHARLOTTESVILLE, VA
Blue Ridge Poison Center
University of Virginia School of Medicine
1222 Jefferson Park Ave.
P.O. Box 800774
Charlottesville, VA 22903
(800) 222-1222
https://med.virginia.edu/brpc/

CHARLESTON, WV
West Virginia Poison Center
Robert C. Byrd Health Sciences Center
3110 MacCorkle Ave., S.E.
Charleston, WV 25304
(800) 222-1222
www.wvpoisoncenter.org

WASHINGTON, DC
National Capital Poison Center
3201 New Mexico Ave., NW
Suite 310
Washington, DC 20016
(800) 222-1222
www.poison.org

CHARLOTTE, NC
Carolinas Poison Center
Atrium Health
P.O. Box 32861
4400 Golf Acres Dr., Suite B-2
Charlotte, NC 28208
(800) 222-1222
www.ncpoisoncenter.org

RICHMOND, VA
Virginia Poison Center
VCU Health System
Virginia Commonwealth University
830 East Main Street, Suite 300
P.O. Box 980522
Richmond, VA 23298-0522
(800) 222-1222
https://poison.vcu.edu/

For a complete list of Poison Control Centers online, please visit: https://www.aapcc.org/centers/

National Poison Control Center
Toll-free number for all U.S.:

(800) 222-1222

Calls to this number will be routed to the closest
Regional/Area Poison Control Center.
Website for the American Association of Poison Control Centers is:

www.aapcc.org/

Applying the Correct Amount in the Right Place

Applying the correct amount of pesticide to the target site is critical for proper pest control. Using the right equipment for the job is an important first step toward achieving this task. Your choice of equipment can be as simple as using an aerosol or granular applicator supplied with the product, or as complex as using a pull behind or utility sprayer for a large area. In each situation, the application equipment must be in good working order and calibrated to put down the correct amount. Ask your Extension agent for publications and assistance with calibration of larger pieces of equipment and backpack sprayers.

Proper Measuring and Mixing

To mix a concentrated formulation of a pesticide, you must first determine (according to label directions) how much concentrate to dilute with water or some other diluent. You can use the conversion charts and other pieces of information in the Reference Tables (to follow) to help you with some measurements. Determining the correct amount to mix is usually just a combination of simple math and knowing the units of measurement.

For example, the product label says, "For the control of aphids on tomatoes, mix 8 fluid ounces of pesticide concentrate into 1 gallon of water and spray the foliage until wet." By filling your sprayer with water and testing the output on your garden, you know that your six tomato plants require only one quart of dilute pesticide to cover their foliage. So you need only 2 fluid ounces of pesticide concentrate mixed in one quart of water to do the job. Why? Because a quart is one-fourth of a gallon, and 2 fluid ounces mixed into a quart make the same strength spray recommended by the label, but in a quantity that can be used all at once.

Consumers can solve similar problems by using careful math, good measurements, and use of the reference information here and in the tables at the end of this section of the guide.

Helpful Hints

If you need to determine the size of a square or rectangular area, such as a lawn for herbicide application, measure and multiply the length times the width. For example, an area 10 feet long by 8 feet wide contains 80 square feet of area. Common area measurements may involve square yards (1 square yard = 9 square feet) or square feet (1 square foot = 144 square inches).

If you need to determine the volume of a space such as a room, measure and multiply the room's length, width, and height. For example, a space 10 feet long, 8 feet wide, and 8 feet high contains a volume of 640 cubic feet. You would use this procedure, for instance, for an aerosol release to control cockroaches.

Most home-use pesticides are measured in terms of volume. Some common equivalents include:

1 gallon (gal.)	=	128 fluid ounces (fl. oz.)
	=	4 quarts
	=	8 pints
	=	16 cups
1 quart (qt.)	=	32 fl. oz.
	=	2 pints
	=	4 cups
1 pint (pt.)	=	16 fl. oz.
	=	2 cups
1 cup	=	8 fl. oz.
1 tablespoon (tbsp)	=	1/2 fl.oz.
	=	3 teaspoons (tsp)
1 teaspoon (tsp)	=	1/6 fl.oz.

In measuring teaspoons or tablespoons of pesticide, use only level spoonfuls, and never use the same measuring devices for food preparation.

The following table provides examples to help you convert label information to your specific use situations. "Amount" can be any measure of pesticide quantity. However, the same unit of measure must be used on both sides of the chart. For example, 8 fluid ounces per gallon of water is equivalent to 2 fluid ounces per quart of water.

Not all dosage rates are included in the examples given here. For rates not included, remember that a pesticide that is diluted with water proportionally changes the quantity of pesticides and the area, volume, or number of items treated. For example, one-half pound per 1,000 square feet is equivalent to one-quarter pound per 500 square feet. Likewise, one-half pound of pesticide in 1 gallon of water applied to 1,000 square feet is equivalent to 1 pound of pesticide in 2 gallons of water applied to 2,000 square feet.

There is a point at which measurements needed for smaller quantities of pesticides are too minute to be accurately measured with typical domestic measuring devices. In such cases, the user can either mix the larger volume, realizing that there will be leftover material; obtain a more accurate measuring device, such as a graduated cylinder or a scale which measures small quantities; or search for an alternative pesticide or less concentrated formulation of the same pesticide.

Table 1.2 - Conversion Table

Pesticide Label Says Mix			**Amount of Pesticide Per**		
Amount Pesticide	**Per**		**1 qt. water**	**1 pt. water**	
8 units	1 gal. water	**equals**	2 units	1 unit	
16 units	1 gal. water	**equals**	4 units	2 units	
32 units	1 gal. water	**equals**	8 units	4 units	
128 units	1 gal. water	**equals**	32 units	16 units	
Pesticide Label Says Apply				**Amount of Pesticide Per**	
Amount Pesticide	**Per**		**20,000 sq. ft.**	**10,000 sq. ft.**	**500 sq. ft.**
1 unit	1,000 sq. ft.	**equals**	20 units	10 unit	1/2 unit
2 units	1,000 sq. ft.	**equals**	40 units	20 units	1 unit
5 units	1,000 sq. ft.	**equals**	100 units	50 units	2 1/2 units
10 units	1,000 sq. ft.	**equals**	200 units	100 units	5 units
Pesticide Label Says Release				**Cans Per**	
Aerosol Cans	**Per**		**20,000 cu. ft.**	**10,000 cu. ft.**	**5,000 cu. ft.**
1	10,000 sq. ft.	**equals**	2	1	don't use
1	5,000 sq. ft.	**equals**	4	2	1
1	2,500 sq. ft.	**equals**	8	4	2

Table 1.3 - Table of Weights, Measures, and Dilutions

Weights:
28.35 grams = 1 ounce
16 ounces = 1 pound = 453.6 grams
1 pint of water = 1.04 pounds
1 gallon of water = 8.34 pounds
1000 micrograms = 1 milligram
1000 milligrams = 1 gram = 0.035 ounce avoirdupois
1000 grams = 1 kilogram = 2.2 pounds

Volume And Liquid Measure:
3 teaspoons = 1 tablespoon = 14.8 cubic centimeters (cc)
2 tablespoons = 1 fluid ounce = 29.6 cc
8 fluid ounces = 16 tablespoons = 1 cup = 236.6 cc = 1/2 pint
2 cups = 32 tablespoons = 1 pint = 473.1 cc = 16 fluid ounces
2 pints = 64 tablespoons = 1 quart = 946.2 cc = 0.946 liter
4 quarts = 256 tablespoons = 1 gallon = 3785 cc
1 gallon = 128 fluid ounces = 231 cubic inches = 3785 cc
1 milliliter (ml) = 1 cubic centimeter = 0.034 fluid ounces
1000 milliliters = 1 liter = approximately 1 quart, 1 fluid ounce
1 liter of water = 1 kilogram
1 bushel soil = 1.25 cubic feet

Land Measure:
43,560 square feet = 1 acre = 0.404 hectare
1 mile = 5280 feet = 1609.35 meters
10 millimeters = 1 centimeter = 0.3937 inches
100 centimeters = 1 meter = 39.37 inches

Length Of Row Required For One Acre:

Row Spacing	*Length or Distance*
24 inch	7260 yards = 21,780 feet
30 inch	5808 yards = 17,424 feet
36 inch	4840 yards = 14,520 feet
40 inch	4356 yards = 13,069 feet
42 inch	4149 yards = 12,446 feet
48 inch	3630 yards = 10,890 feet

Dilutions:

1 part per million (ppm)	= 1 milligram per liter
	= 1 milligram per kilogram
	= 0.0001 percent
	= 0.013 ounce by weight in 100 gal
1 percent	= 10,000 parts per million
	= 10 grams per liter
	= 1.29 ounces by weight per gallon
	= 8 pounds per 100 gallons

Temperature:
To change temperature in degrees Celsius to temperature in degrees Fahrenheit, multiply Celsius by 9/5 and add 32.
Example: 30 degrees Celsius = 30 x 9/5 + 32 = 86 degrees Fahrenheit.

Abbreviations:
Formulations:
A = aerosol
B = bait
C = concentrate
D = dust
E or EC = emulsifiable concentrate
F = flowable
G = granules or granular
L = liquid
LC = liquid concentrate
M = microencapsulated
P = pellet
RTU = ready-to-use
S = solution
SP = soluble powder
ULV = ultra-low volume
W or WP = wettable powder
WDG = water dispersible granule
WS = water soluble
WSP = water-soluble powder or water-soluble packet

Pesticide Calibration Tables

Table 1.4 - Travel Speed Chart

Miles per Hour	Time Required in Seconds to Travel 100 ft	200 ft	300 ft
1	68	136	205
2	34	68	102
3	23	46	68
4	17	34	51
5	14	27	41
6	11	23	34
7	10	20	29
8	9	17	26
9	8	15	23
10	7	14	21

1 mph = 88 feet per minute
1 mph = 1.466 feet per second
Speed in mph = Number of 35-inch steps per minute/30

Table 1.5 - Equivalent Quantities of Dry Materials (Wettable Powders) For Various Quantities of Water

Water	Quantity of Material					
100 gal[1]	1.0 lb	2.0 lb	3.0 lb	4.0 lb[1]	5.0 lb	6.0 lb
50 gal	8.0 oz	1.0 lb	1.50 lb	2.0 lb	2.50 lb	3.0 lb
5 gal[1]	0.80 oz (3 tbsp)[2]	1.60 oz	2.40 oz	3.20 oz[1]	4.00 oz	4.8 oz
1 gal	0.16 oz (2 tsp)[2]	0.32 oz (3 tsp)[2]	0.48 oz (1 1/2 tbsp)[2]	0.64 oz (2 tbsp)[2]	0.80 oz (3 tbsp)[2]	0.96 oz (3 tbsp)[2]

[1]**Example**: If a recommendation calls for a mixture of 4 pounds of wettable powder to 100 gallons of water, it would take 3-1/4 ounces to 5 gallons of water to give 5 gallons of spray mixture of approximately the same strength.

[2]**Note**: Wettable pesticide materials vary considerably in density. Therefore the teaspoonful (tsp) and tablespoonful (tbsp) measurements in this table are approximate but not exact dosages by weight. However, we believe that they are within the bounds of safety and efficacy for mixing small amounts of spray.

Table 1.6 - Equivalent Quantities of Liquid Materials (Emulsifiable Concentrates, etc.) for Various Quantities of Water

Water	Quantity of Material					
100 gal[1]	1/2 pt	1.0 pt	2.0 pt	3.0 pt	4.0 pt[1]	5.0 pt
50 gal	4.0 fl oz	8.0 fl oz	1.0 pt	24.0 fl oz	1.0 qt	2 1/2 pt
5 gal	0.40 fl oz (1 tbsp)[2]	0.80 fl oz	1.60 fl oz	2.40 fl oz	3.20 fl oz	4.0 fl oz
1 gal[1]	0.08 fl oz (1/2 tsp)[2]	0.16 fl oz (1 tsp)[2]	0.32 fl oz (2 tsp)[2]	0.48 fl oz (3 tsp)[2]	0.64 fl oz (4 tsp)[2]	0.80 fl oz (5 tsp)[2]

[1]**Example**: If 4 pints of a liquid concentrate is recommended to 100 gallons of water, 4 teaspoons of the chemical in 1 gallon of water will give a mixture of approximately the same strength.

[2]Approximate figure.

Decontaminating Sprayers

If you use your sprayer for an herbicide application (such as spraying herbicides like 2,4-D on your lawn) and later use it to apply an insecticide application on your garden or shrubs, you could kill those vegetables and ornamentals. You cannot totally decontaminate a sprayer of phenoxy herbicides. For this type of situation you should buy two sprayers; one for herbicides and another for other pesticide applications. You should clearly mark these sprayers accordingly. For other herbicides and for spraying less sensitive plants, you can use the same sprayer after cleaning it properly.

Cleaning a Sprayer

Immediately after application, you should flush the sprayer with water and spray this water on a site that is listed on the label. Rinse several more times with water before storing; additionally, rinse the sprayer with water at least once immediately before reusing. Most pesticide formulations can be removed by repeated washing with water.

Storage

Pesticide storage at home should be kept to a minimum. Often, buyers of home pesticides are tempted to purchase concentrated formulations because they cost less per dosage to mix and use. Unfortunately, most of us never think about the rest of the bottle. As a result, we often end up storing these chemicals somewhere in our homes or in an outside shed where the chemical will freeze or heat up and be rendered useless within a few years. You should:

- Select products that are ready-to-use or are marketed with limited packaging and in amounts to only carry you through the current use season.
- Store pesticides in a locked cabinet away from children and pets. The storage cabinet should be separated from other household items and should never be located in the living areas of the home. Never put pesticides in a cabinet with, or near, food, medical supplies, or cleaning materials.
- Always store pesticides in their original containers. Labels should be protected to prevent damage and to remain readable. Never transfer pesticides into other containers unless the original container is damaged. Never use drink bottles or other containers that children and others may associate with something to eat or drink. If you must transfer chemicals because of a broken container, make sure you remove the original label and place it on the replacement container. Always refasten child-proof closures and lids.
- Avoid storing pesticides in places where flooding is possible, or in open places where they might spill or leak into the environment. If you have any doubt about the content of a container, dispose of it using the directions below.

Disposal

The best way to dispose of a small, excess amount of pesticide is to use it—apply it according to label directions. If you cannot use it, ask a neighbor whether he or she can use it. If all the pesticide cannot be used, first check with your local solid waste management authority to determine whether your community has a household hazardous waste collection program or any other program for handling disposal of pesticides. Several communities in Virginia have sponsored these programs in the past. If you live on a farm or have purchased an old farm and have leftover pesticides that were left from previous farming operations, you should contact your local Extension agent to determine if your locality is holding a pesticide waste collection program for leftover farm chemicals.

- Do not pour leftover pesticides down the sink or into the toilet. Chemicals in pesticides could interfere with the operation of wastewater treatment systems and pollute waterways because many municipal systems cannot remove all pesticide residues.
- An empty pesticide container can be as hazardous as a full one because of residues remaining inside. When empty, a pesticide container should be triple rinsed and disposed of according to the pesticide label directions.
- Do not puncture or burn pressurized product containers—they could explode.
- If you have any doubts about proper pesticide disposal, contact your solid-waste management agency or other sources of assistance referenced on the pesticide label.

For further information on pesticide storage and disposal, please see:

Pesticide Storage & Disposal - A Quick Guide for Home Use https://www.pubs.ext.vt.edu/ENTO/ENTO-385/ENTO-385.html.

Additional Information

1. Virginia Tech Pesticide Programs. (2020). *The Virginia Core Manual: Applying Pesticides Correctly*. Blacksburg, VA: Virginia Cooperative Extension.
2. Helfrich, L. A., Weigmann, D. L., Hipkins, P., & Stinson, E. R. (2009). *Pesticides and Aquatic Animals: A Guide to Reducing Impacts on Aquatic Systems*. Virginia Cooperative Extension. Retrieved from https://vtechworks.lib.vt.edu/handle/10919/48060
3. Whitford, F., Miller, B., Bennett, R., Jones, M., & Bledsoe, L. (2008). Pesticides and Wildlife: An Introduction to Testing, Registration, and Risk Management. *Purdue Pesticide Programs*. Retrieved from https://ppp.purdue.edu/wp-content/uploads/2016/08/PPP-30.pdf
4. Environmental Protection Agency (2005). Citizen's Guide to Pest Control and Pesticide Safety. *U.S. EPA – Prevention, Pesticides and Toxic Substances*. Retrieved from https://www.epa.gov/safepestcontrol/citizens-guide-pest-control-and-pesticide-safety

Table 1.7 - Toxicity Data for Some Common Pesticides Used in Home Grounds and Animals

Fungicides

Pesticide (Brand Name)	Humans	Soils	Water	Birds	Mammals	Earthworms	Fish	Bees
captan	L	24	L	N	L	L	H	N
chlorothalonil (Daconil, Bravo)	L	30	L	L	L	M	H	H
copper sulfate	M	-	H	M	M	L	H	N
mancozeb (Manzate)	L	7	H	L	L	L	H	N
sulfur	N	-	L	N	N	-	N	N

Herbicides

Pesticide (Brand Name)	Humans	Soils	Water	Birds	Mammals	Earthworms	Fish	Bees
2,4-D amine (2,4-D)	M	10	M	M	M	L	L	N
glyphosate (Roundup)	L	47	N	L	L	L	L	N
MCPA	L	120	H	M	L	L	M	N
mecoprop-P	L	60	H	M	L	L	L	-
pendimethalin (Pendulum, Prowl)	L	120	L	L	L	L	M	L
triclopyr	L	46	H	L	L	L	M	-

Insecticides

Pesticide (Brand Name)	Humans	Soils	Water	Birds	Mammals	Earthworms	Fish	Bees
acephate (Orthene)	L	10	L	M	M	-	L	H
Bacillus thuringiensis (BT, Dipel)	N	-	N	N	L	N	N	N
bifenthrin	M	varies	L	L	M	-	H	H
carbaryl (Sevin)	M	16	M	L	M	EH	M	H
cypermethrin	M	60	L	L	M	H	H	H
imidacloprid (Merit)	M	varies	L	L	M	-	L	H
malathion	L	10	L	M	L	L	H	H
metaldehyde (Deadline)	M	-	L	L	M	-	L	L
pyrethrins (PyGanic)	L	10	L	L	L	L	EH	H
soap, insecticidal (Safer Soap)	N	-	N	N	N	-	N	L

Humans: based on oral LD50 in rats
Soils: half-life in soils (number of days)
Water: highest of either runoff or leaching potential
Birds: based on LD50 to most sensitive species
Mammals: based on oral LD50 in rats
Earthworms: based on test results
Fish: based on oral LC50 on most sensitive species
Bees: based on article on bee hazards by R. D. Fell

EH: Extremely high hazard rating
H: High hazard rating
M: Moderate hazard rating
L: Low hazard rating
N: No hazard rating
(*): Highly toxic to aquatic invertebrates
(-): means data unavailable

Virginia Pesticide Information Directory

This directory is intended for use by persons who need assistance with general and emergency pesticide-related information. We hope that it will save time and money by directing you to the proper government and industry sources.

The pages to follow are broken down into **EMERGENCY** and **GENERAL INFORMATION**. In the blank lines provided, please take time to list your local phone numbers for these sources. In the case of an emergency, it might save a life or avoid added expense and inconvenience. Keep a copy of this guide, with this directory section marked, near your phone for future reference.

For emergency information about an agricultural chemical, please refer to a current product label or call CHEMTREC at (800) 424-9300 or (800) 262-8200.

Emergency Information

Treatment for Poisonings: If poisoned, have someone take you immediately to your nearest emergency room with the label of the container.

The blanks below are supplied for recording the name and telephone number of the nearest poison control center. Please refer to the Regional and Area Poison Control Centers listed previously.

My nearest poison control center is located at:

____

____

Phone Number: ______________________________

Emergency Information

Spills, Leaks, Exposure, Fire, accidents, and other related emergencies	CHEMTREC (for assistance) Chemical Transportation Emergency Center Industry assistance with clean-up procedures, etc. www.chemtrec.com/	**(800) 424-9300 or (800) 262-8200** (call day or night)
Accidents Or Incidents that constitute a threat to any person, public safety and health, or the environment must be reported to:	Virginia Department of Agriculture and Consumer Services Office of Pesticide Services Field Operations	**(804) 371-6560**
For Assistance With Spills And Emergencies take time to jot down your local emergency numbers in the space provided	State Police ________________ Fire Department ________________ Ambulance ________________ **911**	

General Information

General Information	**Virginia Tech** **Your Local Extension Office** https://ext.vt.edu/offices.html	
	Virginia Tech Pesticide Programs Blacksburg, VA 24061 (0409) vtpp.ento.vt.edu or vtpp.org.	**(540) 231-6543**
Regulatory Information including permit or license information and reporting pesticide missuse.	**Virginia Dept. of Agriculture and Consumer Services** Office of Pesticide Services 102 Governor Street, Lower Level Richmond, VA 23219 www.vdacs.virginia.gov/pesticides.shtml	**(804) 786-3798**
Hazardous Waste Disposal Information (Follow label directions first, call for help only after reading label carefully.)	**Virginia Department of Environmental Quality** 1111 East Main Street, Suite 1400 P.O. Box 1105 Richmond, VA 23218 http://www.deq.virginia.gov/	**(804) 698-4000** **(800) 592-5482**
Pesticide Information Dealing with pesticide chemistry and toxicology	**National Pesticide Information Center (NPIC)** Oregon State University 310 Weniger Hall Corvallis, OR 97331-6502 http://npic.orst.edu/	**(800) 858-7378** **Monday - Friday** **8:00 AM - 12:00 PM PT** **11:00 AM - 3:00 PM ET**
Citizen's Assistance general consumer-related information and complaints	**U.S. Consumer Product Safety Commission** https://www.cpsc.gov/	**(800) 638-2772** **(800) 638-8270 TTY** **8:00 AM - 5:30 PM ET**
Animal Poisonings Assistance (Emergency Services)	**Virginia-Maryland Regional College Of Veterinary Medicine** Virginia Tech (0442) 205 Duck Pond Drive Blacksburg, VA 24061 https://www.vetmed.vt.edu/	**(540) 231-4621** **(Your veterinarian may contact this number 24 hours a day for consultation.)** **540-231-7666 (SWITCHBOARD)**
	ASPCA Animal Poison Control Center https://www.aspca.org/pet-care/animal-poison-control	**(888) 426-4435**
Toxicology Information	**Virginia Department of Health** **Toxic Substances Information** 109 Governor Street, P.O. Box 2448 Richmond, VA 23219 http://www.vdh.virginia.gov/	**(804) 864-8127**
For Information on drinking water regulations and pesticides in drinking water	**EPA Safe Drinking Water Hotline** https://www.epa.gov/ground-water-and-drinking-water	**(800) 426-4791** **Monday - Friday** **9:00 AM - 4:00 PM ET**

Also try EPA's Home Page for more consumer information on pesticides at https://www.epa.gov/safepestcontrol

Professional Associations

National Pest Management Association (NPMA)
10460 North Street
Fairfax, VA 22030
(703) 352-6762
https://www.pestworld.org/

National Assocation of Landscape Professionals, Inc.
12500 Fair Lakes Circle
Suite 200
Fairfax, VA 22033
(703) 736-9666
(800) 395-2522
https://www.landscapeprofessionals.org

Virginia Nursery and Landscape Association
5101 Monument Avenue, Suite 203
Richmond, VA 23230
(804) 256-2700
https://vnla.org/

Virginia Pest Management Association (VPMA)
P. O. Box 7161
Fredericksburg, VA 22404
(540) 374-9200
http://www.vpmaonline.com/

Virginia Turfgrass Council (VTC)
P. O. Box 5989
Virginia Beach, VA 23471
(757) 464-1004
https://vaturf.org/

This directory neither endorses those private groups listed nor was intended to exclude groups who may be appropriate but were not listed. Those who feel that they should be included are welcome to call or write for inclusion in future revisions: Virginia Tech Pesticide Programs (MC0409), 302 Agnew Hall (Bldg. 0109), 460 West Campus Drive, Blacksburg, VA 24061, (540) 231-6543. For a more complete list of pesticide-related sites, please visit to the Virginia Tech Pesticide Programs Home Page at vtpp.ento.vt.edu (or vtpp.org).

Protecting Honey Bees

James Wilson, Extension Apiculturist, Virginia Tech Department of Entomology

Honey bees are a valuable service to apiculture and agriculture not only because of they produce honey and beeswax, but they are the most important pollinators of cultivated crops. Pesticide poisoning of honey bees, and other beneficial insects, can be a serious problem. Every effort should be made to minimize the exposure of honey bees to pesticides in treated areas.

An Updated Note on Protecting Pollinators in Virginia

Federal guidelines mandate that each state develop a plan for the mitigation of pesticide exposure to managed pollinators in their own state. The plan is known as the "Voluntary Plan to Mitigate the Risk of Pesticides to Managed Pollinators" and was finalized in May of 2017.

This voluntary plan encourages an increase in communication between pesticide applicators and the managers of pollinators to reduce the potential for damaging pesticide exposure. Since this plan is voluntary there are additional guiding documents for most involved stakeholders, see table below for links. This plan has been adopted by the Commonwealth of Virginia and can be found in its entirety at the 1st link provided below. Virginia is using the Bee Check tool for beekeepers, and the Field Check tool for applicators to help reduce pesticide exposure risk (the respective sign-up links are below). Questions and comments should be directed to VDACS with the contact information given below.

Virginia's Voluntary Plan to Mitigate the Risk of Pesticides to Managed Pollinators

Link: http://www.vdacs.virginia.gov/pdf/BMP-plan.pdf

Beekeepers can sign up for the Bee Check Program at: https://beecheck.org/signup#beekeeper

Applicators can sign up for the Field Program at: https://driftwatch.org/signup#applicator

Best Management Practices:

Stake Holder Category	VDACS Recommended Best Management Practices
Beekeepers	https://www.vdacs.virginia.gov/pdf/BMP-Beekeeper.pdf
Commercial Ag. Applicators	https://www.vdacs.virginia.gov/pdf/BMP-Ag-Commercial-Applicator.pdf
Agricultural Producers	https://www.vdacs.virginia.gov/pdf/BMP-Ag-Producer.pdf
Structural Pest Management	https://www.vdacs.virginia.gov/pdf/BMP-Structural-Pest-Management.pdf
Horticultural Production	https://www.vdacs.virginia.gov/pdf/BMP-Horticultural-Industry.pdf

VDACS Contact Points:

Liza Fleeson Trossbach, Program Manager
Office of Pesticide Services
liza.fleeson@vdacs.virginia.gov
804.371.6559

Keith Tignor, State Apiarist
Office of Plant Industry Services
keith.tignor@vdacs.virginia.gov
804.786.3515

Causes of Honey Bee Poisoning

1. The majority of honey bee poisoning occurs when pesticides are applied to crops in bloom. This includes crop plants such as sweet corn, which is routinely sprayed when in tassel. Honey bees do not pollinate corn; however, they will collect pollen from corn tassels and transport it back to the honey bee hive.
2. The application of pesticides to fields with weeds in bloom. The spring application of pesticides to alfalfa fields with flowering weeds is a particular problem in Virginia.
3. The drift of toxic sprays or dusts to adjoining crops or weeds in bloom.
4. The contamination of flowering ground-cover crops in orchards treated with pesticides.
5. The contamination of water or dew on foliage and flowers. This includes the water collected by honey bees for drinking and cooling the honey bee hive.
6. The application of systemic pesticides and the potential contamination of nectar and pollen collected by foraging honey bees. The use of neonicotinoid pesticides (e.g., clothianidin, imidacloprid, and thiamethoxam) is a concern for honey bee poisoning; although, there is a need for more research evidence.

The most serious poisonings result with honey bees that collect pesticide-contaminated pollen or nectar and transport these materials to the honey bee hive. Pesticide dusts (e.g., Sevin) and encapsulated pesticides are especially dangerous. These pesticides can adhere to foraging honey bees, are transported to the hive, and stored for long periods of time. Such pesticides may cause honey bee mortality in the hive for several months.

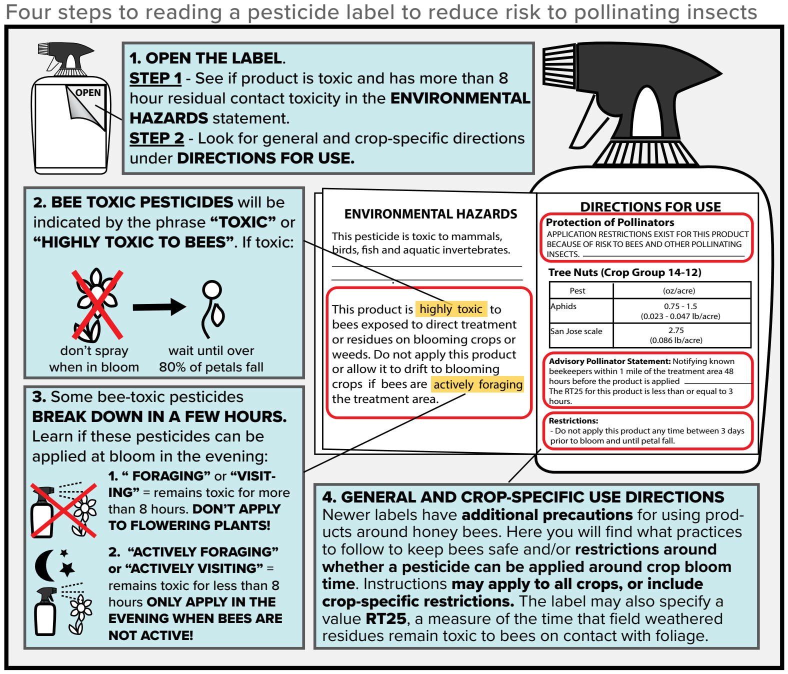
Ways to Reduce Honey Bee Poisoning

1. Contact beekeepers with honey bee hives near areas to be treated with pesticides that are hazardous to honey bees.
2. Do not apply pesticides that are toxic to honey bees on crops in bloom.
3. Use pesticides that are less toxic to honey bees when such choices are consistent with pest control recommendations (e.g., see table of relative pesticide toxicities).
4. Choose the least hazardous pesticide formulations when possible. Pesticide dusts and encapsulations are more toxic than sprays of the same material. Pesticides applied as wettable powder sprays tend to have longer residual effects (and are more toxic) than the emulsifiable concentrate sprays. Granular applications of pesticides are typically the safest method of treatment in areas with honey bee hives.
5. Avoid drift of toxic pesticide sprays onto ground-cover plants, weeds, and crops in nearby fields.
6. Control weeds in fields and avoid direct pesticide applications to flowering weeds when possible. Mow before pesticide application, if orchards have ground-cover plants in bloom.
7. Apply pesticides in the late evening or early morning when honey bees are not actively foraging. This is important with crops such as corn, since pollen is released in the morning. The evening application of pesticides to such crops are less hazardous and will reduce unintentional honey bee poisonings.
8. Do not apply pesticides if temperatures are expected to be unusually low following pesticide treatment. Pesticide residues can remain toxic to honey bees for longer periods of time under low temperature conditions.
9. Avoid the direct application of pesticides over honey bee hives.
10. Allow beekeepers with honey bee hives near areas to be treated with pesticides an option to move the hives or confine the honey bees, if there is a potential for honey bee loss.

NAPPC

PROTECT POLLINATORS READ PESTICIDE LABELS

Four steps to reading a pesticide label to reduce risk to pollinating insects



www.pollinator.org/pesticide-education

Graphic by Iris Kormann and Andony Melathopoulos - Oregon State University; Rose Kachadoorian and Gilbert Uribe - Oregon Department of Agriculture
Text on reverse of card by the NAPPC Pollinator Health Task Force

MINIMIZING PESTICIDE EXPOSURE TO BEES

Understanding pesticide label information on the hazard and risks of bees is an important first step to protecting bees. Insecticides and some fungicides are of concern for bees. Here are a few actions to help minimize pesticide exposure to bees while managing pests and diseases.

1. Avoid sprays during bloom when possible. Bees face the highest exposure when pesticides are applied to the bloom of bee-attractive crops and weeds. When possible, use sprays before bloom to control pests and diseases to reduce the need for treatments at bloom.

2. If you must treat during bloom, choose products carefully and apply in the evening. Choose insecticides that are not labeled as 'Toxic' or 'Highly Toxic' to bees (front of card, Point 2). Avoid insecticides where residues remain toxic to bees for longer than 8 hours (Point 3). Always look to the Directions for Use for more specific information on when a product can be applied at reduced risk to bees (Point 4)

3. Cooperate and communicate with beekeepers in a timely manner. Contact beekeepers at least 48 hours prior to applying insecticides or fungicides to blooming bee-attractive crops. The beekeeper may choose to cover or move colonies, or may leave colonies in place depending on the toxicity of the product being sprayed.

4. Avoid spraying bee colonies and bee habitat. Avoid placing bees directly in the crop. In cases where colonies can only be set in the crop, turn sprayers off as you pass over the colonies. Reduce drift onto adjacent flowering habitat by using coarser droplet sizes, drift reducing agent, or intelligent sprayer technology.

5. Mow blooming weeds. If there are bee-attractive blooming weeds (e.g., mustard, clover or dandelion), mow them before spraying.

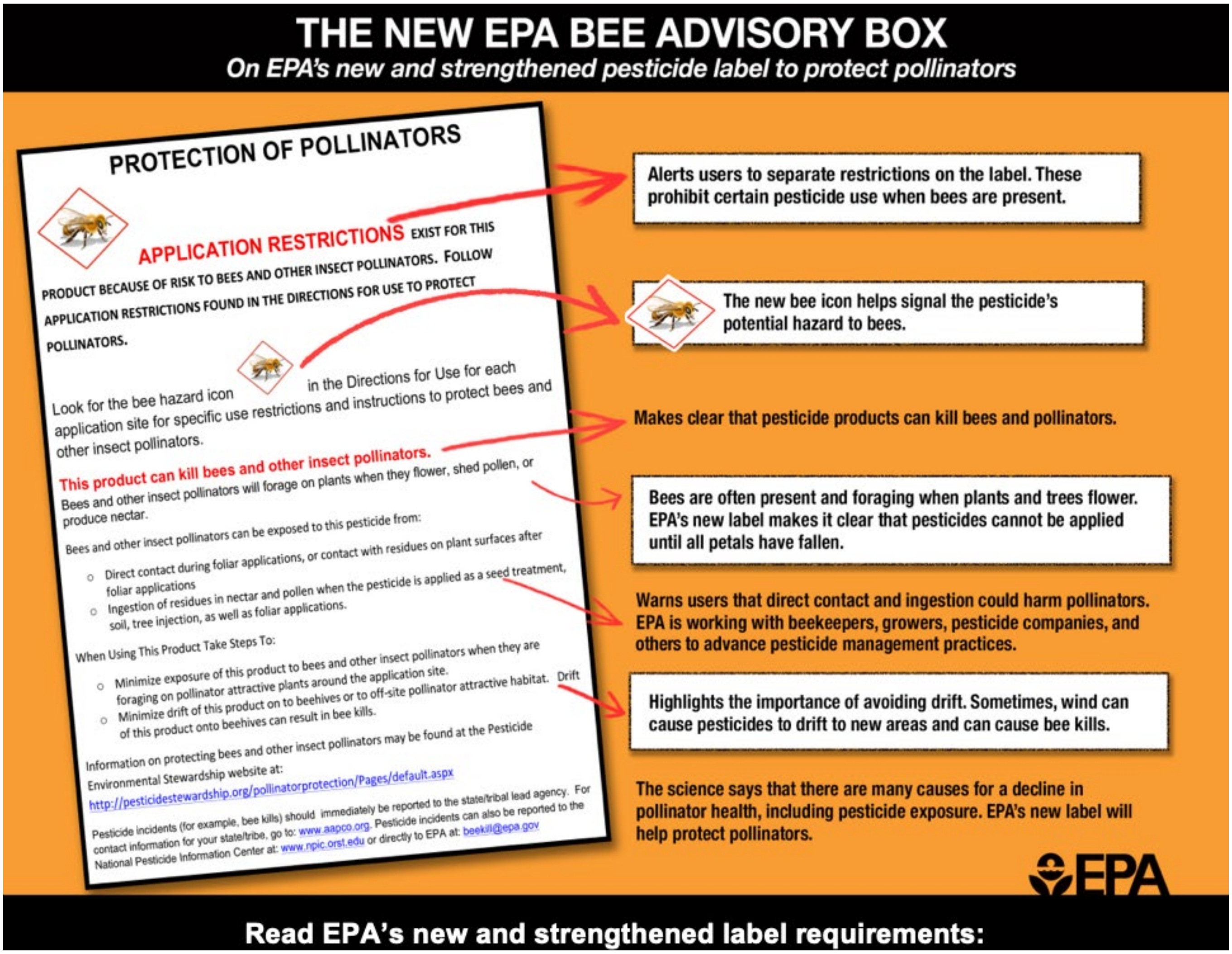
6. Review Pollinator Protection Plans and use IPM. Many states and industries provide information on how to protect bees and other pollinators. Contact your Department of Agriculture to obtain these plans. Integrated Pest Management (IPM) can also reduce bee pesticide exposure. Contact your regional IPM Center for details.

7. Report pesticide incidents with bees. Let EPA know as soon as you think bees have been killed by a pesticide (beekill@epa.gov). Also reach out to your state or tribal pesticide regulatory agency - contact information can be found at: http://npic.orst.edu/incidents.

HELPFUL LINKS

The **North American Pollinator Protection Campaign (NAPPC)** is a growing collaborative body of more than 170 diverse partners, including respected scientists, researchers, conservationists, government officials and dedicated volunteers. NAPPC's mission is to encourage the health of resident and migratory pollinating animals in North America.

The SARE Sustainable Agriculture Research & Education; FFAR; North Central IPM Center; USDA National Institute of Food and Agriculture U.S. DEPARTMENT OF AGRICULTURE


THE NEW EPA BEE ADVISORY BOX
On EPA's new and strengthened pesticide label to protect pollinators
PROTECTION OF POLLINATORS
APPLICATION RESTRICTIONS EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.
Look for the bee hazard icon in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.
This product can kill bees and other insect pollinators.
Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.
Bees and other insect pollinators can be exposed to this pesticide from:
Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications
Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.
When Using This Product Take Steps To:
Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives can result in bee kills.
Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at:
http://pesticidestewardship.org/pollinatorprotection/Pages/default.aspx
Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency. For contact information for your state/tribe, go to: www.aapco.org. Pesticide incidents can also be reported to the National Pesticide Information Center at: www.npic.orst.edu or directly to EPA at: beekill@epa.gov
Alerts users to separate restrictions on the label. These prohibit certain pesticide use when bees are present.
The new bee icon helps signal the pesticide's potential hazard to bees.
Makes clear that pesticide products can kill bees and pollinators.
Bees are often present and foraging when plants and trees flower. EPA's new label makes it clear that pesticides cannot be applied until all petals have fallen.
Warns users that direct contact and ingestion could harm pollinators. EPA is working with beekeepers, growers, pesticide companies, and others to advance pesticide management practices.
Highlights the importance of avoiding drift. Sometimes, wind can cause pesticides to drift to new areas and can cause bee kills.
The science says that there are many causes for a decline in pollinator health, including pesticide exposure. EPA's new label will help protect pollinators.
EPA
Read EPA's new and strengthened label requirements:

Relative Toxicity of Pesticides to Honey Bees by Laboratory and Field Tests

Group I. Highly Toxic

Severe losses may be expected if these pesticides are used when honey bees are present at treatment time or within a day *thereafter*.

Abamectin

Acramite (bifenazate)

Actara, Centric, Platinum, Helix, Cruiser, Adage (thiamethoxam)

Acephate

Admire, Advantage, Gaucho, Merit, Premise, Touchstone (imidacloprid)

Advantage

Ambush (permethrin)

Ammo (Fury) (>.025 lb/A) (cypermethrin)

Apollo, Ovation (clofentezine)

Asana (esfenvalerate)

Avaunt (Advion) (indoxacarb)

Avid (avermectin)

Baygon (propoxur)

Baythroid (cyfluthrin)

Bidrin (dicrotophos)

Capture, Annex, Brigade (bifenthrin)

Carzol

Clutch (clothianidin)

Commodore (lambda-cyhalothrin)

Comply (fenoxycarb)

Curacron (profenofos)

Cygon (dimethoate)

Cymbush

Danitol (fenopropathin)

Dasanit (fensulfothion)

DDVP (dichlorvos)

Decis (decamethrin)

Delegate, Radiant (spinetoram)

Denim (emamectin benzoate)

Dibrom (naled)

Dimate (dimethoate)

Diazinon (spectracide)

Dimecron (phosphamidon)

Dinotefuran

Dursban, Eradex (chlorpyrifos)

Endigo

Envidor (spirodiclofen)

Ethyl guthion (azinphos-ethyl)

Flagship (thiamethoxam)

Fipronil

Furadan F (carbofuran)

Gardstar (permethrin)[1]

Guthion (azinphos-methyl)

Imidan (phosmet)

Karate

Lannate D (methomyl)

Lindane

Lorsban (chlorphyrifos)

Malathion

Matacil (aminocarb)

Mesurol (methiocarb

Monitor (methamidophos)

Nexter (pyridaben)

Nudrin (methomyl)

Orthene (acephate)

Parathion

Pay Off (flucythrinate)

Phosphamidon

Pirimiphos-methyl (Execute, Actellic)

Poncho, Titan, Clutch, Acceleron, Arena, Belay, Celero (clothianidin)

Pounce (permethrin)

Prallethrin

Proaxis (gamma-cyhalothrin)

Proclaim (emamectin)

Provado (imidacloprid)

Pydrin (fenvalerate 0.1 lb/A)[2]

Pylon, Phantom (chlorfenapyr)

Pyramite

Rebelate (dimethoate)

Resmethrin

Scout (tralomethrin)

Sevin (carbaryl)[3]

Sniper

Spectracide

Steward (indoxacarb)

Sumithion (fenitrothion)

Supracide (methidathion)

Swat (bonyl)

Synthrin (resmethrin)

Talstar

Tameron (methamidophos)

Tefluthrin (Force)

Temik (aldicarb)

TEPP

Tralomethrin (Saga)

Trimax

Vapona (dichlorvos)

Venom (dinotefuran)

Warrior (lambda-cyhalothrin)

Zectran (mexacarbate)

Zephyr (Agri-Mek) (abamectin)

Zeta-cypermethrin

[1]Can be applied to ground in front of honey bee hives for the control of small hive beetles.
[2]Can be applied in the late evening at rate of 0.1 lb/A or less.
[3]Some formulations of Sevin XLR are rated as moderately toxic to honey bees.

Group II. Moderately Toxic

These can be used around honey bees if dosage, timing, and method of application are correct, but should not be applied directly on honey bees in the field or at the honey bee hive.

Abate (temophos)
Acramite, Floramite (bifenazate)
Assail (acetamiprid)
Banol (carbanolate)
Bolstar (sulprofos)
Calypso (thiacloprid)
Carzol (formetanate)
Chlordane
Ciodrin (crotoxyphos)
Coumaphos[1] (Agridip, Asunthol)
Counter (terbufos)
Decis, Battalion (deltamethrin)
Di-Syston (disulfoton)
Dyfonate (fonofos)
Elgetol (dinitrocresol)
endrin
Esteem (pyriproxyfen)
Ethodan (Ethion)
Larvin (thiocarb)
Metasystox (demeton-s-methyl)
Metasystox R (oxydemeton-methyl)
Mocap (ethoprop)
Oil sprays (superior type)
Rimon, Pedestal (novaluron)
SpinTor, Conserve SC, Entrust, Success (spinosad)
Spirotetramet (Movento)
Systox (demeton)
Trigard (cyromazine)
Thimet (phorate)[2]
Thionex (endosulfan)
Trithion, Thiodan (carbophenothion)
Vydate (oxamyl)

[1]Checkmite (coumaphos) strips can be used in honey bee hives to treat for varroa mites and small hive beetles.
[2]Thimet EC should only be applied during late evening.

Group III. Relatively Nontoxic

These can be used around honey bees with a minimum of injury; safest if applied in the evening or early morning.

Acaraben (chlorobenzilate)
Acarol (bromopropylate)
Agri-Mek (avermectin)
Allethrin
Altosid (methoprene)
Amitraz
Apollo, Ovation (clofentezine)
Applaud, Centaur (buprofezin)
Aza-direct (azadirachtin)
Baam (amitraz)
Bacillus thuringiensis (Accoate, Biotrol, Dipel, Thuricide)
Birlane (chlorfenvinphos)
Calypso (thiacloprid)
Chlorantraniliprole
Chloroparacide (chlorbenside)
Confirm, Mimic (tebufenozide)
Cyd-X (CM granulovirus)
cyrolite
Delnav (dioxathion)
Demize (D-Limonene)
Dessin (dinobuton)
Dimilin (diflubenzuron)
Dinocap (Karathane)
Dylox (trichlorfon)
Endeavor (Pymetrozine)
Ethrel (ethephon)
Esteem (pyriproxyfen)
Flonicamid
Fujimite, Akari (fenpyroximate)
Fulfill (pymetrozine)
Fundal, Galecron (chlordimeform)
Heliothis polyhedrosis virus
Herculex
Hexygon
Intrepid (methoxyfenozide)
Isomate
Kanemite (acequinocyl)
Kelthane (dicofol)
Mach 2 (halofenozide)
Mavrik (tau-fluvalinate)[1]
methoxychlor (Marlate)
Mitac (amitraz)
Morocide (binapacryl)
Murvesco (fenson)
Neemix, Align (azidirachtin)
Neotran
nicotine
Omite (propargite)
Ovotran (ovex)
Pentac (dienochlor)
Plictran [mitacid] (cyhexatin)
Pynamin
Pyrellin (rotenone/pyrithrin)
pyrethrum (natural)
rotenone
ryania
sabadilla
Saphos (menazon)
Savey, Onager (hexythiazox)
Shuttle
Smite (sodium azide)
Spiromesifen (Oberon, Forbid)
Spur (fluvalinale)
Sucrocide (sucrose octanoate esters)
Surround (kaolin)
Talus (buprofezin)
Tedion (tetradifon)
tetram
Tetrasan
Torak (dialifor)
Trigard (cyromazine)
Vendex (fenbutatin oxide)
Yieldgard
Zeal, Secure (etoxazole)

[1]tau-fluvalinate is used in Apistan strips to treat honey bee hives for varroa mites. It is illegal to use Mavrik in honey bee hives.

Fungicides

As a general rule, fungicides are safe to use around honey bees.

Afugan (pyrazophos)
Arasan (thiram)
Bayleton (triadimefon)
Benlate (benomyl)
bordeaux mixture
Boscalid (emerald, endura, pristine)
Bravo (chlorothalonil)
Captan
Carbendazim (Fungisol, Polyphase)
copper oxides
copper oxychloride sulfate
copper sulfate
cupric hydroxide (Kocide)
Cyprix (dodine)
Cyprodinil
Daconil (chlorothalonil)
Dessin (dinobuton)
Difenoconazole
Difolatan (captafol)
Dithane D-14 (nabam)
Dithane M (maneb, manzeb)
Dithane Z (zineb)
Du-Ter (fentin hydroxide)
Dyrene (anilazine)
ferbam
fluoxastrobin
Glyodin
Hinosan (edifenphos)
Indar (butrizol)
Iprodoine[2]
Karathane
Lesan (fenaminosulf)
Maneb
Mancozeb
Morestan (oxythioquinox)
Morocide (binapaeryl)
Myclobutanil
Mylone (dazomet)
Phygon (dichlone)
Plantvax (oxycarboxin)
Polyram (metriam)
Propiconazole[1] (Alamo, Banner)
Pyraclostrobin[2]
Pyrimethanil[1] (Philabuster, Penbotec)
Ridomil
Rovral (iprodione)[2]
sulfur
Syllit (dodine)
Terraguard[1], Procure (triflumizole)
Tetraconazole (Domark, Eminent)
Thiram
Thylate
Vinclozolin[2]
Vitavax (carboxin)
Zineb

[1] May increase the toxicity of neonicotinoid pesticides to honey bees if used together.
[2] May cause loss of honey bee larvae. Use with caution where honey bees are foraging.

Herbicides, Defoliants and Dessicants

2,4-D
2,4-DB
2,4-DP (dichlorprop)
Alachlor
Alanap (naptalam)
Alopex (clofop-isobutyl)
Amiben (chloramben)
Amitrol
Ammate
Atrex (atrazine)
Avenge (difenzoquat)
Balan (benefin)
Banvel (dicamba)
Basagran (bentazon)
Betanal AM (bentanex)
Bladex (cyanazine)
Blazer (acifluorfen)
cacodylic acid
Cambilene (2,3,6-TBA)
Caparol (prometryn)
Chloro-IPC (chlorpropham)
Cotoran (fluometuron)
Daconate (MSMA)
dalapon
diquat
DSMA
Dual (metolachlor)
Endothall (endothall)
Eptam
Evik (ametryn)
Evital (norflurazon)
Exhalt 800
Folex (desmedipham)
Garlon (triclopyr)
Glyphosate
Gramoxone (paraquat)
Herbisan (EXD)
Hoelon (diclofop-methyl)
Hyvar (bromacil)
IPC (propham)
Karmex (diuron)
Kerb (proamide)
Lasso (alachlor)
Lorox (linuron)
MCPA
Methar, DSMA
Milogard (propazine)
Modown (bitenox)
MSMA
Mylone (dazomet)
Nortron (ethofumesate)
Oxyfluorfen[1]
Paarlan (isopropalin)
paraquat
Pendimethalin[1] (Prowl)
Phenmedipham (Betanal)
Pramitol (prometone)
Princep (simazine)
Probe (methazole)
Propanil[1]
Prowl (pendimethalin)
Pyramin (chloridazon)
Ramrod (propachlor)
Randox
Ronstar (oxadiazon)
Sancap (dipropetryn)
Sencor (metribuzin)
Sinbar (terbacil)
Surflan (oryzalin)
Sutan (butylate)
Telvar (monuran)
Tolban (profluralin)
Tordon (picloram)
Treflan (trifluralin)[1]
Vegadex
Zorial (norflurazon)

[1] Slightly toxic to honey bees

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Introduction for Home Vegetable Insect Section

Eric R. Day, Extension Entomologist, Virginia Tech

Insect pests are rarely a problem on vigorous plants that are adapted for the climate zone where you have your home vegetable garden. Consult your local Virginia Cooperative Extension office for vegetables recommended for Virginia.

In addition to the following tips for pest management, follow these links for more information on control and management of pests in gardens:

An Introduction to Integrated Pest Management (ENTO-365) - Integrated pest management (IPM) is commonly discussed and used by pest management professionals, but is not widely understood by the general public. This publication explains the fundamentals of IPM and why it is an important tool for professionals and homeowners.

Organic vs. Conventional (Synthetic) Pesticides: Advantages & Disadvantages (ENTO-384) - This factsheet attempts to clarify some of the information surrounding organic and synthetic pesticides. Knowing their similarities and differences will prepare you to choose the best management solution for your pest problem.

Myth-busting IPM for Extension Master Gardeners (ENTO-388) - A survey conducted in March 2020 identified a handful of myths among Extension Master Gardeners (EMGs) concerning integrated pest management (IPM). This publication highlights the myths associated with IPM, explains the facts, and serves to increase overall understanding of IPM among EMGs and others.

The following tips adapted from Integrated Pest Management for Vegetable Gardens, Publication 426-708 will help in reducing insect and mite problems:

- Plant crops and varieties that are well suited to the soil and climate, and recommended by Virginia Cooperative Extension and the School of Plant and Environmental Sciences.
- If possible, select for insect resistance in vegetable varieties.
- Inspect transplants when purchasing so that they are insect pest free. Insects in young seedlings may start in greenhouses or plant beds and cause heavy losses in the garden.
- Develop a calendar, by writing down the time of year you find a particular pest and if control was needed. Refer to it next year to check for earlier signs of infestations. A daily walk in the garden will do a world of good.
- Space plants properly and thin young vegetables to a proper stand. Overcrowding causes weak growth and reduces air movement, resulting in increased insect problems.
- Keep down weeds and grass. They often harbor insect and mite pests.
- Rotate your garden plot, if you can. Do not grow the same kind of produce in the same place each year. Use related crops in one site only once every three or four years. Avoid mixing soils in areas by forming permanent raised beds with distinct borders.
- Gardens growing in areas that were turf or grass the year before will often have white grub and wireworm problems the first year or two. Consider using a planting time soil insecticide.
- Time plantings in such a way that the majority of your crop will avoid the peak of insect infestations. For example, plant cucurbits in mid June to avoid squash bug and cucumber beetles. Plant beans in early May so that they mature before Mexican bean beetles build up and cause damage.
- Use row covers over cucurbits from time of planting to just before bloom to avoid squash vine borer.
- Keep a record of the dates insect problems occur to use as a guide for following years.
- Inspect plants for egg clusters, beetles, caterpillars, and other insects as often as possible. Handpick as many pests as you can. Avoid sprays until the population of insects has reached a critical threshold level.
- Where slugs are a problem, use approved baits and traps and try to create drier conditions. Heavy mulches may encourage slugs. Diatomaceous earth, crushed eggshells, beer baits, and hydrated lime near plants may help deter slug activity.
- Insecticides are valuable tools for dealing with insect problems, make sure the insecticide is labeled for the crop you are protecting and be sure to read the label before mixing and applying.
- Encourage beneficial insects by tolerating insect damage and not spraying. Naturally occurring predators and parasites are found in gardens, orchards, and fields. Learn to properly identify these species as benefits of your environment. Avoid using pesticides around them. They are as susceptible to insecticides as the pests.

Organic Controls for Insects

Eric R. Day, Extension Entomologist, Virginia Tech
Alejandro Del-Pozo, Extension Entomologist, Virginia Tech

Table 2.1 - Organic Products and Predators

Product[1]	Insects Controlled	Remarks
Azadirachtin	Beetles, Aphids, Caterpillars, Others	Various Trade names including AzaGuard, AzaMax, Azatin, AzaSol, etc.
Bacillus thuringiensis	Most caterpillars, loopers, hornworms, bagworms	This product, also known as *Bt*, is sold under many trade names.
Beauveria bassiana	Beetles, Aphids, Others	Various Trade names including BotaniGard, Mycotrol, and Naturalis
Foil, M-One, M-Track, Novodor	Colorado potato beetle	Two strains of *Bt* will control potato beetles: *Bacillus thuringiensis* ssp. *san diego* is genetically engineered and therefore is not allowed in certified organic production. On the other hand, *B. thuringiensis* ssp. *tenebrionis*, a form of *Bt* that is not genetically engineered, can be used by organic producers.
Hot Pepper Wax	Aphids, mites, thrips	See label for precautions.
Insecticidal soap	Works well on soft bodied insects, in particular aphids, mites, mealybugs	This product is sold under many trade names and is a fatty acid soap.
Kaolin clay	Beetles, Aphids, Caterpillars, Others	Various Trade names
Neem	Broad spectrum	See label for precautions.
Mineral Oil	Caterpillar eggs and soft bodied insects such as aphids and thrips	Only use products labeled for use on vegetable plants for pest control
Pyrethrin	Broad spectrum; works on a wide variety of insects	Usually sold mixed with other botanical insecticides.
Pyrethrum/Diatomaceous Earth	Whiteflies, fireants	See label for precautions.
Spinosad	Caterpillars, beetles	See label for precautions.

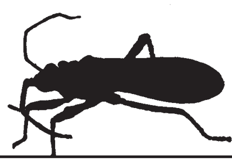
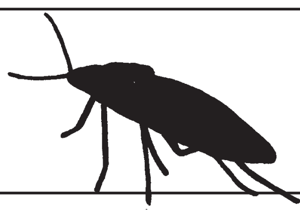
[1]Botanical insecticides are derived from various plant parts and are commonly used in organic control situations. It is important to read the label and follow all precautions regarding protective clothing, mixing, and labeled plants. Just because they are derived from plants doesn't mean that safety can be disregarded. Biological control is in two major forms. Microbial, which is a formulation containing a microorganism such as *Bacillus thuringiensis*, or the other form, which involves the release of predatory insects or mites, such as lady beetles. Use caution with insecticides when a release of predators is planned.

Table 2.1 - Organic Products and Predators (cont.)

Organic Predators

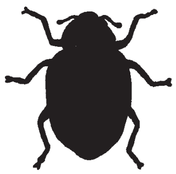
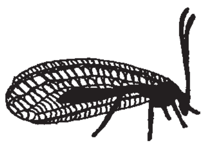
Encourage Beneficial Insects: Naturally occurring predators and parasites of pests are found in gardens, orchards, and fields. Learn to properly identify these species as benefits of your environment. Avoid using pesticides around them. They are as susceptible to insecticides as the pests. The key to keeping native or purchased natural enemies is to eliminate spraying any insecticides including organic insecticides.

Beneficial Insects and Mites: Many species of beneficial insects and mites can be purchased although many occur naturally. Beneficial insects are target specific, and require gardener knowledge of existing pests. Timing of release is an important factor, and if pests are not present, neighboring gardens may benefit more than your garden. In general, these insects have specific requirements for long-term survival, and may need to be released anew each season. If interested in releasing them, you can check the Updated List of Commercial Suppliers andInsectaries/Laboratories Selling Predators and Parasitoids for Augmentative Biocontrol, ENTO 480 at https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/ENTO/ento-480/ENTO-480.pdf.

Beneficial Insects and Mites	Remarks
	Assassin bug - *Reduviidae* - The assassin bug feeds mainly on aphids, caterpillars, Colorado potato beetles, Japanese beetles, leafhoppers, and Mexican bean beetles. Naturally occurring also.
	Bean Beetle Parasite (*Pediobius foveolatus*) for Mexican bean Beetle. These wasps are shipped to you inside their host—Mexican bean beetle larvae. Once the adults emerge, the females deposit their eggs in the larvae of the Mexican bean beetle. Release rate: timing is critical; release one unit (6 mummies/unit, 20-25 wasps/mummy=120-150 wasps/unit) for every 400 sq ft of beans or 100 units/A when the bean beetle larvae are present. These wasps do not overwinter. See: https://pubs.ext.vt.edu/ENTO/ENTO-170/ENTO-170-PDF.pdf
	Damsel bug - *Nabidae* - The damsel bug feeds on aphids, leafhoppers, mites, and caterpillars.
	Big-eyed bug - *Gocoridae* - Big-eyed bugs feed on aphids, caterpillar eggs and larvae, immature bugs, leafhoppers, and spider mites.
	Predacious stink bug - *Pentatomidae* - Predacious stink bugs feed on Colorado potato beetles and various caterpillar larvae. Most commonly sold is the Spined Soldier Bug but it occurs naturally as well.

Adapted from VCE Publication 426-708

Table 2.1 - Organic Products and Predators (cont.)

Beneficial Insects and Mites (cont.)	Remarks
	Syrphid fly larvae - *Syrphidae* - Fly larvae of this species feed on aphids and mealybugs.
	Lady beetles - Hippodamia convergens - Naturally occurring lady beetles feeds mainly on aphids and other soft-bodied insects, such as mealybugs and spider mites. *Hippodamia convergens* is commonly sold for use in gardens but is not recommended because they leave the garden area soon after release.
	Green lacewing larvae - *Chrysoperla* sp. - Lacewing larvae, known as aphid lions, feed on insect eggs, aphids, spider mites, thrips, leafhopper nymphs, and small caterpillar larvae. Adult lacewings are not predacious.
	Predatory mites - *Phytoseiulus persimilus* and several other species feed on many mite pests, including the two-spotted spider mite. Release at the rate of 2/square foot.
	Predatory Nematodes: For wood boring and ground dwelling insects. These nematods will see host insects and not harm plants or humans.
	*Trichogramma* wasp - *Trichogrammatidae* - This tiny wasp attacks eggs of more than 200 pest species, including cutworms, corn borers, corn earworms, armyworms, codling moths, and cabbage moths. Release time is critical for their effectiveness since they only attack pest eggs.
	Encarsia wasp - *Encyrtidae* - The greenhouse whitefly is parasitized by this wasp in third and fourth larval instars when Encarsia lay their eggs inside the whitefly pupa.

Adapted from VCE Publication 426-708

Vegetable Insects

Eric R. Day, Department of Entomologist, Virginia Tech

How to use this guide: Find the crop in table 2.2 and check the list of common pests in those crops. Go to the specific table for the pest for management and control. If your pest is not found consider submitting a sample to the Insect Identification Laboratory for identification.

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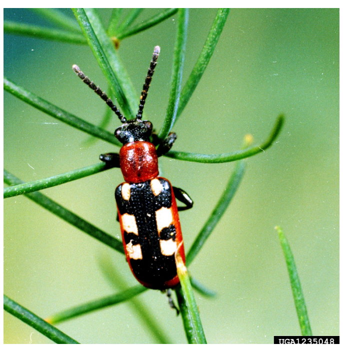
Table 2.2.1 – Asparagus Beetle



Clemson Univeristy– USDA Cooperative Extension Slide Series, Bugwood.org

Description: Adults of the asparagus beetle are 1/4 inch (6.25 mm) long, metallic blue to black, and have wing covers with three or four white spots and reddish margins. The thorax is red and usually marked with two black spots. The spotted asparagus beetle is about 1/3 inch (8.3 mm) long and orange with 12 spots on its wing covers. Larvae of both are olive green to dark gray with a black heads and legs and attain a length of about 1/3 inch (8 mm). Both have eggs that are approximately 4/100 inch (1 mm) long, oblong, shiny, black and are attached by one end to asparagus spears.

Cultural Control: Harvest spears as early as possible. Beetles are attracted to plants with an abundance of foliage; therefore, growers can leave a small portion of their crop unharvested as a decoy for beetles to congregate, while the rest of the crop is harvested. Thoroughly remove all plant debris from garden and surrounding areas after harvest to eliminate beetle overwintering sites.

Control: Treat with a registered insecticide when beetles begin to lay eggs, or when beetle larvae are feeding on the foliage. Because asparagus spears are harvested almost daily, it is important to use an insecticide with little residual activity. Be sure to follow the necessary wait period between insecticide application and the days before you can harvest again.

Chemical Control (and precautions)

Carbaryl – (Do not apply within one day of harvest)

Malathion – (Do not apply within one day of harvest),

Bifenthrin – (see label)

Permethrin – (Pre-harvest interval = 3 days),

Neem Oil can be applied on day of harvest, must be allowed to dry

Organic Control (and precautions)

Pyrethrins – (Can be applied on day of harvest, must be allowed to dry

Table 2.2.2 – Grasshoppers

Common Host Plant(s): Lettuce, beans and corn.

Damage: Feed on any available vegetation. When abundant, they may destroy complete plantings of such crops as lettuce and potato.

Cultural Control: Avoid planting gardens next to hay fields and ditch banks with high grasshopper populations. Covering them with netting or cheesecloth may protect seedlings. It also helps to remove debris and till the soil in the fall to help expose the eggs to predators and the weather.

Control: Treat using a registered insecticide, following all label instructions, precautions, and preharvest intervals specific to the crop.

Chemical Control

Carbaryl – Do not apply within one day of harvest

Malathion – Do not apply within one day of harvest

Permethrin – pre-harvest interval = 3 days

Organic Control

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Insecticidal Soap – Can be applied up to the day of harvest

Grasshopper (Clemson University)

Table 2.2.3 – Aphids

Description: Aphids, or plant lice, are small, soft-bodied insects. Most aphids are about 1/10-inch-long (2.54 mm), and though green and black are the most common colors, they may be gray, brown, pink, red, yellow, or lavender

Damage: Aphids remove sap from plants and cause yellowing, stunting, and puckering of leaves. In addition, aphids may leave clear sticky honeydew on plants that allows black sooty mold to grow.

Control: Treat using a registered insecticide, following all label instructions, precautions, and preharvest intervals specific to the crop.

Chemical Control

Acetamiprid pre-harvest interval = 7 days

Bifenthrin See label for instructions

Imidacloprid pre-harvest interval = 21 days

Malathion – (Do not apply within one day of harvest)

Cyfluthrin – See label for instructions

Esfenvalerate – See label for instructions

Malathion – pre-harvest interval = 7 days

Permethrin – See label for instructions

Organic Control

Insecticidal Soap – Can be applied on day of harvest,

Canola oil – Can be applied on day of harvest, must be allowed to dry

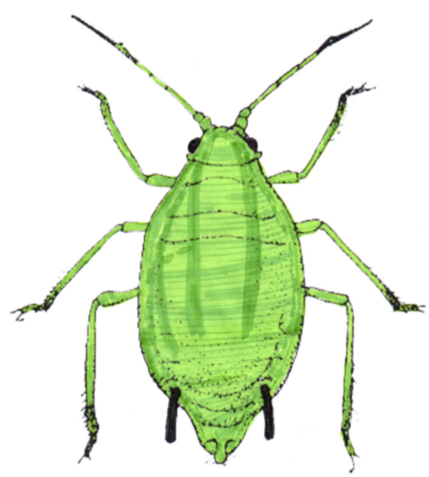
Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Beauveria bassiana – Can be applied on day of harvest, must be allowed to dry

Paraffin Oil – (Can be applied up to the day of harvest)

Azadirachtin – (Can be applied on day of harvest, must be allowed to dry)

Neem Oil – (Can be applied on day of harvest, must be allowed to dry)



Aphid (USDA)

Table 2.2.4 – Corn Earworm

Other Common Names: Tomato fruitworm, sorghum headworm vetchworm, podworm, and cotton bollworm.

Plants Attacked: The vegetables most commonly attacked by this pest include sweet corn, tomatoes, beans, broccoli, cabbage, pepper, and lettuce.

Description: Fully developed, larvae reach a maximum length of about 1 inch. They have an orange-brown head, and their body color can range from brown, green pink, and yellow, to mostly black.

Control: Treat using a registered insecticide, following all label instructions, precautions, and preharvest intervals specific to the crop.

Chemical Control

Bifenthrin – See label for instructions

Carbaryl – Do not apply within one day of harvest

Imidacloprid – pre-harvest interval = 21 days

Malathion – Do not apply within one day of harvest

Organic Control

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Spinosad – pre-harvest interval = 3 days

Corn Earworm (Eric Day)

Table 2.2.5 – Mexican Bean Beetle

Description Adult: Copper colored, oval, 1/4-inch-long, 16 black spots on back. Larva: Orange to yellow, fuzzy or spiny, up to 1/3-inch long.

Common Host Plant(s): Beans, lima beans.

Damage: Adults and larvae feed on pods and on underside of leaves; pods and leaves are skeletonized. Damaging populations of Mexican Bean Beetles start to appear in late June and early July and can continue for the remainder of the growing season.

Cultural Control: Clean up plant debris after harvest. Plant Beans as early as possible in the spring so that harvest is completed before the July peak of activity for this pest.

Organic/Biological Control: Natural enemies include several species of assassin bugs and a tiny parasitic wasp, Pediobius foveolatus.

Control: Treat with a registered insecticide when damage first appears. For best control, also direct sprays to undersides of leaves.

Chemical Control

Acetamiprid – pre-harvest interval = 7 days

Carbaryl – Do not apply within one day of harvest

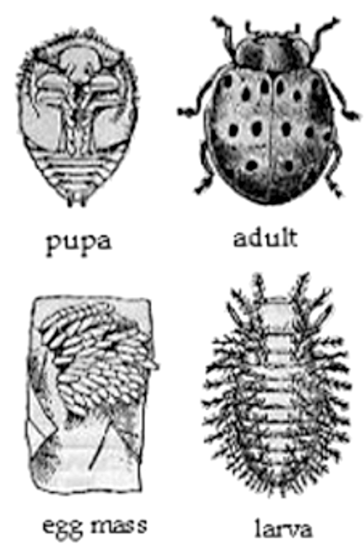
Malathion – Do not apply within one day of harvest

Bifenthrin – See label for instructions

Permethrin – pre-harvest interval = 3 days

Organic Control

Pyrethrins – Can be applied on day of harvest, must be allowed to dry



Mexican bean beetle life stages (USDA)

Table 2.2.6 – Spider Mites

Description: Tiny, only about 1 mm in length or about 1/50 of an inch. Pale in color, often with two dark spots.

Common Host Plant(s): Beans, tomatoes, bedding plants, and greenhouse plants.

Damage: Mite feeding leaves tiny yellow spots, large numbers of mites cause the leaves to look sandblasted, yellowed, and eventually brown. Mites leave silk webbing and debris on leaves.

Cultural Control: Remove from the garden and compost any green weeds and clumps of grass in the winter. Make sure plant have adequate water.

Organic/Biological Control: Phytoseiid mites can be purchased, and released for control. These are beneficial mites that eat spider mites.

Control: Treat with a registered insecticide when damage first appears. For best control, also direct sprays to undersides of leaves.

Chemical Control: Not recommended, as insecticides may kill off the beneficial mites and make the spider mites worst.

Organic Control

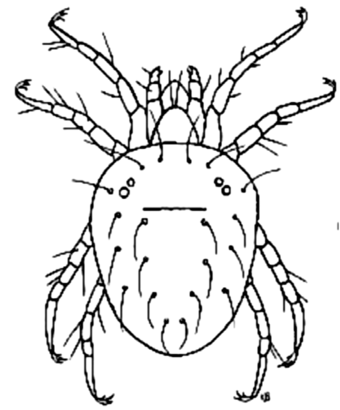
Insecticidal Soap – Apply when mites are first found on leaves.

Canola Oil – Can be applied on day of harvest, must be allowed to dry

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Soybean Oil – See label for instructions

Spinosad – pre-harvest interval = 3 days



Spider Mite (USDA)

Table 2.2.7 – Stink Bugs

Identification: Stink bugs have the characteristic five-sided shield shape and are about 5/8 inch long when full grown. Eggs of both species are barrel shaped and laid in clusters of 20 to 70. Nymphs resemble adults in shape but are smaller and have contrasting color patterns. The two most common stink bugs are the Harlequin Bug and the Brown Marmorated Stink but many other specie damage vegetables in Virginia. Leaffooted bugs cause similar damage and are controlled in the same manner as stink bugs

Damage: Adults and nymphs suck sap, feeding primarily on buds and seedpods. This feeding result in weakened plants and malformed buds and fruit. On okra and bean pods, the damage appears as pimples or wart-like growths. On tomatoes and peppers, white marks, often resembling halos, appear on the fruit. On pecans and beans, the damage shows up as brown spots on the nutmeat or seed. On some tree fruit, stink bugs can cause a deforming condition called cat facing on the fruit.

Cultural Control: Controlling weeds and wild fruit trees adjacent to fields helps to prevent some species of stink bugs.

Control: Treat with a registered insecticide when damage appears or when insects appear in damaging numbers. Repeat as needed and carefully follow label instructions.

Chemical Control

Acetamiprid – pre-harvest interval = 7 days

Bifenthrin – See label for instructions

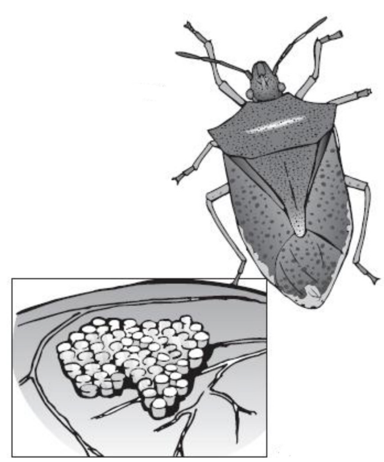
Carbaryl – Do not apply within one day of harvest

Imidacloprid – pre-harvest interval = 21 days

Malathion – Do not apply within one day of harvest

Organic/Biological Control

Pyrethrins – Can be applied on day of harvest, must be allowed to dry



Stink Bug eggs and adult (Virginia Cooperative Extension)

Table 2.2.8 – Thrips

Description: Bright yellow, but because of their small size are hard to see. The adult is about 1/25-inch long. The immatures are wingless and look like adult but smaller.

Common Host Plant(s): Onion, beans, beet, carrot, cabbage, cauliflower, celery, cucumber, melons, peas, squash, tomato, and turnip.

Damage: Since they feed in the bud, the damage is seen as distorted and damaged leaves and vegetables. Adults and larvae suck out juices and leave white blotches appear on leaves. Tips of leaves wither and turn brown.

Lifecycle: Thrips overwinter as adults and immature nymphs in plant debris in or near fields. Thrips fly to gardens in early summer and lay eggs on buds and leaves. The time span from egg to adult can occur in 3-4 weeks. Multiple, overlapping generations occur annually in Virginia.

Cultural Control: Some varieties of sweet onion are resistant to thrips.

Control: Treat with a registered insecticide when damage appears or when insects appear in damaging numbers. Repeat as needed and carefully follow label instructions.

Chemical Control

Acetamiprid – pre-harvest interval = 7 days

Carbaryl – Do not apply within one day of harvest

Imidacloprid – pre-harvest interval = 21 days

Malathion – Do not apply within one day of harvest

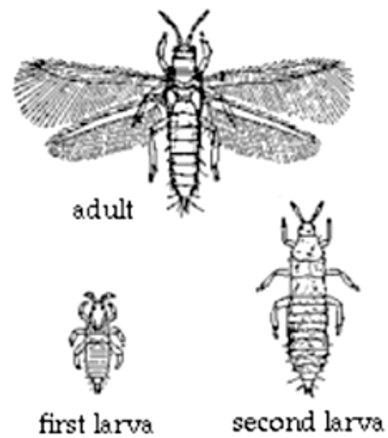
Organic/Biological Control

Apply a dust of diatomaceous earth to control thrips. Minute pirate bugs and some lady beetle are predators of thrips.

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Insecticidal Soap – Can be applied up to the day of harvest

Spinosad – pre-harvest interval = 3 days



Life stages of thrips (USDA)

Table 2.2.9 – Flea Beetles

Description: Many species. Black, brown, or striped beetles; about 1/16-inch long. Active, hops away when disturbed.

Common Host Plant(s): Tomato, pepper, cabbage and related crops, eggplant, beet, spinach, turnip, mustard and radish.

Damage: Young plants, especially transplants, are severely damaged. Adults and larvae chew many tiny holes in leaves.

Lifecycle: Adults overwinter in soil; in early spring they begin feeding on crop foliage. Females deposit eggs near the soil line where larvae emerge in about a week and feed on roots. Larvae feed for two to three weeks until reaching maturity and then pupate, emerging from the soil as adults in about two weeks.

Cultural Control: Plow under weed and crop debris in the fall after harvest.

Control: Treat with a registered insecticide when damage appears or when insects appear in damaging numbers. Repeat applications as needed and carefully follow label instructions.

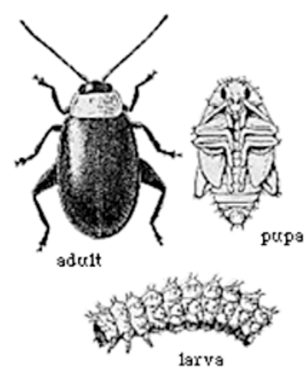
Chemical Control

Carbaryl – Do not apply within one day of harvest FOR SWEET CORN: CAUTION Application of Carbaryl to tassel region of corn during the pollen shedding period will seriously reduce the bee population

Imidacloprid – pre-harvest interval = 21 days

Malathion – Do not apply within one day of harvest

Thiamethoxam – See label for instructions



Life stages of the Flea Beetle (USDA)

Organic/Biological Control

Dust with diatomaceous earth or rotenone for serious infestations.

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Kaolin clay – See label for instructions

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Table 2.2.10 – Imported Cabbage Worm

Description: Velvety green with faint yellow longitudinal stripes and many fine hairs; up to 1 and 1/4 inches long.

Common Host Plant(s): Cabbage, cauliflower, collards, Brussels sprouts, mustard, turnip and kale.

Damage: Feeds on underside of leaves, producing ragged holes; bores into heads.

Lifecycle: Imported cabbageworms overwinter in plant debris as pupae. The time span from egg to adult moth is about four to five weeks. Multiple generations occur annually in Virginia.

Cultural Control: Handpick caterpillars where found. Conduct thorough postharvest cleanup in gardens where the imported cabbageworm has been a problem in the previous year.

Chemical Control: Treat with a registered insecticide every 4 days after first true leaves appear until harvest if worms are still present. Direct insecticides to the undersides of leaves.

Carbaryl – pre-harvest interval = 3 days

Malathion – pre-harvest interval = 7 days

Permethrin – Do not apply within one day of harvest

Organic/Biological Control: *Bacillus thuringiensis*, or Bt, (Bactur, Dipel, SOK BT, Thuricide) 2.0 to 3.0 tbsp in 1 gallon water. It is not necessary to wait before harvesting after an application of Bt. A parasitic wasp, *Trichogramma* sp., attacks imported cabbageworm eggs; mass releases of *Trichogramma* sp. may be successful in reducing pest populations. Several other parasites attack pupae and larvae of the imported cabbageworm. The braconid wasp *Apanteles glomeratus* is most effective. The imported cabbageworm is also susceptible to attack by generalist predators such as stinkbugs and *Polistes* sp. wasps. Natural control by viruses and bacterial diseases occurs as well.

Beauvaria bassiana – Can be applied on day of harvest, must be allowed to dry

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Bacillus thurgingiensis – Can be applied on day of harvest, must be allowed to dry

Insecticidal Soap – Can be applied on day of harvest, must be allowed to dry

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Spinosad – Do not apply within one day of harvest

Fig. 1: Adult and larva of Cabbageworm, with leaf damage. Left photo: David Cappaert, Michigan State University, Bugwood.org, right photo: Clemson University – USDA Cooperative Extension Slide Series, Bugwood.org

Table 2.2.11 – Cabbage Looper

Description: Pale green measuring worm with thin white stripes down back and sides. Up to 1 and 1/2 inches long. Caterpillar doubles-up, or loops, when it crawls.

Common Host Plant(s): Cabbage, lettuce, cauliflower, kohlrabi, collards, Brussel sprouts, turnip, mustard, broccoli and kale.

Damage: Feeds on underside of leaves producing ragged holes; large loopers burrow into heads. Damage similar to Imported Cabbageworm.

Lifecycle: Several generations of cabbage loopers can occur during a year with the time from egg to adult only taking a few days over a month.

Cultural Control: Handpick caterpillars off plants. Plow under crop remnants in spring to bury overwintering pupae before the emergence of adults.

Chemical Control: When worms are present, treat with a registered insecticide every 4 days after first true leaves appear until harvest. Direct insecticide to the undersides of leaves.

Carbaryl – pre-harvest interval = 3 days

Malathion – pre-harvest interval = 7 days

Permethrin – Do not apply within one day of harvest

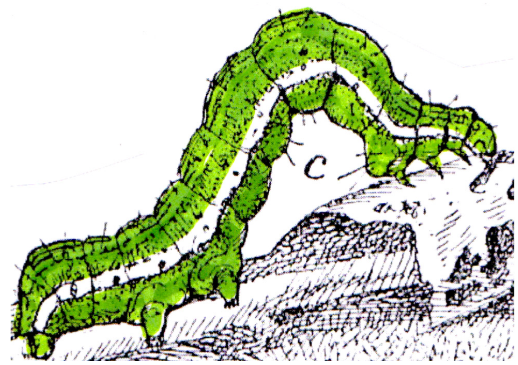


Fig. 1: Caterpillar stage of Cabbage Looper

Biological Control

Bacillus thuringiensis, or Bt, (Bactur, Dipel, SOK BT, Thuricide) 2.0 to 3.0 tbsp in 1-gallon water. *Bacillus thuringiensis* will work but its results are not quickly observable; loopers (and other caterpillars) get sick the first day and die later. It is not necessary to wait before harvesting after an application of Bt.

Several parasitic wasps (Hyposoter, Copidosoma, Trichogramma) attack the cabbage looper as do general predators and virus diseases. Mass releases of Trichogramma may provide control in tomatoes.

Organic Control

Beauvaria bassiana – Can be applied on day of harvest, must be allowed to dry

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Bacillus thurgingiensis – Can be applied on day of harvest, must be allowed to dry

Insecticidal Soap – Can be applied on day of harvest, must be allowed to dry

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Spinosad – Do not apply within one day of harvest

Table 2.2.12 – Root maggots

Identification: Root maggots are small pale fly larvae that are found in the soil near rotting sections or roots and seeds.

Damage: Plants infested grow slower and have a stunted or yellow appearance. In severe cases, the newly germinating seeding dies and the row has very spotty emergence of crop plants.

Cultural Control: Root maggots are a problem on cold wet soils. Use raised rows and planting bed that make the soil warmer. This will promote quick germination and plant growth.

Chemical Control: Use a granular insecticide at planting time.

Table 2.2.13 – Parsleyworm

Also referred to as the Black swallowtail, Carrot Caterpillar, or Celeryworm.

Description: Green with yellow and white spotted black band; up to 2 inches long. Two orange “horns” just behind the head are projected when the caterpillar is disturbed. This caterpillar is the larva of the black swallowtail butterfly.

Common Host Plant(s): Carrot, celery, parsley, dill and parsnip.

Damage: Chews leaves and stems, destroys tops. Seldom numerous enough to reduce yield.

Lifecycle: After the black swallowtail butterfly emerges from its cocoon in the spring it deposits eggs on plants in the carrot family. This insect overwinters as pupa on the host plant. There are two or more generations annually.

Cultural Control: Handpicking these caterpillars is usually sufficient.

Organic/Biological Control

Bacillus thuringiensis, or Bt – can be applied up to the day of harvest.

Chemical Control: Treat with a registered insecticide if cultural control fails, follow all label instructions regarding wait period between application and harvest.

Cypermethrin – spray up to 1 day before harvesting.

Caterpillar of Parsleyworm (USDA)

Table 2.2.14 – Squash Vine Borer

Plants Attacked: Cucumber, cantaloupe, winter squash, pumpkin, gourd, summer squash, and watermelon, as well as many other species of cucurbits.

Damage: Larval stage borers into stems can cause the vine or entire plant to wilt and die.

Lifecycle: Adult moth lay eggs on vines and after hatching the new larvae quickly borers into the stem where it will feed until its full size and ready exit the vine and pupate into the adult.

Cultural Control: Plant cucurbits as late as possible to avoid this and other pests. Use a row cover from planting until first flower. For cucurbits with long running vines, place a single shovel full of soil over the vine about every 6 feet, this will aid in developing secondary roots.

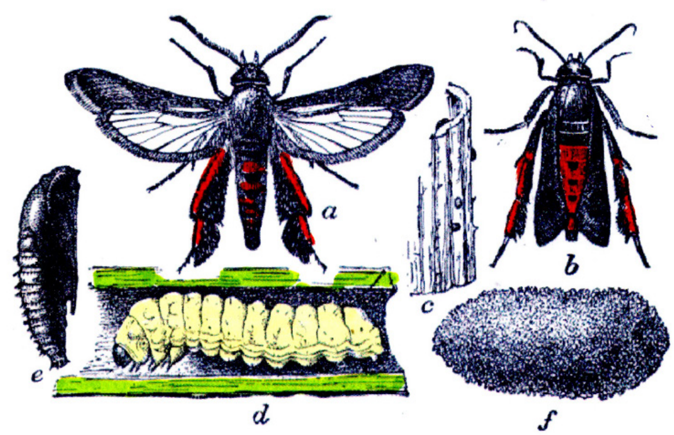
Organic Control

Kaolin clay – Can be applied up to the day of harvest

Chemical Control: Treat with a registered insecticide if cultural control fails, follow all label instructions regarding wait period between application and harvest. For Squash Vine Borer, it’s important to treat as soon as the first damage is found and continue every 10 days for the rest of the growing season.

Acetamiprid – Can be applied up to the day of harvest

Permethrin – Can be applied up to the day of harvest



Squash Vine Borer (USDA)

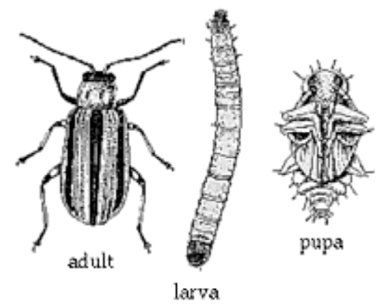
Table 2.2.15 – Cucumber Beetles

Plants Attacked: Cucumber, cantaloupe, winter squash, pumpkin, gourd, summer squash, and watermelon, as well as many other species of cucurbits. Cucumber beetles may also feed on beans, corn, peanuts, potatoes, and other crops.

Description of Damage: Cucumber beetles damage leaves, stems, and fruit. They can also transmit a disease called bacterial wilt.

Cultural Control: Plant as late as possible, plant pumpkins, squash and cucumbers after June 15th, this date may have to be adjusted depending on local conditions. Use a row crop covers that will exclude the beetles. Row cover needs to be in place from planting until bloom. Row covers may also provide protection from cucumber beetles, and in addition provide late frost protection and help in moisture retention.

Control Practices: Chemical control is often needed, particularly in commercial plantings. To prevent cucumber beetle damage to seedlings, treat when one beetle per 10 feet of row is found. To prevent bacterial wilt, treat when one beetle per 100 feet of row is found.



The Striped Cucumber Beetle, Acalymma vittatum (Fabricius) Coleoptera: Chrysomelidae (USDA)

Organic/Biological Control

Azadirachtin – Can be applied up to the day of harvest

Kaolin clay – See label for instructions

Neem Oil- Can be applied on day of harvest, must be allowed to dry

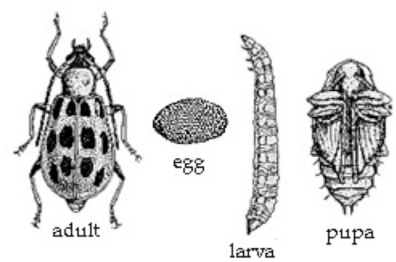
Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Chemical Control: Treat with a registered insecticide if cultural control fails, follow all label instructions regarding wait period between application and harvest.

Carbaryl – pre-harvest interval = 3 days

Imidacloprid – pre-harvest interval = 21 days

Permethrin – Can be applied up to the day of harvest



Spotted Cucumber Beetle, Diabrotica undecimpunctata howardi Barber. Coleoptera: Chrysomelidae (USDA)

Table 2.2.16 – Leafhopper

Description: Several species. Adults: Green wedge shaped, up to 1/8 inch long; they fly quickly when disturbed. Nymphs resemble adults but are smaller; they crawl sidewise like crabs.

Common Host Plant(s): Beans, lettuce, and potato. Also, can damage shade trees such as maple.

Damage: Adults and nymphs attack beans and potatoes. Leaves of beans curl, or roll downward, crinkle, and tend to become yellow or bronze. Some plants are dwarfed and may die. On potatoes attack by Potato Leafhoppers causes hopperburn. Tips and sides of potato leaves curl upward, turn yellow to brown, and become brittle. Potato and western potato leafhoppers are most destructive.

Cultural Control: Pick and destroy infested leaves.

Organic/Biological Control: Lacewings, damsel bugs, lady beetles, minute pirate bugs, and spiders are included among the natural enemies of leafhoppers. Dusting plants lightly with diatomaceous earth may help control leafhoppers.

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Canola oil – Can be applied on day of harvest, must be allowed to dry

Spinosad – pre-harvest interval = 3 days

Neem Oil & Azadirachtin – Can be applied up to the day of harvest

Neem Oil – Can be applied on day of harvest, must be allowed to dry

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Kaolin clay – Can be applied up to the day of harvest

Chemical Control: Treat with a registered insecticide when damage first appears.

Permethrin – Can be applied up to the day of harvest

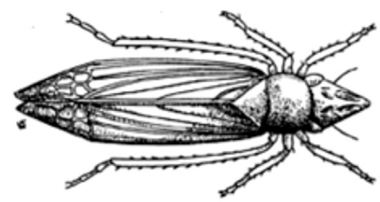

Leafhopper (USDA)

Table 2.2.17 – Leafminers

Description: Larva: Yellow, 1/8-inch-long, lives in leaves. Adult fly: Tiny, black and yellow. Several generations of this insect develop in a summer.

Damage: Larvae make long, slender, winding, white tunnels in leaves.

Cultural Control: Pick and destroy infested leaves.

Organic/Biological Control: Parasitic wasps often control leafminers.

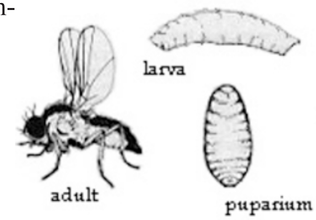
Chemical Control: Treat with a labeled insecticide as soon as damage is first noticed; repeat as needed.

Permethrin – Can be applied up to the day of harvest

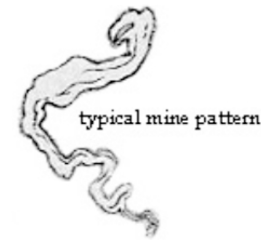
Kaolin clay – See label for instructions

Insecticidal Soap – Can be applied up to the day of harvest

Pyrethrins – Can be applied up to the day of harvest



Life stages of a Leafminer (USDA)



Example of Leafminer damage (USDA)

Table 2.2.18 – Squash bug

Identification: Squash bug eggs are laid in clusters and are coppery brown just before hatch. Just after hatch nymphs are green and later turn gray. Adult squash bugs are dark brown to black.

Damage: Squash bugs can attack cucumber but prefer squashes. Feeding causes leaves to wilt and for fruit to develop poorly and rot. Squash bug damage can be confused with bacterial wilt in cucumbers which is transmitted by cucumber beetles.

Cultural Control: Use a row cover from planting until flowering.

Chemical Control: For home gardens use a registered insecticide as soon as squash bugs are found; repeat as needed.

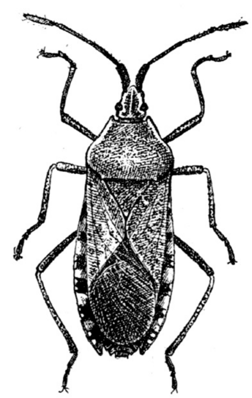
Permethrin – Can be applied up to the day of harvest

Kaolin clay – See label for instructions

Insecticidal Soap – Can be applied up to the day of harvest

Pyrethrins – Can be applied up to the day of harvest

See: https://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/ENTO/ENTO-64/ENTO-64-pdf.pdf



Squash Bug (USDA)

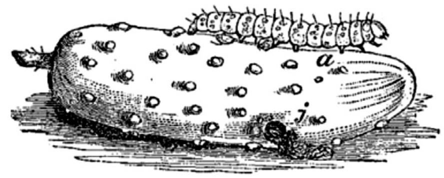
Table 2.2.19 – Pickleworm

Identification: Young pickleworm larvae are yellowish-white with a brownish head. There are numerous rows of dark spots in young larvae, but these disappear with age. Older larvae are greener and may turn pinkish and coppery close to pupation. Larval coloration may vary with their food plant. Mature larvae measure 25–30 mm (about 1 inch) long. Adult moths are distinctively colored with a wingspan of about 3 cm (1.2 inches). Both the front wing and the hind wing have a central yellow splotch bordered by chocolate brown; the central splotch is somewhat transparent. Legs and antennae are yellowish. Both sexes have a prominent brush of yellow hairs on the tip of the abdomen that serve in pheromone communication.

Damage: Pickleworm larvae burrow into the buds, flowers, and developing fruits of their host plant to feed. Tunneling in buds and flowers limits fruit set, while feeding in fruits ruins them. Caterpillars neatly chew round holes in the host plant; wet, pulpy frass (fecal material) is often found at these entrances. Feeding injury also encourages the onset of disease, but the presence of pickleworm larvae ruin the fruit for consumption anyways. Larvae will attack the central vines once the blossoms and fruits have been eaten.

Cultural Control: Plant early using resistant and/or early maturing varieties. Plantings made in very early spring are seldom damaged by pickleworm. Crush or otherwise destroy infested fruit and pupae among leaves whenever found. Destroy vines, unused fruits, other crop residue, and nearby weeds as soon as the crop is harvested. Spading or plowing in the early fall will destroy pickleworm pupae, although pupae are not likely to survive our winters in Virginia.

Chemical Control


Pickleworm and damage (USDA)

Permethrin – Can be applied up to the day of harvest

Kaolin clay – See label for instructions

Insecticidal Soap – Can be applied up to the day of harvest

Pyrethrins – Can be applied up to the day of harvest

Source: https://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/3104/3104-1559/3104-1559_pdf.pdf

Table 2.2.20 – Mushroom Pests

Fungus Gnats are small pale larvae that damage the below ground sections of mushrooms and cause poor growth.

Rove Beetles are small beetles that damage the upper sections of the mushroom.

Cultural Control: Start with clean sterile manure

Chemical Control: Azadirachtin – Can be applied up to the day of harvest

Table 2.2.21 – Cowpea Curculio

Identification: Small black weevils about ¼ inch long. If disturbed, will quickly drop to the ground.

Damage: Cowpea Curculios feed on the seeds in the pod while the plant is still growing leaving hole and damaged peas and beans.

Cultural Control: Since this insect does not fly, rotating crops is effective.

Chemical Control

Esfenvalerate – See label for instructions

Spinosa – Can be applied up to the day of harvest

Table 2.2.22 – Colorado Potato Beetle

Identification: The adult beetle is orange with black spots and the wing covers have alternating yellow and black stripes. The larvae are reddish in color with two rows of black spots along each side and eggs are yellow and found in clusters.

Damage:. Larva chew away leaves until only the midribs and stems are left in place. Heavily damaged plants are completely defoliated and have poor potato set.

Cultural Control: Hand pick and drop in soapy water for small populations.

Biological control: *Bacillus thuringiensis* var. san diego and *Bacillus thuringiensis* var. tenebrionis are two strains of Bt that work on Colorado Potato Beetle. Other strains of Bt that are for caterpillars will not work on beetles.

Organic control: Neem (azadirachtin) or cryolite are effective if applications are timed to coincide with peak egg hatch and small-larvae activity. Spinosad is effective against both larvae and adult

Chemical Control

Imidacloprid – pre-harvest interval = 21 days

Permethrin – pre-harvest interval = 7 days

Neem Oil & Azadirachtin – Can be applied up to the day of harvest

Pyrethrins – Can be applied up to the day of harvest

Colorado Potato Beetle (USDA)

Spinosad – Can be applied up to the day of harvest

Cryolite – See label for instructions

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Canola Oil & Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Neem Oil – Can be applied on day of harvest, must be allowed to dry

Table 2.2.23 – European Corn Borer

Description of Damage: Borer into stems of potatoes and cause lodging of plants and borer in to green peppers and cause fruit rot. On corn, they enter the stalk near the ear and cause it to break.

Identification: When fully grown, ECB larvae are 3/4 to 1 inch in length and creamy-white to pink in color. The larval head capsule is dark brown and, on top of each abdominal ring or segment, there are several small dark brown or black spots. (Figure 1)

Cultural Control: Remove and destroy infested stems and peppers.

Chemical Control Must be applied as soon as damage is noticed to stop additional borers from entering the plants.

Acephate – pre-harvest interval = 7 days

Acetamiprid – pre-harvest interval = 7 days

Carbaryl – pre-harvest interval = 7 days

Permethrin – pre-harvest interval = 3 days

Azadirachtin & Pyrethrins – Can be applied up to the day of harvest

Pyrethrins – Can be applied up to the day of harvest

Horticultural Oil – See label for instructions

Imidacloprid – See label for instructions

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Neem Oil – Can be applied on day of harvest, must be allowed to dry

European corn borer larva. (USDA)

Table 2.2.24 – White Grubs

Description: Several species, but the most common white grub is larva of the Japanese beetle. Other white grubs can be May beetles, June beetle, chafers, and other scarab beetles. White grubs are white or light yellow, hard brown heads, curved; 1/2 inch to 1 1/2 inches long when fully grown. White grubs live in soil. They require 3 years to mature.

Damage: Larvae feed on roots and underground parts of potato and many other plants. Adults feed on tree foliage.

Cultural Control: Turn over the soil in late summer or early fall. This will kill many grubs and expose others to predators.

Organic/Biological Control: Birds, hogs, and skunks are natural predators of the grubs. Parasitic wasps may also provide some control.

Chemical Control: Apply a planting time soil insecticide, follow all label precautions and directions

Depicted are 3 species, among the pest complex called "white grubs." The photo is useful as a comparison for size and appearance of these. The species L to R are: Japanese beetle, Popillia japonica, European chafer, Amphimallon majalis, and june bug, Phyllophaga sp. David Cappaert, Michigan State University, Bugwood.org

Table 2.2.25 – Potato Tuberworm

Description: Pinkish white, brown head, up to 1/2-inch long.

Damage: Tunnels in stems, leaves, and tubers. Shoots wilt and die.

Lifecycle: Larvae or pupae overwinter in tubers or in the soil. Moths appear in spring and may be seen at dawn or dusk when they are normally active or when plants are disturbed. Females lay 60-200 eggs, singly, on plants in as little as four days. Usually eggs are deposited in the tuber eyes or on the underside of potato foliage. Larvae emerge in 3-6 days. Larvae often enter potato tubers through the eyes, leaving frass around the eye. Larvae may feed near the tuber surface or tunnel deeply into the tuber, leaving a trail of excrement along their path. During the summer larvae mature in 7-10 days and pupate in soil or plant debris around potato plants. Second generation moths emerge in approximately a week. Multiple generations occur annually in Virginia.

Cultural Control: Protective measures for controlling the potato tuberworm include the following:

1) plant only seed pieces that are not infested,
2) cultivate so as to hill the soil against the plants – keeping at least 2 inches of soil over the developing tubers, 3) harvest as soon as the crop is mature. During harvest, do not leave the dug potatoes in the field overnight, and do not cover piles of potatoes with potato tops,
4) destroy all culled or infected potatoes as soon as possible,
5) store tubers at temperatures below 52 degrees F is possible and practical. Use either new or thoroughly cleaned bags or baskets when storing. The storage area should be screened or enclosed in such a way that moth cannot get in. Without such an enclosed storage area, moths can still fly in and still become a problem even though the storage area was clean and potatoes insect-free when stored.

Organic Control:

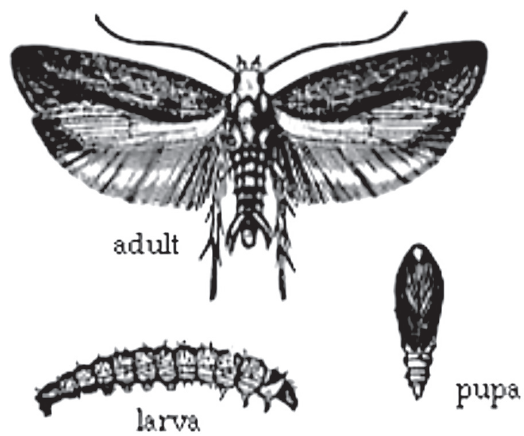
Pyrethrins – Can be applied up to the day of harvest

Chemical Control: There is no known chemical control for this insect in stored potatoes.

Esfenvalerate – See label for instructions

Permethrin – pre-harvest interval = 14 days

Pyrethrins – Can be applied up to the day of harvest



Life stages of the Potato Tuberworm (USDA)

2.2.26 – Whiteflies

Description: Adult whiteflies are small and large numbers will fly away when heavily infested plants are moved. Immature stages are pale and attached to the undersides of the leaves.

Cultural Control: When purchasing plants, check carefully to make sure they are pest free.

Chemical Control:

Horticultural Oil – See label for instructions

Imidacloprid – pre-harvest interval = 21 days

Permethrin – Can be applied up to the day of harvest

Azadirachtin – Can be applied on day of harvest, must be allowed to dry

Canola Oil – Can be applied on day of harvest, must be allowed to dry

Neem Oil – Can be applied on day of harvest, must be allowed to dry

Insecticidal Soap – Can be applied up to the day of harvest

Pyrethrins – Can be applied up to the day of harvest

Table 2.2.27 – Leafrollers

Description: Leaves folded over with silk. Small caterpillar inside.

Cultural Control: Handpick and destroy small infestations.

Chemical control

Capsaicin & Oil of Mustard – Can be applied on day of harvest, must be allowed to dry
Carbaryl – pre-harvest interval = 7 days
Horticultural Oil – See label for instructions
Malathion – pre-harvest interval = 3 days
Permethrin – pre-harvest interval = 7 days
Azadirachtin – Can be applied up to the day of harvest
Canola Oil & Pyrethrins – Can be applied on day of harvest, must be allowed to dry
Neem Oil – Can be applied on day of harvest, must be allowed to dry
Neem Oil & Azadirachtin – Can be applied up to the day of harvest
Pyrethrins – Can be applied on day of harvest, must be allowed to dry
Spinosad – Can be applied up to the day of harvest

Table 2.2.28 – Strawberry Rootworm and Strawberry Clipper

Description: Holes in leaves, cut leaf petioles, and poor growth.

Cultural Control: Renovate strawberry bed and replant as far away as possible.

Chemical control to be applied only when damage to leaves is occurring.
Capsaicin & Oil of Mustard – Can be applied on day of harvest, must be allowed to dry
Carbaryl – pre-harvest interval = 7 days
Horticultural Oil – See label for instructions
Malathion – pre-harvest interval = 3 days
Permethrin – pre-harvest interval = 7 days
Azadirachtin – Can be applied up to the day of harvest
Canola oil & Pyrethrins – Can be applied on day of harvest, must be allowed to dry
Neem Oil – Can be applied on day of harvest, must be allowed to dry
Neem Oil & Azadirachtin – Can be applied up to the day of harvest
Pyrethrins – Can be applied on day of harvest, must be allowed to dry
Spinosad – Can be applied up to the day of harvest

Table 2.2.29 – Corn Sap Beetle

Description: Small brown beetles found in ears near rot. They are secondary and feed on rot after the ear is damaged by earworms or birds.

Cut off and discard damaged sections of ear, remaining is OK to eat.

Chemical Control

Carbaryl – pre-harvest interval = 3 days
Esfenvalerate – See label for instructions
Malathion – pre-harvest interval = 5 days
Permethrin – pre-harvest interval = 3 days
Pyrethrins – Can be applied up to the day of harvest

Table 2.2.30 – Japanese Beetle

Description: Shiny metallic green beetles feed on the silk and disrupt pollination.

Cultural control: Place and Japanese Beetle trap about 30 feet away from the corn.

Chemical Control:

Carbaryl – pre-harvest interval = 3 days

Esfenvalerate – See label for instructions

Malathion – pre-harvest interval = 5 days

Permethrin – pre-harvest interval = 3 days

Pyrethrins – Can be applied up to the day of harvest

Photo by Eric Day.

Table 2.2.31 – Fall Armyworm

Description: Brown caterpillars feeding on the ear in a similar manner to Corn Earworms.

Cultural Control: Hand pick small populations

Chemical Control

Carbaryl – See label for instructions

Horticultural Oil – Can be applied up to the day of harvest

Permethrin – pre-harvest interval = 3 days

Neem Oil & Azadirachtin – Can be applied up to the day of harvest

Photo by Russ Ottens,University of Georgia, Bugwood.org.

Table 2.2.32 – Blister Beetles

Description: Black beetles with gray lines or tan beetles with brown strips show up in clusters and feed on the leaves of tomato. If handled beetles can cause blisters on human skin.

Cultural Control: Wear gloves if hand picking to avoid blisters. Drop beetles in soapy water.

Chemical Control

Capsaicin & Oil of Mustard – Can be applied on day of harvest, must be allowed to dry

Carbaryl – pre-harvest interval = 3 days

Malathion – pre-harvest interval = 1 day

Beauvaria bassiana – Can be applied up to the day of harvest

Neem Oil & Azadirachtin – Can be applied up to the day of harvest

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

Table 2.2.33 – Tomato Hornworm

Two species of hornworm damage tomato plants in Virginia, the tobacco hornworm, *Manduca sexta* (Linnaeus) and the tomato hornworm *Manduca quinquemaculata* (Haworth) (Insecta: Lepidoptera: *Sphingidae*).

Description: Both species are green with diagonal lines on sides and prominent horn on rear end. They can be up to 4 inches long.

Damage: These caterpillars feed on leaves and green fruit. They are typically found on the upper portions of the plant. Since they consume 90% of the foliage just before they pupate they seem to appear “overnight”. This is not actually true; the smaller stages of the caterpillars did limited feeding that was quickly covered by regrowth. They in fact were on the same plant all along.

Cultural Control: Hand pick worms, but do not destroy caterpillars with cocoons, leave in garden to continue biological control.

Organic/Biological Control

Bacillus thuringiensis, Bt, will control the caterpillars but must be applied when they are less then ½ inch long.

Chemical Control: Apply a labeled insecticide, following all instructions and precautions. Insecticides must also be applied when the caterpillars are less then ½ inch long.

Capsaicin & Oil of Mustard – Can be applied on day of harvest, must be allowed to dry

Carbaryl – pre-harvest interval = 3 days

Malathion – pre-harvest interval = 1 day

Beauveria bassiana – Can be applied up to the day of harvest

Neem Oil & Azadirachtin – Can be applied up to the day of harvest

Pyrethrins – Can be applied on day of harvest, must be allowed to dry

Figure 1, Left: tomato hornworm, Whitney Cranshaw, Colorado State University, Bugwood.org Center: Tobacco hornworm, Sturgis McKeever, Georgia Southern University, Bugwood.org Right: Hornworms with cocoons of wasp parasites, Clemson University – USDA Cooperative Extension Slide Series, Bugwood.org

Table 2.2.34 – Tomato Russet Mite

Description: Tiny slender mites make leaves turn pale and brown. Russet mite damage is similar to spider mites, but they do not make silk webbing.

Cultural Control: Purchase clean damage free plants.

Chemical Control: Treat with insecticidal soap as soon as mites or damage is found.

Table 2.2.35 – Tarnished Plant Bug

Tarnished Plant Bugs are also known as Lygus bugs. The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), is in the order Hemiptera, family Miridae.

Description: The adult is a small insect, about 1/4” in length. It is light brown and variously spotted.

Common Host Plant(s): Strawberries, vegetables, tree fruits, and flowers (dahlias, chrysanthemums, marigolds, zinnia, and many others).

Damage: Damage when the fruit is small can cause the fruit to be deformed and misshapen when it reaches maturity, thus catfaced. The fruit may also be aborted and drop to the ground if it is too heavily damaged.

Control: Insecticide treatments probably are only partially effective. Plant bugs are active and move about freely, thus avoiding the treatment. Feeding injury can resume as soon as the effectiveness of sprays dissipates.

Chemical control

Carbaryl – See label for instructions

Esfenvalerate – pre-harvest interval = 1 days

Permethrin – pre-harvest interval = 3 days

Pyrethrins – Can be applied up to the day of harvest

Fall armyworm – Carbaryl – See label for instructions

Horticultural Oil – Can be applied up to the day of harvest

Permethrin – pre-harvest interval = 3 days

Neem Oil & Azadirachtin – Can be applied up to the day of harvest

Tarnished plant bug. Scott Bauer, USDA Agricultural Research Service, Bugwood.org

Table 2.2.36 – Cutworms

Description: Many species. Cutworms are dull gray, brown, or black, and may be striped or spotted. They are stout, soft-bodied and smooth, and up to 1 and 1/4 inches long. They curl up tightly when disturbed.

Common Host Plant(s): Tomato, pepper, cabbage, peas, beans, and squash.

Damage: Cut off plants above, at, or below soil surface. Some cutworms feed on leaves, buds, or fruits; others feed on the underground portions of plants. Particularly destructive to early season plantings.

Cultural Control: Place a stiff 3-inch cardboard collar around the stems; allow it to extend about 1 inch into the soil and protrude 2 inches above the soil; clear the stem by about 1/2 inch. Till garden so that weedy growth is not present in the spring.

Organic/Biological Control: *Bacillus thuringiensis* (Bt is sold under various trade names and formulations) will kill cutworms and is safe. Worms get sick the first day and die later.

Chemical Control: If cultural control fails, follow the label instructions and precautions for pre-planting treatment of cutworm for Beans, Beets, Cabbage, Carrots, Cauliflower, Celery, Collards, Cucumbers, Endive, Kale, Lettuce, Lima Beans, Melons, Muskmelons, Onions, Parsley, Parsnips, Peas, Peppers, Potatoes, Radishes, Snap Beans, and Sweet Corn.

Bifenthrin – See label for instructions

Capsaicin & Oil of Mustard – Can be applied on day of harvest, must be allowed to dry

Carbaryl – pre-harvest interval = 3 days

Cyfluthrin – See label for instructions

Esfenvalerate – See label for instructions

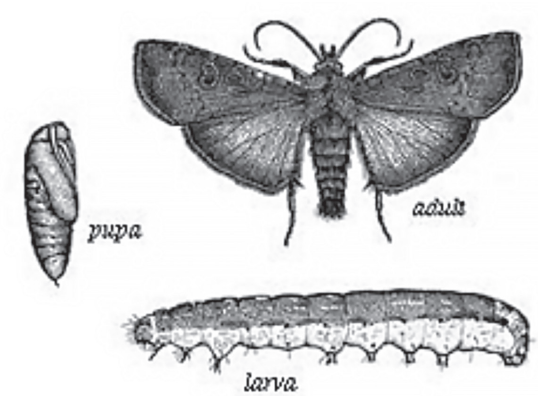
Imidacloprid – See label for instructions

Malathion – pre-harvest interval = 1 day

Permethrin – pre-harvest interval = 3 days

Azadirachtin – Can be applied up to the day of harvest

Spinosad – Can be applied up to the day of harvest



Life stages of Cutworms (USDA)

This chapter was not reviewed in 2022.

Vegetable Diseases

Steven L. Rideout, Vegetable Plant Pathologist, Eastern Shore AREC

Overview

Home gardeners can avoid many disease problems in their vegetable gardens by practicing cultural and other preventative tactics. If a disorder is found, the first step in controlling the disease is to accurately identify the pathogen. Often abiotic (non-living) problems or insect problems are mistaken for plant diseases and pesticides are used needlessly. Accurate identification of the pathogen ensures that pesticides are used appropriately and only when other control tactics can't control the problem. Accurate identification of the pathogen also allows formulation of an integrated pest management approach to control the disease based on the pathogen's life cycle. Use pesticides in conjunction with cultural and other control tactics.

General Cultural Controls

- Provide optimal growing conditions: Healthy plants are less likely to become diseased than stressed plants.
  - Provide adequate water and fertilization, but avoid over-fertilization, which creates succulent tissue that is prone to disease and pest problems. Also do not apply fertilizer close to tender root and stem tissue, since this can seriously injure or kill plants.
  - Ensure soil pH is optimal for nutrient uptake by plants by submitting a soil sample for analysis to the Virginia Tech Soil Testing Laboratory when starting a new garden. Re-test every two to three years.
  - Plant crops at recommended planting times. Planting too early, in particular, predisposes seedlings and transplants to disease.
  - Space plants adequately to ensure vigor and to promote foliar drying—wet foliage favors most foliar diseases.
  - Stake or cage tomato plants.
  - Check the soil drainage and if drainage is poor, correct before planting. Excessively wet soils can cause soilborne diseases and poor growth even in the absence of a pathogen.
  - Irrigation: Most plant diseases favor high humidity and wet foliage. Avoid overhead irrigation when possible, as it creates wet foliage. If irrigating overhead, do so early in the day to promote foliar drying. Also avoid over-irrigation; this can cause root problems and favors the development of certain pathogens.
- Sanitation:
  - Rotate crops: Avoid growing the same crop species AND same crop family (e.g. solanaceous family: potato, tomato, pepper, eggplant) in the same garden location for consecutive years, since this may result in a build-up of pathogen inoculum in the soil.
  - Use disease-free seed and/or transplants. Certain pathogens survive in seed, so purchase certified seed and be mindful when saving your own seed, as it may harbor pathogens. Do not save seed from diseased plants.
  - Some plant pathogens can survive on plant debris. Therefore, removing diseased plants and crop debris from the garden reduces inoculum for new infections in the next season's garden. Compost crop debris or till it into the soil at the end of the growing season; however, some pathogens produce survival structures that are not killed by composting or burying in soil.
  - Stakes, rototillers, and gardening tools can be infested with pathogen inoculum; stakes, equipment and tools must be cleaned and disinfected. Also, some pathogens may be present in soil, so avoid any practice that moves infested soil to non-infested areas.
  - Avoid working or harvesting in the garden when plants are wet. This spreads pathogens.
  - Weeds are alternate hosts for many pathogens, so controlling weeds reduces the likelihood of some diseases.
- Resistance:
  - To avoid commonly occurring disease problems use disease-resistant plants if they are available (e.g. late blight-resistant tomato).

General Biological Controls

- Disease-resistant plants: Resistant cultivars are available for some common plant disease problems. For example, tomato varieties designated with the letters "VFN" are resistant to Verticillium and Fusarium species, soil borne fungi with no chemical controls. The 'N' indicates root-knot nematode resistance, another soil-borne pathogen with no available chemical controls.
- Soil amendments: Adding compost or other organic matter to garden soil may increase populations of beneficial microbes in the soil. Some of these microbes may be antagonistic, predatory, or may simply out-compete pathogens, and reduce the likelihood of disease.
- Biological pesticides: Biological pesticides are formulated from living organisms, such as fungi, bacteria, and nematodes that may be antagonistic, predatory, parasitic or may simply out-compete pathogens. The number of biological control products available to homeowners for disease control is growing. These products are safer to handle, break down quickly, and are considered to be environmentally friendly compared to other pesticides. Some biological pesticides are ineffective or less effective compared to other pesticide products for controlling certain plant diseases. However, when biological pesticides are used in conjunction with cultural and other control tactics, or when disease pressure is low, disease may be controlled to an acceptable level with these pesticides.
- Naturally-occurring organisms: Using broad-spectrum pesticides may reduce populations of naturally occurring organisms that are beneficial to crops or have an adverse effect on plant pathogens and other pests. Use these pesticides only when necessary.

General Mechanical Controls

- Most plant disease problems are made worse by wet foliage. Staking crops, like tomatoes, reduces leaf wetness and promotes foliar drying. Staking also reduces spread of inoculum that may splash onto foliage and fruit from the soil.
- Reflective row covers deter insects that carry plant pathogens.
- Organic and plastic mulches reduce the spread of some soil-borne pathogens and also reduce weeds that may host plant pathogens.

General Chemical Controls

- Fungicides can also be used to manage disease problems in the home garden. When using fungicides, it is important that you read and follow the fungicide product label. The active ingredients in the fungicides listed in this section are available under many different commercial names and may be found in garden centers or ordered over the Internet. Because different manufacturers' labels vary widely, always check the label carefully before purchasing a particular brand to make sure it is labeled for both your crop and the disease you are trying to control. For disease problems not covered in the recommendations, contact your local Extension agent.
- Calibrate sprayers and spreaders.
- Wear Personal Protective Equipment (PPE) when applying chemicals, as specified on the pesticide label. Each pesticide product varies in toxicity and must be evaluated individually regarding re-entry and preharvest intervals.
- Most homeowner pesticides are protectants and must be applied preventatively, before infection occurs. It is important to completely cover the plants when using these pesticides. Most homeowner pesticides cannot cure plants that are already diseased and do not have systemic activity.
- Each pesticide has different amounts of toxicity and each can have a different negative effect on the environment and other organisms. Pesticides receiving EPA approval today are generally less toxic and have reduced negative impact on the environment than those approved prior to the late 1990s.

Precautions

- Humans: Protect yourself when applying chemicals: read the product label to determine the proper PPE and accessories you need before using any chemicals. Do not assume that because a product is labeled "organic" it is non-toxic to humans. Products vary in human toxicity and each pesticide product must be assessed according to its product label.
- Bees: In general broad-spectrum insecticides are toxic to bees. Read each product label and determine what precautions to take to protect bees and other beneficial insects when applying pesticides.

- Animals (pets, birds, etc.) and water: Read the specific product label to determine what precautions to take to protect the health of other animals and aquatic invertebrates when applying pesticides.
- Pesticide resistance: Over-using pesticides may make pests resistant to the pesticide. Pesticides containing thiophanate-methyl, for example, often develop resistance. Broad-spectrum pesticides have a low risk of developing resistance. Read the pesticide product label to determine if a pesticide is at risk of developing pesticide resistance. To avoid pesticide resistance:
  - Limit applications of the pesticides (the number of allowed applications is usually specified on the label for at-risk pesticides),
  - Use pesticide products with different modes of action or use a mix of pesticides with different modes of action
  - Use the recommended rate as specified on the product label.

Factsheets

- Virginia Cooperative Extension Plant Disease Factsheets http://pubs.ext.vt.edu/category/plant-diseases.html

Virginia Tech Diagnostic and Identification Laboratories

- Plant Disease Clinic https://spes.vt.edu/affiliated/plant-disease-clinic.html
- Insect Identification Lab http://www.idlab.ento.vt.edu/
- Soil Testing Lab http://www.soiltest.vt.edu/

Table 2.3 – Fungicide Brands Available for Home Vegetable Gardens

Chemical Name	Product Name
Captan	American Captan Garden Fungicide Bonide Captan 50W Dragon Captan Wettable Hi-Yield Captan Fungicide 50W Orthocide Garden Fungicide Southern Agricultural Home and Garden Captan Fungicide
Chlorothalonil	Bonide Fung-onil Dragon Daconil 2787 Earl May Fung-onil Ferti-Lome Liquid Fungicide Fung-onil Multipurpose Gordon's Multi-Purpose Fungicide Ortho Daconil 2787 Ortho Garden Disease Control Southern Agricultural Lawn, Ornamental, & Vegetable Fungicide
Basic copper	Acme Bordeaux Mix Bonide Garden Dust Cooke Copper Fungicide Cooke KopRSpray Conc. Dragon Bordeaux Mix Fertilome Bordeaux Mixture Gordon's Bordeaux Mix Hi-Yield Bordeaux Mix Lilly Miller Microcop Fungicide – Basic $CuSO_4$ Southern Agricultural Neutral Copper Fungicide Southern Agricultural Tomato Dust
Fixed copper	American Copper Fungicide Bonide Liquid Copper Fungicide Dragon Copper Fungicide Hi-Yield Copper Fungicide Southern Agricultural Liquid Copper Fungicide
Mancozeb	Bonide Mancozeb Flowable with Zinc Dragon Mancozeb Green Light Broad Spectrum Mancozeb Fungicide Southern Agricultural Dithane M-45
Neem oil	Green light Powdery Mildew Killer Garden Safe Fungicide 3
PNCB (pentachloro-nitrobenzene)	Hi-Yield Terraclor Granule Southern Agriculture Terraclor
Potassium bicarbonate	Bonide Remedy Cleary First Step
Sulfur	Bonide Liquid Sulfur Bonide Sulfur Fungicide Dragon Garden Sulfur Green Light Wettable Dusting Sulfur Hi-Yield Lime Sulfur Ortho Garden Sulfur Dust Safer Garden Fungicide Southern Agricultural Wettable or Dusting Sulfur

Table 2.4 - Disease Management Tools for Specific Crops and Diseases

Crop Disease	Treatment (PHI)[1]	Rate/Gal. (Unless otherwise Stated)	Remarks
Asparagus Rust	Mancozeb	2.0 tbsp	Use resistant varieties or apply 3-4 post-harvest sprays at 7- to 10-day intervals beginning in late June.
Beans (Snaps or Lima) Anthracnose (Lima bean only)	chlorothalonil 12.5% (7)	2.0 tbsp	Begin early bloom – reapply every 7 to 10 days. For use only on beans to be harvested dry with pods removed.
Bacterial Blights	copper	1.5 tbsp powder	Use certified western-grown seed. Begin with 4.0 tsp liquid at tri-foliage and reapply every 7 to 10 days.
Botrytis Blight (Gray mold)	chlorothalonil 12.5% (7) chlorothalonil 30% (7)	4.0 tbsp 1.0 tbsp	Begin at early bloom; apply after extended wet periods.
Downy mildew (Lima beans only)	chlorothalonil 12.5% (7)	2.0 tsp	Begin early bloom – reapply every 7 to 10 days. For use only on beans to be harvested dry with pods removed.
Powdery mildew	Neem Oil Wettable Sulfur or Sulfur dust	2.0 tbsp 2.5 tbsp or 6.0 tbsp dust	Spray or dust at first sign and reapply every 7 days. Sulfur may injure blossoms and some varieties of beans.
Rhizoctonia root and stem rot	PCNB	4.0 tbsp/gal for 1000 ft row	Apply at planting only. Direct spray in the seed furrow or over the planted row.
Rust	chlorothalonil 12.5% (7) chlorothalonil 30% (7) Wettable Sulfur or Sulfur dust	2.0-4.0 tbsp 1.0 tbsp 2.5 tbsp 6.0 tbsp dust	Spray or dust at first sign and reapply every 7 days. Sulfur may injure blossoms and some varieties of beans.
Seed rot and damp-ing off	Captan	0.5 tsp/1lb seed	Mix thoroughly in paper bag or glass jar.
Viruses	No chemicals registered		Clover control around edge of garden areas is important to reduce spread of virus from clover to beans. Some bean varieties are resistant. Aluminum foil mulch may prevent aphid feeding.
Beets *Cercospora*	copper leaf spot	2.0 tbsp	Spray at 7- to 10-day intervals beginning when disease first appears.
Seed rot and damp-ing off	Captan	2.5 tsp/1 lb seed	Mix thoroughly in paper bag or glass jar.
Cabbage, Broccoli, Brussels Sprout, Cauliflower, Turnips, Kale, Collards Black leg, Black rot	copper	2.0 tbsp	Use western-grown, hot-water treated seed. Use resistant varieties for black rot control. Apply copper at 7- to 10-day intervals. Copper sprays may reduce spread of blackrot.
Club root	PCNB	1.0 tbsp	Apply in transplant water. Use 0.5 pt per plant. Thoroughly mix with the soil.
Downy mildew, *Alternaria* leaf spot	chlorothalonil 12.5% chlorothalonil 30% copper	2.5 tbsp 1.0 tbsp 1.0 tsp	Begin when disease threatens and reapply every 7 days. Do not spray copper when plants are stressed.
Seed rot and damp-ing off	Captan	0.5 tsp/1 lb seed	Mix thoroughly in paper bag or glass jar.
Carrots Leaf Blight	chlorothalonil 12.5% chlorothalonil 30% copper	2.5 tbsp 1.0 tbsp 2.0 tbsp	Start applications when disease threatens and reapply every 7 to 10 days if needed.

[1]PHI = post-harvest interval and indicates the number of days before harvest that the last fungicide application can be made.

Table 2.4 - Disease Management Tools for Specific Crops and Diseases (cont.)

Crop Disease	Treatment (PHI)[1]	Rate/Gal. (Unless otherwise Stated)	Remarks
Celery Bacterial Blight	copper	2.0 tbsp	Apply at first sign of disease; reapply every 7 to 10 days.
Cercospora (Early Blight)	chlorothalonil 12.5% (7) chlorothalonil 30% (7) copper	3.0-4.0 tbsp 1.0 tbsp 2.0 tbsp	Apply at first sign of disease; reapply every 7 days.
Septoria (Late blight) or Stalk rot (*Rhizoctonia*)	chlorothalonil 12.5% (7) chlorothalonil 30% (7)	3.0 tbsp 1.0 tbsp	Apply at first sign of disease; reapply every 7 days.
Cucurbits (Cucumbers, Summer Squash, Cantalopes, Pumpkins) *Alternaria* leaf spot; Anthracnose; Downy mildew; Gummy stem blight	chlorothalonil 12.5% chlorothalonil 30% mancozeb (5) copper	2.0-3.0 tbsp 1.0 tbsp 2.0 tbsp 2.0 tbsp	Apply at first sign of disease or after runners are formed and reapply every 7 days. Shorten the spray interval to 5 days if disease pressure is high.
Angular leaf spot (cucumbers only)	copper	1.0-2.0 tbsp	Apply at first sign of disease and reapply every 7 days. Copper may injure some young plants.
Belly rot (*Rhizoctonia*)-suppression only	chlorothalonil 30%	1.0 tbsp	Use mulch to keep fruit off soil surface. For plants in bare soil, begin when plants are in first true leaf stage. Apply during wet soil conditions.
Powdery mildew	chlorothalonil 12.5% chlorothalonil 30% copper Neem Oil potassium bicarbonate	3.0 tbsp 1.0 tbsp 2.0 tbsp 2.0 tbsp 2.0 tbsp	Begin at first sign of disease. Reapply every 7 days. Shorten interval if disease is severe.
Seed rot and damping off (melons and squash)	Captan	0.5 tsp/1 lb seed	Mix thoroughly in paper bag or glass jar.
Irish Potatoes Early blight, late blight, and *Botrytis* vine rot	chlorothalonil 12.5% chlorothalonil 30% mancozeb (14) copper	2.0 tbsp 1.5 tbsp 2.0 tbsp 2.5 tbsp	Apply at first sign of disease and reapply every 7 days.
Onion Bacterial Soft rot	copper	2.0 tbsp	Apply during extended periods of wet soil. Reapply every 7 days up to harvest.
Onion (dry bulb) *Botrytis* leaf blight, Downy mildew, Purple blotch	chlorothalonil 12.5% (7) chlorothalonil 30% (7)	2.0 tbsp 1.0 tbsp	Apply at first sign of disease and reapply every 7 days. Do not apply to exposed bulbs.
Onion (green bunching), leeks, shallots	chlorothalonil 12.5% (14) chlorothalonil 30% (14) copper	2.0-4.0 tbsp 1.0 tbsp 2.0 tbsp	See above. Do not apply chlorothalonil more than 3 times per season and maneb more than 7 times per season.
Peas Powdery mildew and Bacterial blight	copper Neem Oil	2.0 tbsp 2.0 tbsp	Apply at first sign of disease and reapply every 7 days up to harvest.
Seed rot and damping off	captan	0.5 tsp/1 lb seed	Mix thoroughly in paper bag or glass jar.
Peppers Anthracnose, fruit rot			Begin when fruit are half size. Spray on a 7- to 10-day interval.

[1]PHI = post-harvest interval and indicates the number of days before harvest that the last fungicide application can be made.

Table 2.4 - Disease Management Tools for Specific Crops and Diseases (cont.)

Crop Disease	Treatment (PHI)*	Rate/Gal. (Unless otherwise Stated)	Remarks
Bacterial spot and *Cercospora* leaf spot	copper	2.0 tbsp	Apply at first sign of disease and reapply every 7 days up to harvest.
Phytophthora blight	No chemicals registered		Avoid planting in low land. Grow resistant varieties, 'Paladin' or 'Aristotle'.
Southern Blight	PCNB	1.0 tbsp	Apply at transplant. Apply 0.5 pt/plant.
Sweet Corn Bacterial wilt	No chemicals registered		Plant resistant varieties. Spray with approved insecticide to control flea beetles.
Leaf blight, Rust	chlorothalonil 12.5% (14) chlorothalonil 30% (14) mancozeb (7)	1.0-2.5 tbsp 1.0 tbsp 1.5 tbsp	Apply after observing disease and reapply every 7 days.
Tomato Early blight, late blight, *Septoria* leaf spot, gray mold, Anthracnose and *Rhizoctonia* fruit rot	chlorothalonil 12.5% chlorothalonil 30% mancozeb (5) copper	3.0-4.0 tbsp 1.0 tbsp 3.0 tbsp 2.0 tbsp	Repeat at 7- to 10-day intervals throughout the season. Under severe conditions shorten spray intervals.
Bacterial spot and speck	copper	2.0 tbsp	Apply after observing disease and reapply every 7 days.
Fusarium wilt and *Verticillium* wilt			Use resistant varieties. Maintain soil pH from 6.5-7.0. Rotate out of area.
Southern Blight	PCNB	1.0 tbsp	Apply at transplanting. Apply 0.5 pt/plant
Watermelon Anthracnose, gummy stem blight, *Alternaria* leaf blight, downy mildew and powdery mildew	chlorothalonil 12.5% chlorothalonil 30% mancozeb (5) copper Neem Oil (powdery mildew)	3.0-4.0 tbsp 1.0 tbsp 2.0 tbsp 2.0 tbsp 2.0 tbsp	Apply at first sign of disease or when runners meet within the row and reapply every 7 days. Shorten interval under severe conditions.

[1]PHI = post-harvest interval and indicates the number of days before harvest that the last fungicide application can be made.

Table 2.5 - Nematode Disease Control in Home Vegetables

Nematode	Remarks
Root knot and other plant parasitic nematodes	Plant parasitic nematodes may cause reduced yield and stunted or weakened plants. There are no chemical controls for nematodes in home gardens. Root knot nematodes cause galls to form on roots. They are soil-borne and are difficult to control. The host range of the root knot nematode is very broad, so using crop rotation to control them is challenging. Several tactics can be implemented to minimize nematode problems in the home garden. 1) Avoid transporting nematodes to new areas on tillers, tools, soil, plant debris, etc. 2) Early, cool season crops are generally less affected by root knot nematode, because populations of nematodes are lower in the early part of the growing season. 3) Consider using certain cover crops that can reduce nematode populations, e.g. cover crop radish. 4) Control weeds, which may harbor nematode populations. 5) Ideally, the whole garden should be rotated to a different area each year, with any known nematode-infested areas being used only once every three years; however, this is impractical for most situations. Alternatively, rotating crops among plant families within a vegetable garden will minimize the chance of nematode problems. For example, rotate solanaceous crops with cucurbit crops, solanaceous crops with cruciferous crops, etc. 6) Incorporate hardwood leaf litter mulch into soil to increase beneficial fungi that kill nematodes and to increase tannins that inhibit nematode reproduction. Increasing the amount of organic matter in the garden soil is generally a good approach. 7) Root knot-resistant cultivars are available for tomato. These varieties are usually designated by the letters "VFN" after the variety name (the "V" designates Verticillium wilt, the "F" Fusarium wilt and the "N" root-knot nematode). 8) Consider using grafted transplants that possess rootstocks resistant to root-knot. These are new additions to the homeowner/garden arena and some rootstocks can offer resistance to other soilborne diseases. Both already-grafted transplants and transplanting kits for do-it-yourself grafting are available.

Weed Management in Home Vegetable Gardens

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Overview

Weed management is necessary in vegetable gardens. Weeds compete with vegetable crops for water, nutrients, and light, and can harbor insect and disease pests. Start a weed control program before planting and then continue weeding throughout the growing season. Keeping weeds down early in the season, when they are small, reduces the amount of hand weeding required later in the summer when higher temperatures and humidity make this task more difficult. Weeds are difficult to eradicate. Their seeds can remain dormant but viable for five, 10, 20, or more years in the soil, depending on species. Control weeds in areas near the garden to limit the movement of weed seed or weed propagules into the garden. Prevent weeds from flowering, as this helps reduce the amount of weed seed in the soil over time.

Cultural control of weeds in vegetable gardens is preferred because there are few chemical control options. Not many herbicides can be applied to a wide range of vegetables. For information related to larger areas planted with an individual vegetable species, such as a planting of an acre or more, consult the Commercial Vegetable Production Recommendations guide (Va. Coop Ext. Pub. 456-420).

General Cultural Controls

Winter cover crop: Plant rye, annual ryegrass, or other cover crops in the fall after the final harvest. Till the cover crop into the soil in spring prior to planting vegetables.

Cultivation/Hoeing/Hand weeding: Tilling the garden in spring controls winter annual weeds like common chickweed and controls or suppresses perennial weeds. Troublesome perennial weeds like bermudagrass, quackgrass, yellow nutsedge, and other creeping perennials need repeated tilling. Hoe weeds out of the alleyways between vegetable rows. Cut annual weeds at or slightly below the soil surface to minimize soil disturbance. Deeper hoeing brings weed seed from greater depths in the soil to the surface where they can germinate. Controlling weeds prior to flowering reduces weed populations in future years by depleting the weed seed reservoir in the soil.

Organic mulches: Pine bark, pine straw, sawdust, and grass clippings are good mulching materials. Do not use grass clippings from a lawn or pasture that has been recently treated with an herbicide, especially herbicides used for controlling broadleaf weeds. Monitor soil fertility, as nitrogen tie-up can occur when using mulches like sawdust. Organic mulches conserve soil moisture and cool the soil. Spread mulch two to four inches deep. Place newspaper on the soil surface prior to applying mulch in order to suppress weeds. Organic mulches suppress or control annual weeds but will not control perennial weeds. Use mulches that are free of weed seed and that do not have a rotten egg or ammonia odor. Improperly composted mulch can have a low pH and contain chemicals that injure crop plants.

Synthetic mulches: Using solid black plastic or a landscape fabric improves weed control compared to mulch alone. Solid black plastic is more effective for weed control than the available landscape fabrics but water cannot pass through it. Place drip irrigation under solid black plastic to allow water to reach plant roots. Landscape fabrics allow for air and water movement but weed roots and/or shoots can penetrate through openings in the material. Place plastic or fabric on the soil surface and then cut an X or a hole into the material to transplant plants or vegetable seeds. One can place organic mulch over these materials; however, weeds may germinate in the mulch layer and then send roots through the fabric to the soil below. Black plastic and landscape fabrics control annual weeds and suppress perennial weeds like yellow nutsedge.

General Biological Controls

There currently are no biological control options for weed control in vegetable gardens.

General Chemical Controls

Organic

Postemergence: Acetic acid (Weed Pharm 20% acetic acid or other labeled formulation). Contact nonselective herbicide. Do not use unlabeled forms of acetic acid. Wear eye protection, a long-sleeved shirt, long pants, shoes, socks, and waterproof gloves since this product is corrosive. Cover the weed foliage thoroughly. Treat weeds when small, as large annual weeds may require retreatment. Perennial weeds need retreatment, as this is a contact herbicide and does not affect underground plant parts such as roots, bulbs, and rhizomes. Keep the spray off the foliage and stems of desired plants by using a shield. No residual control.

Conventional

After final harvest in fall or prior to planting: Glyphosate (Roundup and other trade names). Apply at least one week before planting. Rinse glyphosate off plastic prior to transplanting vegetables through the black plastic or do not use glyphosate at all when using plastic mulch. Use glyphosate to control perennial weeds like bermudagrass, quackgrass, and horsenettle. Apply to weed foliage before frost, when the weeds are still actively growing.

At planting: Trifluralin (Preen Garden Weed Preventer, Miracle-Gro Garden Weed Preventer, or other labeled formulation). Apply at seeding of broccoli, Brussels sprouts, cabbage, carrots, cauliflower, celery, collards, black-eyed peas, field peas, garden peas, lima beans, mustard greens, snap beans, and turnip greens. Apply before transplanting celery, broccoli, Brussels sprouts, cabbage, cauliflower, eggplant, peppers, onions, and tomatoes. Apply to established cantaloupe, cucumber, and watermelon that have at least four true leaves. Apply to established asparagus prior to spear emergence. Apply after planting potatoes. Trifluralin will not control existing weeds. It does provide preemergence control of annual grasses like crabgrass, foxtail, and goosegrass, and small-seeded broadleaf weeds like purslane and pigweed.

Perennial weeds

Perennial vines and weeds (bermudagrass, poison ivy, dock, honeysuckle, etc.) around the garden borders or in the tilled area may be controlled with a postemergence application of glyphosate (Roundup or other labeled formulations) after completion of the summer vegetable harvest. For small areas or individual weed treatments, the Roundup formulation is packaged in small quantities suitable for home use and does not require special sprayers. Many of the perennial weeds are more effectively controlled when treated in late summer or fall before frost causes the leaves to drop. Since glyphosate is not biologically active in the soil, it cannot result in residue problems.

Do not spray vegetables with a sprayer that has been used to apply 2,4-D or other broadleaf herbicides to turfgrass.

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Home Fruit Disease and Insects

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Overview

Growing fruits in the home orchard or garden can be an interesting and satisfying hobby, as well as a source of nutritious food for the home gardener. Tree fruits and small fruits require considerable care, and the needs of tree fruit plants and small fruit plants differ considerably. Generally, the flowers and fruit of most fruit varieties should be protected from diseases and insects by protective sprays from early pre-blossom time until near harvest. Gardeners who don't wish to maintain their fruit plantings on a weekly basis may be disappointed with their harvests.

There are no shortcuts to quality fruit production. Production of blemish-free fruit requires applying pesticides according to the manufacturer's label instructions. The number of protective sprays required per season varies, depending on the kind of fruit and the number of blemishes the grower will tolerate. It requires a greater number of protective sprays to grow a clean crop of apples or peaches than it does a crop of blackberries or strawberries. If a home grower is not interested in producing blemish-free fruit, but will tolerate a few disease or insect scars on the fruit surface, the number of protective sprays is reduced.

The spray schedules in this publication are designed to assist the home fruit gardener in producing fruit for home use, not necessarily of market quality. Thus, the number of suitable protective pesticides that are specified and the number of applications recommended are reduced to a minimum. Several pesticide manufacturers have one-package, general-purpose fungicide and insecticide mixtures on the market that are specially prepared for home fruit growers. If these mixtures are used in accordance with the recommendations on the label, they should provide satisfactory control of the pest for which they are recommended. For any protectant pesticide to be effective, it must be applied thoroughly at the proper time and cover all leaves and fruit, since protectants are meant to prevent disease and insect damage, not cure it.

Information on insect and disease identification and monitoring, including many color photographs, is available in the Mid-Atlantic Orchard Monitoring Guide. This is available from the Natural Resource, Agriculture, and Engineering Service, (607) 255-7654, as NRAES-75. Information may also be obtained on the Web at the Virginia Fruit website at http://www.virginiafruit.ento.vt.edu.

General Cultural Controls

- **Canopy Management (Grape) –** In-season canopy management (shoot thinning, shoot positioning, fruit thinning, leaf pulling) is a very important management tool, not only to control vigor and yield of the grape crop, but also to manage diseases. Many grape pathogens require moisture (rain water, high humidity, etc.) to have successful infection, thus, good air circulation can reduce the risk of infection. In addition, grape powdery mildew thrives under shaded conditions, thus, it is important for leaves to have good sun exposure.
- **Sanitation** – Remove mummified fruit from trees, and dropped fruit from the ground. These can harbor inoculums of fruit diseases (e.g. grape black rot), complicating later chemical control and increasing reliance on pesticides. Some insects are also fostered by allowing dropped fruit to remain, such as the apple maggot and spotted-wing drosophila. For some pests, it is important to harvest promptly, because these pests attack fruit as they approach ripeness, and infestations can worsen if ripe fruit are allowed to remain on the plant. Examples are spotted wing drosophila in berry crops, and strawberry sap beetle.
- **Host vigor** – Maintain proper levels of host vigor. Nutrient-deficient trees are more prone to some diseases and insects; conversely, overly vigorous trees are more vulnerable to other pests.
- **Pruning** – Improve spray coverage and shorten drying time through good pruning practices. Trees should be "opened up" to allow spray and sunlight penetration. Prune out all dead and decaying branches because such wood may harbor insects and diseases. Remove all healthy prunings from the tree because these can be colonized by rot fungi and increase inoculum levels of some rot diseases. Keep the height of the trees low to enable good coverage.
- **Thinning** – It is important to thin fruit properly to provide good disease and insect control. Thin all tree fruits so that the mature fruits will not touch each other. Protectant pesticides cannot effectively cover fruits that touch each other; hence, this provides a place for insects and diseases to become established.
- **Tree size** – It is almost impossible to produce high-quality fruit in the home orchard on old, large trees because the spray pressure commonly used is inadequate to force the pesticides to the tops of such trees. Therefore, old trees should be replaced with dwarf or semi-dwarf trees that are allowed to reach a height of no more than 12-15 feet.

- **Ground cover management –** Grape root borer is increasing in severity in Virginia grapes. If a weed-free strip is maintained in the vine row, most young larvae die of desiccation as they penetrate the soil surface to reach the roots (unless the vineyard is irrigated). Alternatively, if soil is pulled into a mound about 8-12" high along the vine row after pupae have formed and left until fall, adult moths are unable to escape the soil (the mound must be pulled down again in the fall).

General Biological Controls

Disease-resistant plant information – The varieties listed in nursery catalogs as "disease-resistant apples" are immune or highly resistant to scab, one of the most troublesome early season diseases. Many of them also have reduced susceptibility to powdery mildew and fireblight, but require protection against these diseases if disease pressure is high. Although they may be indicated as resistant to cedar apple rust, they are mostly untested against quince rust and would therefore require fungicide protection (with Immunox) from pink to first cover stages in rust-prone areas. All of the scab-resistant varieties are susceptible to the usual spectrum of insect pests, sooty blotch, fly speck, and fruit rots. Some scab-resistant varieties (not included below) are McIntosh types, which would not be expected to perform well in Virginia except at higher elevations.

The following scab-resistant varieties, listed in approximate order of ripening in central Virginia, are suggested for backyard trial in Virginia:

Table 3.1a - Some Suggested Scab-resistant Apple Cultivars for Virginia

Cultivar	Ripening Period Winchester, Va.	Disease rating[1]				Description/weakness
		PM	CAR	QR	FB	
Pristine	Mid- to late July	R	S	R	S	Very early, yellow apple, pleasant mild flavor with a smooth, waxy, attractive finish. Blooms heavily; must be thinned well for good size.
Williams Pride	Late July	R	S	?	MR	Early, dark red-purple apple. Large fruited, semi-tart flavor. Sometimes shows water-core or bitter pit.
Redfree	Early to mid-Aug.	S	VR	R	S	Early, sweet summer apple. Red crisp. Fruit hangs on tree well. Does not store well.
Dayton	Mid- to late Aug.	R	R	?	MR	A large attractive glossy red fruit with moderately tart flavor. An annual cropper and "grower- friendly" tree.
Scarlet O'Hara	Mid-September	S	S	S	HS	Fruit brownish red, round crisp with mild flavor; spreading growth habit.
Crimson Crisp	Early-Mid- Sept	HS	S	S	S	Fruit medium-sized with an attractive crimson red color. Firm, crisp texture with a tart, flavor. Tree is grower friendly with a spreading habit.
Jonafree	Mid- to late Sept.	R	HS	S	S	Mid-season firm red apple, slightly tart. Flavor improves after storage. Similar to Jonathan.
Liberty	Late September	R	VR	S	MR	Attractive red over yellow skin. High-quality dessert apple. Good well-balanced sweet-tart flavor which improves after storage. Annual bearer. Being planted for direct sales in the Northeast.
Sundance	Early to mid-October	HS	VR	R	MR	Late season, yellow fruit. Golden Delicious type.
Enterprise	Mid-October	R	VR	S	MR	Good quality, late season, large, smooth glossy red apple. Stores well. Susceptible to a fruit spotting disorder correctable with calcium sprays.
GoldRush	Mid-October	HS	HS	S	MR	Excellent quality fruit, good storage apple. Firm, Golden Delicious type. Fruit may crack.

All of these cultivars are immune to scab based on ratings in Winchester, Va., and Kearneysville, W.V.

[1] PM = powdery mildew; CAR = cedar apple rust, QR = quince rust; FB = fire blight
VR = very resistant. No control needed in a home orchard.
MR = moderately resistant. Control only needed with fire blight susceptible rootstocks or under high disease pressure.
R = resistant. Control only needed under high disease pressure.
S = susceptible. Control usually needed where disease is prevalent.
HS = highly susceptible. Control always needed where disease is prevalent.

Table 3.1b – Some Suggested Wine Grape Varieties for Virginia[1]

	Disease rating[2]					Sensitivity to chemicals[3]		
Cultivar	**BR**	**DM**	**PM**	**Bot**	**Phom**	**S**	**C**	**Description**
Cayuga white	MR	MS	MR	MR	MR	No	Slight	Early white variety with a vigorous, highly productive vine. A good cold hardiness.
Chambourcin	MS	MS	MS	MR	MS	Yes	No	A mid to late season red variety. Its loose cluster provides a good resistance to fruit rots.
Chardonel	MS	MS	MS	MR	?	No	?	Ripens early to mid-season, cold hardy white variety with high acidity and low pH.
Corot noir	MR	MS	MR	MR	?	No	No	A mid- to late-season red variety with moderate cold hardiness. It tends to have low acidity and low pH.
Noiret	MR	MS	MR	MR	?	Slight	No	A mid-season red variety with moderate cold hardiness. It tends to have low acidity and low pH. Sensitive to the strobilurin fungicides.
Norton/ Cynthiana	MS	MS	MR	MR	MR	Yes	No	A late- to very late season red variety. Good cold hardiness. Early bud break. High pH.
Traminette	MR	MS	MR	MR	?	Yes	?	A mid-season white variety with a good cold hardiness.
Vidal blanc	MR	S	MS	MR	MR	No	No	A mid- to late-season white variety with a good cold hardiness. Non-grafted vines are susceptible to tomato and tobacco ring sport virus.

[1] For more complete list of cultivars, please refer to this web site: http://www.fruit.cornell.edu/grape/index.html

[2] BR = Black rot, DM = Downy mildew, PM = Powdery mildew, Bot = Botrytis bunch rot, Phom = Phomopsis cane and leaf spot, MR = Moderately Resistant, MS, Moderately Susceptible, S = Susceptible, ? = Unknown.

[3] S = Sulfur, C = Copper

- **Friendly insects/animals/organisms** – Many insect and mite pests of fruit crops are naturally controlled by predatory or parasitic insects, unless these beneficial species are disrupted by certain sprays. Important beneficial groups are predatory mites, lady beetles (some specializing in aphids, some on mites), syrphid fly larvae, lacewings, minute pirate bugs, aphid midges, and parasitic wasps. Many of these are illustrated in the Virginia Fruit website, with the address given in the overview.
- **Companion planting** – This is an ongoing area of research. Some companion plants provide a beneficial nectar and pollen source for beneficial species. This is a complex area however, and some such plants can actually harbor pest species. Geraniums have been cited as useful for Japanese beetle control because of a paralytic effect after feeding. This is not useful in some crops, however, which are more attractive than the geraniums (e.g. raspberries). This area of the guide is subject to later updates.

General Mechanical Controls

Netting can keep birds from consuming ripening fruit. Another use for this approach is during outbreaks of periodical cicada (17-year cicada). Netting of appropriate mesh may be more effective than pesticides available to the home fruit grower. Growing berries under row covers or in greenhouses can help reduce injury by spotted-wing drosophila.

General Chemical Controls

Sprayers/spreaders – Various sprayers and dusters are available to the home fruit grower. Generally, however, dusters do not work well when applying pesticides to home fruit trees. Therefore, the home fruit grower is limited to a choice of small hand or power sprayers to protect his fruit crops. There is no one sprayer that works for all home fruit spray problems. Hence, the grower must make the decision on what type of sprayer to purchase for a particular planting.

If there are only a few trees (five to eight) to spray, along with a few strawberries and brambles, a hand sprayer of the compressed-air type would probably be adequate. However, the type of hand sprayer where the compressed air tank is pumped-up before one starts to spray is relatively poor because there is an uneven air pressure at different times during the application of the protectant pesticide. The "knapsack" type of sprayer which is hand pumped as the operator moves along, has the advantage in that the pressure in the tank remains relatively constant as the spray is being applied. The overall reach of the hand sprayers can be extended somewhat by removing the short brass tube where the nozzle is attached, and replacing it with a 4- to 6-foot piece of copper tubing purchased at a hardware store. Have the copper tubing threaded with the same size threads as the brass tube so that the nozzle will fit properly. This inexpensive alteration of the hand sprayer facilitates coverage of trees up to 12 feet in height and also will help the operator avoid being covered by the spray mist that falls when spraying overhead.

For the home fruit growers who have 25-50 fruit trees, as well as home lawns and gardens to spray, a small power-driven sprayer would probably be more satisfactory. These sprayers are distributed by various dealers. They come with tank capacities of 15-50 gallons and pumps that will deliver from 50-350 pounds of pressure per square inch. Therefore, start an inquiry about three months before you plan to buy one of these sprayers and read all the information that you can obtain on the different types. Check with your nearest pesticide dealer, farm machinery distributors, large department stores, local extension staff, and an Extension Specialist at a land grant university with pest management expertise. After the correct size has been decided, purchase a standard brand so it is easier to obtain parts or have the sprayer repaired when necessary.

Tips on sprayer maintenance: Some pesticides are corrosive to metals; therefore, a sprayer must be properly cleaned after each use. For best results with any sprayer, study the owner's manual and follow instructions carefully. Keep hose clamps tight and the trigger mechanism working properly without dripping. At the end of the day or treatment, thoroughly wash the nozzle(s), hose pipes, and tank both inside and out. **Caution**: Never wash a sprayer where the water will puddle or stand where children or pets will play in it. There may be enough toxicant in the wash-water to cause serious injury to children or pets. Never store a sprayer where small children can play with it. There may be enough of the pesticide toxicant left on the sprayer, if a child rubs its hands over the sprayer then puts them in its mouth, to cause serious illness or even be fatal.

Garden hose sprayers: There are several types and models of the garden hose type sprayer. They attach to a garden hose and the pressure is derived from the water system rather than from a hand or motor pump. When tested, garden hose sprayers seem less effective than other types, but may be best suited to gardeners who cannot lift a 3- to 4-gallon sprayer. When purchasing, be sure that the sprayer is designed to use wettable powders. Since wettable powders do not dissolve in water, but remain in suspension, be sure that the screen over the end of the suction hose is not so fine that it will become clogged with pesticide particles. Read and follow the manufacturer's instructions.

When and How to Apply Home Fruit Pesticides

Timing: Proper timing and thorough application of pesticide sprays are essential for quality fruit production. Make certain that the spray reaches all parts of the tree and covers all of the foliage and fruit. If coverage is not uniform, it may be necessary to adjust or change the parts (disk) of the sprayer nozzle. It is difficult to determine the exact time or date to start the protective spray, since there are usually several kinds and varieties within a home fruit planting. A simple general rule, however, may be used for most home fruit plantings. Start the protectant pesticide spray program in the spring when the young foliage is approximately 1/4 inch long on the earliest variety to breakbud and spray all varieties at the same time. It is much easier to follow this procedure than it is to attempt to spray each variety according to its stage of growth. Some fruit varieties need spray application during the full blossom stage of some varieties. This spray usually will not interfere with pollination because no insecticides are included with the fungicides recommended for use at this time.

How much spray per tree: There is no accurate measure of how much spray to apply per tree. There are too many variables in the types of sprayers that are available, the wetability of the leaves and fruit of the different species, the amount of wetting agent (surfactant) contained in the different pesticides, and the extreme variability of the environment (wind blowing, dry, hot, wet, cool, etc., each of which influences wetting the foliage) when the protectant pesticide is being applied. A general rule of

Table 3.2 - How Much Spray Per Tree with Different Dimensions

Height in feet	Spread in feet	Gallons per application[1]
5-8	3-6	1
8-10	4-8	1-2
10-15	8-15	4-5
15-20	15-25	8-10
20-25	25-30	11-14
25-30	30-35	15-18

[1] As indicated in the text, these amounts are only for guidance. The environment at the time of spraying, as well as how the tree is pruned, will influence the amount of spray that will properly cover a tree.

thumb is to spray the foliage and fruits until droplets form and begin to run or drip off. For the beginner, the amount of pesticide suggested for coverage of different size trees (Table 3.3) will be helpful.

Protective equipment to be worn while applying chemicals: Long sleeves and gloves should be worn while applying pesticides. Specific requirements for Personal Protective Equipment (PPE) will be included on the product label. These vary with the pesticide.

Organic Chemical Controls

Contrary to the belief of many, organic crop production does not mean no pesticides are applied. It means that any pesticides applied must be natural products. These must be approved by OMRI (Organic Materials Review Institute). This designation will be included on the label. Many insecticides and fungicides based on natural products have a shorter residual life and so must be applied more frequently.

Precautions

- **Humans** – Generally, most pesticides are toxic or poisonous to animals and/or some plants. For the most part, however, pesticides recommended for homeowner use are selected from the least toxic of those available. Nevertheless, they should be kept in a locked container and kept out of reach of children and animals. Be safe, do not take pesticides lightly. When using pesticides, never breathe the dust or spray and always wear a pair of rubber gloves and goggles. Do not smoke or eat while using pesticides. Destroy pesticide containers as directed on the container label. Always change clothes and wash with soap and water immediately after completing the job and launder your clothes before they are worn again.
- **Bees** – Bees are important parts of the fruit arthropod community. Not only are they required for the production of the fruit crop, but careless spray practices can harm bees even after the fruit pollination period. Do not apply insecticides at bloom. Be conscious of the fact that blooming weeds also attract bees, and insecticides will harm these bees as well. Puddles near sprayed areas may become contaminated with spray material, and pose a threat to bees that come to the puddles for the water they need to cool the hive.
- **Animals (pets, birds, etc.)** – Keep pets away from pesticide preparations, and avoid spills that can result in puddles of pesticides. Some pesticide labels prohibit allowing livestock to feed on pomace or fallen fruit; check the label.
- **Water** – Many pesticides (including fungicides and herbicides) are toxic to fish. Use care around bodies of water.
- **Plants** – Do not use 2,4-D weed killing mixtures or other herbicides in the spray tank used to spray fruit, flowers, vegetables, or lawns. As a rule, herbicides cannot be satisfactorily removed from the spray tank; this may cause injury to cherished plants. Use herbicides in sprayers kept for that purpose only.

When to call a professional

- When a pest cannot be identified with resources available, or if plants decline despite control efforts, seek advice from your local VCE office. If you cannot treat plants adequately because of equipment limitations, seek a professional service.

Special Considerations

- **Invasive plants, animals or insects** – Regulatory agencies strive to prevent the establishment of exotic invasive insects and diseases. This is a difficult job in this era of increased international movements of humans and goods, and occasionally pests slip through. An example is the recent introduction of brown marmorated stink bug (http://www.virginiafruit.ento.vt.edu/BMSB.html), which was first detected in eastern Pennsylvania in 1996, and has since expanded throughout much of the United States, causing serious damage to fruit and other crops.
- **A new invasive insect:** In January 2018, a new invasive insect was found in Virginia. Spotted lanternfly came to Virginia from southeastern Pennsylvania, and had been expanding its range in the Shenandoah Valley and Piedmont. SLF feeds on more than 70 different hosts, and can cause significant injury on some. Some of our important fruit crops are on the host list: grape, caneberry, blueberry, stone and pome fruits, and hops; grape is the most vulnerable commercial crop. Populations can build to create a severe nuisance in residential areas as well. An eradication effort has been implemented in 2018, and a quarantine was established by VDACS in May 2019. More information on the quarantine program is posted (https://www.pubs.ext.vt.edu/ENTO/ENTO-319/ENTO-319.html). An online training is available to allow certification as part of the quarantine effort (https://register.ext.vt.edu/search/publicCourseAdvancedSearch.do?method=doPaginatedSearch&cspIndex=true&showInternal=false&courseSearch.courseDescriptionKeyword=slf). SLF is now beginning to cause economic loss in our agricultural crops, particularly grapes. Fruit growers should be aware of the pest's appearance, and how to handle finds you may make in your operations. For information on SLF appearance and management in vineyards, refer to our fact sheet (https://www.pubs.ext.vt.edu/ENTO/ENTO-323/ENTO-323.html). For updated information and updated distribution maps, visit the spotted lanternfly page in the Virginia Cooperative Extension web site (https:ext.vt.edu). For updated control information and updated distribution maps, visit the SLF page in Virginia Fruit (https://www.virginiafruit.ento.vt.edu/SLF.html). To report suspected discoveries, please contact your Virginia Cooperative Extension agent.

Guidance on How to Find Specific Recommendations

- Is it a disease or an insect or should both be checked?
- Timing of chemical applications

Links to Useful Sources of Information

- **Diagnostic keys or aids** – The Virginia Fruit website contains biological information, usually with photographs, of important fruit pests and beneficial species. Different sections of the website deal with apples, pears, stone fruits, grapes, and small fruits. The URL (web address) is: http://www.virginiafruit.ento.vt.edu/

General Information on Pesticides for Home Fruit Use

Fungicides

Captan is a 50% wettable powder fungicide used to control apple scab, peach brown rot, grape downy mildew, and other fungus diseases of orchard fruit and brambles. Note that Captan does not control powdery mildew or apple rust diseases, or grape black rot, which are common in Virginia. Do not use with spray oils or within one week of an oil application.

Chlorothalonil (Fung-onil) is registered for control of several early-season diseases on peach, nectarine, apricot, cherry, plum, and prune. Consult the label for disease control spectrum and use directions. Do not apply after petal fall on plums and prunes or after shuck-split stage (about two weeks after petal fall) on peaches, nectarines, apricots, and cherries. Chlorothalonil is not registered for grapes.

Copper materials There are numerous copper products available to home fruit growers. On apples and pears, copper can be used as a green-tip bud spray for fire blight suppression or a scab fungicide. On peaches and nectarines, coppers can be used in the fall at leaf drop or at bud swell in the spring for leaf curl control or bacterial spot suppression. On grapes, coppers can be used throughout the season, but many winemakers prefer not using coppers (or captan or sulfur) within 3-4 weeks of harvest. Some copper products are approved for organic production. However, if coppers are used in successive sprays at full rates during the growing season, they can cause fruit russetting and purple spots on apple leaves and shothole and defoliation of peach and nectarine leaves. Copper soaps, which tends to have a lower copper concentration, can be used on some grape cultivars which are known to be sensitive (cause burn on leaves) to coppers.

Fruit Tree & Plant Guard by Bonide is a multi-purpose product that combines two fungicides (pyraclostrobin and boscalid) and an insecticide (lambda-cyhalothrin). It is registered for control of a wide range of diseases and insects on pome fruits (apple, crabapple, loquat, mayhaw, oriental pear, pear, and quince) and on stone fruits (apricot, sweet cherry, tart cherry, nectarine, peach, plum, plumcot, and prune). Fruit Tree & Plant Guard should be especially useful on fruit rots and other summer diseases of apples, and fruit rots and leaf spots of pears, and fruit rots of stone fruits. It is of particular interest on pears, where the availability of products for home orchards is quite limited. Because lambda-cyhalothrin and similar insecticides may be toxic to orchard predators and cause an increase in mite populations which can be deleterious to pear foliage, it is suggested that timely oil sprays with thorough coverage be applied to pears in late winter and early spring to suppress both mites and pear psylla. Apply Fruit Tree & Plant Guard at the rate of 2 fl oz per gallon of mix. On pome fruits do not make more than four applications of per year, and do not apply it closer than 21 days to harvest. On stone fruits do not make more than five applications of Fruit Tree & Plant Guard per year, and do not apply it closer than 14 days to harvest.

Immunox (Spectracide Immunox Multi-Purpose Fungicide) is a 1.55% emulsifiable concentrate myclobutanil fungicide formulation registered for apples, stone fruits (peaches, nectarines, cherries, apricots, plums, and prunes), and grapes. The Immunox rate is 1/2 fluid ounce per gal on all tree fruit crops. On apples, it is particularly suggested as a supplement for control of cedar apple rust, quince rust, and powdery mildew and is also effective for scab. For management of these diseases it should be used on a 7- to 10-day schedule from green tip until about one month after petal fall. Do not apply Immunox to apples more than 10 times per season and do not treat within two weeks of harvest. On stone fruits, Immunox is registered for control of brown rot and powdery mildew. Treatments may be applied to stone fruits the day of harvest but no more than 7 times per season. On grapes, Immunox controls black rot, anthracnose, and powdery mildew. Mix 2 fluid ounces per gal of water and treat every two weeks. Do not treat within two weeks of harvest and do not apply to grapes more than six times per season. Immunox is also registered for numerous ornamental diseases. **Do not confuse Immunox with Immunox Plus, a formulation which is not registered for edible fruits.**

Mancozeb Flowable is a multi-purpose fungicide that is formulated as a 4 lb active ingredient per gallon of flowable product. It provides supplemental protective control against a broad range of apple and pear diseases including: apple and pear scab, cedar-apple rust and quince rust, black rot, bitter rot, sooty blotch and fly speck, and Fabraea leaf spot on pears. Mancozeb is comparable to Captan as a protective fungicide, but Mancozeb is registered for use on pears, is more effective against rusts and is compatible with oil and Immunox sprays on apple. Apply Mancozeb Flowable at the rate of 1.5 teaspoons per gallon of mix (equivalent to the label rate of 2.4 qt per acre at 300 gallons of water per acre). On pome fruits do not make more than four applications per year, and do not apply it after bloom. On grapes, mancozeb can be used to protect against downy mildew, black rot, and Phomopsis, but do not apply mancozeb closer than 66 days to harvest. **Mancozeb is not registered for use on stone fruits.**

Table 3.3a - Effectiveness[1] of Fungicides for Control of Tree Fruit Diseases

Disease	Captan[2]	Copper[3] (Bordeaux)	Fung-onil	Spectracide Immunox	Lime Sulfur	Sulfur	Fruit Tree & Plant Guard	Mancozeb Flowable
Apple								
Scab	G	-	-	E	G	F	E	G
Powdery mildew	-	-	-	E	G	G	E	-
Rusts	-	-		E	F	-	F-G	G
Sooty blotch, fly speck	G	-	-	-	F	-	E	G
Fruit rots	G	-	-	-	F	-	E	G
Peach and Nectarine								
Leaf curl	-	G	E	-	G	-	-	-
Scab	G	-	-	-	-	G	G	-
Brown rot	G	-	-	E	-	G	E	-
Plum								
Brown rot	G	-	-	E	G	G	E	-
Black knot	G	-	-	-	-	-	-	-
Cherry								
Brown rot	G	-	-	E	-	G	E	-
Leaf spot	G	-	G	-	-	-	E	-

[1] E = excellent; G = good; F = Fair; - = not recommended, not registered, or not applicable.

[2] Do not mix captan with any oil. The combination causes leaf-spotting damage.

[3] **Caution:** if coppers are used in successive sprays during the growing season, they can cause fruit russetting and purple spots on apple leaves and shothole injury of peach and nectarine leaves.

Note: Always check label for crop and disease, rate, timing, and minimum days to harvest.

Table 3.3b – Effectiveness[1] of Fungicides for Control of Grape Diseases

Disease	Captan[2]	Copper[3] (Bordeaux)	Immunox (Spectracide)	Lime sulfur[3, 4]	Mancozeb	Neem Oil	Phosphorus acid	Potassium bicarbonate	Sulfur[3]
Phomopsis	G	-	-	F	E	-	-	-	-
Black Rot	-	-	E	F	E	-	-	-	-
Downy mildew	G	G	-	F	E	-	E	-	-
Powdery Mildew	-	G	E	G	-	F	-	G	G
Botrytis	G	-	-	-	F	-	-	-	-
Anthracnose	F	-	F	G	-	-	-	-	-

[1] E = excellent; G = good; F = fair; - = not recommended, not registered, or not applicable

[2] Do not mix captan with any oil. It will cause damage to grapevines.

[3] Some varieties are sensitive to copper or sulfur; please check their sensitivity. Copper octanoate fungicides are less phytotoxic to grapevines.

[4] Rate will be different based on the target pathogen and time of application; please refer to the label

Note: Always check label for crop, disease, rate, timing, and minimum days to harvest.

Phosphorous acid (e.g., Agri-Fos) is a fungicide to control downy mildew of grape. It is best to be used with mancozeb or captan because these two provide protective effect and phosphorous acid provides kick-back activity. Do not use with copper spray or within a week of a copper spray.

Wettable Sulfur is a fungicide that is used for the control of apple scab, peach brown rot, powdery mildew, and other diseases. It is a finely-ground powder to which a small amount of wetting agent has been added. Do not use in high temperatures. Do not use with oil sprays or within two weeks of an oil spray.

Insecticides/Miticides

Carbaryl (Sevin) 80% soluble powder is recommended for control of Japanese beetle. Use separately as necessary about June 15 for Japanese beetle. Add to the spray beginning June 15 and continue at 10-14 day intervals for remainder of season for apple maggot control. Do not spray apples for six weeks after bloom with Carbaryl as it is a thinning agent and will cause some fruit to drop. Carbaryl reduces populations of beneficial predators; use alternative insecticides when available.

Dormant Spray Oil diluted with water is effective in suppressing scale insects and red mite egg hatch. It should be used only on dormant trees or with up to 1/2-1 inch of green showing. OMRI approved.

Malathion, an organophosphate, is used to control aphids, mites, and scale insects in the crawler stage. A 57% emulsifiable concentrate formulation and an 8 lb emulsion are the most commonly available for homeowners. Malathion does not persist long. Check label for fruit crops registered.

M-Pede is a potassium salt of fatty acids effective against soft-bodied insects and mites. It may be applied until the day of harvest, with a 12-hour restricted-entry interval. Apply to wetness; higher volumes can cause fruit injury. May cause marking of table grapes and pears. Do not apply after delayed dormant stage of pears. OMRI approved.

Specific Disease and Insect Biology

Apple Diseases

Apple Scab, a fungus disease of apples, is found in all countries where apples are grown. This disease causes almost as much loss to apple growers as all the rest of the apple diseases put together. The scab fungus attacks leaves, stems, and fruit. The apple scab fungus overwinters in the dead apple leaves under the trees. During the winter months, the fungus forms small, black, flask-like structures in the leaves called perithecia. The mature perithecia are filled with minute spores called ascospores. Spring rains cause the perithecia to discharge ascospores into the air where they are carried by the air current to the new green leaves and opening fruit buds of the apple tree. The first visible sign of infection is a light brown or olive colored spot. Depending on the temperature, first visible symptoms may show as soon as eight days after the initial penetration by the ascospore. Hundreds of new spores called conidia, or summer spores, are formed in the infection lesion. Rain disperses the conidia from the infection lesion to healthy leaves and to the young developing fruit, where they start a secondary infection. Thus, the fruit and foliage must be protected from green-tip until harvest with protectant fungicides.

Powdery Mildew, a fungus disease, is of major importance on several apple varieties grown in Virginia. Varieties such as Ginger Gold, Idared, Jonathan, Rome, Granny Smith, and Stayman have been the most seriously affected. York, Fuji, and Delicious have been less severely attacked. The powdery mildew fungus attacks twigs, leaves, blossoms, and fruit. The disease appears with the opening of buds that were infected the previous season. The first symptoms are felt-like patches of fungus mycelium on the lower surfaces of leaves, which soon become crinkled and curled. The fungus spreads rapidly and soon covers the entire leaf surface with mycelium and a powdery coating of spores. The entire growing terminal may be affected. The terminals become stunted and may be killed as a result of the disease. Blossoms may become infected from the overwintering mycelium in the dormant buds. In this case, the floral parts are so badly deformed that no fruit is produced. Fruit infection occurs as early as pink stage and appears on the fruit as a net-type russet. Protectant sprays are required from early pink through mid-summer to suppress this disease.

Apple Rusts are serious apple diseases in the Appalachian area. There are two kinds of apple rusts, cedar rust and quince rust. Red cedar is the alternate host for both the cedar-apple and quince rusts and severity of these diseases is related to the distance of the apple tree from infected cedars in the area. Cedar rust, caused by a fungus, appears as orange or greenish yellow spots on the fruit and as yellowish to orange spots on the leaves. Leaf infection results in extensive defoliation and devitalization of the tree during dry periods. York Imperial, Rome Beauty, Golden Delicious, and Jonathan are among the most susceptible of the varieties grown in Virginia. Cedar-apple rust galls, or "cedar apples," are located on the twigs of cedar. They develop masses of gelatinous spore horns during rainy periods, early in the growing season, from which spores are discharged that infect the apple. Apple quince rust, incited by a fungus, has caused heavy fruit losses of Red Delicious, Stayman, Winesap, Rome, and York under Virginia conditions. The disease appears as sunken or deformed areas ranging from deep green to brown, usually on the calyx end of the fruit. The infection goes deep into the fruit and makes it worthless. Quince rust does not affect apple foliage. Starting in mid-summer, quince rust sometimes produces tufts of fluorescent orange spores that are conspicuous and may be incorrectly identified as cedar apple rust. Protectant sprays are required from early pink through June 10 for control of the rust diseases. Immunox is the most effective fungicide listed here that adequately protects against rusts. In some years rust infection occurs later than petal fall. Where rust pressure is heavy, two or three sprays of Immunox may be required to cover the six-week period of fruit and foliage susceptibility from pink to four weeks after petal fall.

Black Rot of Apple, a fungus disease, occurs throughout the warmer regions of the world. The fungus attacks fruit, leaves, and limbs. Infection of the fruit may occur from the time the fruit is initiated until harvest. Also, the fungus may cause postharvest decay. The disease first appears as a small brown spot any place on the surface of the fruit. The black rot infection develops slowly, and complete decay of the fruit usually does not occur until the fruit is mature. As the rot progresses, the decayed tissue is firm and leathery. Eventually, the decayed fruit becomes shrunken and mummified. Finally, the rotted fruit turns black; hence, the common name black rot. Symptoms first appear on the leaves as small, dark purplish spots. As the spots enlarge, they are irregularly shaped. The margins of the lesions retain their purple cast while the centers become brown to yellowish brown; thus, the popular common name frogeye leaf spot. Some types of spray injury may also look like frogeye leaf spot.

Botryosphaeria Rot of Apple, caused by a fungus, is widespread and attacks many host plants. Fruit infection may occur from the time of initiation to harvest. The small lesions (rot infections) first appear as small, circular, brown spots surrounded by a conspicuous red area. The infections start slowly but progress rapidly as the fruit approaches maturity. The lesions on fruit of the red skinned varieties may bleach during the decaying process; thus, the disease has acquired the name “white rot.” Completely rotted fruit exudes droplets of a clear gummy fluid and eventually mummifies.

Bitter Rot of Apple, caused by a fungus, is a serious disease of apples in Virginia. It is most serious during warm, moist summers. These conditions frequently exist in the eastern and southern sections of Virginia. Bitter rot begins on the fruit as small, light brown spots just under the skin. These spots grow rapidly in warm, moist weather. Masses of spores are formed in pustules arranged in concentric rings on the surfaces of the spots. Rain disperses spores to other fruit and branches below where they may start a new infection. The rotted fruit hangs on the tree and dries out. It is important that all mummified fruit and cankered branches be removed during the pruning operation, since they may supply inoculum for new infections.

Sooty Blotch and Fly Speck are a complex of surface blemish disease symptoms that commonly appear on apples in late summer and fall. A range of symptoms may appear together, and they are caused by as many as 60 different fungi. Sooty blotch appears as more or less sooty smudges or spots, not; while fly speck appears as small circular black spots that occur in groups and resemble true fly specks. The development of these diseases is favored by moderate temperatures and high humidity. Infection may occur as early as June, but late-summer infection is the major concern with these diseases. Both diseases are superficial and do not rot the fruit, although sooty blotch-affected fruit may shrivel in storage as a result of the ruptured cuticle.

Fire Blight, caused by the bacterium *Erwinia amylovora,* is one of the most destructive diseases of apple and pear in the United States. The fire blight bacterium may attack any part of the tree from the roots to the leaves. The disease usually appears in the spring as blossom, leaf, and twig blight. Infected blossoms suddenly wilt and soon turn light to dark brown. As the disease progresses down the pedicel, the tissue becomes water-soaked and dark green. If the infection moves beyond the pedicel, it invades the fruit spur and spreads out into the leaves. The leaves wilt and the entire spur growth turns brown on apple, or dark brown to black on pear, and dies. The blighted leaves remain attached throughout the growing season. The fire blight bacteria may move down the twig and into branches and limbs, where the infection becomes established. These infected branches and limbs may become entirely girdled with the infection, which spreads upward and downward. A severely infected apple or pear tree may have so many blighted terminals that it has the appearance of being scorched or burned by fire. Thus, the name fire blight was coined for the disease.

Twig blight begins with an infection of the young terminal shoots. The invading bacteria progress more rapidly down the shoots or twigs than in the fruit spur. Infected shoot tissue becomes watery, dark green, and has an oily appearance. The leaves on the blighted terminals, as in spur blight, turn brown on apple or dark brown to black on pear and remain attached throughout the growing season, and in many cases they remain attached after the healthy leaves have fallen in the fall. A characteristic symptom of twig-blight is the bending of the blighted terminal, which resembles a shepherd’s crook.

Fruit infection may occur on apples and pears. The fruit becomes water-soaked with numerous exuding droplets of bacterial ooze. The diseased fruit is firm and later leathery. Still later, the fruit shrivels, turns brown on apple or black on pear and usually remains attached to the spur. Infection of some very susceptible dwarfing rootstocks such as M.9 and M.26 will cause death of trees younger than seven years. The newer “Geneva-series” apple rootstocks are more resistant to fire blight and collar rot and these are suggested for planting if available. The causal bacteria overwinter in living host tissue at the margins of cankers on the larger twigs, branches, and trunk. In the spring, highly infectious, milky-white to cream colored droplets of ooze containing tremendous numbers of bacteria are produced at the margins of active cankers. The bacterial ooze usually appears first when the trees are in the late-pink to early-bloom stage of development. Wind-blown rain and insects help spread the causal bacteria from the oozing cankers to the developing blossoms and young leaves where new infections may develop.

Fire blight control, like most bacterial diseases, is difficult and expensive. As a rule, fire blight is much worse on tissues that are succulent. Thus, home fruit growers should attempt to manage their trees so as to prevent extensive rapid growth of young shoots in varieties of pear and apple especially susceptible to blight. The excessive use of nitrogenous fertilizers and the cultivation of the orchard to promote excessive growth and excessive pruning should be avoided. Water sprouts or suckers should be removed as they are formed on susceptible varieties. Their removal will often prevent canker formation on limbs, trunks, and roots of the trees. Avoid any pruning during the blossom period and immediately thereafter. Large populations of sucking insects are present in the trees during bloom, and it has been demonstrated that sucking insects spread the bacteria to blossoms and open wounds. Thus, the use of effective insecticides "following bloom" to control such insects as aphids, plant bugs, and leaf hoppers is advisable when blossom blight occurs. Streptomycin sulfate, an antibiotic, is the most effective material for fire blight control. Use streptomycin at the rate of 60 ppm of dilute spray. The first application should be completed just before the center blossoms begin to open. Additional applications should be made at 5-day intervals until all petals have fallen. This will usually mean two or three sprays. CAUTION: Spray to wet only; antibiotics are usually locally systemic and over spraying may cause foliage chlorosis and reduce fruit set.

Boron Deficiency Corking is a cluster of dead cells, tan to brown in color, which is the most common symptom that indicates a lack of boron in an orchard. Aside from nitrogen, boron is the nutrient most commonly deficient in Virginia orchards. They may occur anywhere in the fleshy portion of the fruit, their location being affected by the variety and severity of the deficiency. Boron deficiency corking in apple fruit can be confused with other types of cork. A fruit analysis showing less than 10 ppm of boron is sometimes used to confirm the diagnosis. Affected fruit may ripen and drop prematurely. Boron deficiency can be corrected through the application of 0.5 lb of agricultural borax to each mature tree. This rate may be increased to a pound for very large trees and should be reduced to 0.25 lb for dwarf or young trees. The treatment to be effective during a given year should be applied during the preceding fall or winter. Applying boron every third year should control this disorder. Control also can be obtained by applying 1.0 lb of solubor per 100 gallons in two sprays during late bloom and early post bloom each year. If applied at too high a rate or too close to the trunk of young trees, soil applications of borax can cause injury. It should be applied in an area 3 to 6 feet from the trunk of young trees and near the drip line of older trees.

Table 3.4 - A Checklist of Major Apple Diseases in Virginia

Disease	Usual stage of occurrence[1]	Infection conditions
Early season		
Scab	Green tip to whenever conditions are favorable	Extended wet periods, 33º to 76ºF
Powdery mildew	Leaves; tight cluster, until shoot growth stops	Dry weather, 50º to 75ºF
Cedar apple rust	Tight cluster to 2nd cover	Extended wet periods above 56ºF
Quince rust	Pink to 1st cover	Extended wet periods above 56ºF
Fire blight	Bloom to mid-season	Open blossoms, daily mean above 60ºF, wetting
Mid-season		
Frogeye-leaf spot (Black rot)	Pink to harvest	Moderate and wet, optimum 80ºF
Moldy core	Bloom to petal fall	Moderate and wet
Brooks fruit spot	2nd to 4th covers	Moderate and wet
Sooty blotch	2nd cover to harvest	Moderate and wet, optimum 65ºF
Fly speck	2nd cover to harvest	Moderate and wet
Late season		
Black rot	Pink to late season	Warm and wet periods, hail
Bitter rot	Mid- to late season	insect or mechanical fruit injury
White rot	Mid- to late season	

[1]Refer to spray schedule for apples, Table 3.5 for spray timings.

Bitter Pit is a type of corking that is distinct from other types. It consists of small cork-like clumps of tissue just beneath the surface of the fruit. These spots appear as dark areas and are concentrated at the calyx end of the fruit. One distinctive characteristic of this type of corking is that it does not appear until near harvest time or during fruit storage. As with other types of corking, bitter pit is more common on some varieties than on others. Grimes Golden is more susceptible than most varieties grown in Virginia. The maturity of the fruit at harvest affects the occurrence of bitter pit. Early harvested fruit is more susceptible than fruit picked at maturity. Calcium chloride sprays have generally reduced the severity of bitter pit from 50-90%. This treatment might be justified where severe bitter pit has been experienced. To reduce bitter pit, use one-half ounce of calcium chloride per 1.0 gallon of water. Make four applications at two-week intervals starting 10 weeks before picking time.

Apple Insects

Aphids – Three species of aphid frequently cause problems: (1) Rosy apple aphid – This pink-bodied aphid causes severe puckering and knotting of the fruit. Infestations may be noted by the curling and wrinkling of leaves near young apples, but, by this time, much of the fruit will be lost. At weekly intervals, beginning when the leaves are about 1/4 inch long, look for aphids in the foliage. (2) Woolly apple aphid – This aphid affects the root systems primarily, but may be found in cracks and wounds on the upper portions of the trees. They produce a white, waxy mass over their reddish-purple bodies. On the roots, they cause galls and an increased number of secondary roots, which stunt the tree and reduce production. Rootstocks in the MM series will reduce root damage from woolly apple aphids. (3) Green aphids – This mix of spirea aphids and apple aphids is most commonly seen on apple trees. When aphids infest more than an average of 4 leaves per shoot, treatment is justified, especially if less than 20% of the colonies harbor natural enemies. A variety of predators assist in controlling green aphids.

Codling Moth – Presence of this pest is usually recognized by a hole bored into the side or blossom end of the fruit. This larva may completely destroy the infested fruit. It is a pinkish-white worm approximately 1/2 inch long with a brown head. At maturity, the larva leaves the apple and falls to the ground or climbs to the tree to pupate under the bark or in debris on the soil surface where it overwinters. There are two or three generations in Virginia. Oriental fruit moth may cause similar injury in apples, especially late in the season.

Plum Curculio – Injury is in the form of small crescent-shaped cuts in the skin of small fruits. An egg is deposited in a small hole at one end of the incision. Depressions in the fruit usually develop at such sites. Examination reveals a grayish-white worm inside with a brown head capsule and no legs. Infested fruits fall prematurely and are usually hard, knotty, and misshapen. In some years, there may be two generations east of the Blue Ridge Mountains.

Apple Maggot – This black-and-white fly is a pest in orchards in the northeastern states; in Virginia the headless, legless larva is found mainly in backyard trees and abandoned orchards. Picking up dropped fruit promptly will aid in its control by preventing entry into the ground for pupation. Maggots cause winding brown paths through the fruit. Most adults emerge the following season. For a small number of backyard trees, commercially available apple maggot traps (red spheres or yellow panels) can help reduce infestation, with one trap hung per tree.

Mites – Two species are frequently injurious to apple foliage, the two-spotted spider mite and the European red mite. They produce a stippling of the leaves by puncturing the cells of the leaf and sucking out the juices. The two-spotted mite spins a silk webbing over the infested area, which explains the origin of the name "spider mites." The two-spotted mite may be green or orange in color, depending on host plant, time of year, and maturity of the mites. They have two large dark spots on the lateral margins of their abdomens. The European red mite is dark red with dorsal hairs on humps of the body and has tan colored legs. A hand lens is required for accurate observation of these parts. **Do not apply miticides on a preventative basis.** Many predators of mites are native to Virginia and can help control this pest if not killed by sprays. More information on these predators can be obtained on the Virginia Fruit website, http://www.virginiafruit.ento.vt.edu/.

Leafrollers – There are several species of leafroller moths that affect fruit in Virginia, notably redbanded leafroller, tufted apple bud moth and variegated leafroller. The first-generation redbanded leafroller adults emerge during April. Adult moths are approximately 3/8 inch long and reddish-brown with silver and gray markings. The larvae, which cause the fruit damage, are slender, yellowish green worms that reach a length of 5/8 inch when full-grown. Several generations are found per year in Virginia. The second and third generations cause the most damage. Tufted apple bud moth and variegated leafroller appear somewhat later, and have two generations per year. Injury to fruit is caused by the feeding of the caterpillars on the skin and upper layers of flesh.

San Jose Scale – The San Jose scale overwinters as an immature scale on the bark of twigs and limbs of a wide variety of fruit trees. The scales mature rapidly in the spring. Young, called "crawlers," are produced in large numbers. They have legs and spread to all parts of the tree, or settle down, insert their beaks into the bark, and begin to secrete a waxy scale covering. Scales feed on the sap of trees. They may kill a young tree within two to three years when a heavy infestation exists. When scales set-

Table 3.5 - Spray Schedule for Apples

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control	Remarks
Green tip At bud swell	Copper + superior oil	Mites, scales, and scab	Follow manufacturer's recommendations as to amounts. Apply when a half-inch of green shows at buds.
Delayed Dormant When leaves are 1/2-3/4 inch long	1.3 tbsp Immunox 1.55% EC or 1.5 tsp Mancozeb 4F + 2.0 oz permethrin 2.5% or esfenvalerate (use label rates)	Scab, powdery mildew, rust, mites, aphids, leafrollers	Scab infection may occur at this time. Important spray for mites and aphids.
Pre-pink First pink in floral buds	Same as delayed dormant buds, plus 2.5 fl oz M-Pede	Scab, powdery mildew, rust, aphids, mites, leafrollers	Important for rust and powdery mildew control.
Pink When flowers have separated just before bloom	Same as delayed dormant + streptomycin 15W[2] 1.0 tsp	Scab, powdery mildew, rust, apple rot, fire blight, aphids, mites, green fruitworms, leafrollers	Add streptomycin for fire blight control according to manufacturer's recommendations.
Bloom	1.3 tbsp Immunox 1.55% EC or 1.5 tsp Mancozeb 4F + 1.0 tsp streptomycin 15W[2] **Protect Bees - Do Not Use Insecticide**	Scab, rust, powdery mildew, apple rots, fire blight	Follow label recommendations for rate of streptomycin.[2]
Petal Fall When most of the petals have fallen **First Cover** 10 days after petal fall and **Second Cover** 14 days after first cover	1.3 tbsp Immunox 1.55% EC + 1.5 tbsp Captan 50W or + 1.5 tsp Mancozeb 4F + 2.5 oz M-Pede or 2.0 fl oz permethrin 2.5% or esfenvalerate (use label rates) or 0.25-0.5 lb Surround at Home	Scab, rust, powdery mildew, rots, fire blight, curculio, codling moth, aphids, mites, boron deficiency[3]	If fire blight is present, add streptomycin to this spray. Important sprays for codling moth control. Surround at Home effective for plum curculio, not codling moth. Apply 3 sprays at 7 day intervals beginning at petal fall. Permethrin and esfenvalerate are toxic to orchard predators. Do not apply Mancozeb closer than 77 days to harvest, and do not make more than seven applications per year.
Third Through Fifth Cover Sprays At 14 day intervals	1.5 tbsp Captan 50W plus same insecticides as petal fall or 2 fl oz Fruit Tree & Plant Guard	Sooty blotch, flyspeck, Brooks spot, rots	If mites become a problem, add 5.0 tbsp of M-Pede (2% solution) to the spray. If Japanese beetles become a problem, add 2.0 tbsp Sevin 50W. (Do not use Sevin until 30 days after bloom unless fruit thinning is desired.) Do not make more than four applications of Fruit Tree & Plant Guard per year, and do not apply it closer than 21 days to harvest.
Sixth And Seventh Cover Sprays 2 week intervals, may not be required for early maturing varieties	1.5 tbsp Captan 50W plus same insecticides as petal fall or 2 fl oz Fruit Tree & Plant Guard	Apple rots, sooty blotch, flyspeck, apple maggots (AM), codling moth, bitter pit[4]	Same as 3rd-5th covers. Generally speaking, apply protectant sprays up to 25-30 days before harvest. Sticky sphere traps are available that can control AM on a few backyard trees. Pick up all drop fruit to help control AM. Do not make more than four applications of Fruit Tree & Plant Guard per year, and do not apply it closer than 21 days to harvest.

[1] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 3.1).

[2] Streptomycin sulfate (15-21%) should be used at 60 PPM (approximately 1.0 tsp/gal).

[3] See Apple Disease section for discussion of boron deficiency and its control.

[4] See Apple Disease section for discussion of bitter pit and its control.

Table 3.6 - Spray Schedule for Pears

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control	Remarks
Dormant to green tip	Superior oil + copper	Mites, scales, psylla, fire blight	Follow manufacturer's recommendations as to amounts. Apply when a quarter-inch of green shows at buds.
Green cluster bud	Superior oil + 1.5 tsp Mancozeb 4F or esfenvalerate (use label rates)	Psylla	Scab infection may occur at this time. Important spray for mites and aphids.
Pre-pink First pink in floral	1.5 tsp Mancozeb 4F or Sulfur 90W 2.0-4.0 tbsp + 2.0 fl oz permethrin 2.5% or esfenvalerate (use label rates)	Scab, powdery mildew, psylla, aphids, mites, leafrollers	
Pink When flowers have separated just before bloom	Same as Pre-pink + streptomycin 1.0 tsp	Scab, powdery mildew, fire blight, aphids, mites, green fruitworms, leafrollers	Add streptomycin for fire blight control according to manufacturer's recommendations.
Bloom	1.5 tsp Mancozeb 4F or Sulfur 90W 2.0-4.0 tbsp + 1.0 tsp streptomycin 15W[2] **Protect Bees - Do Not Use Insecticide**	Scab, powdery mildew, apple rots, fire blight	Also follow label recommendations for rate of streptomycin. [2]
Petal Fall When most of the petals have fallen **First Cover** 10 days after petal fall and **Second Cover** 14 days after first cover	1.5 tsp Mancozeb 4F or Sulfur 90W 2.0-4.0 tbsp + 2.0 fl oz permethrin 2.5% or esfenvalerate (use label rates) or 0.25-0.5 lb Surround at Home	Scab, powdery mildew, rots, fire blight, curculio, codling moth, aphids, mites, boron deficiency	If fire blight is present, add streptomycin to this spray. Important sprays for codling moth control. Surround at Home effective for plum curculio, not codling moth. Permethrin and esfenvalerate are toxic to orchard predators. Do not apply Mancozeb closer than 77 days to harvest, and do not make more than seven applications per year.
Third Through Fifth Cover Sprays At 14-day intervals	Sulfur 90W 2.0-4.0 tbsp plus same insecticides as petal fall or 2 fl oz Fruit Tree & Plant Guard	Sooty blotch, flyspeck, leaf spot, rots	If mites become a problem, add 5.0 tbsp of M-Pede (2% solution) to the spray. If Japanese beetles become a problem, add 2.0 tbsp Sevin 50W. (Do not use Sevin until 30 days after bloom). Do not make more than four applications of Fruit Tree & Plant Guard per year, and do not apply it closer than 21 days to harvest.
Sixth and Seventh Cover Sprays 2-week intervals, may not be required for early maturing varieties	Sulfur 90W 2.0-4.0 tbsp plus same insecticides as petal fall or 2 fl oz Fruit Tree & Plant Guard	Fruit rots[3], leaf spot, sooty blotch, flyspeck, apple maggots (AM), codling moth	Same as 3rd-5th covers. Generally speaking, apply protectant sprays up to 25-30 days before harvest. Sticky sphere traps are available that can control AM on a few backyard trees. Pick up all drop fruit to help control AM. Do not make more than four applications of Fruit Tree & Plant Guard per year, and do not apply it closer than 21 days to harvest.

[1] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 3.1).

[2] Streptomycin sulfate (15-21%) should be used at 60 PPM (approximately 1.0 tsp/gal).

[3] Fruit Tree & Plant Guard is more effective than Sulfur for rot control.

tle on the fruit, reddish rings occur around the insect on the fruit skin. There are two generations during the growing season, one occurring in late May or early June and the other in August. A third generation occurs after harvest.

Gypsy Moth – As the gypsy moth moves southward through Virginia, it will be seen on apple trees in outbreak years. It is susceptible to many spray materials, including Dipel. Time sprays to the end of the wave of immigration of first stage larvae. This is around petal-fall.

Peach, Nectarine, Cherry, Plum

Specific Disease and Insect Biology

Peach Leaf Curl, a fungus disease, is found throughout the world where peaches are grown. The disease is destructive and causes economic losses under Virginia growing conditions. Peach leaf curl is carried overwinter by tiny fungus spores lodged on the surfaces of twigs and buds of the peach or nectarine trees. With the coming of spring and the swelling of the buds, if conditions of moisture and temperature are suitable, the spores germinate, and those that come into contact with the young developing leaves cause an infection. The infected leaves are thickened, and, as they develop, the leaf becomes folded with edges curling inward, so that the undersurface of the leaf is a series of concaved chambers. Very shortly after leaf symptoms appear, it turns red to purple and becomes extremely obvious. The bright color soon fades into a yellowish brown to brown, and the leaf withers and falls off. One thorough application of lime sulfur, copper (Bordeaux), or Fung-onil during November or early spring before bud break will control this disease. If mid-season defoliation due to bacterial spot is a problem, use a copper product at leaf drop in the fall and/or in early spring before bud break for control of leaf curl and suppression of bacterial spot. However, if coppers are used in successive sprays at full rates during the growing season, they can cause shothole injury to peach and nectarine leaves.

Peach Scab, a fungus disease, is widespread in peach and nectarine growing areas of Virginia. The main loss from the disease is from the unsightly blotches on the fruit. The disease first appears on the fruit as small, poorly defined, olivaceous spots less than 1/16 inch in diameter, usually on the upper exposed surface of the fruit. The spots may be numerous on the upper surface of the fruit, more on the sides, and nearly absent on the protected lower surface. The spots may merge to form a uniform, dark-olivaceous, velvety blotch over the surface of the scabbed area. Since the cork area cannot expand with growth of the fruit, fissures or cracks appear in the fruit, providing avenues for brown rot infection.

Brown Rot, caused by a fungus, is the most destructive disease of cherry, nectarine, peach, and plum. The brown rot fungus may overwinter on old, decayed fruit, also called mummies, on the ground, mummies on the tree, and in twig cankers. The brown rot fungus becomes active about the time pink begins to show in the buds, provided there is sufficient rainfall. The brown rot fungus spores attack the blossoms, twigs, and fruit. Blossom blight and early twig infections establish centers of infection which may supply inoculum for fruit infection during periods of rainfall throughout the growing season. Therefore, it is important to control these early infections. Brown rot on the fruit becomes more evident as the fruit approaches maturity. The first evidence of the rot is the appearance of a small, circular, brown spot that enlarges very rapidly as the fruit approaches maturity. The rotted fruit soon becomes covered with ash colored tufts of conida. These masses of spores supply inoculum to infect other fruit. The greatest loss from brown rot occurs from fruit rot in the orchard, in transit, and in the market place. The fungus decays or rots a mature fruit very rapidly. Remove mummified fruit during the dormant season and use chemical sprays as suggested in the spray schedule for brown rot control.

Black Knot is the most conspicuous disease of plum, prune, and cherry trees. Most commercial and home-fruit growers, at one time or another, have observed the black, warty growth on twigs and branches of plum and cherry trees. Trees infected with black knot become almost worthless after a few years if no control practices are used. Twigs and branches may be girdled by the infection, and, with a large number of infections per tree, the trees go into a general decline. Black knot is caused by a fungus. It attacks many species of wild and cultivated plums and cherries including American, European, and Japanese varieties of plums and prunes and both sour and sweet cherries. The disease is destructive and widespread in Virginia. *Symptoms* – Infection occurs primarily on wood of the current season's growth. The infections are caused by small (microscopic) spores that attack the tree from bloom through late May to early June, depending on the climatic conditions. The first evidence of the disease is swelling of the infected twigs or branches during the late summer or fall of the year of infection. Ordinarily, the infected area swells rapidly and the bark is ruptured the following spring. The infection continues to develop throughout the second growing season and the life cycle is usually completed during the second spring after infection with the production of small spores (seed), called ascospores, which may start new infection centers. The elongated black swelling may be from less than an inch to more than a foot in length. The malformation may encircle the entire branch, but is usually one-sided. The cankered areas are greenish when they are first formed, but become black with age. Branches not killed by the disease may be killed by insects that enter the infected area. Infrequently, twigs or branches are deformed and turn right angles at the point of infection. *Control* – Sanitation is extremely important in controlling black knot. All the knots on small twigs and branches must be pruned out during the dormant season and burned. The cuts should be made four inches below the knots. Knots on one side of large limbs that need to be saved can be removed by cutting out the swellings. When knots are removed from a limb, the wound area should be painted with a good asphalt or oil-base paint. Close observation should be made annually during the pruning season to detect and remove any new black knot infections. Pruning alone, however, is not adequate control of the disease. The use of a fungicide spray program (see section on recommended chemical control) along with the sanitation program will usually give good control of black knot.

Cherry Leaf Spot is a fungal disease that affects both sweet and tart cherries. The earliest symptom is a purple lesion and several lesions per leaf can cause the leaf to yellow and fall. Typically, defoliation is first noticed in the top of the tree. By midsummer all leaves are susceptible and, in a wet year, severe defoliation makes trees more prone to winter injury and death. Control is with suggested fungicides applied throughout the susceptible periods with the objective of holding the leaves on the tree until September.

Peach Insects

Scales – Four different scale insects may be found on this fruit: white peach scale, San Jose scale, terrapin scale, and European fruit lecanium. These are small insects that usually go unnoticed until they reach numbers sufficiently high that they begin to injure the tree and fruit. Terrapin scale and European fruit lecanium are usually small and shiny brown in color, whereas the San Jose scale is almost the same color as the tree bark and gives the tree a roughened appearance when the population is high. The white peach scale is easily recognized because the white females give a branch a white-washed appearance when they are abundant. All these scales have more than one generation a year on peach, reproduce rapidly, and can kill branches and even trees if uncontrolled. Terrapin and lecanium scales secrete honeydew that mars the fruit. These insects suck plant juices and gradually hinder tree development. The easiest times to control them are in the crawler stages (just after hatching from the egg). Where populations are found, make checks and spray for live scales throughout the growing season.

Shothole Borer – This small beetle is a serious pest of the young buds. They grow and reproduce in dead or dying wood in the trees. They are highly productive and have overlapping generations. They feed on the buds as well as the trunks and branches. Their common name was derived from the numerous little holes they make in the branches where emerge — resembling a branch shot by a shotgun. If the bark is removed, the wood beneath has numerous galleries and pockets with small white C-shaped larvae. Any dead or dying branch of trees should be removed as soon as possible and destroyed. Sap oozing from numerous buds and small holes in the branches is a good indication of infestation. The pest is a small black beetle about 1/16 inch long and round in shape.

Peachtree Borer – Partly grown to full grown grubs pass the winter beneath the bark of peach, cherry, plum, prune, nectarine, or apricot trees. The caterpillars are yellowish- white with brown heads, and are about 1 1/4 inch long when mature. The adult moths emerge from May to September. The adult female lays eggs on or near the tree trunk. The eggs hatch and the small grubs enter the trunk. The grubs, or “borers,” feed in the tree trunk at or below ground level and will girdle and kill small trees in a single season if several borers are feeding. Borer injury is evident by masses of gum and sawdust-like “frass” occurring at the base of the tree. There is one generation per year.

Lesser Peachtree Borer – The lesser peachtree borer attacks many of the same trees as the peachtree borer. Again, this borer overwinters in various stages of development from young to full-grown larvae. After completing development in the spring, the adults can be found from April to October. The female moths may deposit eggs at any location on the tree but prefer injured areas. The larvae, or “borers,” resemble those of the peachtree borer except that they are slightly smaller. The borers usually feed in the larger limbs and trunks of the trees. Injuries exude gum that contains sawdust-like particles. Limbs and trees are frequently killed by the feeding. There are two generations per year. Both peach tree borer and lesser peachtree borer may be monitored with pheromone traps. If a spray is needed, apply it two weeks after the first moth capture. Adults have slender, black bodies with white markings, and clear wings.

Oriental Fruit Moth – The larvae may severely damage new shoot growth or the fruit as they bore down the young shoots and into the fruit through the stems. They feed throughout the fruit and even into the seed. Some fruit may show no signs of damage until after picking. Trees should be examined for new or young terminals that die suddenly to determine if larvae tunneling in the shoots are the cause. There are several generations a year; the latter generations often bore into the sides of the fruit much like the codling moth in apples.

Plum Curculio – Injury is in the form of small crescent-shaped cuts in the skin of small fruits. An egg is deposited in a small hole at one end of the incision. Depressions in the fruit usually develop at such sites. Examination reveals a grayish-white worm inside with a brown head capsule and no legs. Infested fruits fall prematurely and are usually hard, knotty, and misshapen. In some years, there may be two generations east of the Blue Ridge Mountains.

Mites – See section under apples.

Brown Marmorated Stink Bug – Although there are several native stink bug species that can injure peaches and nectarines, in recent years most of this damage has been due to feeding by the invasive brown marmorated stink bug. Peaches appear to be an excellent host for brown marmorated stink bug and fruit injury from bug feeding may be found from the early stages of develop-

Table 3.7 - Spray Schedule for Cherries[1], Nectarines, Peaches, Plums[1], and Prunes[1]

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[2]	To Control	Remarks
Dormant Before buds begin to swell	Copper (see label for rate) + Superior oil Fung-onil 0.9 tsp	Peach leaf curl Scale, mites	Apply to nectarine and peaches only. All buds must be thoroughly covered. Follow manufacturer's recommendations. Remove and destroy all mummified fruit still hanging on the tree and on the ground. This will reduce inoculum that causes blight and the later fruit brown rot. Do not apply Fung-onil within one week before or after an application of oil.
Pink Spray Early pink to full pink	1.5 tbsp Captan 50W or Fung-onil 0.9 tsp + 1.0 tbsp Carbaryl 80S (Sevin)	Green aphids, tarnished plant bug, blossom blight, black knot	Plums and cherries are not pink, but apply spray at same stage of bud development. See comment on aphid under petal fall spray.
Blossom Sprays Apply just before first blossoms open, and when in full blossom	1.5 tbsp Captan 50W or Fung-onil 0.9 tsp **Protect Bees - Do Not Use Insecticide**	Brown rot, blossom blight, peach scab, powdery mildew, cherry leaf spot, black knot	This is an important spray, particularly late full bloom, as the deteriorating petals are susceptible to the brown rot fungus. Do not apply Fung-onil after shuck slit stage.
Petal Fall Through Fifth Cover Apply when all petals have fallen, then at 14 day intervals for 5 spray applications	1.5 tbsp Captan 50W + 1.0 tsp malathion 57EC + esfenvalerate, 1st-5th cover; use label rates or 2 fl oz Fruit Tree & Plant Guard 1.0 tbsp Carbaryl 80S	Mites, aphids, plum curculio, oriental fruit moth, Japanese beetle, brown rot, peach scab, cherry leaf spot. Cherries are vulnerable to spotted wing drosophila as they color and ripen. Spray for SWD weekly during this period, rotating insecticide groups.	Esfenvalerate is toxic to orchard predators. If mites build up, a 2.0% solution of JMS Stylet Oil may be applied at 10- to 14-day intervals against mite eggs, as long as mites persist, but do not use Captan in combination with JMS Stylet Oil or any type of oil. Malathion is not registered for aphids or oriental fruit moths on nectarines, but if used for other insects, aphid and oriental fruit moths will not be a problem. Do not make more than five applications of Fruit Tree & Plant Guard per year, and do not apply it closer than 14 days to harvest.
Pre-Harvest Apply 3 weeks and 1 week before harvest on all varieties	1.5 tbsp Captan 50W or 1.0 tbsp Immunox 1.55% **No Insecticide** (See Remarks)	Brown rot on fruit, spotted wing drosophila	If Japanese beetles are a problem, 2.0 tbsp of Sevin 50W can be added to the spray up to 1 day before harvest. Spotted-wing drosophila will often be a problem on cherry at this time. Rotate permethrin or other pyrethroid with Sevin, observing Pre-Harvest Intervals. See comments on this insect on pp. 3-19, 3-20, 3-21 and 3-23.
After-Harvest 2 weeks after harvest	1.5 tbsp Captan 50W	Cherry leaf spot	Cherries only.
Peachtree Borer Sprays These two sprays should be applied about July 15 and August 15-25 to all species and varieties	esfenvalerate, various formulations; use label rates	Peachtree borer, lesser peachtree borer	Apply esfenvalerate to trunks and large limbs only. Use according to label.

[1] Most fungicides are not specifically registered for black knot control on plums, prunes, or cherries in home fruit planting; however, where a good spray program for brown rot control is followed, black knot usually will not be a problem. To achieve effective control with fungicides, all knots should be removed and destroyed during the dormant period or when they first appear.

[2] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 3.1)

ment through harvest. External injury appears as thin streams of whitish, jelly-like ooze from feeding sites, known as gummosis, and sunken, discolored and distorted areas on the surface. Internal feeding injury appears as whitish areas of corky, dead tissue that may or may not be associated with apparent external injury. There are two generations of brown marmorated stink bug in Virginia and bugs are present from about May through mid-October.

Grape Diseases

Black Rot – This is a widespread disease of grapes, and if it is not managed properly, it can cause greater loss to growers in Virginia than all other diseases combined. This disease is caused by a fungus that attacks the leaves, shoots, tendrils, canes, blossoms, and fruit. Only the youngest tissues are susceptible, and the fruits are susceptible from bloom to 4-5 weeks after bloom. The foliage infections appear in the spring as tiny, more or less circular spots. They are reddish-brown and are usually encircled by a dark brown ring. Through the coalescence of many spots, large areas of the leaf may become affected. Although spotting occurs on the foliage in the spring, the disease does not attract much attention until mid-summer when the nearly half- grown grapes begin to rot. The disease on the fruit appears as light-brownish, soft, circular spots, which enlarge rapidly, and after a few days the entire berry is discolored. The decaying berries soon begin to shrivel, and within a week they are transformed into black, hard, shriveled mummies, which may remain attached to the bunch for several weeks. The attached mummied fruit is covered with small fruiting bodies of the black rot fungus that exude infective spores during moist wet weather to start new infections on susceptible parts of the vines. These mummified fruit can serve as a source of inoculum for the next year, thus the removal of infected berries is highly recommended.

Botrytis Bunch Rot – This is a fungus disease of berries. It is often a late season disease; however, early season infection of flowers is known to be critical for the disease development. It is a common disease for tightly clustered white varieties, such as Chardonnay, but other varieties can be affected. Proper canopy management to open up the fruiting zone is a very effective means of control. You can remove 1-2 basal leaves from shoots or remove unnecessary lateral shoots to open up the canopy. Wounding events can increase the risk of Botrytis; therefore, insect management (especially, grape berry moth) and bird management (use of netting, visual, sound, etc.) can be a very effective tool. In addition, early season powdery mildew management is important for this disease because skin tissue damaged by powdery mildew can split open later in the season to create wounds.

Downy Mildew – This is a fungus disease, primarily of the grape foliage, but it can infect berries. If the disease occurs early in the season, however, the young bunches of berries may be entirely killed. The causal fungus is widespread in nature. The first evidence of the disease on the leaves often appears as light-yellow spots on the upper surfaces of the infected leaves. Later, a white moldy growth of the fungus mycelial threads and spores forms on the under surfaces of the leaves. Leaves of susceptible varieties can be defoliated in a few weeks and the clusters of fruit may be scalded by the sun. Also, vines defoliated before the ripening season cannot mature the fruit normally and the fruit is of inferior quality. As with black rot, a period between bloom to 4-5 weeks after bloom is the critical time for berry infection.

Powdery Mildew – This disease is caused by a fungus that is present in many vineyards. Because of extensive planting of French-American hybrids and *vinifera* type grapes, the disease has become one of the most economically significant diseases in Virginia. The fungus primarily attacks the foliage, cluster stems, and the berries. Powdery mildew infection appears as a superficial, grayish-white growth on the infected parts of the vine. Severely infected leaves turn brown and necrotic. If the berries are infected, the surfaces appear covered with a gray 'powdery' material. They fail to mature properly, and cracking of the fruit may allow entry of rot organisms. Mildew infection of the cluster stem may cause shelling if the fruit is not harvested immediately. As with black rot and downy mildew, a period between bloom to 4-5 weeks after bloom is the critical time for fruit infection.

Anthracnose, **or Bird's-eye Rot** – This disease is sporadic in nature and its occurrence is usually localized. Some of French-American hybrid cultivars (e.g., Vidal blanc, Marquette, etc.), and table grapes (e.g., Marquis , Mars, etc.) known to be more susceptible. The fungus overwinters in the infected canes and gives rise to infective spores during the spring. The fruit, young shoots, tendrils, petioles, leaf veins, and fruit stems may be attacked severely. Numerous spots will unite and cause girdling. Similar spots develop on the petioles and leaves. Badly infected leaves curl downward from the margins, becoming distorted and spotted and the diseased areas drop out so that the leaf appears ragged. On the fruit, the spots are circular, sunken, and ashy gray. In the late stages of the disease, the spots are surrounded by a dark margin. The name of bird's-eye rot, sometimes applied to this disease, is derived from the appearance of the spots on the berries.

Phomopsis Cane and Leaf Spot – This is a fungus disease of the leaves, trunks, and main branches of grape vines**.** The fungus can attack young leaves, shoots, fruit stems, and occasionally berries. The fungus overwinters in the infected cane or trunk tissues and produces spores April-June to cause new infections. The most easily recognized symptom is tiny yellow specs on infected leaves. When you recognize the leaf symptom, examine shoots for other symptoms. The disease occurs on new cane growth as small purple to black sunken lesions on the first 3-4 internodes. As the disease progresses, the vine either fails to put out shoots or the shoots die back after a few weeks, which is often referred as "dead-arm". These lesions may also occur on the leaf petioles or fruiting stems, which could cause premature fruit drops. The lesion on canes and trunks can exist for two to three years and cause more diseases. Apply sprays as suggested in the spray schedule for control of all grape diseases.

Table 3.8 - Spray Schedule for Grapes

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control[2]	Remarks
Dormant Before buds swell	8.0 tbsp copper sulfate + 8.0 tbsp hydrated lime (Bordeaux Mixture)	Anthracnose, Phomopsis	This spray is necessary only in vineyards where Anthracnose or Phomopsis has been a problem.
Bud Swell Spray	1.0 tbsp Sevin 80S	Grape flea beetle	Apply only if adult beetles are present in damaging numbers.
New Shoot Sprays When new shoots are 1- to 2-inches long, also when new shoots are 6- to 8-inches long.	1.0-1.5 tsp Captan + 1.0-3.0 tbs Sulfur	Black rot, downy mildew, Anthracnose, powdery mildew, Phomopsis	Rake up and destroy all mildew, dead arm, grape leaves, canes, dead twigs, and branches early in the spring to reduce disease and insect incidence. If a concern on Phomopsis is high, make sure to have a spray when shoots are 1 to 2 inches long.
Pre-bloom Spray Just before blossoms open	3.0-4.0 tsp Mancozeb flowable + 1.0 tbsp Sevin 80S + 1.25 fl oz Immunox + 1.0-3.0 tbs Sulfur	Same as new shoot spray plus berry moth, leafhopper	Important black rot spray, thorough coverage necessary for control. If there are many rain events, consider adding a Phosphorous acid (e.g., Agri-Fos) to the spray. Pre-bloom to pea size sprays are critical sprays to prevent developments of multiple grape diseases.
Post-Bloom Spray Immediately after bloom	3.0-4.0 tsp Mancozeb flowable + 1.0 tbsp Sevin 80S + 1.25 fl oz Immunox + 1.0-3.0 tbs Sulfur	Same as pre-bloom	Same as pre-bloom. If powdery mildew or black rot are problems, include Immunox. If there are many rain events, consider adding a Phosphorous acid (e.g., Agri-Fos) to the spray. You may substitute sulfur with an oil product to control powdery mildew. Make sure not to mix oil with sulfur or captan as the combination can cause damage to grapevines.
Pea Size Spray When berries are about pea size, but before they touch in clusters (7-10 days after postbloom spray)	3.0-4.0 tsp Mancozeb flowable + 1.0 tbsp Sevin 80S + 1.25 fl oz Immunox	Same as post-bloom	If Japanese beetles have appeared, use 2.0 tbsp Sevin 50W. Do not apply Mancozeb within 66 days of harvest.
Berries Touch In Cluster 10-14 days after pea size spray, and at 2 week intervals until harvest.	2.0 tbsp Captan 50W + 1.0 tbsp Sevin 80S or 0.5-2.0 fl oz Copper octanoate + 1.0 tbs Sevin 80S	Same as pea size spray plus Japanese beetle	Continue good coverage. Do not apply Immunox more than 5 times per season or within 2 weeks of harvest. Do not use Sevin XLR in combination with Captan.
Later Cover Sprays Apply at 2-week intervals until harvest	Same as berries-touch-in-cluster spray PLUS: label rate of malathion or spinosad, or pyrethrin, or zeta-cypermethrin.	Same as berries-touch-in-cluster spray plus ripe rots, spotted lanternfly	If you are concerned about Botrytis and downy mildew, keep either captan or copper spray at 2-week interval. Red varieties are vulnerable to SWD as they color and ripen. If SWD is an issue, spray weekly during this period, rotating among insecticides. Spotted lanternfly (SLF) may fly into vineyards around this time of the season. Both Sevin and spinosad are known to be effective against SLF. Do not overuse insecticides, but be prepared for re-invasion in late season.

Table 3.8 - Spray Schedule for Grapes (cont.)

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control[2]	Remarks
Grape Root Borer		In early July, mound soil 8-12 inches high around base of trunk, extending 2-3 feet from trunk crown. Pull mound down in fall or spring. Only necessary where grape root borer has been a problem. Control weeds in vine row.	Weed control near vine will cause larval mortality before caterpillars reach roots.

[1] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 3.1).

[2] Captan does not control powdery mildew or black rot. If black rot is a serious problem, substitute captan with mancozeb. If powdery mildew is a serious problem, use a sulfur fungicide. If both powdery mildew and black rot are problem, consider using Immunox. Both captan and sulfur cannot be used within two weeks of an application of oil (e.g., Neem oil, and some insecticide such as Sevin XLR which contains oil). Imidan 12.5W 3.0 tbsp may be substituted for methoxychlor in the grape schedule.

Grape Insects

Grape Berry Moth – Presence of this pest is shown by berries with broad reddish spots, webbed clusters, shriveled fruit, or foliage with semicircular holes cut in foliage. Caterpillars will be found in berries, usually dark gray or gray-green. Each larva may attack several berries during its feeding period of 3-4 weeks. Clusters may also be sticky from juice from injured fruit. There are 3-4 generations per year. Removing fallen leaves in the autumn may reduce infestations.

Grape Root Borer – Adults of this species strongly resemble paper wasps flying through the vineyard. Eggs are laid on trunks and weeds, and after first stage larvae penetrate the soil they feed on grape roots for almost two years. If declining vines are seen, probe around roots within a foot of the trunk with a hand trowel. Large caterpillars may be found in or on hollowed roots. Soil may be mounded around trunks to a depth of 8-10 inches around July 1 to prevent emerging adults from reaching the surface. Pull the mounds down in the spring.

Rose Chafer – Adults emerge in late May or early June, near grape blossoming time, and are tan, long-legged beetles related to the Japanese beetle. For about two weeks, they may feed on blossoms or newly set fruit. Rose chafer is more prevalent in areas with light sandy soil.

Japanese Beetle – This is generally one of the most common insects feeding on Virginia's grapevines. On grapes, beetles feed mainly on leaves, rarely gouging fruit. Peak adult activity is in July, but begins in late June and may extend into September. Populations are generally lower in seasons following drought years. Leaf damage occurring in the first part of the Japanese beetle activity period has less effect on fruit quality. Young vines are especially vulnerable.

Grape Phylloxera - Both foliar and root forms occur, but the root form is rare in eastern states. The less damaging foliar form is commonly seen in the form of galls on the lower leaf surfaces.

Grape Tomato Gall - This is one of several types of galls formed on grape leaves, tendrils, and buds by small gall midges. Complete control by sprays is difficult. Removing galls by hand may reduce future populations.

Grape Flea Beetle - Adult beetles appear on the vines at about the time of bud swell. Beetles feed on buds; they make a large hole in the side and gouge out the bud interior. Larvae are seen during the summer, brown grubs making chain-like feeding marks on leaves. This larval feeding is insignificant.

Spotted-Wing Drosophila - This invasive fly established in our area in 2011. Unlike native drosophilid fruit flies, which lay eggs in rotting fruit material, SWD prefers to lay eggs in ripening fruit on the plant. Berry crops including grape are at risk. Spray weekly in red grapes during the final ripening period, alternating chemical mode of action if possible. Prompt harvest of ripe fruit will minimize impact of spotted wing drosophila. For more information, visit www.virginiafruit.ento.vt.edu/SWD.html.

Spotted Lanternfly - SLF is a new invasive pest in the state. While this insect feeds on more than 70 different host plants, grape is the most vulnerable. Please read the SLF section on page 3-5.

Strawberry Insects

Cyclamen Mite – These tiny, whitish mites may be found in crevices of leaves, along stems, and among the hairs of plants, but they are not visible to the naked eye. The young mites are concentrated near the centers or crowns of the plants where they feed on the young tender expanding leaves. Their feeding causes severe distortion and stunting, often accompanied by a bronze discoloration. They reproduce rapidly and often reach populations dense enough for the feeding to reduce yields severely. Insecticides such as malathion remove natural predators and allow the mites to reproduce unchecked. A hot water treatment of plants as they are planted will give control.

Spider Mites – Two-spotted spider mite is the main species on strawberries. Hot, dry weather is favorable to their development. The time from egg hatch to adult may be five days at 75˚F. Ten generations per season have been recorded in the Blacksburg area. Predatory mites may give control, but they are sensitive to certain pesticides (e.g. Sevin).

Table 3.9 - Spray Schedule for Strawberries

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control	Remarks
When Blossom Buds Are Visible In The Crown	2.0 tbsp Captan 50W + 2.0 tsp malathion 57EC + 1.0 tbsp Sevin 80S	Weevil, spittlebug, spider mites, leaf aphids, fruit rots, and leaf spots Strawberry rootworm	Good thinning and mulching of plants during late February to early March is important for fruit rot control. Spray Sevin for rootworms if adults are seen feeding on leaves in the spring in high numbers (10/sq ft).
Pre-bloom When flowers have pushed	Same as above. 1.25 fl oz Immunox	Same as above, cyclamen mite; powdery mildew	Include Immunox for improved powdery mildew and leaf spot control.
Bloom When most blossoms are full open	1.25 fl oz Immunox 2.0 tbsp Captan 50W **No Insecticide**	Fruit rots, leaf spots, powdery mildew	Be sure of complete coverage for future fruit rot control. Then include Immunox for improved powdery mildew and leaf spot control. Immunox may be applied up to day of harvest. Do not apply more than six times per season. Do not plant a new crop in the same place as the crop that was treated within 30 days of the last application of Immunox.
Post-bloom Apply 10 days after bloom and continue at 7- to 10-day intervals until harvest	2.5 tsp Captan 50W[2] + 2.0 tsp malathion 57EC 1.25 fl oz Immunox	Fruit rots, leaf spots, aphids, root weevils, spotted wing drosophila	Spraying for strawberry pests must be thorough to get good coverage. Use 40-50 pounds of pressure in the tank and hold nozzle close enough to force spray between foliage. If spotted wing drosophila is an issue, do not extend intervals between sprays longer than 7 days.

[1] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 3.1).

[2] Captan 50W 2.5 tsp/gal can be used during harvest for fruit rot control.

Note: AGRI-FOS is registered for control of red stele and leather rot of strawberries caused by ***Phytophthora*** sp. As a pre-planting dip, dip planting material in 1/3 fl oz of AGRI-FOS/gal of water for 30 minutes, then plant within one day. After planting as a foliar spray to perennial crops, make the first application 14 to 21 days post planting, and repeat at 1- to 2-month intervals when disease is evident.

For leather rot control, use 2 to 3 tsp of AGRI-FOS/gal of water and apply at 10% bloom and early fruit set, then at 1- to 2-week intervals as required for disease control.

Aphids – Two species may cause problems on strawberries: strawberry aphid and strawberry root aphid. The former is a small, pale, yellow aphid widely distributed in the U.S. Wingless females overwinter around the bases of the plants. In the spring, winged forms develop and disperse to other plants. These give rise to several overlapping summer generations, all of which are females, which give birth to living young. Nymphs feed on the foliage (not the roots), mainly on the undersides of the leaves. As they feed on plant sap, honeydew is excreted, which may support a fungus growth on the leaves. Nymphs mature in about ten days, depending on temperatures, and adults may live 2-3 weeks while producing 20 to 25 nymphs. One of the main causes for damage is the transmission of viruses to the strawberry, notably "yellows." Certified plant stock and pulling out diseased plants may be useful in virus control. An insecticide may be applied when aphids first appear in late May and two weeks later.

Spittlebugs – Adults resemble robust leafhoppers, but this group of pests is better known from the mass of "spittle" produced by nymphs. There are several species involved, but the meadow spittlebug is common and ranges from light brown to almost black. Eggs overwinter after being laid in rows of 1-30 between sheaths and stumps near the soil surface. These hatch in April. Nymphs are initially yellow but turn green as they grow. The nymphs feed on plant sap, and excretion products are mixed with air from a specialized "air canal." This creates the spittle, a white frothy mass, which protects the nymphs from desiccation and possibly predation. The adult stage is reached in 30-45 days, depending on temperature and other factors. After mating, females oviposit in late August or early September. There is only one generation per year. Spittlebugs are general feeders but may be particularly damaging to strawberry. Plant growth and yield may be reduced. They are also a source of annoyance to pickers.

Spotted-Wing drosophila - This invasive fly established in our area in 2011. Unlike native drosophilid fruit flies, which lay eggs in rotting fruit material, SWD prefers to lay eggs in ripening fruit on the plant. Berry crops including strawberry are at risk, especially when strawberries are grown as a summer or fall crop. For more information, visit www.virginiafruit.ento.vt.edu/SWD.html.

Strawberry Root Aphid – This insect is a blue-green species found in the eastern U.S. The winter is spent as shiny black eggs on stems and foliage. In early spring, females hatch and begin feeding on new leaves. Ants carry some to the strawberry roots where several generations of wingless females occur. Winged females are produced in October; they then return to the foliage. These give birth to males and females that mate, producing overwintering eggs. In mild winters, wingless females may persist. Fruit on infested plants dries up and falls. An infestation may not be detected until the plants are already low in vigor and have pale foliage. Another sign is the presence of many ants in the beds. When setting a new bed, use uninfested plants, and give the ground thorough cultivation in early spring to reduce ant populations. Injury may be reduced if aphids are controlled early enough.

Strawberry Rootworm – This is a shiny oval beetle with four dark blotches on the wings, about 3 mm long. Larvae feed on roots, but the most damage results from adult foliar feeding, especially in late summer. It is impractical to control larval populations. Adults may be controlled before egg laying begins when the weather warms in the spring.

Strawberry Root Weevil – Adult root weevils are light brown to black, ranging from a quarter to a half inch in length. The wing covers are marked by rows of punctures. Adults feed on strawberry leaves, but the main injury is caused by larval root feeding. Larvae are cream-colored, legless grubs with a brown head capsule. Adults may be controlled when actively feeding. Avoid planting strawberries after sod. If plowing of old beds can be delayed until fall, the old planting can serve as a trap crop.

Strawberry Weevil – This is a small (about 3 mm) brown weevil with a black patch on each elytron (wing cover). It feeds on wild and cultivated strawberries, brambles, and several other plants. Adults overwinter in debris and emerge in early spring. When strawberry blossom buds are formed, a single egg is deposited in a feeding puncture there. Then, below this site, the weevil cuts partly through the plant and the bud wilts, hangs, or drops to the ground. White, legless, curved grubs develop in these buds. The larvae pupate and emerge as adults in mid-summer. After feeding for a short time, the adults enter hibernation. There is only one generation per year. This insect is also referred to as the strawberry clipper.

Blueberry Diseases and Insects

The diseases listed below are representative of a much larger group of problems that affect highbush and rabbiteye blueberry cultivars. While these are the most common problems, local conditions may occasionally result in severe damage from less common pathogens. The key to control and management of blueberry diseases is prevention. Start with the best plants or cuttings available. Insist upon virus-free certification. Follow plant selection with proper site selection and preparation. Finally, use recommended cultural practices and carefully monitor your planting for abnormal growth or appearance of plants.

Mummy-Berry Disease – The fungus causing this disease overwinters in dropped, infected fruit. In early spring, small cups grow from the dropped fruit and discharge spores to infect new leaves and, ultimately, flowers and fruit. Direct crop losses and reduced plant size and vigor result. White or pale-red berries among normal blue fruit are often the first sign of this important disease.

Table 3.10 - Spray Schedule for Blueberries[2]

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control	Remarks
Dormant	None	Insect stem gall, scale insects, twig blight	Prune out insect- or disease-infested canes or parts of canes and destroy prunings by burning or burying in a land-fill.
Delayed Dormant	3.0 fl oz superior oil	Scale insects	This spray is not necessary if no scale insects are present.
From Time Of Bud Break Until Blossoms Open	See Remarks	Mummy berry cups on soil	Use clean culture between rows and around the plants. Rake or hoe around plants to bury (2 inches) fungus cups that form on the mummified berries.
Leaf Bud Break Through Petal Fall (7-10 day intervals)	2.0 tbsp Captan 50W	Phomopsis twig blight, Mummy berry twig/ flower infection	Twig blight affects top several inches of the twig tops. This schedule will control both mummy berry and Phomopsis twig blight.
When 3/4 Of Blossoms Have Fallen (Repeat in 10 days)	1.0 tbsp Carbaryl 80S (Sevin)	Cherry fruit worm, Cranberry fruit worm,	Use good coverage.
When Berries First Turn Blue (Repeat at 10- to 14-day intervals through harvest)	0.15 lb Surround at Home or 1.0 tbsp Carbaryl 80S (Sevin) or malathion 57EC 2 tsp + 2.0 tbsp Captan 50W	Blueberry tip borer Blueberry maggot, blueberry tip borer, fruit rot, spotted wing drosophila	Sevin will control Japanese beetles and fruit worms. Do not extend spray intervals longer than 7 days if there is pressure from spotted wing drosophila. Open pruning will aid in SWD management, as will prompt harvest of ripe berries. Addition of table sugar at the rate of 1/5 oz per gal will aid in efficacy of chemical control of SWD.
Post Harvest	2.0 tbsp wettable sulfur	Phomopsis twig blight	Prune out all diseased canes and destroy by burning.

[1] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 1).

[2] Blueberries thrive best when the pH of the soil where they are growing is between 4.3 and 4.8. If the acidity needs to be increased, sulfur is a safe and economical chemical compound to use. It usually will require 1.0 lb of sulfur per plant to lower the pH (increase the acidity) one pH number. Work the sulfur lightly in the soil on a 15- to 18-inch radius around each bush.

Phomopsis Twig Blight – Conditions in Virginia and North Carolina favor twig die-back disease rather than the stem canker caused by Phomopsis fungi in northern areas. Buds and tips die first, followed by a downward spread of blighted tissue.

Stem Cankers – Several fungi enter stems and destroy the bark tissues. The resulting cankers are often first noticed when large branches "flag," or wilt, with off-colored foliage. These branches usually have one or more cankers part way down the stems. Severe damage to plants and whole fields can result.

Leaf Spots – Fungal-caused leaf spots can defoliate plants and eventually reduce their vigor. They also may be the first stages in a disease that affects stems and fruit. This is particularly true in the case of Anthracnose, which causes leaf, stem, and fruit problems.

Root Rots – Most root-rots are associated with poor site selection or planting practices. Cuttings placed too deep in soil or planted in heavy, poorly-drained sites seem especially prone to fungi that destroy the roots and, of course, the entire plant.

Viruses – Virus infected plants are poor producers and have short lives. They also serve as reservoirs of disease for passing insect or nematode vectors. A number of virus and virus-like diseases occur in blueberries. The most severe problems are shoestring and stunt (a virus-like disease). Other diseases are mosaic, red-ring spot and witches-broom. Virus-free plants and cuttings are the key to control of these problems.

Spotted-Wing Drosophila – This invasive fly established in our area in 2011. Unlike native drosophilid fruit flies, which lay eggs in rotting fruit material, SWD prefers to lay eggs in ripening fruit on the plant. Berry crops including blueberry are at risk. Spray weekly during the final ripening period, alternating chemical mode of action if possible. Get harvest berries into refrigeration as soon as possible. For more information, visit www.virginiafruit.ento.vt.edu/SWD.html

Caneberry (Raspberry and Blackberry) Diseases and Insects

Anthracnose – The fungus attacks the leaves and canes of both raspberries and blackberries. Anthracnose symptoms first appear on the canes as light grayish spots about 1/8 inch in diameter. The spots enlarge and develop rather conspicuous borders (dark in color) with gray centers. Infected canes may become girdled or cracked, causing either decline or death. Spots on the leaves are small with gray centers and purple margins. Leaf infection rarely causes defoliation. The infected tissue, however, may drop out and give the leaf a shot-hole appearance. In general, fruit on infected canes ripens abnormally.

Cane Blight – The disease is widespread in areas of raspberry culture. The causal fungus enters the canes only through wounds. Dark-brown cankers appear at the wound site, and, as the disease progresses, they extend down the cane and may encircle it. The lateral branches of infected canes wilt and die during warm weather.

Leaf Spot – The disease occurs throughout the United States and is of economic concern in Virginia. Symptoms are first noticed on raspberry as tiny greenish-black spots on the upper surfaces of the leaves. The spots turn gray as the leaves mature. The infected areas may drop out to leave a shot-hole appearance. Symptoms may be slightly different on blackberry, where spots with whitish centers and purple or brown borders occur on both the leaves and canes.

Blackberry Psyllid – These are small winged insects about 1/8 inch long. Wings have three reddish stripes running lengthwise. Adults appear on the blackberry (but not raspberry) plants in the spring and are most common when near conifers. They jump when disturbed. Adult feeding causes leaves to be tightly curled and stunts the growth of the plant.

Japanese Beetles – These beetles usually appear in large numbers and feed on the leaves and fruit of many plants. They may cause defoliation, stunting, and reduced production or death if defoliation is too severe.

Spotted-Wing Drosophila — This invasive fly established in our area in 2011. Unlike native drosophilid fruit flies, which lay eggs in rotting fruit material, SWD prefers to lay eggs in ripening fruit on the plant. Open pruning to aid air movement will help minimize SWD infestation, as well prompt harvest of ripe berries. Berry crops, especially caneberries, are at risk. Spray weekly while ripening berries are present, alternating chemical mode of action. Get berries into refrigeration as soon as possible. For more information, visit www.virginiafruit.ento.vt.edu/SWD.html.

Borers – Three species may bore into brambles. These differ in controls required. Consult your Extension agent for identification and recommendations.

Visit www.virginiafruit.ento.vt.edu/small-fruit-ipm.html#canepests for more information.

Table 3.11 - Spray Schedule for Blackberries and Raspberries

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control[2]	Remarks
Delayed Dormant When buds begin to break	8.0 tbsp copper sulfate + 8.0 tbsp hydrated lime (Bordeaux Mixture)	Anthracnose, cane blight, spur blight	A good thinning, pruning and general clean-up and removal of dead canes will help control Anthracnose as well as cane and spur blight.
New Cane Spray When new canes are 6-12 inches high	1.3 tbsp Immunox	Same as delayed dormant except no cane blight	Good coverage is important since the canes and foliage are hard to wet.
Pre-bloom Just before blossoms open	1.3 tbsp Immunox + 1.5 tsp malathion 57EC or 2.0-4.0 tbsp esfenvalerate 0.425%	Same as new cane spray plus thrips, strawberry weevil, blackberry psyllid	Coverage is a must to be sure of insect control. Fruit worms may or may not be present.
Post-bloom Until Harvest At 10- to 14-day intervals	1.3 tbsp Immunox + 1.5 tsp malathion 57EC + 1.0 tsp Sevin 80S	Same as pre-bloom spray plus Japanese beetles, spotted-wing drosophila and fruit rot	Malathion is necessary if sap beetle appears as fruit begins to color. Observe 7-day pre-harvest interval for Sevin. Do not apply Immunox more than four times. Caneberries are at great risk from spotted-wing drosophila during the ripening period. Spray at least weekly, alternating any over the counter pyrethroid insecticide (bifenthrin, zeta cypermethrin) with malathion, observing maximum number of applications per season, and days-to-harvest.
After Harvest Apply in 14 days	1.0 tbsp Sevin 80S	Anthracnose, Japanese beetles	Various borers cause problems in the canes of brambles.[2]

[1] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 3.1).

[2] Canes with borer damage, wilted, and with galls, should be cut and burned. Also control weeds because they harbor insects and disease. Three main borer species differ in additional control measures required. Consult your Extension agent for identification and recommendation.

Weed Management in Home Fruit Plantings

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Overview

Weed management is necessary for fruit plantings. Weeds compete with crop plants for water, nutrients, and light, and they can harbor insect and disease pests. Bees may prefer weed flowers, like dandelions, over fruit blossoms. Poison ivy and wild brambles interfere with harvest and other operations. Develop a year-round control for managing both summer and winter weeds. Preventing weeds from flowering helps reduce the amount of weed seed in the soil over time. Eliminate perennial weeds, especially perennial broadleaf weeds, before establishing a new fruit planting, as selective control is more difficult after planting. Generally, the tree row is maintained weed-free while the areas between the rows are mowed. Possible groundcovers to plant between the tree rows include tall fescue, fine fescues, Kentucky bluegrass, and perennial ryegrass. These grasses reduce soil erosion. For large plantings, one acre or more, read the Spray Bulletin for Commercial Tree Fruit Growers (Virginia Cooperative Extension Publication 456-419).

Additional References

- Highbush Blueberry Production Guide. Natural Resource, Agriculture, and Engineering Service Publication NRAES-55, Ithaca, NY.
- Mid-Atlantic Orchard Monitoring Guide. Natural Resource, Agriculture, and Engineering Service Publication NRAES-75, Ithaca, NY.
- Raspberry and Blackberry Production Guide for the Northeast, Midwest, and Eastern Canada. Natural Resource, Agriculture, and Engineering Service Publication NRAES-35, Ithaca, NY.
- Strawberry Production Guide for the Northeast, Midwest, and Eastern Canada. Natural Resource, Agriculture, and Engineering Service Publication NRAES-88, Ithaca, NY.
- Wine Grape Production Guide for Eastern North America. Natural Resource, Agriculture, and Engineering Service Publication NRAES-145, Ithaca, NY.
- Website for these publications: *http://www.nraes.org*

General Cultural Controls

Cultivation/Hoeing/Hand weeding: It is important to till areas before putting in a new fruit planting because it controls annual weeds like common chickweed and spotted spurge. Tilling also controls or suppresses perennial weeds. Repeated tilling helps control troublesome weeds like bermudagrass, quackgrass, yellow nutsedge, and other creeping perennials. Be sure that crop roots are not damaged when using cultivation after planting. Hoe weeds out of areas around fruit plants, but cut annual weeds at or slightly below the soil surface to minimize the amount of soil disturbance. Deeper hoeing brings weed seed from greater depths in the soil to the surface where they can germinate. Controlling weeds before flowering reduces weed populations in future years by gradually depleting the weed seed reservoir in the soil. Hoeing or hand pulling weeds controls annual weeds but will not control creeping perennials, like yellow nutsedge, which spread by underground structures such as rhizomes and tubers.

Organic mulches: Pine bark, hardwood bark, pine straw, sawdust, straw, and wood chips are all good for mulching. Monitor soil fertility as nitrogen tie-up can occur for some mulches, like sawdust. Organic mulches are a good choice because they conserve soil moisture and cool the soil. Spread mulch two to four inches deep and avoid over-mulching. Place newspaper on the soil surface before applying mulch to help suppress weeds. Organic mulches suppress annual weeds, but not perennial weeds, and organic mulches may attract rodents. Shredded mulches encourage weed growth more than larger particle mulches. Use mulches that are free of weed seed and that do not have a rotten egg or ammonia odor. Improperly composted mulch can have a low pH and may contain chemicals that injure crop plants. Some pesticides can be carried in the grass clippings and may affect the growth of the plants in the mulched area or result in undesirable chemical residues in the fruit itself. Do not use grass clippings from a lawn or pasture recently treated with a broadleaf herbicide.

Synthetic mulches: Use solid black plastic or a landscape fabric to improve weed control compared to organic mulch alone. Solid black plastic is more effective for weed control than landscape fabrics, but water cannot pass through it. Place drip irrigation under solid black plastic to allow water to reach plant roots. Landscape fabrics allow air and water to move but weed roots or shoots can penetrate through openings in the material. Place plastic or fabric on the soil surface, then cut an X or a hole into the material for fruit plants. Use organic mulch above the fabric or plastic. If organic mulch is placed over the landscape fabric, weeds may germinate in the mulch layer and send roots through the fabric. Be sure to hand weed the mulch layer when weeds are small. Black plastic and landscape fabrics control annual weeds and suppress perennial weeds like yellow nutsedge. Control perennial weeds before using synthetic mulch. Monitor for rodents under the fabric and films since these materials may provide cover for voles and other nuisance animals.

General Biological Controls

There currently are no biological control options for weed control in fruit plantings.

General Chemical Controls

Organic

Preemergence: none recommended at this time

Postemergence: Acetic acid (Weed Pharm 20% acetic acid or other labeled formulation). Contact nonselective herbicide. Do not use unlabeled forms of acetic acid. Wear eye protection, a long-sleeved shirt, long pants, shoes, socks, and waterproof gloves since this product is corrosive. Cover the weed foliage thoroughly. Treat weeds when small, as large annual weeds may require retreatment. Perennial weeds need retreatment, as this is a contact herbicide and does not affect underground plant parts such as roots, bulbs, and rhizomes. Keep the spray off the foliage and stems of desired plants by using a shield. No residual control.

Chemical Control

Measures considered practical weed control by the homeowner on a small area are quite different from those employed by the commercial producer. Homeowners often have a very limited area that may make a precise pesticide application difficult. Thus, some of the materials recommended for commercial use are excluded from homeowner recommendations because they are highly toxic, not readily available in small quantities, or require rather precise applications.

If your need for use of these materials is sufficient, you may consult the information designed for commercial production. Some of the materials used by commercial growers require that the applicator be certified as a pesticide applicator.

If you are not familiar with the application of pesticides, consult a knowledgeable individual before proceeding. Used correctly, herbicides can be very effective, but if misused they may kill the desirable crop plant.

Rates of application are given in ounces of both active ingredient and commercial product per 1000 sq ft. These are extremely small quantities and very careful measurement and application are required.

Dry products cannot be measured on a volume basis because products vary in density. Even a given product will vary depending upon whether it is loose or compressed.

You can make the conversion to a volume basis by weighing a given volume of product and measuring the volume occupied. For instance, 10 oz weight of a given wettable powder, loosely compacted, might occupy 20 oz on a volumetric basis. Once you determine a volumetric conversion factor, you can proceed to measure the product volumetrically (teaspoons or tablespoons) rather than by weight.

Small Sprayer Calibration

To determine the output of a manually-pressurized sprayer, fill the sprayer with water, measure a 1000 sq ft area (8 x 125 ft) and, using the same procedure that you would use to spray the orchard floor, spray the entire 1000 sq ft area. Then measure the number of cups of water required to refill the sprayer. Then divide by 16 (16 cups/gallon) to get the number of gallons. Usually, adequate coverage for ground sprays can be obtained with 1–2 gallons per 1000 sq ft. Next, determine the amount of herbicide needed for 1000 sq ft and add this to the volume of water required to spray the area.

During application, do not make a circle around a tree, because this would result in a heavier application near the tree trunk and may result in injury. To obtain uniform distribution of material on an 8 x 8 area, apply a 4 x 8 ft strip on both sides of the tree.

Table 3.13 - Relative Effectiveness of Preemergence Herbicides in Fruit

(E=Excellent ; G=Good ; F=Fair ; P=Poor; N=None; – =Unknown)

	Dichlobenil (Casoron)	Napropamide (Devrinol)	Norflurazon (Solicam)	Oryzalin (Surflan)
Annual Grasses				
Barnyardgrass	G	G	E	G
Cheat	G	G	G	G
Crabgrass	G	E	E	E
Fall panicum	F	G	E	G
Foxtails	G	E	E	E
Goosegrass	F	E	G	E
Johnsongrass (seedling)	F	P	G	F-G
Annual Broadleaf Weeds				
Annual fleabane	E	G	F	G
Annual morningglory	G	N	F	P-F
Black nightshade	G	N	F-G	P-F
Carpetweed	G	G	G	G
Common chickweed	G	G	G	G
Common lambsquarters	G	F-G	G-E	G
Common ragweed	G	F	F	P
Hairy galinsoga	G	G	-	P
Henbit	G	F	-	G
Horseweed	G	P	G	F
Knotweed	G	G	F	G
Mustards	G	P	F	P-F
Pennsylvania smartweed	G	P	-	P-F
Pigweeds	G	G	F	G
Prickly lettuce	G	G	-	F
Prickly sida	F-G	N	P	P-F
Purslane	G	G	G	G
Shepherds’ purse	G	F	G	G
Speedwells	-	-	-	-
Velvetleaf	-	N	-	P-F
Virginia pepperweed	G	F	G	G
Perennial Grasses And Sedges				
Bermudagrass	N	N	P	N
Dallisgrass	-	N	P	N
Fescues	G	N	F	N
Johnsongrass (rhizome)	-	N	P	N
Nimblewill	-	N	F	N
Orchardgrass	G	N	F	N
Purpletop, Redtop	-	N	F-G	N
Quackgrass	G	N	P	N
Yellow nutsedge	P-F	P	P	N

Table 3.13 - Relative Effectiveness of Preemergence Herbicides in Fruit (cont.)

(E=Excellent ; G=Good ; F=Fair ; P=Poor; N=None; – =Unknown)

	Dichlobenil (Casoron)	Napropamide (Devrinol)	Norflurazon (Solicam)	Oryzalin (Surflan)
Broadleaf plantain	G	N	P	N
Buckhorn plantain	G	N	P	N
Canada thistle	P-F	N	N	N
Chicory	G	N	N	N
Common mallow	G	N	N	N
Common milkweed	-	N	N	N
Common yarrow	-	N	N	N
Dandelion	E	N	N	N
Docks (broadleaf, curly)	G	N	N	N
Goldenrod	F-G	N	N	N
Ground ivy	E	N	N	N
Hemp dogbane	N	N	N	N
Horsenettle	N	N	N	N
Mugwort	G-E	N	N	N
Red sorrel	G	N	N	-
Thistles (bull, musk, curl)	F	N	N	N
White flowered aster	G	N	N	N
Wild carrot	G	N	F	N
Wild strawberry	G	N	P	N
Yellow rocket	G	N	F	N
Yellow woodsorrel	G	N	F	N
Special Perennial Weed Problems				
Bigroot morningglory	N	N	N	N
Brambles (*Rubus* spp.)	N	N	N	N
Common greenbriar	N	N	N	N
Japanese honeysuckle	N	N	N	N
Poison ivy	N	N	N	N
Virginia creeper	N	N	N	N
Wild garlic	F	N	N	N
	Oxyfluorfen (Goal)	**Simazine (Princep)**		
Annual Grasses				
Barnyardgrass	F	F-G		
Cheat	-	G		
Crabgrass	F	F-G		
Fall panicum	-	F-G		
Foxtails	F	G		
Goosegrass	F	E		
Johnsongrass (seedling)	-	N		

Table 3.13 - Relative Effectiveness of Preemergence Herbicides in Fruit (cont.)

	Oxyfluorfen (Goal)	Simazine (Princep)
Annual Broadleaf Weeds		
Annual fleabane	G	G
Annual morningglory	G	E
Black nightshade	G	E
Carpetweed	G	E
Common chickweed	G	E
Common lambsquarters	G	E
Common ragweed	F	E
Hairy galinsoga	G	E
Henbit	G	E
Horseweed	F	E
Knotweed	G	E
Mustards	G	G
Pennsylvania smartweed	G	E
Pigweeds	G	E
Prickly lettuce	G	E
Prickly sida	G	G
Purslane,	G	E
Shepherds'purse	-	E
Speedwells	G	-
Velvetleaf	G	G
Virginia pepperweed	-	E
Perennial Grasses And Sedges		
Fescues	N	P
Johnsongrass (rhizome)	N	N
Nimblewill	N	P
Orchardgrass	N	P-F
Quackgrass	N	P-F
Yellow nutsedge	N	N
Purpletop, Redtop	N	N
Dallisgrass	N	N
Bermudagrass	N	N
Perennial Broadleaf Weeds		
Broadleaf plantain	N	G
Buckhorn plantain	N	G
Canada thistle	N	N
Chicory	N	P-F
Common mallow	N	N
Common milkweed	N	N
Common yarrow	N	-
Dandelion	N	P-F

Table 3.13 - Relative Effectiveness of Preemergence Herbicides in Fruit (cont.)

	Oxyfluorfen (Goal)	Simazine (Princep)
Docks (broadleaf, curly)	N	N
Goldenrod	N	N
Ground ivy	N	N
Hemp dogbane	N	N
Horsenettle	N	P
Mugwort	N	N
Red sorrel	N	N
Thistles (bull, musk, curl)	-	N
White flowered aster	N	N
Wild carrot	-	N
Wild strawberry	-	N
Yellow rocket	-	P
Yellow woodsorrel	G	F
Special Perennial Weed Problems		
Bigroot morningglory	N	N
Brambles (*Rubus* spp.)	N	N
Common greenbriar	N	N
Japanese honeysuckle	N	N
Poison ivy	N	N
Virginia creeper	N	N
Wild garlic	N	N

Table 3.14 - Relative Effectiveness of Postemergence Herbicides in Fruit

(E=Excellent ; G=Good ; F=Fair ; P=Poor; N=None; – =Unknown)

	Fluazifop-P-Butyl (Fusilade)	Glufosinate (Rely)	Glyphosate (Various)	Sethoxydim (Poast)	2,4-D
Annual Grasses					
Barnyardgrass	E	G	E	E	N
Cheat	G	-	E	G	N
Crabgrasses	E	G	E	E	N
Fall panicum	E	G	E	E	N
Foxtails	E	G	E	E	N
Goosegrass	E	G	E	E	N
Johnsongrass (seedling)	E	-	E	E	N
Annual Broadleaf Weeds					
Annual fleabane	N	-	E	N	G
Annual morningglory	N	G	G	N	E
Black nightshade	N	G	E	N	F-G
Carpetweed	N	-	E	N	E
Common chickweed	N	G	E	N	P
Common lambsquarters	N	G	E	N	G
Common ragweed	N	G	E	N	G
Hairy galinsoga	N	-	E	N	G
Henbit	N	G	E	N	P
Horseweed	N	G	E	N	G
Knotweed	N	-	E	N	F
Mustards	N	G	E	N	G
Pennsylvania smartweed	N	G	E	N	P
Pigweeds	N	G	E	N	G
Prickly lettuce	N	G	E	N	P
Prickly sida	N	G	E	N	G
Purslane	N	G	E	N	F
Shepherds' purse	N	G	E	N	G
Speedwells	N	-	E	N	P
Velvetleaf	N	G	E	N	G
Virginia pepperweed	N	-	E	N	G
Perennial Grasses and Sedges					
Bermudagrass	G	P	G	G	N
Dallisgrass	G	-	E	G	N
Fescues	P-F	F	E	P-F	N
Johnsongrass (rhizome)	G	P	E	G	N
Nimblewill	F-G	-	G-E	F-G	N
Orchardgrass	F	P	E	F	N
Purpletop, Redtop	G	-	E	G	N
Quackgrass	G	P	G	G	N
Yellow nutsedge	N	P	G	N	N

Table 3.14 - Relative Effectiveness of Postemergence Herbicides in Fruit (cont.)

(E=Excellent ; G=Good ; F=Fair ; P=Poor; N=None; – =Unknown)

	Fluazifop-P-Butyl (Fusilade)	Glufosinate (Rely)	Glyphosate (Various)	Sethoxydim (Poast)	2,4-D
Perennial Broadleaf Weeds					
Broadleaf plantain	N	F	E	N	G
Buckhorn plantain	N	F	E	N	G
Canada thistle	N	-	F-G	N	F-G
Chicory	N	-	E	N	G
Common mallow	N	-	E	N	-
Common milkweed	N	-	G	N	P-F
Common yarrow	N	-	G	N	F
Dandelion	N	G	E	N	G
Docks (broadleaf)	N	-	G	N	G
Docks (curly)	N	-	E	N	F-G
Goldenrod	N	-	E	N	P-F
Ground ivy	N	G	G	N	P-F
Hemp dogbane	N	-	F	N	P-F
Horsenettle	N	F-G	F-G	N	P
Mugwort	N	-	F	N	P
Red sorrel	N	G	G	N	P
Thistles	N	-	G	N	F
(bull, musk,curl)	N	-	G	N	G
White flowered aster	N	-	E	N	N
Wild carrot	N	-	E	N	G
Wild strawberry	N	-	E	N	P-F
Yellow rocket	N	-	E	N	P-F
Yellow woodsorrel	N	G	E	N	F
Special Perennial Weed Problems					
Bigroot morningglory	N	-	F-G	N	F-G
Brambles (*Rubus* spp.)	N	F-G	G	N	P
Common greenbriar	N	-	P	N	N
Japanese honeysuckle	N	-	F-G	N	P-F
Poison ivy	N	-	G	N	F
Virginia creeper	N	-	F-G	N	F
Wild garlic	N	G	F	N	F

Table 3.15 - Spray Schedule for Weed Control in Home Fruit Orchards

Crop	Herbicide Active Ingredient/1000 sq ft (Product/1000 sq ft)	Remarks
Apples and Pears	dichlobenil 0.1 lb (Casoron 4G 3.4 lb)	Apply granules in the late winter or early spring. Shallow incorporation may improve weed control, especially if application is made during warm temperatures. Do not apply to newly planted trees until 4 weeks after transplanting. Will not give season-long weed control. Do not make more than one application/year. Do not apply within one month of harvest. Do not allow livestock to graze treated area. Especially effective for many herbaceous perennial weeds.
	fluazifop-P-butyl 0.19 oz (Fusilade DX 0.75 fl oz + 1.5 fl oz crop oil concentrate or 0.5 fl oz nonionic surfactant in 1.0 gal of water)	Spot treatment for emerged grasses. Use in non-bearing orchards only. Use as a directed spray on actively growing grasses. Treat annual grasses with lower rate before tillering or heading. Treat perennial grasses according to the following stages of growth: johnsongrass, field paspalum, and purpletop before boot stage; bermudagrass, 4–8 inch runners; quackgrass, 3–5 inch leaves and not more than 10 inches tall. Perennial grasses such as bermudagrass, paspalums, and quackgrass need to be treated with Fusilade when regrowth is evident. Do not treat trees to be harvested within one year after application.
	glufosinate (Rely 280)	Controls annual weeds and certain perennial weeds. Apply when weeds are actively growing. Mix 1.7 fl oz Rely 280/gal. Ensure thorough coverage of weed foliage. Do not allow spray to contact desired foliage or bark. Do not apply within 14 days of harvest.
	glyphosate (Roundup and various other formulations. See label for rates)	Apply as a directed spray. Do not contact bark or foliage of trees or severe injury may result. Extensive care must be exercised to avoid contact of spray, drift, or mist with green foliage, green bark or bark of trees established less than two years, suckers, or fruit of desirable trees. Spray contact with other than mature bark on main trunk can cause serious localized or systemic injury. Injury may become increasingly severe the second season. WARNING: Do not mix, store, or apply Roundup spray solution in galvanized metal or lined steel tanks. Chemical reaction produces hydrogen gas, which is very explosive.
	norflurazon 0.75-1.5 oz (Solicam DF 1.0-1.9 oz)	Apply as a directed spray to weed-free soil and avoid contact with fruit or foliage. May be applied under new plantings if there are no depressions or large cracks which allow the herbicide to accumulate around the root system. Pears must be established one year before treatment. Use the lower rate on sandy soils and the higher rate on clay and loamy soils.
	oryzalin 0.75-2.3 oz (Surflan 4AS 1.5-4.5 fl oz)	For use under newly planted or established trees. Areas to be treated should be free of weeds. Remove or thoroughly mix trash into the soil before application. Use lower rate for short-term control (4 months) and higher rate for long-term control (6–8 months). Apply as a directed spray and avoid spray contact with leaves, branches, or trunks of trees. Do not apply to newly transplanted trees until soil has settled and there are no cracks present. Make only one application/growing season.
	oxyfluorfen 0.2-0.7 oz (Goal 2XL 0.7-2.9 fl oz)	Apply to dormant trees only. Will control certain small seedling weeds plus provide soil residual control of annual broadleaf weeds and certain annual grasses.
	sethoxydim 0.21 oz (Poast 1.5E 1.25 fl oz + 1.25 fl oz crop oil concentrate in 1.0 gal of water)	Do not apply within 14 days of harvest. Spot treatment for emerged grasses. Apply lower rate to annual grasses up to six inches, apply higher rate to annual grasses up to 12 inches tall and to perennial grasses.

Table 3.15 - Spray Schedule for Weed Control in Home Fruit Orchards (cont.)

Crop	Herbicide Active Ingredient/1000 sq ft (Product/1000 sq ft)	Remarks
Apples and Pears (cont.)	simazine 0.8-1.6 oz (Princep 4L 1.5-3.0 fl oz)	Apply to weed-free soil around trees established 1 year or more. Best results are obtained with winter or early spring applications. Adjust rate of application to soil type. Do not use on sandy or gravelly soils. Do not make more than one application/year.
	2,4-D 0.5 oz (Weedar 64, Orchard Master 1.1 fl oz)	Apply as a directed spray to actively growing broadleaf weeds. Gives good control of annual broadleaf weeds and partial control of perennials. Keep spray off tree foliage and fruit or serious injury may result. Use a coarse spray and low pressure to avoid spray drift. Do not harvest within 14 days of application.
Peaches	dichlobenil 0.1 lb (Casoron 4G 3.4 lb)	Apply granules in the late winter or early spring. Shallow incorporation may improve weed control, especially if application is made during warm temperatures. Do not apply to newly planted trees until four weeks after transplanting. Will not give season-long weed control. Do not make more than one application/year. Do not apply within 1 month of harvest. Do not allow livestock to graze treated area.
	fluazifop-P-butyl 0.19 oz (Fusilade DX 0.75 fl oz + 1.5 fl oz crop oil concentrate or 0.5 fl oz nonionic surfactant in 1.0 gal of water)	Do not harvest within 14 days of application. Use as a directed spray on actively growing grasses. Treat annual grasses with lower rate before tillering or heading. Treat perennial grasses according to the following stages of growth: johnsongrass, field paspalum, and purpletop, before boot stage; bermudagrass, 4–8 inch runners; quackgrass, 3–5 leaves and not more than 10 inches tall. Perennial grasses such as bermudagrass, paspalums, and quackgrass need to be treated with Fusilade when regrowth is evident.
	glufosinate (Rely 280)	Controls annual weeds and certain perennial weeds. Apply when weeds are actively growing. Mix 1.7 fl oz Rely 280/gal. Ensure thorough coverage of weed foliage. Do not allow spray to contact desired foliage or bark. Do not apply within 14 days of harvest.
	glyphosate (Roundup and various other formulations. See label for rates.)	Wick or wiper application only. Use on emerged annual and perennial weeds with fully expanded leaves.
	norflurazon 0.75-1.5 oz (Solicam DF 1.0-1.9 oz)	Apply as a directed spray to weed-free soil and avoid contact with fruit or foliage. May be applied under new plantings if there are no depressions or large cracks which allow the herbicide to accumulate around the root system. Use the lower rate on sandy soils and the higher rate on clay and loam soils.
	oryzalin 0.75-2.3 oz (Surflan 4AS 1.5-4.5 fl oz)	Areas to be treated should be free of weeds. Remove or thoroughly mix trash into the soil before application. Use the lower rate for short term control (4 months) and the higher rate for long-term control (6–8 months). Apply as a directed spray and avoid contact with leaves, branches, or trunks of trees. Do not apply to newly transplanted trees until soil has settled and there are no cracks present. Make only one application/growing season.
	oxyfluorfen 0.2-0.7 oz (Goal 2XL 0.7-2.9 fl oz)	Apply to dormant trees only. Will control certain small seedling weeds plus provide soil residual control of annual broadleaf weeds and certain annual grasses.
	sethoxydim 0.21 oz (Poast 1.5E 1.25 fl oz + 1.25 fl oz crop oil concentrate in 1.0 gal of water)	Spot treatment for emerged grasses. Apply lower rate to annual grasses up to 6 inches. Apply higher rate to annual grasses up to 12 inches tall and to perennial grasses. Do not apply within 25 days of harvest.

Table 3.15 - Spray Schedule for Weed Control in Home Fruit Orchards (cont.)

Crop	Herbicide Active Ingredient/1000 sq ft (Product/1000 sq ft)	Remarks
Peaches (cont.)	simazine 0.8-1.6 oz (Princep 4L 1.5-3.0 fl oz)	Apply to weed free soil around trees established 1 year or more. Best results are obtained with winter or early spring applications. Adjust rate of application to soil type. Do not use on sandy or gravelly soils. Do not make more than one application/year.
	2,4-D 0.5 oz (Weedar 64, Orchard Master 1.1 fl oz)	Apply as a directed spray to actively growing broadleaf weeds. Gives good control of annual broadleaf weeds and partial control of perennials. Keep spray off tree foliage and fruit or serious injury may result. Use a coarse spray and low pressure to avoid spray drift. Do not harvest within 40 days of application.
Blackberries, Blueberries, and Raspberries	dichlobenil 1.4 oz (Casoron 4G 2.3 lb)	Apply dry granules in late winter or early spring. Use only on established plantings and do not apply during new shoot emergence.
	fluazifop-P-butyl 0.19 (Fusilade DX 0.75 fl oz + 1.5 fl oz crop oil concentrate or 0.5 fl oz nonionic surfactant in 1.0 gal of water)	Spot treatment for emerged grasses. Do not harvest within 1 day of application to highbush blueberry, blackberries or raspberries. Use as a directed spray on actively growing grasses. Treat annual grasses with lower rate before tillering or heading. Treat perennial grasses according to the following stages of growth: johnsongrass, field paspalum, and purpletop before boot stage; bermudagrass, 4 to 8 inch runners; quackgrass, 3 to 5 leaves and not more than 10 inches tall. Perennial grasses such as bermudagrass, paspalums, and quackgrass need to be retreated with Fusilade when regrowth is evident.
	glufosinate (Rely 280)	Blueberries only. Controls annual weeds and certain perennial weeds. Apply when weeds are actively growing. Mix 1.7 fl oz Rely 280/gal. Ensure thorough coverage of weed foliage. Do not allow spray to contact desired foliage or green bark. Do not apply within 14 days of harvest.
	glyphosate (Roundup and various other formulations. See label for rates.)	Use lower rate to control annual weeds and higher rates for perennial weeds. Can be applied preplant or as a spot treatment after planting. Do not allow spray to contact desired stems or foliage.
	napropamide 1.5 oz (Devrinol 50DF 3.0 oz)	Apply to the soil surface in the fall through early spring prior to weed emergence. Do not apply to frozen ground. Does not control existing weeds. Use as a directed spray and avoid contact with fruit or foliage. Do not apply when fruit is on the ground during the harvest period. Do not graze treated areas. Make only one application/season.
	oryzalin 0.75-2.3 oz (Surflan 4AS 1.5-4.5 fl oz)	Apply in early spring for control of annual grasses and certain broadleaf weeds. Apply to new plantings after rainfall has firmed the soil. May be tank-mixed with simazine for increased broadleaf weed control.
	sethoxydim 0.21 oz (Poast 1.5E 1.25 fl oz + 1.25 fl oz crop oil concentrate in 1.0 gal of water)	Do not apply within 45 days of raspberry or blackberry harvest or within 1 day of highbush blueberry harvest.. Apply as spot treatment for emerged grasses. Treat emerged annual grasses prior to tillering. Perennial grasses may require retreatment.
	simazine 0.8-1.2 oz (Princep 4L 1.5-3.0 fl oz)	Apply for control of annual grasses and broadleaf weeds in the early spring or as a split treatment with 1/2 applied in the spring and 1/2 applied in the fall. Do not use more than 1/2 rate on new plantings less than 6 months old. Do not apply to foliage or while fruit is present.
Grapes	dichlobenil 1.4-2.2 oz (Casoron 4G 2.3-3.4 lb)	Apply granules in winter or early spring. Do not apply until four weeks after transplanting.

Table 3.15 - Spray Schedule for Weed Control in Home Fruit Orchards (cont.)

Crop	Herbicide Active Ingredient/1000 sq ft (Product/1000 sq ft)	Remarks
Grapes (cont.)	fluazifop-P-butyl 0.19 oz (Fusilade DX 0.75 fl oz + 1.5 fl oz crop oil concentrate or 0.5 fl oz nonionic surfactant in 1.0 gal of water)	Spot treatment for emerged grasses. Do not apply within 50 days of harvest. Use as a directed spray on actively growing grasses. Treat annual grasses before tillering or heading. Treat perennial grasses according to the following stages of growth: johnsongrass, field paspalum, and purpletop, before boot stage; bermudagrass, 4–8 inch runners; quackgrass, 3–5 leaves and not more than 10 inches tall. Perennial grasses such as bermudagrass, paspalums, and quackgrass need to be retreated with Fusilade when regrowth is evident. Do not treat vines to be harvested within one year after application.
	glufosinate (Rely 280)	Controls annual weeds and certain perennial weeds. Apply when weeds are actively growing. Mix 1.7 fl oz Rely 280/gal. Ensure thorough coverage of weed foliage. Do not allow spray to contact desired foliage or green bark. Do not apply within 14 days of harvest.
	glyphosate (Roundup and various other formulations. See label for rates.)	Use as a directed spray in established vineyards or for site preparation prior to transplanting new vines. Do not apply when green shoots or canes or foliage are in the spray zone. Do not allow spray, drift, or mist to contact green foliage, green bark, suckers, or vines and renewals less than three years of age. Spray contact, other than with mature bark on the main trunk, can result in serious localized or systemic injury.
	napropamide 1.5 oz (Devrinol 50DF 3.0 oz)	Apply to soil surface in the fall through early spring prior to weed emergence. Do not apply to frozen ground. Does not control existing weeds. Use as a directed spray and avoid contact with fruit or foliage. Do not apply when fruit is on the ground during the harvest period. Do not graze areas. Make only one application/season.
	oryzalin 0.75-2.2 oz (Surflan 4AS 1.5-4.5 fl oz)	Areas to be treated should be free of weeds. Remove or thoroughly mix trash into the soil before application. Use lower rate for short-term control (4 months) and higher rate for long-term control (6–8 months). Apply as a directed spray and avoid contact with leaves, branches, or trunks of vines. Do not apply to newly transplanted vineyards until soil has settled and there are no cracks present. Make only one application/growing season.
	oxyfluorfen 0.2-0.7 oz (Goal 2XL 0.7-2.9 fl oz)	Dormant application only. Will control certain small seedling weeds plus provide soil residual control of annual broadleaf weeds and certain annual grasses.
	sethoxydim 0.21 oz (Poast 1.5E 1.25 fl oz + 1.25 fl oz crop oil concentrate in 1.0 gal of water)	Do not apply within 50 days of harvest. Spot-treatment for emerged grasses. Treat annual grasses prior to tillering. Perennial grasses may require repeat treatment.
	simazine 0.8-1.6 oz (Princep 4L 1.5-3.0 fl oz)	Apply a single application in fall or early spring to weed-free soil. Vineyards must be established at least three years.
Strawberries	napropamide 1.5 oz (Devrinol 50DF 3.0 oz)	Use on established strawberries. Delay application until the desired number of daughter plants has become established. Do not apply from bloom to harvest. Make only one application/season. Does not control established weeds.
	sethoxydim 0.21 fl oz (Poast 1.5E 1.25 fl oz + 1.25 fl oz crop oil concentrate in 1.0 gal of water)	Do not apply within 7 days of harvest. Spot-treatment for emerged grasses. Treat annual grasses prior to tillering. Perennial weeds may require retreatment.

Table 3.15 - Spray Schedule for Weed Control in Home Fruit Orchards (cont.)

Crop	Herbicide Active Ingredient/1000 sq ft (Product/1000 sq ft)	Remarks
Strawberries (cont.)	2,4-D amine 0.4 oz (Formula 40 0.7 fl oz)	Apply for control of emerged broadleaf weeds in established beds. Apply in late winter or early spring when strawberries are dormant, or apply immediately after last picking. Do not apply during bud, flower, or fruit stage or during runner formation. Some foliar injury is to be expected.

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Control of Ornamental Diseases

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Overview

Home gardens are unique ecosystems, unlike professional nurseries. Making a beautiful home garden does not necessarily mean spraying pesticides on a preventive schedule. It is possible to use non-chemical approaches to avoid and control disease problems in home gardens.

General Cultural Controls

Many pathogens attack ornamental plants. Some, like rusts, are very aggressive but may not survive if their host plant tissues are absent. Others, like Botrytis, are ubiquitous and opportunistic; they attack only physiologically-weakened plants. Home gardeners can minimize disease and plant loss by reducing pathogen populations and increasing plant vigor.

- Crop rotation: Rotating crops is an effective way to control diseases caused by soilborne pathogens. Little is known about these pathogens, but it is a safe rule of thumb to plant different crops in a flower bed each year. Each pathogen has a host range and its population may decline if the pathogen's favorite host plants are not present. Crop rotation may not eliminate a pathogen from soil, but it slows the inoculum build-up in a flower bed.
- Sanitation: It is important to remove dead plants and diseased plant parts as well as to keep the tools you use clean. Removing dead plants reduces inoculum during a growing season and removing diseased plant parts avoids unintentional spreading of a pathogen from one plant to another. It is best to remove dead or severely diseased plants from a flower bed as soon as you see them; otherwise, they become sources of inoculum for disease progression. Symptomatic limbs, leaves and flowers should be pruned from plants and removed from the bed. Sterilize pruners with 70% alcohol solution regularly.
- Fertilization and irrigation: Fertilize and water plants only as needed. This improves plant physiology and limits the excess water pathogens need to reproduce, germinate, and attack ornamental plants.

Other Controls

There are many ornamental plant species and cultivars; some are problem-free while others are susceptible to disease or other problems. Using disease resistant plants, when available, is an excellent way to avoid common disease problems in the home landscape and garden. Choosing the right plants is usually site-specific and should be guided by personal experience and careful research. Beneficial microbes that out-compete or are antagonistic to pathogens can be used for biological control of plant pathogens. Use composted green waste or other organic matter to enhance naturally-occurring beneficial microbes already in the soil.

General Chemical Controls

Chemical control should be the last resort for disease management in a home garden. Unlike cultural and biological controls, the efficacy of most chemicals is pathogen-specific. There are five major groups of pathogens: fungi, bacteria, oomycetes (Phytophthora, Pythium, downy mildew), nematodes, and viruses. Some chemicals control only diseases caused by fungi. These chemicals are called "fungicides". Similarly, the pesticides that control only bacterial, oomycete, and nematode diseases are regarded as "bactericides," "oomyceticides," and "nematicides," respectively. When chemical control is necessary, it is critical to first confirm and correctly identify a disease problem, then select an effective pesticide, if use of a pesticide is warranted. Review pesticide labels carefully and follow instructions to avoid health hazards and phytotoxicity. Using the same pesticide repeatedly may make the target pathogen resistant, so follow any precautions and/or directions on the product label regarding development of pesticide resistance.

Determine the Nature of a Disease Problem by Using the Index of Ornamental Plants and Their Diseases

The index below is divided into two groups: Herbaceous Plants and and Woody Ornamental Plants and within each group it is arranged alphabetically by the common name of the host plant with its scientific name in parentheses. Common diseases that usually require chemical treatments are in italics. The Virginia Tech Plant Disease Clinic also has a Plant Problem Image Gallery (https://apps.cals.vt.edu/ppig/) with images of many of the common disease and abiotic (non-living) problems diagnosed in the Clinic. This resource may be helpful for troubleshooting potential problems in the landscape and garden.

Herbaceous Plants

African daisy (*Gerbera*) – Pythium root rot

Ageratum (*Floss flower*) – Southern blight

Anemone – foliar nematode, Phytophthora root rot

***Artemisia* (Dusty miller)** – Rhizoctonia root/stem rot

Asclepias (Milkweed) – anthracnose

***Asclepias tuberosa* (Butterfly weed)** – Rhizoctonia stem rot

Aster – *powdery mildew*, rust

Astilbe – Pythium root rot

Baby's breath (*Gypsophila*) – bacterial soft rot

Balloon flower (*Platycodon*) – Rhizoctonia crown rot

Basil (*Ocimum basilicum*) – Alternaria leaf spot, Fusarium root rot

Bedding plants – damping-off

Begonia – anthracnose, Botrytis blight, Fusarium stem rot, *powdery mildew*, *Rhizoctonia root/stem rot*, root knot nematode

Bergenia – Pythium root rot

Black-eyed Susan (*Rudbeckia*) – Pythium root rot, Rhizoctonia stem rot, *Septoria leaf spot*, downy mildew

Blanket flower (*Gaillardia*) – Pythium root rot, white smut

Bugleweed (*Ajuga*) – Phomopsis dieback, *Phytophthora root rot*, *Pythium root rot*, Rhizoctonia root/crown rot, root knot nematode, *Southern blight*, viral disease, web blight

Buttercup (*Ranunculus*) – bacterial blight, web blight

Cactus – Pythium root rot

Caladium – Pythium root rot

Canarygrass (*Phalaris*) – web blight

Calibrachoa (*Million bells*) – Phytophthora crown rot, black root rot, Rhizoctonia root rot, Southern blight

***Campanula* (Bellflower)** – Fusarium crown rot

Candytuft (*Iberis*) – anthracnose, Pythium root rot

Canna lily (*Canna*) – lesion nematodes, Pythium root rot

Carnation (*Dianthus*) – *Alternaria leaf spot*, bacterial spot, *Botrytis blight*, Fusarium stem rot, *powdery mildew*, Rhizoctonia stem rot, rust

Century plant (Agave) – crown rot

Cereus (*Epiphyllum*) – oedema

Chrysanthemum (*Dendranthema*) – bacterial leaf spot, *Botrytis blight, Mycosphaerella ray blight*, Phytophthora root rot, *powdery mildew, Pythium root/stem rot*, Rhizoctonia root rot, *Septoria leaf spot*, *leaf rust*, Verticillium wilt

Cockcomb (*Celosia*) – Pythium root rot, Rhizoctonia root rot

Coleus – Bacterial spot, botrytis blight, *downy mildew*

Columbine (*Aquilegia*) – Pythium root rot

Coral bells (*Heuchera*) – Pythium root rot

Cyclamen – Fusarium wilt

Dahlia – crown gall, *powdery mildew*

Daisy (Chrysanthemum) – *Pythium root rot*, bacterial blight, web blight

Daylily (*Hemerocallis*) – anthracnose, *rust, leaf streak*, Southern blight

Forget-me-not (*Myosotis*) – web blight

Foxglove (*Digitalis*) – *black root rot*, Fusarium root rot, Pythium root rot

Gayfeather (*Liatris*) – Sclerotinia stem rot

Geranium (*Pelargonium*) – bacterial blight, bacterial leaf spot, bacterial wilt, *Botrytis blight,* oedema, *Pythium root rot/blackleg*, Rhizoctonia root rot, rust, viral disease

Gladiolus – *Botrytis leaf blight, Curvularia leaf blight, Fusarium yellows, Penicillium corm rot*, Rhizoctonia corm rot

Globe amaranth (*Gomphrena*) – leaf spot

Goldenrod (Solidago) – rust

Goldenstar (*Chrysogonum*) – Southern blight

Goutweed (*Aegopodium*) – leaf spot

Hellebore (*Helleborus*) – black leaf spot, Botrytis blight, Pythium root rot, Rhizoctonia root rot, Southern blight

Hollyhock (*Alcea*) – root knot nematode, *rust*

Hosta – *anthracnose*, Botrytis blight, leaf spot, root rot, *soft rot, Southern blight*, virus X

Ice plant (*Delosperma*) – Pythium root rot

Impatiens – *Alternaria leaf spot*, bacterial fasciation, Botrytis blight, *downy mildew, Fusarium crown rot, powdery mildew*, *Pythium root/stem rot*, Rhizoctonia root/stem rot, root knot nematodes, Verticillium wilt, viral diseases

Iris – *Botrytis blight, Heterosporium leaf spot, soft rot*

Jack-in-the-pulpit a (*Arisaem*) – rust

Jade plant (*Crassula*) – oedema, Pythium root rot

Kaffir lily (*Clivia*) – leaf spot, Southern blight

Larkspur (*Consolida*) – Pythium root rot, Rhizoctonia crown/root rot

Leucanthemum – Phytophthora root rot, Rhizoctonia root rot

Lewisia – soft rot

Lily (*Lilium*) – anthracnose, Botrytis blight, Pythium root rot

Lilyturf (*Liriope*) – anthracnose, foliar nematodes, Fusarium wilt, Mycosphaerella leaf spot, Phytophthora root rot, viral disease

Lisianthus (*Eustoma*) – Botrytis blight, Fusarium root/stem rot

Lobelia – Pythium root rot, viral disease

Loosestrife (*Lysimachia*) – Rhizoctonia root/stem rot, *Southern blight*

Lupine (*Lupinus*) – anthracnose, brown spot, Pythium root rot

Madagascar periwinkle (*Catharanthus*) – black root rot, Botrytis blight, *Phytophthora blight*, Pythium root rot, Rhizoctonia stem/root rot

Mallow (*Malva*) – rust

Marigold (*Tagetes*) – Alternaria blight, Botrytis blight, crown gall, Fusarium stem/root rot, Pythium root rot, Rhizoctonia stem rot

Mexican aster (*Cosmos*) – Botrytis blight, Phomopsis stem canker, powdery mildew, white smut

Mondo grass (*Ophiopogon*) – anthracnose

Monkshood (*Aconitum*) – Southern blight

Morning glory (*Ipomoea*) – rust, white rust

Nephthytis (*Syngonium*) – bacterial leaf spot

Orchid (*Cattleya*) – bacterial brown spot

Orchid (*Cymbidium*) – viral disease

Ornamental grass, or Maiden grass (*Miscanthus*) – anthracnose

Pachysandra – leaf spot, Pythium root rot, Southern blight, *Volutella blight*

Pansy (*Viola*) – anthracnose, *black root rot, Botrytis blight*, Cercospora leaf spot, *Phytophthora root/crown rot, Pythium root/crown rot*

Persian violet (*Exacum*) – viral disease

Petunia – Botrytis blight, *Fusarium root/crown rot*, *Phytophthora root/crown rot and foliage blight, Pythium root/crown rot*, Rhizoctonia root/stem root, viral disease

Phlox – bacterial leaf spot, black root rot, Colletotrichum stem canker, *powdery mildew*, Pythium root rot, southern blight, viral disease, web blight

Pincushion flower (*Scabiosa*) – Botrytis blight

Poinsettia (*Euphorbia pulcherima*) – bacteria blight, bacterial leaf spot, Botrytis blight, *powdery mildew, Pythium root rot*, scab

Pratia – Southern blight

Purslane (*Portulaca*) – Rhizoctonia stem rot

Purple heart (*Setcreasia*) – leaf spot *blight*

Peony (*Paeonia*) – Botrytis blight, Cercospora leaf spot, Cladosporium leaf/stem blotch, Rhizoctonia root rot

Rain lily (*Zephyranthes*) – *anthracnose*

Rock rose (*Helianthemum*) – Botrytis blight

Salvia – bacterial leaf spot, downy mildew, Pythium root rot, Rhizoctonia stem rot

Sea thrift (*Armeria*) – web blight

Sinningia (*Gloxinia*) – viral disease

Snapdragon (*Antirrhinum*) – *Cercospora leaf spot*, downy mildew, *Phytophthora root/crown rot*, Pythium root rot, Rhizoctonia stem rot, rust, Verticillium wilt, viral diseases

Solomon seal (*Polygonatum*) – Penicillium rot

Speedwell (*Veronica*) – Phytophthora root rot

Spiderwort (*Tradescantia virginica*) – Southern blight

Spurge (*Euphorbia*) – anthracnose, Botryosphaeria dieback canker

Statice (*Limomium*) – Phytophthora root rot, Pythium root rot, Rhizoctonia root rot

Stone crop (*Sedum*) – anthracnose, bacterial soft rot, bacterial stem rot, Diplodia stem rot, leaf spot, Phytophthora stem rot, Pythium root rot, Rhizoctonia root/stem rot, root knot nematodes, web blight

Strawflower (*Helichrysum*) – Fusarium stem rot

Sunflower (*Helianthus*) – Alternaria leaf/stem spot

Sweet alyssum (*Lobularia*) – Rhizoctonia stem rot

Sweet woodruff (*Galium*) – Rhizoctonia stem/root rot, Southern blight

Thanksgiving cactus (*Schlumbergera*) – oedema, Pythium root rot

Tickseed (*Coreopsis*) – Botrytis blight, Rhizoctonia root/stem rot, rust, viral disease

Tulip (*Tulipa*) – *Botrytis blight*, Fusarium basal rot

Vervain (*Verbena*) – *powdery mildew*, Pythium root rot

Water celery (*Oenanthe javanica*) – Fusarium crown rot

Water lily (*Nelumbo*) – Cercospora leaf spot

Wood sorrel (*Oxalis*) – rust

Yellow archangel (*Lamiastrum*) – Rhizoctonia root/stem rot, Southern blight

Zinnia – *Alternaria blight*, bacterial leaf spot, Botrytis stem canker, *powdery mildew*, Pythium root rot

Woody Ornamental Plants

Arborvitae (*Thuja*) – *Armillaria root/stem rot, Cytospora canker*, Kabatina tip blight, *Phomopsis twig/needle blight, Phytophthora root rot*, Pythium root rot, Seiridium twig canker, web blight

Ash (*Fraxinus*) – anthracnose, ash yellows, Botryosphaeria canker, rust

Aucuba – anthracnose, Botryosphaeria dieback, leaf spot, Phomopsis dieback, ring nematode

Autumn olive (*Elaeagnus*) – Phytophthora root rot

Azalea (*Rhododendron*) – anthracnose, Armillaria root rot, *Botryosphaeria dieback*, Botrytis blight, *Cercospora leaf spot*, Colletotrichum leaf spot, leaf and flower gall, lesion nematodes, oedema, Pestalotia leaf spot, petal blight, Phomopsis dieback, Phyllosticta leaf spot, Phytophthora dieback, *Phytophthora root/stem rot, powdery mildew*, web blight

Bamboo – Pythium root rot

Barberry (*Berberis*) – *Phytophthora root rot*

Bay laurel (*Laurus nobilis*) – Cercospora leaf spot

Bayberry (*Myrica*) – Botryosphaeria dieback, Phytophthora root rot

Bearberry (*Arctostaphylos*) – Pythium root rot, Phytophthora root rot

Beech (*Fagus*) – anthracnose, Botryosphaeria canker, Hypoxylon canker, viral disease

Birch (*Betula*) – anthracnose, Botryosphaeria dieback, Botrytis blight, red heart, Septoria leaf spot

Black gum (*Nyssa sylvatica*) – anthracnose, Botryosphaeria dieback, leaf spot

Bluebeard (*Caryopteris*) – Phytophthora stem/root rot, Pythium root rot

Boston ivy (*Parthenocissus*) – Phyllosticta leaf spot

Boxwood (*Buxus*) – Botryosphaeria dieback, *boxwood blight*, *boxwood decline*, lesion nematode, Macrophoma leaf spot, Volutella blight

Buckeye (*Aesculus*) – Guignardia blotch Butterfly bush (Buddleia) – Phytophthora root rot, Rhizoctonia root rot

Camellia – anthracnose, Botryosphaeria dieback, leaf/flower gall, leaf spot, oedema, petal/flower blight, Phytophthora root rot, Pythium root rot, viral disease

Catalpa – bacterial wetwood, Verticillium wilt

Cedar (*Cedrus*) – Armillaria root rot, *Phomopsis needle/twig blight*

Cherry laurel (*Prunus laurocerasus*) – anthracnose, bacterial leaf spot, bacterial shot hole, Botryosphaeria dieback, Phomopsis dieback, leaf spots, Phytophthora root rot, Pythium root rot, zonate leaf spot

Chokeberry (*Aronia*) – Pythium root rot

Cinquefoil (*Potentilla*) – foliar nematodes

Clematis – leaf spot, Phytophthora root rot

Cleyera – Armillaria root rot

Coneflower (*Echinacea*) – aster yellows, foliar nematodes, Pythium root rot, viral disease

Cotoneaster – leaf spot, Phytophthora root rot, web blight

Crabapple (*Malus*) – Coniothyrium leaf spot, *fire blight, frog-eye leaf spot*, powdery mildew, rust, scab

Crape myrtle (*Lagerstroemia*) – leaf spot, *powdery mildew*, sooty mold

Cypress (*Cupressus*) – Botryosphaeria dieback, Kabatina dieback, tip blights, Phytophthora root rot, *Seiridium canker*

Daphne – anthracnose, Phytophthora root/stem rot

Dawn redwood (*Metasequoia*) – *Dothiorella canker*, needle blight

Dogwood (*Cornus*) – *anthracnose*, Armillaria root rot, Botryosphaeria dieback/canker, Botrytis blight, Discula anthracnose, Fusarium canker, leaf spot, Phomopsis dieback, *powdery mildew*, Pythium root rot, *Septoria leaf spot, spot anthracnose*, viral disease

Douglas fir (*Pseudotsuga*) – Botryosphaeria canker, Swiss needle cast

Dove tree (*Davidia*) – Phomopsis dieback

Dracaena – Fusarium blight, Pythium root rot

Drooping leucothoe (*Leucothoe*) – Botryosphaeria dieback, Cylindrocladium leaf spot, Phyllosticta leaf spot, Phytophthora root rot

Eastern red cedar (*Juniperus virginiana*) – Cercospora blight, Kabatina tip blight, Pestalotia blight, *Phomopsis tip blight, rust, bacterial leaf scorch*, Botryosphaeria canker, Cytospora canker, *Dutch elm disease, Verticillium wilt*

Elm (*Ulmus*) – *bacterial wetwood*

English ivy (*Hedera helix*) – anthracnose, bacterial leaf spot, oedema, Phyllosticta leaf spot, Phytophthora root rot, Pythium root rot, Rhizoctonia root rot

Eucalyptus – anthracnose, Botryosphaeria dieback, crown gall, Fusarium canker, Phomopsis dieback, *Phytophthora* *root rot*, powdery mildew, Pythium root rot

Euonymus – *powdery mildew*

Falsecypress (*Chamaecyparis*) – Phytophthora root rot, Seiridium canker, web blight

Fatsia – leaf spot

Fig (*Ficus*) – anthracnose, Phytophthora root rot

Filbert (*Corylus*) – eastern filbert blight

Fir (*Abies*) – Botrytis blight, Cytospora canker, oedema, *Phytophthora root/crown rot*

Firethorn (*Pyracantha*) – Botryosphaeria dieback, *fire blight*, Phomopsis dieback, scab

Flowering apricot/cherry/peach/plum (*Prunus*) – bacterial blossom blight, bacterial leaf spot, bacterial shot hole, bacterial scorch, black knot, blossom blight/brown rot, *Cytospora canker*, Nectria canker, peach leaf curl, Phomopsis canker, white rot

Flowering pear (*Pyrus calleryana*) – Botryosphaeria canker, Entomosporium leaf spot, fire blight, rust

Forsythia – Botryosphaeria dieback, crown gall, Phomopsis gall, Phytophthora root rot, ringer nematodes, Sclerotinia twig blight, web blight

Fringe tree (*Chionanthus*) – leaf spot

Gardenia – anthracnose, Phytophthora root/crown rot

Germander (*Teucrium*) – Rhizoctonia root rot, Southern blight

Hawthorn (*Crataegus*) – Cercospora leaf spot, *Entomosporium leaf spot*, rust

Heather (*Erica*) – Phytophthora root rot

Heavenly bamboo (*Nandina*) – Cercospora leaf spot, Phytophthora root rot, Pythium root rot

Hibiscus – *Phytophthora root rot*, Pythium root rot, viral disease

Hickory (*Carya*) – downy leaf spot, Gnomonia leaf spot, Phomopsis gall, powdery mildew, zonate leaf spot

Holly (*Ilex*) – *anthracnose*, bacterial blight, black root rot, Botryosphaeria dieback, leaf spot, root knot nematodes, oedema, Phomopsis dieback, *Phytophthora root rot*, Pythium root rot, Rhizoctonia root rot, rust, tar spot, web blight

Honeylocust (*Gleditsia*) – Botryosphaeria canker, Thyronectria canker

Hornbeam (*Carpinus*) – Pythium root rot

Honeysuckle (*Lonicera*) – Botryosphaeria dieback, Botrytis blight, *Herpobaisdium leaf blight*, powdery mildew

Hydrangea – anthracnose, Armillaria root rot, bacterial leaf spot, *Botrytis blight*, Cercospora leaf spot, *Phytophthora root rot, Pythium root rot, powdery mildew*

Incense cedar (*Calocedrus*) – Seiridium canker

Indian hawthorn (*Rhaphiolepis*) – *Entomosporium leaf spot*

Inkberry (*Ilex glabra*) – black root rot, Phytophthora root rot

Japanese cedar (*Cryptomeria*) – needle blight, *Phomopsis twig blight*, Phytophthora root rot

Japanese pieris (*Pieris*) – Botryosphaeria dieback, Phomopsis canker, Phytophthora root rot

Japanese photinia red-tip (*Photinia*) – Armillaria root rot, bacterial blight, Botryosphaeria canker, *Entomosporium leaf spot, powdery mildew*

Juniper (*Juniperus*) – Kabatina tip blight, Pestalotia dieback, *Phytophthora root rot*, Pythium root rot, *rust*

Lavender (*Lavandula*) – Phytophthora root rot, Pythium root rot

Lavender cotton (*Santolina*) – Rhizoctonia root rot

Leyland Cypress (*Cupressocyparis*) – phytophthora root rot

Lilac (*Syringa*) – anthracnose, *bacterial blight, Botrytis blight,* Cercospora leaf spot, *Phytophthora root rot, powdery mildew*

Linden (*Tilia*) – spot anthracnose, white rot

Magnolia – bacterial leaf spot, *powdery mildew*

Maple (*Acer*) – *Anthracnose, bacterial scorch*, *bacterial wetwood*, Botryosphaeria dieback, Cytospora canker, Ganoderma root rot, leaf spot, Nectria canker, Phomopsis dieback, *purple-eye leaf spot*, tar spot, Valsa canker, *Verticillium wilt, zonate leaf spot*

Mimosa (*Albizia*) – Fusarium wilt

Mountain laurel (*Kalmia*) – Botryosphaeria dieback, Cercospora leaf spot

Mulberry (*Morus*) – berry blight

Ninebark (*Physocarpus*) – powdery mildew, Rhizoctonia root rot

Oak (*Quercus*) – *anthracnose*, Armillaria root rot, bacterial scorch, *bacterial wetwood*, Botryosphaeria canker, Cylindrocladium root rot, Discula anthracnose, Hypoxylon canker, *leaf blister*, Phomopsis dieback, *powdery mildew*, rust, smooth patch, spot anthracnose, *Tubakia leaf spot*

Oleander (*Nerium oleander*) – bacterial gall

Paxistima – Phytophthora root rot

Periwinkle (*Vinca minor*) – oedema, *Phoma dieback*, *Phomopsis dieback*, Phyllosticta stem rot/leaf spot, Pythium root rot, Rhizoctonia root/stem rot, Southern blight

Pine (*Pinus*) – Armillaria root rot, Atropellis twig canker, Cenangium dieback, Cytospora canker, *Diplodia tip blight*, Dothistroma needle blight, Eastern gall rust, Fusiform rust, needle cast, needle rust, Phacidiopycnis canker, Phytophthora root rot, *pinewood nematodes*

Pistache (*Pistacia*) – Verticillium wilt

Poplar (*Populus*) – *Botryosphaeria canker*, leaf spot

Pothos (*Epipremnum*) – Phytophthora stem rot

Privet (*Ligustrum*) – anthracnose, Cercospora leaf spot, Phytophthora root rot

Redbud (*Cercis*) – Botryosphaeria dieback, botrytis blight, Fusarium canker, leaf spot, Verticillium wilt

Redwood (*Sequoia*) – Cercospora needle blight, Phomopsis needle blight

Rose (*Rosa*) – anthracnose, *black spot*, Botryosphaeria dieback, Botrytis blight, *crown gall, downy mildew*, Phomopsis canker, *powdery mildew*, Pythium root rot, *rose rosette disease*, viral disease

Rosemary (*Rosmarinus*) – Botrytis blight, crown gall, *Phytophthora root rot*, Pythium root rot

Rose of Sharon (*Hibiscus syriacus*) – leaf spot

Russian arborvitae (*Microbiota decussata*) – Phytophthora root rot

Service berry (*Amelanchier*) – rust, Entomosporium leaf spot

Silverbell (*Styrax*) – leaf spot

Smoke bush (Cotinus) – anthracnose, Verticillium wilt

Snowball bush (Viburnum) – spot anthracnose, bacterial scorch, Botryosphaeria dieback, Botrytis blight, phoma leaf spot, Phytophthora root rot, Rhizoctonia root rot

Sourwood (*Oxydendrum arboreum*) – leaf spot

Spiraea – leaf spot

Spruce (*Picea*) – Cytospora canker, Phytophthora root rot, Pythium root rot, needle blight, tip blight

St Johnswort (*Hypericum*) – Phytophthora stem/root rot, rust, Rhizoctonia root rot

Sweetgum (*Liquidambar*) – Cercospora leaf spot, Endothia canker, Sphaeropsis gall

Sycamore (*Platanus*) – *anthracnose*, bacterial scorch, Botryosphaeria dieback, *powdery mildew*

Thyme (*Thymus*) – Pythium root rot

Tree-of-heaven (*Ailanthus*) – Fusarium stem/root rot

Trumpet vine (*Campsis*) – anthracnose

Tulip tree (*Liriodendron*) – powdery mildew

Umbrella tree (*Schefflera*) – oedema, Pythium root rot

Wax myrtle (*Myrica cerifera*) – anthracnose, Botryosphaeria dieback, Phytophthora root rot, Septoria leaf spot

Weeping fig (*Ficus benjamina*) – anthracnose, Phomopsis gall

Weigela – Phytophthora root rot, Pythium root rot

Willow (Salix) – *Armillaria root rot*, *Botryosphaeria dieback*, Botrytis blight, black canker, Cercospora leaf spot, crown gall, rust, scab, white rot

Wisteria – Botryosphaeria dieback

Witchhazel (*Hamamelis*) – Botryosphaeria dieback, Phyllosticta leaf blight, powdery mildew

Yellowhorn (Xanthoceras sorbifolium) – Botrytis blight

Yellow wood (*Cladastris*) – anthracnose

Yew *(Taxus)* – Botryosphaeria dieback, *Phytophthora root rot*

Yucca – bacterial soft rot, Mycosphaerella leaf spot

When to Call a Professional

The Index of Ornamental Plants and their Diseases (above) is designed as an aid for narrowing down possible common disease problems on herbaceous and woody ornamental plants. Your local VCE office can assist you in obtaining an accurate diagnosis of a plant problem. An accurate diagnosis is necessary for identifying an effective management option and avoids needless and ineffective use of pesticides.

General Pesticide Recommendations for Ornamental Disease Management

The pesticide brands in Table 4.1 are ones that are commonly available for retail sale to home growers and in sizes and formulations appropriate for home growers. Table 4.1 should be used in conjunction with Table 4.2 (ornamental plants) or Table 4.3 (landscape trees) to determine the appropriate pesticide for a particular plant disease. The listing of these products is not an endorsement of the product. Users must read the product label and determine if the desired use is allowed, follow all product label directions and heed product label precautions. Tables 4.2 and 4.3 serve as general guides for selection of an appropriate pesticide active ingredient by plant disease.

Table 4.1—Fungicide Brands Labeled for Use on Home Ornamentals

Active Ingredient	Brand Name/Manufacturer	Comments
Captan	Captan 50% WP (Bonide) Captan 50W Fungicide (Hi-Yield)	
Chlorothalonil	Fung-onil (Bonide) Vegetable, Flower, Fruit and Ornamental Fungicide (Hi-Yield) Broad Spectrum Landscape & Garden Fungicide (Ferti-lome) Garden Disease Control (Ortho) Liquid Ornamental and Vegetable Flowable Fungicide (Southern Ag)	
Copper diammonia diacetate complex	Liqui-Cop (Monterey) Liquid Copper Fungicide (Southern Ag)	May cause phytotoxicity on some plants not specifically listed on the product label—perform a test spray before treating entire plant/planting.
Copper Octanoate (Copper Soap)	Copper Soap Fungicide (Ferti-lome) Captain Jack's Copper Fungicide (Bonide)	May cause phytotoxicity on some plants not specifically listed on the product label—perform a test spray before treating entire plant/planting.
Mancozeb	Mancozeb Flowable with Zinc (Bonide)	
Myclobutanil	Fungi-Max (Monterey) F-Stop (Ferti-lome) Immunox Multi-Purpose Fungicide (Immunox)	Limit the number of applications annually to the number listed on the product label.
Neem oil	Neem Oil (Monterey) 70% Neem Oil (Monterey) Neem (Ferti-lome)	Neem oil is toxic to bees exposed to direct treatment. Do not apply while bees are active on plants.
Potassium bicarbonate	Bi-Carb Old Fashioned Fungicide (Monterey)	

Table 4.1—Fungicide Brands Labeled for Use on Home Ornamentals (cont.)

Active Ingredient	Brand Name/Manufacturer	Comments
Potassium salts of phosphorous acid	Monterey Garden Phos Systemic Fungicide (Monterey)	
Propiconazole	Infuse (Bonide) Liquid Systemic Fungicide II (Ferti-lome)	Do not apply to African violets, begonias, Boston ferns or geraniums.
Streptomycin Sulfate	Fire Blight Spray (Hi-Yield)	
Sulfur	Sulfur Plant Fungicide (Bonide)	Do not use during periods of high temperature OR within 2 weeks of an oil spray. This can be used as a dust or in a spray solution with water, according to product label directions.
Tebuconazole	Disease Control for Roses, Flowers, & Shrubs (Bioadvanced)	
Thiophanate-methyl	Thiomyl Ornamental Systemic Fungicide (Southern Ag)	
Triforine	Ortho Rose Disease Control (Scotts-Ortho)	

Table 4.2—General Guideline for Pesticide Active Ingredient Selection for Home Ornamentals (Refer to Table 4.1 for brand name products by active ingredient.)

Type of Disease	Active Ingredient
Oomyceteous	
Phytophthora root rot Pythium root rot	Potassium salts of phosphorous
Downy mildew Phytophthora blight/dieback	Potassium salts of phosphorous acid Copper diammonia diacetate complex Copper octanoate (copper soap)
Fungal	
Black root rot Cylindrocladium root rot Rhizoctonia root/stem rot Sclerotinia root rot	Thiophanate-methyl
Rhizoctonia blight/web blight	Chlorothalonil Copper octanoate (copper soap) Thiophanate-methyl
Southern blight	Tebuconazole
Botrytis blight	Chlorothalonil Mancozeb

Table 4.2—General Guideline for Pesticide Active Ingredient Selection for Home Ornamentals (cont.)

Type of Disease	Active Ingredient
Tip and twig blights (Diplodia, Kabatina, Phomopsis)	Thiophanate-methyl
Powdery mildew	Myclobutanil Neem oil Potassium bicarbonate Propiconazole Sulfur Tebuconazole Triforine
Rust	Myclobutanil Tebuconazole Triforine
Boxwood blight	Chlorothalonil
Alternaria leaf spot Anthracnose Cercospora leaf spot Curvularia leaf blight Cylindrocladium leaf spot Entomosporium leaf spot (Eastern) filbert blight Gnomonia leaf spot Heterosporium leaf spot Leaf streak (daylily) Macrophoma leaf spot Mycosphaerella leaf spot Phyllosticta leaf spot Purple-eye leaf spot Scab Septoria leaf spot Spot anthracnose Volutella blight Zonate leaf spot	Captan Chlorothalonil Copper diammonia diacetate complex Copper octanoate (copper soap) Mancozeb Propiconazole Thiophanate-methyl Tebuconazole
Black spot (rose)	Sulfur Triforine
Leaf/flower gall	Chlorothalonil Mancozeb
Flower/petal blight	Chlorothalonil Myclobutanil Triforine

Table 4.2—General Guideline for Pesticide Active Ingredient Selection for Home Ornamentals (cont.)

Type of Disease	Active Ingredient
Bacterial	
Bacterial leaf spot	Copper octanoate (copper soap) Copper diammonia diacetate complex
Crown gall	No chemical control for home grower use.
Fire blight	Copper diammonia diacetate complex Streptomycin sulfate
Soft rot	Copper diammonia diacetate complex
Nematode	No chemical control for home grower use.
Viral	No chemical control for plant virus disease.

Diseases of Landscape Trees

Elizabeth Bush, Extension Plant Pathologist, Virginia Tech

Overview

Many diseases of landscape trees can be effectively managed or prevented by cultural control methods. Choosing the right plant for the right place, purchasing healthy disease-resistant plant material, using proper planting techniques, and providing proper nutrition and adequate water will help trees to maintain their best defense against pathogens and keep trees strong and healthy.

General Cultural Controls

- It is advisable to purchase healthy plants from a reputable nursery. Do not purchase pot bound container plants or plants that are off-color, wilting, and/or have signs or symptoms of pests or diseases.
- Avoid common landscape tree diseases by careful selection of tree species or cultivars. Cultivars with resistance to the most common diseases are available for many tree species. Nursery personnel or your local Extension agent can help identify the best resistant cultivars for the tree species you wish to purchase. Refer to electronic fact sheets on problem-free trees and problem-free shrubs for Virginia at the following urls:
- http://pubs.ext.vt.edu/450/450-237/450-237.html
- http://pubs.ext.vt.edu/450/450-236/450-236.html
- Optimal soil pH is critical for optimal nutrient uptake by plants. If a soil pH problem is suspected, soil pH should be determined by a soil test. Fertilizer applications should be based on soil test results to avoid unnecessary fertilizer application, over-application of fertilizer and fertilizer runoff. The Virginia Tech Soil Testing Laboratory provides soil pH and nutrient analysis for a fee. Fertilizer recommendations and recommendations for modifying the soil pH, if necessary, are included in the soil test report.
- Many problems with landscape trees are caused by poor site choice or poor cultural practices. It is especially important to choose a site with the proper soil and drainage for a particular tree species. Poor drainage is a common cause of decline in tree species not adapted to wet sites.
- Drought stress makes many woody plants susceptible to disease and is a common cause of establishment failure in new tree plantings. Research at Virginia Tech shows that in dry conditions (rainfall less than 1" per week), irrigating deeply twice a week for the first year after transplanting helps prevent stress to the tree. Note that irrigation must be applied directly to the rootball of plants transplanted from a container. Also, the rootball of a container plant will dry before surrounding soil, so irrigation may have to be applied more frequently for container transplants. Root balls of pot-bound plants tend to shed water, rather than absorbing water, so avoid purchasing pot bound plants. Moisture stress can also occur over the winter when the ground is frozen. Watering trees in the fall before the ground freezes helps prevent winter desiccation. This is especially important for broad-leaved evergreen plants.
- Improper planting is a common and serious problem associated with unhealthy or declining landscape trees. One of the most common planting problems is planting trees too deeply. Many trees cannot tolerate being planted too deeply and will gradually decline. The structural root nearest the soil line should be placed no deeper than 1 to 3 inches below the soil surface, measured 4 inches out from the trunk. (Structural roots are the large, woody roots that support the tree/shrub.) Note that structural roots are sometimes placed too deeply when potted or planted at the nursery. If this is the case, remove excess soil or potting medium so that plants can be set to the correct depth in the landscape. Also avoid wounding trees when planting, since this can allow colonization by secondary decay fungi and subsequent wood decay.
- Stem-girdling roots are another serious problem that is associated with improper planting and/or planting root bound container trees. Stem-girdling roots cause tree decline, which typically leads to death, and symptoms often only become obvious when trees are mature. To avoid stem-girdling roots, carefully examine roots of container plants before purchasing. Signs of girdling roots include a circular pattern of the fibrous roots on the outer surface of the root ball or main lateral roots that grow straight downward or in a circular pattern instead of extending laterally from the trunk. Do not purchase trees with obvious problems in the main structural roots or container trees that are severely pot-bound. Loosen or sever encircling fibrous roots to prevent continued circular growth after transplanting.

For more information on proper tree planting practices refer to "Tree and Shrub Planting Guidelines" (http://pubs.ext.vt.edu/430/430-295/430-295_pdf.pdf) .

General Biological Controls

- Soil amendments: Adding compost or other organic matter to garden soil may increase populations of beneficial microbes in the soil. Some of these microbes may be antagonistic, predatory, or may simply out-compete pathogens, and reduce the likelihood of disease.
- Biological pesticides: Biological pesticides are formulated from living organisms, such as fungi, bacteria, and nematodes that may be antagonistic, predatory, parasitic or may simply out-compete pathogens. The number of biological control products available to homeowners for disease control is growing. These products are safer to handle, break down quickly, and are considered to be environmentally friendly compared to many other pesticides. Some biological pesticides are ineffective or less effective compared to other pesticide products for controlling certain plant diseases. However, when biological pesticides are used in conjunction with cultural and other control tactics, or when disease pressure is low, disease may be controlled to an acceptable level with these pesticides.

General Mechanical Controls

- Prune trees to maintain shape and remove dead or diseased plant tissues. Canker-causing pathogens may produce fruiting structures or remain dormant on dead or dying branches. Pruning helps to remove pathogen inoculum and prevent future infections. Prune branches well below any evident discolored or dead wood. Remove branches from the site, bury them in soil, or burn them according to local ordinances.
- Dip pruning tools between cuts in rubbing alcohol or in a household bleach solution consisting of 1 part bleach + 9 parts water. The solution is more effective if a little soap is added as a wetting agent.
- Place a thin layer of mulch (no more than two inches deep) in a donut-shaped ring around trees to help prevent lawnmower or weed-eater injury to tree trunks. Mechanical injury to trees can invite secondary decay organisms.
- Apply mulch to trees properly. When mulch is piled against the base of a tree trunk, the bark remains moist and becomes susceptible to invasion by decay organisms or insects and to feeding damage by voles (rodents that feed below the mulch surface). This may girdle and kill the tree. Apply mulch in a donut-shaped ring around the trunk with little or no mulch actually touching the tree trunk.

General Chemical Controls

- Use fungicides to control landscape tree diseases only when a destructive disease is a known threat. Few tree diseases require regular spray schedules on a yearly basis. For example, spraying to control anthracnose diseases is useful during prolonged damp weather in late winter and early spring.
- Most fungicides for home landscape use are designed to be protective. To be effective, they must be applied BEFORE the fungus is deposited on the plant surface.
- Reapply fungicides if they are washed off by rain. Adding a spreader-sticker to the fungicide suspension can enhance disease control.
- Organic control products vary in their application intervals, and many organic products have a shorter application interval than chemical pesticides. Pay careful attention to label instructions.

Restistant Cultivars

- Disease-resistant plants: Resistant cultivars are available for some common plant disease problems. For example, there are dogwood and crape myrtle cultivars resistant to powdery mildew. Using disease resistant cultivars to avoid common disease problems is recommended when possible.

Precautions

- Some chemical fungicides are toxic to fish. It is important to follow recommended procedures for disposing of any excess fungicide. Do not pour excess fungicides into drainage outlets that lead to bodies of water. Prepare only the amount of fungicide needed for a given application so that all of the fungicide can be sprayed and none or little is left over.
- Repeated use of certain fungicides, such as single-site toxicants, can make pathogens resistant to fungicides. If the label lists precautions about the maximum number of sprays allowed in one season or suggests rotation with fungicides of a different chemical class (FRAC code), pay special attention to this information.

When to Call a Professional

- Trees with significant dieback or wood decay may pose a risk to surrounding building structures or to people. Have dead branches pruned promptly to avoid damage to people or property.
- A tree with internal decay in its trunk may be compromised structurally and could be susceptible to wind or storm damage. A certified arborist can test a tree for the extent of the decay. This test is worthwhile if the tree poses a risk to people or nearby buildings.

Links to Useful Sources of Information

- Virginia Cooperative Extension education resources (e.g. plant disease fact sheets) https://www.pubs.ext.vt.edu/
- Plant Problem Image Gallery https://apps.cals.vt.edu/ppig/

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
Ash (*Fraxinus*) Anthracnose (Various fungi)	Chlorothalonil Chlorothalonil + thiophanate methyl Mancozeb Propiconazole Tebuconazole Thiophanate methyl Thiophanate methyl + mancozeb	**Chemical Control**: Apply fungicides at label rates and intervals, beginning at bud break or first sign of disease. **Cultural Control**: Collect and either burn or bury fallen leaves to reduce overwintering of fungal inoculum. **Precautions/Remarks**: Note that some fungicides should be rotated with other products to prevent the development of fungicide resistance in the pathogen population. Pay special attention to label instructions regarding the maximum number of times a product should be applied sequentially or the total quantity of product that may be applied per season.
Rust (*Puccinia*)	Mancozeb Myclobutanil Tebuconazole Thiophanate methyl	**Chemical Control**: Apply fungicides in early spring. Later applications are not effective. Follow label rates and intervals. **Precautions/Remarks**: By the time symptoms of this disease are noted, control will not be effective.
Beech (*Fagus*) Anthracnose (Various fungi)	See fungicide list for ash anthracnose.	**Precautions/Remarks:** Follow recommendations for control of ash anthracnose.
Canker (various fungi)	No chemical controls	**Cultural Control**: Prune affected branches below the canker and remove pruned branches from the landscape.
Birch (Betula) Anthracnose (Various fungi)	See fungicide list for ash anthracnose.	**Precautions/Remarks:** Follow recommendations for control of ash anthracnose.
Black Gum (*Nyssa sylvatica*) Felt Fungus (*Septobasidium fumigatum*)		**Chemical Control:** There are no controls for this fungus and this fungus does not infect or parasitize the tree. If the tree looks healthy during the growing season, it may not be necessary to control the associated scale insect (refer to Insects of Trees section, “Scale insects, General”). **Precautions/Remarks:** Fungi in this genus form parasitic/mutualistic relationships with scale insects. They do not parasitize the plant, but they parasitize the scale insect and they obtain nutrients from the insects after the insects feed on the plant. At the same time, the fungus provides a protective habitat for the scale insect.
Canker (various fungi)	No chemical controls	**Cultural Control**: Prune affected branches below the canker and remove pruned branches from the landscape.
Cryptocline Leaf Spot (Cryptocline betularum)	See fungicide list for ash anthracnose.	**Chemical Control:** Begin fungicide applications when leaf spots first appear and repeat according to label directions. **Cultural Control:** Remove fallen leaves to reduce inoculum available for future infections. **Precautions/Remarks:** This disease is also known as birch anthracnose and occurs on *Betula nigra* and *Betula lenta*. It can cause significant defoliation.
Buckeye (*Aesculus*) Leaf Spot and Blotch (*Guignardia*)	See fungicide list for ash anthracnose.	**Precautions/Remarks:** Follow recommendations for control of ash anthracnose.

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.) (cont.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
Catalpa (*Catalpa*) Verticillium Wilt (*Verticillium*)	No chemical controls	**Precautions/Remarks**: Verticillium wilt cannot be controlled with fungicides. Replace trees that have died from this disease with immune species (see list). **Trees or Shrubs Not Reported to be Affected by Verticillium Wilt**: *Abies* spp. (fir) *Amelanchier* spp. (serviceberry) *Betula* spp. (birch) *Buxus* spp. (boxwood) *Carpinus* spp. (ironwood) *Castanea mollissima* (Chinese chestnut) *Ceanothus* spp. (red-root) *Celtis* spp. (hackberry) *Cercidiphyllum japonicum* (katsura tree) *Cornus* spp. (dogwood) *Crataegus* spp. (hawthorn) *Fagus* spp. (beech) *Ficus carica* (fig) *Ginkgo biloba* (ginkgo) *Gleditsia triacanthos* (honey locust) *Ilex* spp. (holly) *Juglans* spp. (walnut) *Juniperus* spp. (juniper) *Larix* spp. (larch) *Liquidambar styraciflua* (sweetgum) *Malus* spp. (apple, crabapple) *Morus* spp. (mulberry) *Nerium oleander* (oleander) *Picea* spp. (spruce) *Pinus* spp. (pine) *Platanus* spp. (sycamore) *Pyracantha* spp. (firethorn) *Pyrus* spp. (pear) *Quercus alba* (white oak) *Quercus falcata* (southern red oak) *Quercus phellos* (willow oak) *Quercus viriginiana* (live oak) *Salix* spp. (willow) *Sorbus aucuparia* (European mountain ash) *Taxus* spp. (yew) *Zelkova serrata* (zelkova)
Chestnut (*Castanea*) Canker/Chestnut Blight (*Cryphonectria*)	No chemical controls	**Cultural Control**: Excise cankers at least one inch beyond visibly stained bark tissues and remove pruned branches from the landscape. Fungicides are not effective for control.
Cherry, Ornamental (*Prunus*) Brown rot (*Monilinia*)	Chlorothalonil Propiconazole Potassium bicarbonate	**Chemical Control:** Applying a registered fungicide, beginning when blossoms open, may help protect trees from the blossom blight phase of the disease. **Cultural Control:** Control may be difficult if disease is severe.
Cankers (various fungi)		**Cultural Control:** Prune out affected branches below cankers back to healthy wood. **Precautions/Remarks:** Ornamental cherries are susceptible to a variety of fungal canker diseases and therefore may not be the best choice for landscape plantings. Symptoms include swollen, sunken, or cracked areas and oozing gum on the bark. Dieback occurs above the canker. Fungicides are not effective for control. If cankers occur on the trunk, trees cannot be saved.
Cherry leaf spot (*Blumeriella*)	Chlorothalonil Propiconazole Myclobutanil Neem oil Potassium bicarbonate	**Chemical Control:** To prevent the disease on ornamental cherries, fungicide applications are recommended at regular intervals,starting when leaves first become fully mature and continuing until late summer. **Cultural Control:** Rake and remove fallen leaves to prevent overwintering of fungal inoculum. **Precautions/Remarks:** Severe defoliation reduces winter hardiness. Prolonging leaf retention by controlling the disease will improve winter hardiness of the tree.

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.) (cont.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
Cherry, Ornamental (*Prunus*) (cont.) Cercospora leaf spot (*Pseudocercospora*)	Chlorothalonil Myclobutanil Neem oil Potassium bicarbonate Propiconazole	**Chemical Control:** Three to four applications of a preventative fungicide should begin at leaf emergence. Repeat applications according to product label directions. Fungicide applications initiated when symptoms are present will not be effective. **Cultural Control:** Remove fallen leaves to reduce inoculum available for future infections. **Precautions/Remarks:** This disease can cause early defoliation, which will weaken the tree and make the tree more susceptible to winter injury.
Conifers Needle Cast Diseases (various fungi)	Chlorothalonil Mancozeb	**Chemical Control:** Needle casts are caused by a variety of fungi. Generally, a broad-spectrum fungicide, applied at label rates in a series of applications as needles are emerging in the spring, will adequately control most needle cast fungi. Fungicide treatment for several years in a row may be necessary so that new growth will hide branches with missing needles in the interior canopy. Begin fungicide applications at bud break, followed by applications at 3- to 4-week intervals until needles are fully elongated. **Cultural Control:** Collect and remove fallen twigs and needles from the landscape in autumn.
Crabapple (*Malus*) Cedar-Apple Rust (*Gymnosporangium juniperi-virginianae*)	Mancozeb Myclobutanil Propiconazole Tebuconazole Thiophanate methyl Thiophanate methyl + mancozeb	**Chemical Control**: Apply fungicides at label rates beginning at bud break or first sign of disease. **Cultural Control**: Many cultivars of crabapple have resistance to this and other crabapple diseases. Choose cultivars with resistance to as many of these diseases as possible for new plantings. **Precautions/Remarks**: Removal of Eastern red cedars, the alternate host for the fungus, can help to reduce the amount of fungal inoculum available for infecting apples and crabapples; however, this control method is usually not practical as spores can spread from other red cedars in the surrounding area. Note label instructions regarding rotation of certain fungicides with other products to prevent the development of fungicide resistance.
Japanese Apple Rust (*Gymnosporangium yamadae*)	Mancozeb Myclobutanil Propiconazole Tebuconazole Thiophanate methyl Thiophanate methyl + mancozeb	**Chemical Control:** Fungicides recommended for control of cedar-apple rust should also control this rust disease. **Cultural Control:** Japanese apple rust is a disease that was recently introduced to the United States. It is not yet known how cultivars of crabapple that have been bred for resistance to cedar-apple rust will respond to this new rust species. The alternate hosts of Japanese apple rust are Chinese juniper (*Juniperus chinensis*) and Himalayan juniper (*Juniperus squamata*). Removal of these species in the vicinity of susceptible crabapples may reduce disease occurrence on the crabapple. **Precautions/Remarks:** Symptoms of Japanese apple rust on the juniper host are less conspicuous than the galls caused by cedar-apple rust. Japanese apple rust causes fusiform swellings on juniper stems.

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.) (cont.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
Crabapple (*Malus*) (cont.) Fire blight (*Erwinia amylovora*)	Streptomycin sulfate	**Chemical Control:** Streptomycin sprays should be applied at label rates during bloom, starting at 20-30% bloom, using no more than 5 applications at 10-14 day intervals. Use of streptomycin after bloom is not effective. **Cultural Control:** Prune out affected branches at least 6 inches below discolored wood and remove pruned branches from the landscape. It is best to prune in late summer when fire blight bacteria are no longer active to avoid spreading bacteria during the pruning operation. Disinfest pruning tools with rubbing alcohol or a solution of 1 part bleach to 9 parts water between cuts. Many cultivars of crabapple have resistance to this and other crabapple diseases. Choose cultivars with resistance to as many of these diseases as possible for new plantings. **Precautions/Remarks:** Streptomycin sulfate is an antibiotic and should not be sprayed unnecessarily. Follow label rates carefully and do not spray outside the bloom period.
Powdery Mildew (*Podosphaera*)	Chlorothalonil Myclobutanil Neem oil Potassium bicarbonate Propiconazole Sulfur Tebuconazole Thiophanate methyl Thiophanate methyl + mancozeb	**Chemical Control**: Commercial products containing several of these fungicides are OMRI-approved, i.e. neem oil, potassium bicarbonate, and sulfur, so are organic options for home growers. **Cultural Control**: Many cultivars of crabapple have resistance to this and other crabapple diseases. Choose cultivars with resistance to as many of these diseases as possible for new plantings. **Precautions/Remarks**: Note label instructions regarding rotation of certain fungicides with other products to prevent development of resistance in the pathogen population. **Related Fact Sheets:** http://pubs.ext.vt.edu/450/450-603/450-603.html
Scab (*Venturia*)	Mancozeb Myclobutanil Propiconazole Tebuconazole Thiophanate methyl Thiophanate methyl + mancozeb	**Chemical Control**: Apply fungicides at label rates beginning at bud break or first sign of disease. **Cultural Control**: The scab fungus overwinters on fallen leaves. Remove fallen leaves in autumn if practical. Many cultivars of crabapple have resistance to this and other crabapple diseases. Choose cultivars with resistance to as many of these diseases as possible for new plantings. **Precautions/Remarks**: Note label instructions regarding rotation of certain fungicides with other products to prevent development of resistance in the pathogen population.
Needle Cast Diseases (various fungi)	Chlorothalonil Mancozeb	**Chemical Control**: Needle casts are caused by various fungi. Generally, a broad-spectrum fungicide, applied at label rates in a series of applications as needles are emerging in the spring, will adequately control most needle cast fungi. Fungicide treatment for several years in a row may be necessary so that new growth will hide branches with missing needles in the interior canopy. Apply chlorothalonil at bud break, followed by applications at 3- to 4-week intervals until needles are fully elongated. Begin mancozeb sprays in spring or early summer and repeat after heavy rains and at 2-week intervals. **Cultural Control**: Collect and remove fallen twigs and needles from the landscape in autumn. **Precautions/Remarks**: Symptoms of needle cast typically become apparent in late summer and/or autumn and fungicide applications in autumn will not be effective.

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.) (cont.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
CYPRESS FAMILY		
Dawn Redwood (*Metasequoia*) Dothiorella Canker (*Dothiorella*)	No chemical controls	**Cultural Control**: Prune affected branches below the canker and remove pruned branches from the landscape.
Giant Sequoia (*Sequoiadendron giganteum*) **Italian cypress (*Cupressus sempervirens*)** Cercospora Blight (*Pseudocercospora juniper* and *Passalora sequoiae*)	Chlorothalonil Mancozeb Myclobutanil Thiophanate methyl Thiophanate methyl + mancozeb	**Chemical Control:** Apply fungicides at bud break and repeat during the growing season according to product label directions. Fungicides are not practical for large trees. Severely diseased trees should be removed. **Cultural Control:** Allow generous spacing between trees to promote foliar drying. Avoid planting susceptible trees in low lying areas where conditions will be moist and favor disease development. **Precautions/Remarks:** This disease is reported to occur on other members of the Cypress family (*Cupressaceae*), but susceptibility varies among cypress species. In Virginia we have observed Cercospora Blight on Giant sequoia and Italian cypress. This disease causes needle loss that progresses from the bottom of the tree upward and can be quite severe in Virginia's moist climate. Severe defoliation can lead to death, so avoidance of Italian cypress and Giant Sequoia in Virginia may be warranted.
Leyland Cypress (*x Cupressocyparis leylandii*) Cankers (*Seiridium, Botryosphaeria*)	No chemical controls	**Cultural Control:** Trees are predisposed to these canker diseases by drought stress. In some cases, decline can be reversed in the early stages of disease with adequate irrigation. Prune out affected branches below cankers (look for cracked, swollen or sunken bark with resin droplets) and remove pruned branches from the landscape. Dip pruning tools in rubbing alcohol or a solution of 1 part bleach to 9 parts water between cuts to avoid spreading the pathogen. **Precautions/Remarks:** Seiridium canker is a common disease on Leyland cypress.
Dogwood (*Cornus*) Bacterial Wetwood/Slime Flux (various bacteria)	No chemical controls	**Precautions/Remarks**: Bacterial wetwood is a condition that typically does not cause serious harm to the tree. Many tree species, including elm, oak, dogwood, and probably most other hardwood species, can be affected. Conifers are less commonly affected. Often a rancid or stinky odor emanates from affected tissue due to fatty acids produced by a complex of microorganisms. External signs on bark include vertical light or dark streaks with seeping liquids, wet or dry when observed. The word "wetwood" derives from the wet appearance of cross-sections of the wood. This disease has no practical management solution. Fluxing in oak trees may become more severe in trees that have undergone high environmental stress situations and may disappear when stressors are gone. Stinging insects or other pests may be attracted to fluxing sites. Note: In oaks bacterial wetwood is sometimes confused with Ramorum Blight (= Sudden Oak Death), which is not currently known to occur in Virginia.

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.) (cont.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
Dogwood (*Cornus*) (cont.) Discula Anthracnose (*Discula destructiva*)	Chlorothalonil Mancozeb Myclobutanil Neem oil Propiconazole Tebuconazole Thiophanate methyl	**Chemical Control:** Fungicides can be used to manage this disease. Apply according to product label directions when symptoms first appear and repeat fungicides applications according to product label directions. **Cultural Control:** Understory trees are more prone to infection. Plant trees in full sun and water, mulch, and fertilize as necessary to maintain good growth. One cultivar of *Cornus florida* with resistance to Discula anthracnose has been developed ('Appalachian Spring'); however, this cultivar does not have resistance to powdery mildew, another important disease of dogwood. Kousa dogwood (*Cornus kousa*) has resistance but is not immune to the disease; leaf and flower spots will occur on kousa dogwood, but trees are not killed by the fungus. Several hybrids of kousa and flowering dogwood (e.g. 'Stellar' series) with resistance to both Discula anthracnose and powdery mildew are available. **Precautions/Remarks:** This disease develops rapidly and may kill the tree. It is especially serious at cool temperatures, high moisture, higher elevations, and near water sources. Note label instructions regarding rotation of certain fungicides with other products to prevent the development of fungicide resistance.
Powdery Mildew (*Oidium*)	Chlorothalonil Myclobutanil Neem oil Potassium bicarbonate Propiconazole Sulfur Tebuconazole Thiophanate methyl Thiophanate methyl + mancozeb	**Chemical Control**: Apply fungicides at label rates beginning at bud break or first sign of disease. **Cultural Control**: Cultivars of flowering dogwood, kousa dogwood, and hybrid (flowering x kousa) dogwoods with resistance to powdery mildew are available for new plantings. **Precautions/Remarks**: Although powdery mildew diseases of some plant species are primarily a cosmetic problem, powdery mildew of dogwood can severely stunt the tree. Note label instructions regarding rotation of certain fungicides with other products to prevent the development of fungicide resistance.
Septoria Leaf Spot (*Septoria*)	Chlorothalonil Mancozeb Myclobutanil Tebuconazole Thiophanate methyl Thiophanate methyl + mancozeb	**Chemical Control:** Although fungicides are registered for control of Septoria leaf spot, the disease often occurs toward the end of the growing season and fungicide control may not be warranted. If the disease occurs earlier in the season, fungicides can be used to manage, according to product label directions. **Precautions/Remarks:** Leaf spots caused by Septoria may resemble Discula anthracnose leaf spots; however, Septoria leaf spots are more angular and more consistent in size, whereas Discular leaf spots vary widely in size and are not angular. Dieback is not associated with Septoria leaf spot. Note label instructions regarding rotation of certain fungicides with other products to prevent the development of fungicide resistance.

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.) (cont.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
Dogwood (*Cornus*) (cont.) Spot Anthracnose (*Elsinoe*)	Chlorothalonil Mancozeb Tebuconazole Thiophanate methyl + mancozeb	**Chemical Control:** This disease is an early season disease and does not pose a threat to the overall health of the tree, so fungicide treatment is really not warranted. Fungicides may be applied at label rates beginning when buds begin to open and then repeated three times: when bracts have fallen, four weeks after bract fall, and in late summer after flower buds form. **Cultural Control:** Removal of fallen leaves may help prevent new infections. **Precautions/Remarks:** Although the names of the diseases are similar, spot anthracnose is a distinct disease from Discula anthracnose. Spot anthracnose is not fatal to the tree. It is present to some degree every year, but is more severe in wet springs. Leaf and bract spots are tiny and do not enlarge. The fungus attacks the leaves and flowers but not the branches. Note label instructions regarding rotation of certain fungicides with other products to prevent the development of fungicide resistance.
Douglas-fir (*Pseudotsuga*) Swiss Needle Cast (*Phaeocryptopus*)	Chlorothalonil Mancozeb	**Chemical Control**: See comments on control of needle cast diseases in Conifers section.
Eastern Red Cedar (*Juniperus virginiana*) Cercospora Blight (*Cercospora*)	Copper diammonia diacetate complex Mancozeb	**Chemical Control:** Make first fungicide application in early June; second application in late July. Additional applications may be needed during periods of heavy rain. Follow label rates and precautions. **Precautions/Remarks:** This disease is distinguished from Phomopsis tip blight by the appearance of symptoms from the inside of the tree out and from the bottom of the tree to the top. Phomopsis blight only blights the tips of the shoots and typically is a springtime disease. Chemical controls are not warranted in the home landscape. Blighted tips can be pruned out.
Elm (*Ulmus*) Bacterial Scorch (*Xylella*)		**Chemical Control**: No chemical controls are available for home growers and professional applicator controls will only suppress the disease and not cure the tree, so applications will need to be repeated annually. **Cultural Control**: Pruning out affected branches that are not yet severely affected may slow symptom progression. Branches should be pruned back as far as possible. Tree genera most commonly diagnosed with bacterial leaf scorch in Virginia include oak, sycamore and elm, but many other genera are also susceptible to the disease. New hosts of bacterial leaf scorch continue to be identified. Some tree species currently not reported to be hosts to the bacterial scorch pathogen include European black alder (*Alnus glutinosa*), European beech (*Fagus sylvatica*), black gum (*Nyssa sylvatica*), yellow buckeye (*Aesculus flava*), northern catalpa (*Catalpa speciosa*), katsuratree (*Cercidophyllum japonicum*), Kentucky coffeetree (*Gymnocladus dioicus*), American linden (*Tilia americana*), littleleaf linden (*T. cordata*), silver linden (*T. tomentosa*), cucumbertree (*Magnolia acuminata*), Osage orange (*Maclura pomifera*), tulip poplar (*Liriodendron tulipifera*), and Japanese zelkova (*Zelkova serrata*).These species can be considered as replacement trees. **Precautions/Remarks**: The bacterium causes leaf scorch, a slow decline, and, ultimately, tree death. Leafhoppers and treehoppers are known vectors of the disease, but insect control has not proven effective in controlling the disease. **Related Fact Sheets:** http://pubs.ext.vt.edu/3001/3001-1433/3001-1433.html

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.) (cont.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
Elm (*Ulmus*) (cont.) Bacterial Wetwood/Slime Flux (various bacteria)	No chemical controls	**Precautions/Remarks:** See comments for bacterial wetwood on dogwood.
Black Leaf Spot (*Gnomonia*)	Mancozeb	**Chemical Control:** Apply mancozeb at label rates at budbreak and 1 to 2 times thereafter at 10- to 14-day intervals. **Cultural Control:** Collect and either burn or bury fallen leaves to prevent overwintering of the fungus.
Dutch Elm Disease (DED) (*Ophiostoma novo-ulmi*)		**Chemical Control:** Chemical treatment for Dutch elm disease requires injections into the root flare and needs to be performed by a professional applicator. Systemic fungicides should be injected **before** removal of diseased branches. Treatment administered after crown involvement exceeds 5% may not be effective. Injections should be made by certified arborists. **Cultural Control:** An integrated program is strongly recommended to protect susceptible elms from DED. Prompt removal and destruction of affected branches or dead trees is necessary to prevent spread of the fungal pathogen by beetle vectors. Affected branches should be pruned at the trunk using recommended pruning procedures. Root grafts between affected and nearby healthy trees should be severed to prevent transmission of the fungus through graft unions. There are many DED-resistant cultivars available, so use a resistant cultivar for any new planting.
Filbert/European hazelnut (*Corylus avellana*) --ornamental filbert ONLY Eastern Filbert Blight (*Anisogramma anomala*)	Copper diammonia diacetate complex	**Chemical Control:** Preventative fungicides can be used to manage this disease on ornamental filbert trees that are not already severely affected. Note that filbert used for nuts as a food source cannot be treated. This recommendation is for ornamental filberts only. Beginning at budswell, apply three to four applications of a copper fungicide at product label intervals. Follow label precautions and directions. **Cultural Control:** Infected branches should be pruned out well below visible cankers. Do not leave infested debris in the landscape. **Precautions/Remarks:** Precautions/Remarks: Carefully follow copper fungicide label precautions relating to phytotoxicity. **Related Fact Sheet:** http://wiki.bugwood.org/Anisogramma_anomala_(eastern_filbert_blight)
Hawthorn (*Crataegus*) Cedar-Quince Rust (*Gymnosporangium clavipes*)	Chlorothalonil Chlorothalonil + thiophanate methyl Myclobutanil Tebuconazole Thiophanate methyl	**Chemical Control**: Spray fungicides at label rates at pre-bloom stage. Generally three sprays, beginning at bud break, are effective in preventing the disease. Fungicides applied after bloom are not effective for control. **Precautions/Remarks:** Note label instructions regarding rotation of certain fungicides with other products to prevent the development of fungicide resistance.
Hickory (*Carya*) Leaf Spot (*Microstoma juglandis)* Gnomonia leaf spot *(Gnomonia caryae)*)	No chemical controls	**Chemical Control**: These leaf spot diseases are not serious enough to warrant chemical control. **Cultural Control**: Remove fallen leaves to prevent overwintering of the fungus.

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.) (cont.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
Honeylocust (*Gleditsia*) Cercospora Leaf Spot (*Cercospora*)	Chlorothalonil Mancozeb Myclobutanil Thiophanate methyl Thiophanate methyl + mancozeb	**Chemical Control**: Apply fungicides at label rates beginning at bud break or first sign of disease and repeat according to product label directions.
Larch (*Larix* sp.) Mycosphaerella Needle Cast (*Mycosphaerella*)	Mancozeb	**Chemical Control:** Preventative fungicides can be used to manage this disease. Three to six applications of preventative fungicides, repeated at product label intervals, beginning in early June are recommended. **Cultural Control:** Remove fallen needles to reduce fungal inoculum for future infections. **Precautions/Remarks:** Repeated needle loss from this disease can lead to branch dieback and/or stunting.
Magnolia (*Magnolia*) Leaf Scorch/Winter Injury		**Chemical Control:** Magnolia and other broad leaved evergreens leaves are especially prone to winter desiccation. A foliar anti-transpirant, such as Wilt Stop (Bonide), can be applied according to manufacturer's directions. **Cultural Control:** If conditions are dry in the fall, water the tree deeply before the ground freezes.
Sooty Mold (various fungi)	No chemical controls for the fungus	**Chemical Control:** In some cases an appropriate insecticide may be recommended. Identify and control insects that secrete the honeydew on which the sooty mold grows. For magnolia, refer to the section on control of magnolia scale in the "Insects of Trees and Shrubs" section. **Precautions/Remarks:** Sooty mold fungi appear as a black coating on the leaf surface of several different tree and shrub species. They do not parasitize the plant; they simply grow on the honeydew substance secreted by certain insects, such as aphids and scales.
Maple (*Acer*) Anthracnose (*Kabatiella*, others)	See fungicide list for ash anthracnose.	**Chemical Control:** This disease is common in spring, but is generally harmless except in very wet springs. When weather is conducive to disease development, the fungicides recommended for ash anthracnose can be used for control. **Cultural Control**: Remove fallen leaves to reduce overwintering of fungal inoculum.
Purple-eye Leaf Spot (*Phyllosticta minima*)		**Chemical Control:** This is not a serious threat to the overall health of the tree and does not usually warrant fungicide control. **Cultural Control:** Raking and removing fallen leaves in fall will reduce the amount of overwintering inoculum that will be available to infect the trees next year.
Verticillium Wilt (*Verticillium*)	No chemical controls	**Cultural Control:** Some research indicates that vigorous nitrogen fertilization with ammonium sulfate, above the rate a tree might receive on a standard maintenance program, may enhance recovery in infected trees. Avoid planting susceptible species in soil where trees have been diagnosed with Verticillium wilt. Refer to the list under the Catalpa section.
Zonate Leaf Spot (*Cristulariella*)	Mancozeb	**Chemical Control:** This disease often appears late in the season when fungicide treatment is no longer warranted. If the disease appears early in the season, which is sometimes seen in Norway and red maple, mancozeb fungicide can be used at label rates. **Cultural Control:** Collect and either burn or bury diseased leaves to prevent overwintering of the fungus.

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.) (cont.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
Mimosa (*Albizia*) Mimosa Wilt (*Fusarium*)	No chemical controls	**Cultural Control:** The mimosa wilt pathogen is soil-borne but has a very narrow host range. Replace trees that have died from this disease with species other than mimosa. **Related Fact Sheets:** https://www.pubs.ext.vt.edu/content/pubs_ext_vt_edu/en/SPES/SPES-230/SPES-230.html
Mountain Ash (*Sorbus*) Cytospora Canker (*Cytospora*)	No chemical controls	**Cultural Control:** Prune affected branches back to healthy wood and remove pruned branches from the landscape.
Oak (*Quercus*) Anthracnose *(Various fungi)*	See fungicide list for ash anthracnose.	**Chemical Control:** Normally this disease is not serious enough to warrant chemical control; however, fungicides recommended for control of ash anthracnose can be used if fungicide control is desired. Adequate coverage may be difficult for large trees.
Bacterial Scorch (*Xylella*)	See control information for bacterial scorch on elm.	**Related Fact Sheets:** http://pubs.ext.vt.edu/3001/3001-1433/3001-1433.html
Bacterial Wetwood (various bacteria)	No chemical controls	**Precautions/Remarks:** See remarks for bacterial wetwood on dogwood.
Chlorosis (abiotic)	Soil pH can be changed chemically to alleviate symptoms.	**Cultural Control:** The most common cause of chlorosis in oaks is high soil pH (≥7.0). Lowering soil pH makes nutrients that aid in chlorophyll synthesis more available to the plant. Soil pH can be lowered by applying an acid-producing fertilizer, sulfur, aluminum sulfate, or other acidic compound to the soil. For an exact rate, submit soil samples to the VT Soil Testing Lab for analysis and recommendations. On sites where soil is difficult to amend, foliar applications of iron chelate can be used. Trunk implantation devices, such as capsules or “Medicaps,” are also available. **Precautions/Remarks:** Chlorosis (yellowing) is a common problem in the Virginia highlands on pin oak (*Quercus palustris*) and in other oak species in other areas of the state. Although the most common cause of chlorosis on oaks in Virginia is high soil pH, chlorosis can also be caused by structural abnormalities in roots, e.g. girdling roots, or by poor drainage, a condition that is common in parking lot islands.
Endothia Canker (*Endothia*)	No chemical controls	**Cultural Control:** Remove cankered branches at the trunk or at the major adjoining branch and remove pruned branches from the landscape. Avoid wounding of any kind, especially lawnmower injuries and pruning wounds (especially in pin oak). Keep pin oaks well watered and apply fertilizer as needed. **Precautions/Remarks:** Endothia canker is most commonly seen on pin oak, but may also occur on other species of oak, including live oak.
Leaf blister (*Taphrina*)	Mancozeb	**Precautions/Remarks:** This disease rarely causes significant stress to oak trees in Virginia. The pathogen infects leaves early in the spring and repeat infections do not occur. By the time symptoms are noticed, chemical control is not effective. If fungicides are used, they must be applied in early spring prior to disease development. Follow label rates and precautions.
Powdery Mildew (*Sphaerotheca*)	No chemical control needed	**Precautions/Remarks:** This disease is usually a late season disease on oaks and control is not warranted.

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.) (cont.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
Oak (*Quercus*) (cont.) Ramorum Blight (Sudden Oak Death) (*Phytophthora ramorum*)	Not known to occur in Virginia at this time	**Chemical Control:** The disease is not known to occur in Virginia at this time and treatment is not recommended in areas where infected plants are not already present. **Precautions/Remarks:** Purchase plants only from reputable growers. This disease is present on the west coast of the United States and affects many woody shrub species, causing symptoms that can be easily overlooked. Quarantines have been invoked on infested counties in the West and all plants shipped from nurseries in infested counties are inspected and approved prior to shipment; however, there is little to no oversight of individuals who may sell plants via the internet. The disease can spread from woody shrub species to oak trees. Virginia nurseries are actively inspected for presence of this disease, so it is best to purchase plants from a reputable local nursery.
Tubakia Leaf Spot (*Tubakia*)	No chemical control needed	**Chemical Control:** This disease is usually a late season disease and chemical control is typically not warranted. However, fungicides containing the active ingredients chlorothalonil and propiconazole are registered for control. **Cultural Control:** Rake and remove fallen leaves to prevent overwintering of the fungus.
Ornamental Pear (*Pyrus*) Fire Blight (*Erwinia amylovora*)	No chemical control needed for ornamental pear	**Cultural Control:** Bradford pear (*Pyrus calleryana*) has resistance to fire blight, but cultivars vary in their level of resistance. In years when weather is conducive to fire blight, some dieback may occur in Bradford pear. In general, the level of damage does not warrant chemical control. Prune out affected branches well below any signs of bark discoloration. Disinfest pruning tools between cuts by dipping in rubbing alcohol or a solution of 1 part bleach to 9 parts water. Remove pruned branches from the landscape. **Precautions/Remarks:** Bradford pear is more prone to mechanical and cultural problems than it is to disease. Branches break easily in wind or ice storms. The species is also very sensitive to deep planting and poor drainage and responds to these conditions by turning black (both foliage and branches) throughout the tree. These symptoms could be confused with fire blight, but fire blight generally affects only a few individual branches at a time on this species.
Pine (*Pinus*) Diplodia Tip Blight (*Diplodia*)	Chlorothalonil Propiconazole Thiophanate methyl	**Chemical Control:** Apply chlorothalonil at bud swell and repeat at 10- to 14-day intervals. Apply thiophanate methyl in spring when new growth emerges. Make a second application just before needles emerge from the sheath and a third application 7 days later. Thorough coverage with fungicides is necessary for optimal disease control. **Cultural Control:** Clubbed shoot tips, which serve as a source of fungal inoculum, should be pruned back to healthy wood. Austrian and other 2-needled pines are especially susceptible to this disease. In some cases, cankers form on branches and white resin accumulates on bark. Such branches should be pruned back to healthy wood. Take care to disinfest pruning tools frequently in rubbing alcohol or a solution of 1 part bleach to 9 parts water. **Precautions/Remarks:** On highly susceptible species, such as Austrian pine, the disease may kill the tree in the absence of early intervention. Note label instructions regarding rotation of certain fungicides with other products to prevent the development of fungicide resistance.

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.) (cont.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
Pine (Pinus) (cont.) Dothistroma Needle Blight (*Dothistroma*)	Copper Octanoate (Copper Soap)	**Chemical Control:** Begin protectant fungicide applications when new needles first emerge in spring and repeat 3 to 4 weeks later. Fungicide applications when needles drop later in the spring and summer will not be effective. **Cultural Control:** Remove fallen twigs and needles to reduce fungal inoculum for future infections. **Precautions/Remarks:** Refer to information on Bordeaux mixture above (under Pine, Diplodia Tip Blight). Follow copper product label precautions regarding copper phytotoxicity.
Disorders of Eastern White Pine (*Pinus strobus*)	No chemical controls	**Precautions/Remarks:** Eastern white pine is a species that is particularly sensitive to a wide array of stresses. It is easily injured by insufficient or excess soil moisture and does not do well where soil profiles have been disturbed or where soil is compacted, e.g. around new building construction. White pine is also susceptible to certain herbicides, deicing salt and air pollutants. Most of these stresses result in overall yellowing, browning and/or stunting of the needles.
Needle Cast Diseases (various fungi)	See Conifers section	**Chemical Control:** Refer to information on control of needle cast diseases in the Conifers section.
Needle Rust (*Coleosporium*)	No chemical control needed	**Precautions/Remarks**: Although this disease may be unsightly on the needles, it rarely causes significant stress to trees and fungicide control is not warranted.
Pine Wilt (esp. in Japanese Black Pine) (*Bursaphelenchus*)	No chemical controls	**Cultural Control:** Remove affected trees, including stumps, to prevent egg-laying by the beetles that vector the nematode pathogen. **Precautions/Remarks**: As the beetles mature in the stump or dying tree, they acquire the pine wilt nematode. When adults emerge and fly to healthy trees, they transmit the disease.
Seasonal Needle Drop (abiotic)	No chemical controls	**Precautions/Remarks**: Conifers regularly lose the oldest needles when those needles are 2 or more years old. Many conifers lose these inner needles gradually and the discoloration and needle loss goes unnoticed. White pines, however, are especially prone to losing the oldest needles all at once in the fall. The innermost needles turn yellow all over the tree and remain on the tree for some time before they drop, resulting in a striking inner yellowing of the tree. These symptoms often lead homeowners to believe the trees are dying. Seasonal needle drop is a natural occurrence in pines and other conifers. It may be more noticeable in some years than others, but it is no cause for concern.
Procerum Root Disease (White Pine Root Decline) (*Leptographium*)	Insecticides may be needed if stumps are not removed.	**Chemical Control:** If stumps are not removed, insecticide treatment of stumps is recommended to prevent further spread of the disease by the pales weevil. Refer to the weevils section in (pales weevil) Table 4.5 in the “Insects of Trees, Shrubs, Annuals, and Perennials” for a recommendation for stump treatment for pales weevil . **Cultural Control:** Complete removal and/or destruction of dying trees, including stumps, is recommended. White pine should NOT be used as a replacement tree. **Precautions/Remarks:** The fungus *Leptographium* (=*Verticicladiella*) *procerum* is the suspected causal agent, but may not be the sole contributing factor. Pales weevils are believed to introduce the fungus to the tree or provide entry ports for the fungus. These weevils breed in stressed trees or in stumps of trees that have been cut down.

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.) (cont.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
Planetree (See Sycamore)		
Ornamental Plum (*Prunus*) Black Knot (*Dibotryon*)	Chlorothalonil	**Chemical Control**: Fungicide sprays are not effective if sanitation is not practiced. See cultural control information below. Fungicide sprays can be applied from bud break until early summer during wet seasons, which are conducive to disease. Follow label rates and timing of application. **Cultural Control**: Prune out galled branches at least 2 inches below the gall as soon as galls are noticed. The fungus produces its black fruiting bodies on the surface of the gall. To prevent new infections, if possible, prune out affected branches before the galls turn black. Remove pruned branches from the landscape. Avoid planting ornamental plums near stands of wild cherry trees, which often serve as a source of fungal inoculum.
Poplar (*Populus*) Canker (various fungi)	No chemical controls	**Cultural Control**: Prune out cankered branches back to healthy wood and remove prunings from the landscape. **Precautions/Remarks**: Avoid planting Lombardy poplar, which is highly susceptible to canker diseases.
Redbud (*Cercis*) Botryosphaeria dieback (*Botryosphaeria*)	No chemical controls	**Cultural Control**: Prune out affected branches back to healthy wood (where entire cut surface appears creamy white). Dip pruning tools in rubbing alcohol or a solution of 1 part bleach to 9 parts water between cuts. Infection often follows drought stress. Water trees deeply during drought to prevent disease. **Related Fact Sheets:** http://pubs.ext.vt.edu/450/450-726/450-726.html
Spruce (*Picea*) Cytospora canker (*Cytospora*)	No chemical controls	**Cultural Control**: Prune out cankered branches back to healthy wood and remove prunings from the landscape. Infection often follows drought or other stresses. Water trees deeply during drought to prevent disease.
Rhizosphaera needle cast (*Rhizosphaera*)	Chlorothalonil Mancozeb	**Chemical Control**: Begin fungicide application when new needles are ½ to 1 inch long. Repeat fungicide application when needles are full length. **Precautions/Remarks**: The disease kills the interior needles and fungicide treatment may be needed for several consecutive years before trees appear to have full foliage again.
Stigmina needle cast (*Stigmina*)	No research-based results available on chemical control	**Chemical Control**: The symptoms of this disease are very similar to those of Rhizosphaera needle cast. Little to no research has been done comparing effectiveness of fungicide treatments for this disease. Until such results become available, we suggest trying the fungicide treatment recommended for Rhizosphaera needle cast.
Sweetgum (*Liquidambar*) Bleeding canker (*Botryosphaeria*)	No chemical controls	**Cultural Control**: Stress, particularly drought stress, predisposes trees to disease. Watering trees deeply during drought can prevent disease and can sometimes help the tree to wall off early infections. **Related Fact Sheets:** http://pubs.ext.vt.edu/450/450-726/450-726.html

Table 4.3 - General Guideline for Pesticide Active Ingredient Selection for Landscape Trees (Refer to Table 4.1 to identify examples of brand names of pesticide products available for home growers.) (cont.)

Plant and Disease	Labeled Pesticides—by common chemical name	Recommendation
Sycamore (*Platanus*) Anthracnose (Various fungi)	For list of foliar-applied fungicides, see fungicide list for ash anthracnose. Propiconazole	**Chemical Control**: The fungicide listed for ash anthracnose can be used for control of sycamore anthracnose as well; however, if spray application is undesirable because of the tree's location or size, fungicide injections can be made in late summer by a certified arborist. **Cultural Control**: London planetree, which is a hybrid of sycamore and oriental planetree, has resistance to anthracnose and is preferable to sycamore for new plantings. **Precautions/Remarks**: Anthracnose can be severely disfiguring to sycamore during repeated long, moist cool springs. Trees may appear to be almost completely defoliated early in the growing season; however, as weather warms up, the fungus becomes less active and trees usually put out a flush of new growth in midsummer. Anthracnose should not be confused with bacterial scorch (see below). Anthracnose lesions tend to follow the leaf veins, whereas symptoms of bacterial scorch appear along leaf margins.
Bacterial Scorch (*Xylella*)	See controls for bacterial scorch of elm.	**Chemical Control**: See comments for bacterial scorch of elm.
Black walnut (*Juglans nigra*) Anthracnose (Various fungi)	See fungicide list for anthracnose of ash.	**Chemical Control**: Follow directions for control of ash anthracnose.
Thousand cankers disease (*Geosmithia morbida*) (vectored by the walnut twig beetle – *Pityophthorus juglandis*)	At this time there are no chemical controls for the fungus that causes Thousand Cankers Disease.	**Cultural Control:** Avoid introduction of the disease to new locations. Do not transport walnut plants or products from one location to another. Buy walnut logs, lumber or firewood only from a reputable source. If you suspect walnut thousand cankers disease, place samples of affected, but not dead, branches 1-4" in diameter in a sealable plastic bag, then place into a second sealable bag and seal. Bring samples to your local county VCE office for mailing to the Plant Disease Clinic for diagnosis. If you remove a walnut tree growing within the quarantine area, be aware that under quarantine regulations, you may not dispose or distribute the wood outside the quarantine area. **Precautions/Remarks:** To see a Virginia map and list of Thousand Cankers Disease quarantined counties visit this url (http://www.vdacs.virginia.gov/images/tcdmap.jpg) at the Virginia Department of Agriculture and Consumer Services. Under the quarantine, all walnut plants and plant parts of walnut, including lumber, logs, stumps, firewood, roots, branches, mulch and chips, are prohibited from being moved out of the quarantine area.
Willow (*Salix*) Black canker and scab (*Physalospora /Glomerella* and *Venturia*)	Mancozeb	**Chemical Control**: Apply fungicide beginning at bud break at label rates and intervals. **Precautions/Remarks**: These two diseases often occur together, causing damage to new shoots and twigs. Disease is more severe in wet springs. Cultivars of willow vary in susceptibility to this disease.
Galls (various causes)	No chemical controls	**Cultural Control:** If desired for cosmetic purposes, galls on larger trees may be removed surgically. Disinfest tools between cuts with rubbing alcohol or a solution of 1 part bleach to 9 parts water. Galls should be removed during late fall or midsummer when sap flow is minimal.
Fungal cankers (various cankers)	No chemical controls	**Cultural Control**: Prune out cankered branches back to healthy wood and remove prunings from the landscape. **Precautions/Remarks**: Willows are susceptible to a variety of fungal canker diseases. Symptoms appear as discolored or cracked bark with dieback above the canker.

Insects of Trees, Shrubs, Annuals, and Perennials

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These recommendations are intended for the non-professional gardener. The more common pest species can be controlled safely and simply with a minimum number of pesticides. For complex or persistent problems and for large shade trees or expansive areas, it is wise and economical to engage the services of an experienced commercial arborist or custom spray applicator.

Identification and Significance of Pest Problems

Two frustrating problems with ornamentals are: 1) Knowing if, what, and when pesticides should be used on more than 100 different plant genera, and 2) determining the identity and importance of any given pest found feeding on valuable and long-established trees and shrubs. More than 2,000 species of insects and mites may be encountered on woody plants. A great majority of these are uncommon, occasional, and pose little threat of serious damage to the plants, while about 15 percent are common, injurious, and potentially destructive. For color photographs and biology of tree and shrub pests, see Garden Insects of North America by Whitney Cranshaw and David Shetlar. *Insects that Feed on Trees and Shrubs* 2nd Ed Revised is an excellent resource and is currently available.

The aesthetic nature of prized ornamentals creates high values for individual plants. Therefore, even a minor or uncommon pest can be an important and costly problem for the owner if it is severe on only one or a few plants. The average home gardener is familiar with very few of even the more important pests, thus each unfamiliar insect found feeding on valuable ornamentals creates uncertainty as to possible damage or loss of plants.

To help identify pest problems, an index is provided listing the insects and mites reported from more than 125 different kinds of ornamental plants. It is not feasible to list all of the specific pests. For example, 20-30 species of scale are known from camellia, 18-20 species from elm, and 20-24 species from oak. There are 22-25 species of borers known to attack oak, and 8-10 species of mites known to attack elm. In the index the pests are listed by type as groups or individuals. **Those of major importance which are common, injurious, and usually require control treatments are *in italics*.** Those which are occasional, minor, have no known control, or for which control is unnecessary in usual situations are not in italics. For each important pest or pest group, control recommendations are suggested in Table 4-5 following the index. Table 4-6 provides directions for usage.

Most pests can be identified tentatively with a minimum knowledge of entomology. To use these recommendations for a given problem, look in the index under the host plant involved. By scanning the list, the appropriate group or pest usually can be found by knowing the difference between aphids, borers, leafhoppers, scale insects, lacebugs, leafminers, defoliators, etc. To further identify pests and obtain details on life histories, habits, and precise timing for control measures, consult reference books and Virginia Cooperative Extension (VCE) publications. The most complex groups are scale insects and borers. There is great variation in seasonal development patterns, and hence in timing the application of control measures. Extension agents and specialists at Virginia Tech can provide additional assistance on pest problems.

Determining the Need for Control Measures

Applying insecticides at the wrong time of year or when unnecessary **may constitute a misuse of pesticides.** In cases of serious common pests, it is important to apply control measures before populations become large. Often, an insect infestation is found after it becomes intense and conspicuous. Then, in most cases, it is NOT the best time to apply control measures. Yet many people feel the urgency of taking remedial action immediately. Pesticides must be applied at the proper time to be effective. Frequently, it is unnecessary to apply sprays at all if the pest is minor and only present in small numbers. For numerous pests, especially gall insects, there is no known control; spraying is not feasible. Finally, it is usually unnecessary to use insecticides after an infestation has peaked and begun to subside. Parasites and predators are often present and help reduce the remaining number of pests. They can be favored by avoiding the use of pesticides. For common serious pests, application of chemicals early, when populations are first getting established, is most effective. Natural enemies are not adversely affected when the pest is controlled before the beneficial insects appear. Remember that unnecessary or untimely applications may be considered a serious **MISUSE** of pesticides. It is **not** a good policy to spray all plants simply because it seems like a good idea, nor to use more insecticide than specified on the label. Pesticides are essential to the preservation of plant materials which enhance man's environment where he lives and works. Used as recommended they do much more to improve than upset it. Relatively few serious insect and mite pests of woody ornamental plants can be controlled by other than chemical means. More and more, public demands and governmental regulations require minimizing the use of pesticides. Therefore, this guide recommends relatively few materials for use around the home. These are the least toxic in nature, exhibit the least potential threat to the environment, and are essential for effective results. However, certain pests may be more difficult to control, require more costly chemicals, and require more frequent use of other pesticides. Certified Applicators' services should be utilized when necessary.

Pesticide Names

There are four ways to identify pesticide products: the **chemical** name; the **accepted common** name; the **trade** name; and the **brand** name. Brand names (such as Bug-B-Gon) are capitalized and denote the manufacturer or distributor but do not indicate the chemical ingredients. Trade names (such as Sevin, Orthene, etc.) are capitalized and are trademark names for specific insecticides. Common names (such as carbaryl, permethrin, malathion, etc.) are coined names (not capitalized), accepted by industry, scientists, and governmental agencies for specific insecticides. Chemical names for complex organic chemicals may be found on labels but are meaningless to the average user. It is essential to know which are insecticides or miticides and what concentrations are in each pesticide formulation that is to be used for the desired purpose.

Insecticides and Miticides

It is essential to use some residual insecticides to protect trees, shrubs, and turf. Many destructive insects emerge over an extended period of time or are highly mobile. Non-residual chemicals kill only those insects contacted at the time of application. It is not feasible to spray diverse ornamentals frequently enough to protect them from many types of pests. Residual insecticides are highly effective for those species and are essential until suitable alternatives can be developed. Systemic insecticide-miticide materials are not recommended for the home gardener, except imidacloprid.

Pesticides vary greatly in their properties. Malathion and diazinon on foliage remain toxic to insects for a very short period, normally not exceeding one or two days. Carbaryl may last 7- to 10-days on foliage or much longer on bark. Insecticides and miticides have varying residual properties depending on how they are used. Most miticides have considerable residual effectiveness for several days or more.

Resmethrin residues may persist for as much as a week or two. Pesticides also vary in their effects on pests. Carbaryl kills insects but not mites. The use of carbaryl actually encourages larger mite populations than if it is not used at all. Other insecticides have some effect in depressing mite populations but are not adequate for thorough control of mite infestations. They are also much more effective against certain pests than others. Systemic insecticides can kill both insects and mites, but usually do not work on mites and some armored scales.

When using pesticides, it is essential to treat only when necessary with accurate amounts of the recommended chemical. Over spraying is not economical, potentially hazardous, not more effective, and may cause plant injury or result in environmental imbalances favoring certain pests. Obtaining the correct dilution of spray with small garden equipment requires the measurement of very small quantities of chemical, such as by teaspoon or tablespoon. The percentage of error from inaccuracy can be high. Be sure to measure slightly rounded but not heaping spoonfuls of dry formulation. Although rates of application are given in these recommendations, mixing directions are provided on the label of each pesticide. Be sure to read the amounts carefully when preparing insecticidal sprays each time that sprays are applied. Keep pesticides in their original containers and the label in readable condition.

Formulations

Most pesticides are not soluble in water and cannot be applied effectively without dilution. They must be diluted greatly in order to apply very small amounts effectively without plant injury. Therefore, insecticides are first dissolved in organic solvents to make a liquid or mixed with inert dry diluents to make a "powder." By the addition of an emulsifier or wetting agent, either an emulsifiable concentrate (EC) or wettable powder (WP) formulation is produced to be mixed in water for applying extremely dilute, small quantities of toxicant evenly over the very large surface area to be protected. In addition to emulsifiable concentrates and wettable or sprayable powders, insecticides may be formulated and used without further dilution as dusts (D) for direct dry applications to plants, or granules (G) for direct soil or ground surface treatments. Dusts or granules should **never** be mixed with water for making applications.

Still another common formulation in the small-package or home-garden market is the pressurized can or aerosol. A true aerosol utilizes a propellant chemical which dispenses very fine droplets that float in the air. Such a space spray is for flying insects and will not provide a surface deposit to kill crawling insects. Residual spray applicators are available, either pressurized or containing a propellant, which are suitable for spraying plants. These produce coarse droplets which wet the insects and the plants. Be especially careful not to hold the applicator too close to the target; propellants can cause plant injury. It is most important to be sure the product is intended for use on ornamentals. Pressurized sprays for household pests may contain solvents which cause severe injury to plants and are intended for use only on wood or other manufactured materials.

Combination Sprays

While these recommendations suggest the use of specific insecticides or miticides for each individual pest problem, many formulations of pesticides provide spray concentrate (liquid or wettable powders) with two or more pesticides combined. Hence, the landscape gardener can purchase one product to control several pests. In some cases, a fungicide is combined with one or more insecticides plus a miticide. An advantage of combination sprays is that less total solvent and emulsifier or wetting agent are used compared to home mixes of the same ingredients. Two disadvantages are a "trade-off" for the convenience and multiple pest coverage: 1) combination concentrates are usually more costly and 2) several pesticides are applied unnecessarily if only one pest is present. For best results in pest control, judicious use should be made of both approaches: use a "rifle shot" where it alone is effective, and the "shot-gun" where it is appropriate. Most combination spray concentrates contain less of each toxicant than if purchased separately. For example, a rose and floral spray powder might contain 12.5 percent Sevin plus other active ingredients, whereas a Sevin wettable powder usually contains 50 percent active ingredient. The rate of application for the rose and floral spray may be 8 tablespoons per gallon of water versus 2 tablespoons for the 50 percent wettable powder to achieve the same dilution rate of Sevin in the spray tank. There are many brands of spray combination concentrates available in the marketplace.

Sprayers and Spraying

The most important consideration is to fit the spray equipment to the job to be done. Sprayers vary from finger-depresser pumps in small bottles to large high-powered machinery. The most effective and convenient is the compressed air or knapsack sprayer.

Hose-on sprayers are the most desirable if more than a small area is to be treated regularly. Portable mist blowers are effective for plants up to 20-30 feet high, but can give erratic results and plant injury if not used properly. For large areas and tall shade trees, the services of qualified arborists or custom applicators with heavy-duty spray equipment should be engaged.

To be effective, sprays must thoroughly wet the surfaces to be treated or come into contact with the insects. Plants with highly waxy foliage often retain little spray material. Insects such as mealybugs and scale insects are protected under dense waxy secretions. It is frequently advisable to put additional spreader-sticker or more wetting agent in the spray. However, if an additive is used at all times, increased run-off and less deposit of spray material may result on non-waxy surfaces. If a wetting agent is needed but not convenient to obtain in stores, a non-sudsing detergent can be used at the rate of 1 teaspoon in 3 gallons of spray mixture.

Emulsifiable concentrates are most resistant to washing off by rain. Wettable powder sprays are not as persistent, while dusts are readily washed off by rain or irrigation. Any type of spray will be washed off if rain occurs before the sprays have dried. If sprays dry thoroughly, rain does not remove appreciable amounts of residue; the process is gradual over a period of time, depending on the amount of precipitation and the residual toxicity, chemically, of the pesticide used. If water supplies are highly alkaline (pH = 8 or higher), many insecticides will break down immediately and be ineffective.

Spray Injury

It is very important to read all the directions and precautions on the label. Some plants are sensitive to certain insecticides. Carbaryl may cause injury to tender foliage if plants are wet when treated or in the presence of high humidity. Carbaryl will cause severe foliage injury and leaf drop on Boston ivy and Virginia creeper. Malathion is injurious to several ferns and Elaeagnus. Dimethoate is highly variable in phytotoxicity to plants; some varieties of azalea are completely defoliated while others show minor leaf burn or no effects. Dimethoate may defoliate Burford and Chinese holly; andromeda and elm foliage may be injured. Dormant oils may injure sugar and Japanese maples and numerous thin-barked trees. It should not be used on hickory, beech, birch, douglas fir, and juniper and will remove the bluish bloom from spruces. The label on the insecticide container specifies plants susceptible to injury. **Be sure to read ALL of the directions and use insecticides only for those pests specified on the label.**

Index to Insects and Mites by Host

Pests are listed by type as groups or individuals. Those of major importance, which are common, injurious, and usually require control treatments, are in italics.

Abelia – scale insects

Agertum – *aphids, cyclamen mite, spider mite, whiteflies*

Alder – aphid (woolly), borers, defoliators, lacebug, scale insects, spider mites

Althea (Hibiscus) – aphids, defoliators, *scale insects*, weevils

Andromeda – *lacebugs*, scale insects, *spider mites, whiteflies*

Araucaria – *mealybugs, scale insects*

Arborvitae – *bagworm*, Emerald ash borer, *leafminer*, scale insects, *spider mites*, weevils

Ash – aphid, flower gall mites, *borers*, defoliators, Emerald Ash borer, lacebug, leafminer, leaf roller, rhinoceros beetle, sawfly, *scale insects*, spider mites

Aster – aphids

Aucuba – *scale insects, spider mites*

Azalea – *aphid, lacebug*, defoliators, *leafminer, leaf tier, scale insects*, spider mites, *borers*, weevils, thrips, *whiteflies*

Balsam Fir – aphids

Barberry – aphid, *scale insects, webworm*

Bayberry – *defoliators*, mealybugs, scale insects

Beech – *aphid* (woolly), borers, erineum mite, *defoliators*, Japanese beetle, leafhopper, *scale insects*, spider mites

Begonia – *aphids, mealybugs*, broad mite, cyclamen mite, *spider mite*, thrips, black vine weevil, *whiteflies*

Birch – *aphids, borers, Japanese beetle, lacebug, leafminer, leaf skeletonizer, leaf tier*, scale insects

Bittersweet – *aphids, scale insects*

Box Elder – aphids, borers, *boxelder bug, defoliators*, scale insects, spider mites, webworm

Boxwood – giant hornet, *leafminer, psyllid, scale insects, spider mites*, webworm

Buckeye – defoliators, mealybugs, *scale insects*, spider mites

Butternut – *aphids*, borers, *defoliators*, gall insects, gall mites, lacebug, scale insects

Buttonbush – *aphids*, scale insects

Cactus – mealybugs, scale insects

Camelia – *aphids*, defoliators, leafroller, *mites, scale insects*, weevils

Catalpa – aphids, *defoliators*, scale insects

Cedar (Cedrus) – aphid, *bagworm*, bark beetle, borers sawfly, *scale insects*, weevils

Chamaecyparis – aphid, *scale insects, spider mites*, weevils

Cherry Laurel –aphid, scale insects, *weevils*, whitefly

Chestnut – aphid, borers, *defoliators*, scale insects, webworm, weevils

China Aster – *aphids*, broad mite, thrips, *whiteflies*

Chokecherry – borers, *defoliators, scale insects, tent caterpillar*

Citrus – *aphid*, bagworm, borers, defoliators, leafroller,

Cotoneaster – *lacebugs, defoliators*

Crape Myrtle – *aphid, scale insects*, weevil

Cypress – aphid, bark beetle, borer, defoliators, *scale insects, spider mites*

Dahlia – aphids, beetles, borers, plant bugs, caterpillar leafhoppers, giant hornets (tear bark)

Day Lily – aphids, scale insects, thrips

Delphinium – *cyclamen mites*, aphids, leafminers

Deutzia – aphids, leafminer, scale insects, weevil

Dogwood – aphids, *borers*, cicada, gall midge, *defoliators*, leafhopper, leafminer, leafroller, *sawflies, scale insects*, whitefly

Douglas Fir – *aphids*, bark beetles, borers, budworm, defoliators, scale insects, weevils

Elaeagnus – *aphids, scale insects*

Elm – *aphids*, bagworm, *bark beetles*, borers, case bearers, defoliators, gall insects, gall mites, *Japanese beetle*, lacebugs, leafhoppers, *leafminer, rust mites, spider mites, scale insects*, weevils

Euonymus – aphids, *scale insects, weevils*

Ferns – *scale*, thrips, mealybugs

Fir – aphids, bagworm, bark beetles, borers, budworm *defoliators*, needleminer, *sawflies*, spider mites

Flowering Fruits – *aphids, aphids (woolly)*, bark beetles, *borers*, bud moth, casebearers, *defoliators*, fruit moths, *Japanese beetle*, *lacebugs*, leafhopper, leafroller, skeletonizer, leaf tier, mealybugs, *mites*, plant bugs, *sawflies*, *scale insects*, *tent caterpillar*, thrips, webworm, weevils

Forsythia – *plant bugs*, scale insects, weevils, gall insects, mites

Gardenia – aphid, *mealybugs*, *scale insects*, *spider mites*, thrips, weevils, *whitefly*

Geranium – aphids, mites, scale, Fuller rose beetles

Gingko – defoliator, scale insects

Gladiolus – thrips, mealybugs, caterpillars, aphids, borers, bulb mites, corn earworms

Hackberry – bark beetles, borers, *lacebug*, defoliators, gall mites, *psyllids*

Hawthorn – aphids (woolly), bark beetle, borers, bud moth, casebearer, defoliators, Japanese beetle, *leafminer*, leaf roller, leaf skeletonizer, sawfly, *scale insects*, *spider mites*, weevil

Hemlock – aphids, bark beetle, borers, defoliators, needleminer, *rust mites*, sawfly, *scale insects*

Hibiscus – Japanese beetles, whitefly, aphids, sawflies

Hickory – aphid (woolly), bark beetle, borers, casebearer, cicada, defoliators, *gall aphids*, *gall mites*, *lacebugs*, leaf roller, mites, sawflies, *scale insects*, *spider mites*, *thrips*, webworm, weevils

Holly – aphid, bud moth, berry midge, defoliators, *leafminers*, leaf tier, mealybugs, rust mite, *scale insects*, *spider mites*, weevils

Honey Locust – *bagworm*, borers, *mimosa webworm*, *plant bug*, pod gall, midge, rust mite, *spider mites*

Honeysuckle – aphids, defoliators, leaf roller, plant bugs, sawfly, *spider mites*, webworm

Horse Chestnut – bagworm, borer, *Japanese beetle*, leaf roller, scale insects, spider mites

Hydrangea – leaf tiers, lygus bugs, spider mites

Iris – *borer*, thrips, weevil, aphids, bulb mites, slugs

Ivy (Boston) –defoliators, *Japanese beetle*, leafhopper, scale insects, weevil

Ivy (English) – defoliators, *Japanese beetles*, leafhopper, scale insects, weevil

Juniper – aphid, *bagworm*, bark beetle, midge, *scale insects*, *spider mites*, twig girdler, *webworm*, weevils

Lantana – aphids, cyclamen mites, fleahoppers, leaf tiers, whitefly, mealybugs

Larch – aphid (woolly), bagworm, bark beetle, borer, bud moth, *casebearer*, defoliators, *sawfly*, weevil

Laurel – bud moth, psyllid, *scale insects*, weevils

Ligustrum – scale insects

Lilac – aphid, *borers*, *European hornet*, rhinoceros beetle, *rust mite*, *scale insects, thrips*, weevils, whitefly

Lily – aphids, bulb mites, symphylan

Linden – *aphids*, bagworm, *borers*, *defoliators*, *lacebugs*, leafrollers, sawflies, *scale insects*, *rust mite*, *spider mites*, whitefly

Locust (Robinia) – aphid, bagworm, *borers*, defoliators, *leafminers*, leaf roller, treehoppers, scale insects, spider mites

London Plantree – *borers*, *scale insects*

Magnolia – borers, *scale insects*, *weevil*, whitefly

Maple – *aphids*, aphid (woolly), bagworm, *borers*, boxelder bug, defoliators, gall midges, gall mites, *Japanese beetle*, leafhoppers, leaf roller, leaf skeletonizer, *scale insects*, spider mites

Marigold – fleahoppers, *lygus bugs*, leafhoppers, slugs, *spider mites*, stalk borers

Mimosa – bagworms, scale insects, *webworm*

Mountain Ash – aphid, bark beetle, *borers*, *lacebug*, *sawfly*, scale insects, *spider mites*

Mountain Laurel – *borers*, *lacebug*, *scale insects*, spider mite, weevils, *whitefly*

Mulberry – lacebug, scale insects, whitefly

Myrtle – aphids, mealybugs, *scale insects*

Nandina – scale insects

Narcissus (Daffodil) – bulb mites, bulb flies, mealybugs

Oak – *aphids*, *borers*, *cicada*, *defoliators*, *gall insects*, *gypsy moth*, *Japanese beetle*, *lacebugs*, *leafminers*, *leafrollers*, *leaf skeletonizers*, *leaf tier*, *oakworm*, rust mites, sawflies, *scale insects*, *spider mites*, *tent caterpillars*, treehoppers, webworm, weevils

Osmanthus – scale insects, webworm

Pachysandra – *scale insects*, spider mites

Palm – mealybugs, *scale insects*, *spider mites*, thrips

Peony – ants, aphids, rose chafers, 4-lined plant bug, thrips

Periwinkle – (Vinca) aphids

Persimon – *borers*, *defoliators*, mealybugs, psyllid, *scale insects*, thrips, whitefly

Petunia – aphids, climbing cutworms, fleabeetles, flea hoppers, mealybugs, mites

Phlox – phlox bug, Asiatic garden beetle, 4-lined plant bug, *spider mites*, stalk borers

Photinia – scale insects, aphids

Pine – *aphids*, bagworm, *bark beetle*, borers, budworm, *defoliators*, rust mites, *sawflies*, *scale insects*, spider mites, spittlebug, *tip moth*, webworm, *weevils*

Poplar – aphids, *borers*, *defoliators*, *gall insects*, giant hornet, lacebug, leafminers, leafroller, *sawflies*, *scale insects*, spider mites, treehoppers, webworm, weevil

Privet – aphid, borer, leafhopper, *leafminer*, rust mite, *scale insects*, spider mites, thrips, weevils

Pyracantha – aphids, *lacebugs*, *scale insects*, *spider mites*, *webworm*, *leaf crumpler*, *weevils*

Redbud – leaf roller, *scale insects*, treehopper

Rhododendron – *aphids*, *borers*, budworm, giant hornet, Japanese beetle, *lacebugs*, *scale insects*, *spider mites*, thrips, *weevils*, *whitefly*

Rose – *aphids*, *borers*, budworm, *defoliators*, *Japanese beetle*, *leafhopper*, leafroller, leaf tier, midge, *sawflies*, *scale insects*, *spider mites*, *thrips*, treehopper, webworm, weevils, whitefly

Sassafras – defoliators, *Japanese beetles*, leafroller, scale insects, *weevil*

Serviceberry – borers, leafminer, sawfly, *scale insects, spider mites*

Snapdragon – corn earworms, cyclamen mites, plant bugs, slugs, spider mites

Sourgum – borer, leafminer, *scale insects*

Spirea – *aphids*, defoliators, leafhopper, leafroller, scale insects, *spider mites*

Spruce – aphids, bark beetles *borers*, bud moth, budworm, defoliators, *gall aphids*, needleminer, scale insects, *spider mites*, weevils

Stephanotis – scale insects

Sweetgum – bagworm, borers, defoliators, leaf tier, *scale insects*, webworm

Sweetpea – aphids, cutworms, symphylan, lygus bugs, spider mites

Sycamore – aphids, bagworm, borers, *defoliators*, Japanese beetles, *lacebugs*, scale insects, treehopper, webworm, weevils

Taxus (Yew) – *gall mite*, *scale insects*, *weevils*

Tulip Tree – aphids, borers, *scale insects*, *weevils*

Tree-of-heaven - spotted lanternfly

Tupelo – aphids, leafminer

Virginia Creeper – aphids, *defoliators*, *Japanese beetle*, leafhoppers, scale insects, weevils

Walnut – *aphids*, borers, casebearer, *defoliators*, *lacebugs*, rust and gall mites, sawfly, *scale insects*, spider mites, webworm

Weigela – plant bug, scale insects, weevil

Willow – *aphids*, *borers*, *defoliators*, *gall insects*, giant hornet, *Japanese beetle*, *lacebugs*, leafhoppers, *sawflies*, *scale insects*, *spider mites*, spittlebug, thrips, treehopper, webworm, weevils

Wisteria – aphids, defoliators, leaf roller, *scale insects*, spider mites, webworm, weevil

Witchhazel – defoliators, gall insects

Yucca – plant bug, *mealybugs*, *scale insects*

Zinnia – aphids, Asiatic garden beetles, fleahopper, Japanese beetle, lygus bugs, spider mites, whitefly

Table 4.4 - Proposed Timing for Borer Treatment

Pest	Time of Treatment
ash borer, banded	Late July and early September
azalea stem borer	Mid-May and mid-June
bronze birch borer	Mid-May and early, mid- and late June
dogwood borer	Mid-May and repeat 2 to 3 times at 6-week intervals
dogwood twig borer	Early to mid-May
emerald ash borer	April or May with systemic insecticide
iris borer	When leaves are 5-6” tall
lilac borer	Early May and repeat 6 weeks later
locust borer	Late August to mid-September (when goldenrod is in bloom)
mottled willow borer (poplar and willow borer)	Mid- to late June and late August to early September
peach tree borer	July and repeat at 6-week intervals
rhododendron borer	Late June
round-headed and flat-headed tree borers	Early May, early June, and early July
two-lined chestnut borer	Mid- to late May and mid- to late June
Zimmerman pine moth	Mid-April and late fall

Table 4.5 - Proposed Timing for Scale Insect Treatment

Pest	Crawler Dates	Treatment Dates
azalea bark scale	June 5 to 30	June 10 and 20
brown soft scale	—	Treat when scale insects appear, then 2-3 times at 10 day intervals
calico scale	Same as lecanium scale	
camellia scale	May 1 to June 5 and September 15 to 30.	May 10 and 20 and/or September 10 and 20
cottony maple scale	June 5 to 25	June 10 and 20
cottony maple leaf scale	June 1 to 10	June 15 to 30
cottony camellia scale	June 1 to 10	June 10 to 20
euonymus scale	May 5 to June 10, 1st generation; July 1 to 25, 2nd generation	May 10 and 20, and July 5 and 15
European elm scale	June 5 to 25	June 10 to 15
European fruit lecanium scale	June 1 to 20	June 10 to 15
fletcher scale	June 5 to 25	June 10 to 15
florida red scale	May 5 to 15	May 15 to 30
florinia hemlock scale (elongate hemlock scale)	Peak May 15 to June 20	May 20 to 25 and June 5 to 10
forbes scale	June 1 to 15	June 5 to 10
golden oak scale	June 1 to 30	June 10 and June 20
gloomy scale	June 10 to 20	June 20 to 30
Japanese scale	—	Treat at 2-week intervals, June 1 to September 1
juniper scale	April 5 to 20 and June 5 to 20	April 10 to 15 and/or June 10 to 15
latania scale	—	June 25, July 10, and September 20
lecanium scale	May 25 to June 25	June 15 to 20

Table 4.5 - Timing for Scale Insect Treatment (cont.)

Pest	Crawler Dates	Treatment Dates
magnolia scale	—	September 1 to 20
obscure scale	—	red oaks in mid-July; white oaks in mid-August
oak kermes	June 1 to 20	June 10 to 15
oystershell scale	May 1 to 20 and July 15 to 25	May 5 to 20 and/or July 20 to 25
pine needle scale	April 20 to May 30 and July 10 to 20	May 5 to 20 and/or July 10 to 20
pine tortoise scale	June 10 to July 5	June 20 to 25
rose scale	Late May to June 30	June 5 to 10; June 20 to 25; and in mid-August
San Jose scale	—	June 10 to 15; July 10 to 15; and September 10 to 15
tea scale	—	2 to 3 times at 10 day intervals when infested
tuliptree scale	—	September 1 to 20
wax scale	June 1 to 25	June 10 to 30
white peach scale	April 25 to May 15; July 1 to 15; and August 20 to September 15	May 1 and 10; July 5 and 15; and September 1 and 10
woolly pine scale	Mid-June	June 15 to 20

Plant Injury

Insecticides vary greatly in their phytotoxicity. Be sure to avoid treating sensitive plants. Cautions on the label usually indicate plants which should not be sprayed. **Read the entire label carefully. Carbaryl** may injure tender foliage if plants are wet when treated or in the presence of high humidity; it should not be used at any time on Boston ivy or Virginia creeper. **Malathion** may cause injury to certain junipers, Elaeagnus, hibiscus, some rose varieties, and certain ferns. Petroleum oils for dormant or summer spraying are much safer, but should not be used on birch, beech, sugar and Japanese maple, hickory, walnut, butternut, douglas fir, spruces, or juniper.

It is important not to mix pesticides which are not compatible with each other, and avoid formulations not intended for use on plants. Formulations used for structural pest control should not be applied to plants.

Table 4.6 - Control Measures for Major Pests and Pest Groups

Pest	Pesticides Approved	Recommendations
Adelgids Spruce gall adelgid	Carbaryl Bifenthrin *Paraffin oil* *Dormant oil*	**Timing of pesticide treatment:** Treat just before buds break in the spring, and/or in September and early October after galls have opened. Use Dormant oil in late March. **Remarks:** Spring treatments should be applied before cottony egg masses are evident on buds. Cooley spruce gall adelgid on Douglas fir does not produce galls; it feeds openly on the needles. Sprays can be applied in September and October. **Biological controls:** Brown lacewings **Cultural control:** Remove and destroy galls when green, moist and growing. Avoid growing Douglas firs and spruce together. Plant resistant or tolerant varieties of Douglas firs. Green needled plants are generally more resistant than blue. **Related fact sheet:** https://pubs.ext.vt.edu/ENTO/ENTO-146/ENTO-146.html
Pine bark adelgid	*Paraffin oil* *Dormant oil*	**Timing of pesticide treatment:** Treat in late April or early May and repeat 2-3 weeks later. **Remarks:** Use a forceful spray to penetrate cottony secretions and wash aphids from twigs and bark. Use less-toxic materials in public areas and around homes. **Biological controls:** Larvae of lady beetles, lacewings, and hoverflies **Cultural control:** General overall health. Avoid fertilizing plants too much. Extra nutrients encourage bug growth. **Related fact sheet:** https://pubs.ext.vt.edu/2907/2907-1402/2907-1402.html
Hemlock woolly adelgid	Imidacloprid Dinotefuran *Dormant oil* *Potassium laurate* Thiamethoxam see table 4.7	**Timing of pesticide treatment:** Treat anytime with Dormant oil although early November is best. Treat with Imidacloprid in April or May as a soil drench. For imidacloprid, see "Bee Advisory Box" **Remarks:** The best compounds are horticultural oils which smother the insects. A 1% solution is recommended from May through September, and a 2% solution from October to April. Thoroughly wet entire plant including the bark of branches and the trunk. Use a forceful spray; be sure the new growth is thoroughly wet. Dormant oil is also called horticultural oil. **Biological controls:** Black lady beetle, Chinese lady beetles, Tooth-necked fungus beetle **Cultural control:** Discourage animal visits; monitor plant material movement from around it; clean vehicles, clothes, etc; selectively remove heavily infested trees. Don't stress the plant. Prune dead limbs; don't fertilize infested trees; use a stream of water to dislodge eggs and crawlers between April and June. Plant resistant species. **Related fact sheet:** https://pubs.ext.vt.edu/3006/3006-1451/3006-1451.html
Hickory leaf-stem gall aphid	Carbaryl	**Timing of pesticide treatment:** Treat just as new buds are beginning to open. Timing is critical. **Biological controls:** Because aphids begin feeding immediately as leaf buds begin to open, control is very difficult and often ineffective. A minor pest of older well established trees. **Cultural control:** Encourage natural predators by not removing all of the galls. Prune out galls while still green. Rake up and destroy fallen infested leaves. **Related fact sheet:** https://pubs.ext.vt.edu/ENTO/ENTO-146/ENTO-146.html

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Aphids (general)	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* Insecticidal Soap *Spinosin* *Pyrethrins* Soybean Oil Zeta-Cypermethrin	**Timing of pesticide treatment:** When first seen. Some (spirea, willow twig, white pine) occur in the spring. Others (crape myrtle, giant bark, willow leaf, linden, maple, and oak) build up in mid-summer. Many (white pine aphid) may be present, migrating to hosts throughout the season and in the fall. For imidacloprid, see “Bee Advisory Box” **Biological controls:** Apply control measures before populations become large. Aphids may infest buds, leaves, stems, branches, or trunks of the host plants. Be sure to follow all label directions and precautions. Use less toxic and less hazardous materials in public areas, around homes, and where plants are to be moved or transplanted. Be aware of lady beetles, aphis lions, syrphid larvae, and other predators that may reduce populations. Do not spray when plants are flowering and honey bees are active. Green lacewings, lady beetles, and aphid parasites (*Aphidius colemani, Aphidius ervi* and *Aphidius abdominalis*). **Cultural control:** Keep the plant in overall good health. Do not overuse nitrogen when fertilizing. **Related fact sheet:** https://pubs.ext.vt.edu/444/444-220/444-220.html
Bagworms General	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Bacillus thruingensis (Bt)* *Spinosin* *Pyrethrins* Soybean Oil Zeta-Cypermethrin	**Timing of pesticide treatment:** Apply treatments when bags are less than 1/2 inch, late May in coastal Virginia, early to mid-June elsewhere. Controls less effective in mid- to late summer. **Remarks:** Lightly misting the foliage is sufficient. Mist blower treatments are effective. Do not use the more toxic or hazardous materials in public areas or around homes. Carbaryl may lead to mite increases. **Biological controls:** Parasitic wasps. **Cultural controls:** Pick off the bags in light infestations and destroy them, remove silk to not girdle the limb. **Related fact sheet:** https://pubs.ext.vt.edu/2808/2808-1008/2808-1008.html
Bark beetles General	*Azadirachtin* Bifenthrin Cypermethrin Disodium octaborate tetrahydrate Imidacloprid Permethrin Zeta-Cypermethrin see table 4.7	**Timing of pesticide treatment:** Treatments should be applied to prevent infestation of and breeding in the bark. Treat trees and wood with bark attached as soon as they are cut. Treat weakened or injured trees in late April and repeat 2 or 3 times at monthly intervals. For imidacloprid, see “Bee Advisory Box” **Remarks:** Thoroughly soak the bark of the trunk and branches. Sprays are more concentrated than usual foliar treatments; avoid excessive drip and wear protective clothing and equipment. **Biological controls:** Encourage natural predators: woodpeckers, blackbellied clerid, trogossitid, snakeflies, and parasitic wasps. Release has not helped heavily infested trees. **Cultural controls:** Reduce tree stress. Be sure the tree is suited to the area. Avoid injuries, damage and soil compaction. Properly prune infested limbs, remove and dispose of so that the beetles do not emerge and infest nearby plants. **Related fact sheet:** https://pubs.ext.vt.edu/444/444-216/444-216.html

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Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Bark beetles (cont.) Elm bark beetle	*Azadirachtin* *Beauveria bassiana* Bifenthrin Carbaryl Imidacloprid Permethrin see table 4.7	**Timing of pesticide treatment:** Immediately destroy all branches larger than 1 1/2" in diameter as soon as they begin to die or are cut to prevent infestation and breeding by beetles. For imidacloprid, see "Bee Advisory Box" **Remarks:** Wood should NEVER be piled or stored unless all of the bark is removed. Where possible, susceptible wood should be burned or buried with at least 18-inch fill. **Biological controls:** Encourage natural predators: parasitic wasps, clerid beetles. **Cultural controls:** Maintain a healthy, stress-free condition for the plant. Prune infested branches out of the tree during the dormant season. Remove, burn or bury the pruned branches. Plant tolerant or resistant elms to Dutch elm disease. **Related fact sheet:** https://pubs.ext.vt.edu/444/444-216/444-216.html
Shot-hole borer, fruit tree bark beetles, ash bark beetle	See General Bark beetles	**Timing of pesticide application:** Drench the bark of healthy trees in late April and early June. **Remarks:** Normally these pests are infrequent, so it is not necessary to spray all healthy trees annually. If any beetles or signs of their presence are found, treat all healthy trees in the vicinity. **Biological controls:** See General Bark beetles **Cultural controls:** See General Bark beetles **Related fact sheet:** https://pubs.ext.vt.edu/444/444-216/444-216.html
Conifers, pine bark beetle	Beta-cyfluthrin Imidacloprid Permethrin *Pyrethrins*	**Timing of pesticide treatment:** Treat unhealthy, weakened, or damaged trees in early April, early June, and August if near infested trees. Also effective in preventing spread if sprayed on infested trees or wood before beetles emerge, or in preventing infestations in uninfested wood that is cut but cannot be disposed of immediately. For imidacloprid, see "Bee Advisory Box" **Remarks:** Thoroughly wet all of the bark. Healthy vigorous trees are not likely to be attacked and do not require spraying. Beetles will not reinfest or attack wood or trees dead more than one year. **Biological controls:** Natural predators – woodpeckers, blackbellied clerid, trogossitid, snakeflies and parasitic wasps **Cultural controls:** Reduce tree stress. Be sure the tree is suited to the area. Avoid injuries, damage, and soil compaction. Properly prune infested limbs, remove and dispose of so that the beetles do not emerge and infest nearby plants. Sanitation should be done throughout the year, particularly during the growing season, when trees begin dying or wood is cut. Prune out large, dying, or recently dead branches. Dispose of susceptible wood, slash, and bark from stumps by utilization burning, burying where feasible. Beetles will not reinfest or attack wood or trees dead longer than one year. **Related fact sheet:** https://pubs.ext.vt.edu/444/444-216/444-216.html

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Granulate ambrosia beetle	Beta-cyfluthrin Bifenthrin Cryolite Cyfluthrin Cypermethrin Disodium octaborate tetrahydrate Esfenvalerate Imidacloprid Lambda-Cyhalothrin Permethrin see table 4.7	**Timing of pesticide application:** Treat trunk and larger branches in early April when the daytime temperature exceeds 70°F for the first time. For imidacloprid, see "Bee Advisory Box" **Remarks:** Sawdust projecting from the trunk like a toothpick is diagnostic for this insect. Treat the bark but leave infested trees in place as trap trees for 1 month before removing and destroying. Trees can often survive small infestation of just 1 or 2 beetles, so not all infested trees will need to be removed. **Biological controls:** None known at this time. **Cultural controls:** Remove and burn infected trees.
Borers Azalea stem borer, dogwood twig borer	Bifenthrin Imidacloprid	**Timing of pesticide treatment:** Treat one-year-old stems throughout the tree in mid-May and in mid-June. For imidacloprid, see "Bee Advisory Box" **Remarks:** Cut out and destroy infested wilting stems. Imidacloprid as a soil drench prior to infestation. **Biological controls:** Tachinid fly and Braconid wasp. Encourage native predators such as woodpeckers. **Cultural controls:** Remove infested branches below hollow section to prevent larvae spread. Remove dead branches. Increase overall plant health. **Related fact sheet:** https://pubs.ext.vt.edu/444/444-625/444-625.html
Banded ash borer	*Azadirachtin* Beta-cyfluthrin Bifenthrin Carbaryl Cyfluthrin Imidacloprid Permethrin *Spinosyn*	**Timing of pesticide treatment:** Treat trunk and main stems in late July and again in early September. For imidacloprid, see "Bee Advisory Box" **Remarks:** Control measures are preventive treatments aimed at egg-laying adults and/or newly hatched larvae prior to tunneling into the tree. **Biological controls:** Several parasitic wasps (braconid wasp & Chaclid wasp). **Cultural controls:** Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid planting in full sun. Avoid injuries, damage, and soil compaction. It has been suggested that wrapping young plants from soil to first large limb prevents sunburn and infestation but some studies have shown that wrapping during planting increases the possibility of borer damage. Properly prune infested limbs, remove and dispose of so that the beetles do not emerge and infest nearby plants. **Related fact sheet:** https://pubs.ext.vt.edu/ENTO/ENTO-133/ENTO-133.html
Bronze birch borer	Bifenthrin Imidacloprid Permethrin see table 4.7	**Timing of pesticide treatment:** Treat all bark surfaces, especially in the uppermost part of the tree in mid-May, and early, mid-, and late-June. For imidacloprid, see "Bee Advisory Box" **Remarks:** Often infests older trees that are in decline. Imidacloprid as a soil drench prior to infestation. **Biological controls:** Several parasitic wasps (Braconid, Ichneumon & Chaclid wasp). **Cultural controls:** Plant varieties that are more resistant to infestation. River birch (*Betula nigra)* and its cultivar Heritage birch are the most resistant while European white birch (*Betula pendula*) is the most susceptible. Grow herbaceous plants over shallow root systems to reduce heat stress. Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid planting in full sun. Avoid injuries, damage, and soil compaction. Properly prune infested limbs, remove and dispose of so that beetles do not emerge and infest nearby plants.

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Borers (cont.) Dogwood borer	Acetamiprid Bifenthrin Permethrin *Azadirachtin*	**Timing of pesticide treatment:** Treat trunk and larger branches in mid-May and repeat after 6 weeks. **Biological controls:** Entomophagous nematode, *Steinernema carpocapsae* **Cultural controls:** Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid planting in full sun and grafted species to reduce possibilities of burr knots. Avoid injuries, damage, and soil compaction. Properly prune infested limbs, remove and dispose of so that the beetles do not emerge and infest nearby plants. **Related fact sheet:** https://pubs.ext.vt.edu/2808/2808-1010/2808-1010.html
Emerald ash borer	Systemic Insecticides: Imidacloprid *Azadirachtin* Dinotefuran emamectin benzoate Contact Insecticides: Permethrin Bifenthrin Carbaryl Cyfluthrin	**Timing of pesticide treatment:** Systemics (Imidacloprid, Azadirachtin, or emamectin benzoate) need to be applied in April or May when active uptake from the roots is occurring. Contact insecticides used for branch and trunk sprays need to be applied in early May and early June. For imidacloprid, see “Bee Advisory Box” **Remarks:** Systemics must be applied **before** the trees show signs of infestation. Imidacloprid should be applied as a soil drench and emamectin benzoate must be applied by direct tree injection by an arborist. **Biological controls:** None commercially available at this time. **Cultural controls:** Remove infested trees as soon as possible. Consider planting resistant Asian species of ash. **Related fact sheet**: http://pubs.ext.vt.edu/ENTO/ENTO-76/ENTO-76.html and https://pubs.ext.vt.edu/2904/2904-1290/2904-1290.html
Lilac borer, ash borer	Bifenthrin Imidacloprid Permethrin see table 4.7	**Timing of pesticide treatment:** Treat trunk and branches in early May and again 6 weeks later. For imidacloprid, see “Bee Advisory Box” **Remarks:** Treatments also kill emerging as well as entering borers. Thorough wetting and soaking of the bark is necessary. Foliage need not be treated. **Biological controls:** None known at this time. **Cultural controls:** Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid planting in full sun. Avoid injuries, damage, and soil compaction. Properly prune infested limbs in fall and winter, remove and dispose of so that beetles do not emerge and infest nearby plants. **Related fact sheets:** https://pubs.ext.vt.edu/444/444-278/444-278.html https://pubs.ext.vt.edu/ENTO/ENTO-142/ENTO-142.html
Locust borer	Bifenthrin Imidacloprid Permethrin see table 4.7.	**Timing of pesticide treatment:** Treat the trunk and larger branches in late August to mid-September (before goldenrod is in bloom). For imidacloprid, see “Bee Advisory Box” **Remarks:** Sprays applied in early spring provide adequate control if fall treatments were not made. Imidacloprid as a soil drench prior to infestation. **Biological controls:** Encourage natural predators: woodpeckers & wheel bugs. **Cultural controls:** Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid planting in full sun. Avoid injuries, damage, and soil compaction. Properly prune infested limbs, remove and dispose of so that beetles do not emerge and infest nearby plants. **Related fact sheet:** https://pubs.ext.vt.edu/ENTO/ENTO-141/ENTO-141.html

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Borers (cont.) Mottled willow borer (poplar and willow borer)	Bifenthrin Imidacloprid Permethrin see table 4.7	**Timing of pesticide treatment:** Treat all bark surfaces in mid- to late June and in late August to early September. For imidacloprid, see "Bee Advisory Box" **Remarks:** Imidacloprid as a soil drench prior to infestation.
oak borer	Bifenthrin Imidacloprid Permethrin see table 4.7	**Timing of pesticide treatment:** Treat trunk to ground level in early June. For imidacloprid, see "Bee Advisory Box" **Remarks:** Large populations are likely in even-numbered years. **Biological controls:** Possible benefit from *B. bassiana* **Cultural controls:** Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid injuries, damage, and soil compaction. Properly prune infested limbs, remove and dispose so that beetles do not emerge and infest nearby plants. **Related fact sheet**: http://pubs.ext.vt.edu/444/444-215/444-215.html
Peach tree borer	*Azadirachtin* Bifenthrin Chlorantraniliprole Esfenvalerate Gamma-cyhalothrin Lambda-Cyhalothrin Permethrin Zeta-Cypermethrin see table 4.7	**Timing of pesticide treatment:** Treat trunks and soil around the base in July and repeat in 6 weeks. **Biological controls**: Parasitic wasps & nematodes: Braconid & Ichneumon wasps and *Steinernema carpocapsae* nematode. Pheromone traps. **Cultural controls:** Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid injuries, damage, and soil compaction. Properly prune infested limbs, remove and dispose of so that beetles do not emerge and infest nearby plants.
Pine sawyer	Permethrin	**Timing of pesticide treatment**: Treat in May. **Remarks**: Treat trunks of remaining trees after infested trees are removed. These insects are usually secondary. **Biological controls**: None known at this time. **Cultural controls**: Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid injuries, damage, and soil compaction. Properly prune infested limbs, remove and dispose of so that beetles do not emerge and infest nearby plants. **Related fact sheet:** https://pubs.ext.vt.edu/2907/2907-1399/2907-1399.html
Rhododendron (clearwing) borer	Bifenthrin Permethrin	**Timing of pesticide treatment**: Treat the trunks and larger branches in late June. **Biological controls**: Encourage natural predators: woodpeckers & hymenopterous parasitoids. Pheromone traps. **Cultural controls**: Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid injuries, damage, and soil compaction. Properly prune infested limbs, remove and dispose of so that borers do not emerge and infest nearby plants. **Related fact sheet**: http://pubs.ext.vt.edu/444/444-215/444-215.html
Round-headed and flat-headed tree borer	Acetamiprid Avermectin B1 Clothianidin Esfenvalerate Imidacloprid Permethrin see table 4.7	**Timing of pesticide treatment**: Treat bark of trunk and branches in early May, early June, and early July. For imidacloprid, see "Bee Advisory Box" **Remarks**: Imidacloprid as a soil drench prior to infestation. **Biological controls**: None known at this time. **Cultural controls**: Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid injuries, damage, and soil compaction. Properly prune infested limbs when borers are not active, remove and dispose of so that beetles do not emerge and infest nearby plants. **Related fact sheet**: http://pubs.ext.vt.edu/444/444-215/444-215.html

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Borers (cont.) Two-lined chestnut borer	Bifenthrin Permethrin Imidacloprid	**Timing of pesticide treatment**: Treat trunk and branches during mid- to late May and mid- to late June. For imidacloprid, see "Bee Advisory Box" **Remarks**: Imidacloprid as a soil drench prior to infestation. **Biological controls**: Encourage natural predators: woodpeckers, Chalcid wasps. **Cultural controls**: Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid injuries, damage, and soil compaction. Soil aeration is helpful. Properly prune infested limbs when borers are not active, remove and dispose of so that beetles do not emerge and infest nearby plants.
Boxelder bug	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Bacillus thruingensis* (Bt) *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: Treat seed bearing female trees and flower beds where seeds fall and collect. **Remarks**: Boxelder bugs are rarely pests on their host trees but become nuisances when they collect on the outside of buildings and enter buildings in search of overwintering sites. **Biological controls**: None known at this time. **Cultural controls**: Replace female boxelder trees in landscape.
Cicada (periodical cicada) General	Beta-cyfluthrin Bifenthrin Carbaryl Cyfluthrin Deltamethrin Esfenvalerate Gamma-cyhalothrin Lambda-Cyhalothrin see table 4.7	**Timing of pesticide treatment**: Treat bark of twigs on susceptible hosts soon after adult male singing becomes evident, usually around early May. **Remarks**: Netting around small trees may keep most cicada off the trees. Use netting with a 1/4" holes. Cicada damage is caused by adult females inserting eggs in deep slits in twigs. Control is necessary only for young trees in the year of the 13-year and 17-year brood emergence in various locations. Annual cicadas in late summer are not pests. See *http://pubs.ext.vt.edu/444-276/444-276.html* for emergence dates of the 17-year cicada in your county. **Biological controls**: None known at this time. **Cultural controls**: Use netting to cover newly planted trees. Remove flagging damage. Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid injuries, damage and soil compaction. **Related fact sheet**: https://pubs.ext.vt.edu/444/444-276/444-276.html
Cutworms, climbing cutworms	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Bacillus thruingensis* (Bt) *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: Treat when cutworms are found. For imidacloprid, see "Bee Advisory Box" **Remarks**: Feeding occurs at night. Thoroughly wet the soil with spray. Apply in the evening. Physical barriers may work as well. **Biological controls**: Encourage natural predators: birds, Ichneumonid, Chalcid, and Braconid wasps, and *Steinernema carpocapsae* nematodes. **Cultural controls**: Consider using endophytic grasses for renovations. Remove broadleaf weeds in spring after the first leaves have expanded. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1547/3104-1547.html

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Defoliators (caterpillars, sawflies, leaf beetles)	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Bacillus thruingensis* (Bt) *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: When insects are first observed feeding. Timing varies with the species. It is critical to observe plants regularly to detect feeding as soon as it begins. Once caterpillars are larger than 1.5 inch long, it is usually too late for control that season. For imidacloprid, see "Bee Advisory Box" **Remarks**: Insecticide combinations marketed by formulators and distributors are available. Consult the labels for specific uses and precautions. Mist blowers are effective. (Use *Bt* only for caterpillars.) Imidacloprid is an option for leaf feeding beetles. **Biological controls**: The *Coleomegilla maculata*, *Hippodamia convergens*, *Harmonia axyridis* lady beetlles. **Cultural controls**: For a small number, handpick the individuals off of plants. Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid injuries, damage and soil compaction. Properly prune infested limbs if numbers are too large. **Related fact sheet**: https://pubs.ext.vt.edu/ENTO/ENTO-75/ENTO-75.html
Buck moth caterpillar	Gamma-cyhalothrin *Bacillus thuringiensis* (Bt)	**Timing of pesticide treatment**: Treat in mid- to late May or June when eggs have hatched but larvae are small. **Biological controls**: None known at this time. **Cultural controls**: Remove individually from plants if there are low numbers. Be careful to not touch with bare hands and hollow hairs will break off in gloves. **Related fact sheet**: https://pubs.ext.vt.edu/ENTO/ENTO-18/ENTO-18NP.html
Cankerworms	*Azadirachtin* *Bacillus thuringiensis* (Bt) *Canola oil* Carbaryl Cyfluthrin Deltamethrin *Insecticidal soap* Lambda-Cyhalothrin *Spinosin* see table 4.7	**Timing of pesticide treatment**: In May when the leaves are half to two-thirds full size, treatments must be applied when loopers are small. **Biological controls**: Parasitizers (wasps: *Telenomus alsophilae, Euplectrus mellipes, Trichogramma minutum*), birds, and ground beetles (*Calosoma frigidum*) **Cultural controls**: Band tree trunks with sticky traps to prevent the females from laying eggs. Improve general overall health. Reduce tree stress. Be sure the tree is suited to the area. Avoid injuries, damage, and soil compaction.
Eastern tent caterpillar	Bifenthrin Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Bacillus thruingensis* (Bt) *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: Treat in April after leaves open. **Remarks**: A sporadic pest, not a pest every year. **Biological controls**: Encourage natural predators: birds, some beneficial wasps or tachinid flies. **Cultural controls**: Find and remove eggmasses in the fall after leaves have fallen. In the spring, scrape tent off the tree in the early morning or late afternoon so caterpillars are in the tent and either crush or drop into soapy water to destroy caterpillars. Prune lightly; too much does more damage than needed. **Related fact sheet**: https://pubs.ext.vt.edu/444/444-274/444-274.html

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Defoliators (cont.) Euonymus leaf notcher	Bifenthrin Carbaryl Dimilin Zeta-Cypermethrin	**Timing of pesticide treatment**: In late March or early April when insects are seen. **Remarks**: Sprays are usually ineffective if applied when caterpillars are less than 0.5 inch long. **Biological controls**: None known at this time. **Cultural controls**: Prune out egg masses. Avoid planting euonymus in affected areas.
Fall webworm	Bifenthrin Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Bacillus thruingensis* (Bt) *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: When larvae first begin to feed in late June. Repeat in late July. **Biological controls**: Encourage natural predators: birds, predatory stink bugs, predatory wasps and flies. **Cultural controls**: Pull down webs in larger trees and destroy the caterpillars. Pruning out webs in small trees is also effective. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1013/2808-1013.html
Flea beetles	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Bacillus thruingensis* (Bt) *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: When insects are found feeding on host plants as adults or as larvae. For imidacloprid, see "Bee Advisory Box" **Remarks**: Carbaryl may injure tender foliage if plants are wet when treated or humidity is high. **Biological controls**: None known at this time. **Cultural controls**: Plant seedlings and transplants in well-prepared beds to hasten growth and vigor. Control weeds, and remove trash-plant particles to maintain good sanitation. Gauze can be used as a mesh for seedlings in heavy infestations or use floating row covers. Mulching helps in isolated plantings. Vacuuming foliage is effective but needs to be repeated often. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1549/3104-1549.html
Grasshoppers	*Azadirachtin* Bifenthrin Carbaryl Cyfluthrin Deltamethrin Esfenvalerate Imidacloprid *Insecticidal soap* Malathion Permethrin see table 4.7	**Timing of pesticide treatment**: When grasshoppers are found feeding. For imidacloprid, see "Bee Advisory Box" **Remarks**: Grasshoppers are infrequent pests but can be destructive when abundant. **Biological controls**: Encourage natural predators: birds and parasites (robber flies). Poultry have been known to heavily eat grasshoppers. Use the protozoan, *Nosema locustae*, in baits to attract and infect the insects with the pathogenic spores. **Cultural controls**: Water breeding areas to grow more vegetation and keep grasshoppers off ornamental plants. Avoid mowing these areas. Floating row covers are also effective for young plants. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1550/3104-1550.html

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Defoliators (cont.) Gypsy moth	See Gypsy Moth separately.	**Timing of pesticide treatment**: When leaves have expanded but caterpillars are small, usually in mid-May. **Remarks**: Mist blowers and aerial applications are effective. Large trees may require power equipment.
Japanese beetle	Acetamiprid Bifenthrin Malathion Esfenvalerate Imidacloprid Permethrin Clothianidin Deltamethrin Lambda-Cyhalothrin Gamma-cyhalothrin Thiamethoxam Zeta-Cypermethrin see table 4.7	**Timing of pesticide treatment**: In late June or early July after adults have begun to congregate on selected hosts. Repeat as necessary into August. For imidacloprid, see "Bee Advisory Box" **Remarks**: Since adults actively fly and move continuously, they seem to be present constantly even where treatments have been applied. Treat with Imidacloprid in spring when new growth starts. **Biological controls**: Nematodes (*Steinernema*), Milky spore (*Bacillus popillae*) can be used for turf application to suppress grubs, but are slow acting. Traps with floral lures and sex attractants can be placed in landscape but it is possible to attract more beetles than were originally in the area if there is not a larger effort to reduce amounts. **Cultural controls**: Plant resistant plant species. Remove diseased fruit from trees and ground and maintain good sanitation. In early stages, picking off bugs by hand helps, or shake branches early in the morning when insects are sluggish. Drop insects into soapy water to kill. **Related fact sheet**: https://pubs.ext.vt.edu/2902/2902-1101/2902-1101.html
Rose chafer	Acetamiprid *Azadirachtin* Carbaryl Imidacloprid Lambda-Cyhalothrin Malathion Permethrin *Pyrethrins* see table 4.7	**Timing of pesticide treatment**: During June and mid-summer when insects are found. For imidacloprid, see "Bee Advisory Box" **Remarks:** Adults are active flyers and move continually onto susceptible hosts. **Biological controls**: Use pheromone traps around affected area to trap beetles. **Cultural controls**: For few beetles, hand picking is effective. Cultivating in May will help destroy pupae. Increasing soil moisture (planting clover with turf) and shade will reduce the larvae that survive. Cover plants with cheese cloth, or use trap plants (spirea, deutzia, andromeda, white rose, and blackberry) to reduce damage to other plants and increase yield when handpicking. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1564/3104-1564.html
Rose slugs	Carbaryl Deltamethrin *Insecticidal soap* see table 4.7	**Timing of pesticide treatment**: Throughout the growing season when young larvae are seen on plants, especially in May, June. **Remarks**: Close inspection of plants is necessary to time treatments when larvae are young and damage is not yet severe. **Biological controls**: None known at this time. **Cultural controls**: Handpick to remove insects carefully as this is a stinging caterpillar, or spray plants with water; once knocked off, the insects cannot climb back onto the plant.
Sawflies	See sawflies separately.	**Timing of pesticide treatment**: Timing varies in the season depending on the host plant and the sawfly species. **Remarks**: Label uses are limited to pines, larch, ash, and spruce.
Tussock moth	*Azadirachtin* Bifenthrin Carbaryl Chlorantraniliprole Diflubenzuron Gamma-cyhalothrin Lambda-Cyhalothrin Lannate Methoxyfenozide Permethrin *Pyrethrins* Tebufenozide see table 4.7	**Timing of pesticide treatment**: In mid-May or late August. **Remarks**: Treat when larvae are small. **Biological controls**: Encourage natural predators (parasitic wasps, spiders, and birds) in the early larval stage. **Cultural controls**: Prune out localized infestations.

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Defoliators (cont.) Willow leaf beetle	Bifenthrin Carbaryl Imidacloprid *Spinosyn* see table 4.7	**Timing of pesticide treatment**: In May, June, and later if infestations persist. There may be several generations in a season. For imidacloprid, see "Bee Advisory Box" **Remarks**: Be sure to treat the undersides of the leaves. **Biological controls**: Encourage natural predators: Assassin bugs and asian lady beetles. **Cultural controls**: Some pubescent (layer of hairs on leaf) varieties are resistant. Maintain overall health of the plant. Generally requires several years of heavy feeding to kill tree. **Related fact sheet**: https://pubs.ext.vt.edu/ENTO/ENTO-139/ENTO-139.html
European hornet	2-methyl-1-butanol & Acetic acid & Heptyl butyrate	**Timing of pesticide treatment**: By observing the direction and flight path of hornets from the point of damage, the nesting site can be found. Destroy the nest. Hornets collect the bark for use in building their nest. **Remarks**: Lilac, boxwood, and certain other trees and shrubs. Rarely sting. Usually nest in hollow trees. **Biological controls**: None known at this time. **Cultural controls**: Fill in holes in old trees and man-made structures to reduce places for insects to nest. **Related fact sheet**: https://pubs.ext.vt.edu/2911/2911-1422/2911-1422.html
Fire ant (red imported fire ant)	**Baits** Hydramethylnon Avermectins (abamectin) Hydramethylnon Indoxacarb methoprene Fipronil Spinosad Semicarbazone **Mound Treatments** Beta-cyfluthrin Bifenthrin Carbaryl Cyfluthrin Deltamethrin Imidacloprid Lambda-Cyhalothrin Permethrin see table 4.7	**Timing of pesticide treatment**: When ants or mounds are observed. **Chemical Control:** The Two-Step method of a bait followed in several days by mound treatments to sensitive or highly trafficked areas is effective within the quarantine area. Treat in sensitive or highly trafficked areas is recommended. Combinations of chemicals are also available. Many products are sold under multiple trade names. For imidacloprid, see "Bee Advisory Box". **Remarks**: VDACS does not provide within the quarantine area. Nurseries and landscapers shipping out of the quarantine area must contact VDACS **Biological controls**: no commercially available organisms. **Cultural controls**: Pour boiling water onto ant hills after cool mornings, especially after a rainfall when the highest number of ants will be in the hill at a time. Plant shade trees, inspect new plants before buying to ensure the plants are pest free. Remove litter and organic matter from lawns to reduce feeding areas and maintain good sanitation. Mowing frequently will encourage the disturbed colonies to move to less bothered areas. Don't transport planting items (plants themselves, mulch, soil, etc.) from infected areas. **Resources:** Follow this link for fire ant distribution and resources: https://www.ento.vt.edu/4-H_Entomology/fire_ant/resource_page.html

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Gall insects	Carbaryl	**Timing of pesticide treatment**: Treatments are effective when insects are active, before galls appear in spring. **Remarks**: Most gall insects sting or feed on the host to incite the galls. Most gall insects leave the galls when mature. Disposing of galls is not effective in reducing the pest unless they can be cut out while they are actively growing, such as horned oak gall and gouty oak gall. **Biological controls**: None known at this time. **Cultural controls**: Maintain good overall health of the plant. Fertilize in the summer, irrigate during dry times, and prune limbs regularly. If galls numerous, some can be pruned out and destroyed. **Related fact sheets**: https://pubs.ext.vt.edu/ENTO/ENTO-147/ENTO-147.html https://pubs.ext.vt.edu/ENTO/ENTO-146/ENTO-146.html https://pubs.ext.vt.edu/ENTO/ENTO-145/ENTO-145.html
Gypsy moth	Acetamiprid Bifenthrin Carbaryl Cis-7,8-Epoxy-2-methyloctadecane Cypermethrin Dimillin Gypsy moth NPV Lambda-Cyhalothrin Methoxyfenozide Permethrin *Spinosyn* Tebufenozide *Azadirachtin* *Bacillus thuringiensis* (Bt) *Canola oil* *Pyrethrins* see table 4.7	**Biological controls**: Encourage natural predators: mice, shrews, and ground beetles. **Cultural controls**: Burlap skirts and barrier bands: Collect caterpillars under the burlap skirt every few days and kill by placing in a water/detergent mixture. Barrier bands are either slick or sticky and stop insect movement up to the foliage. Scraping off egg masses into soapy water is also effective in the fall or winter. **Related fact sheets:** http://pubs.ext.vt.edu/444/444-840/444-840.html
Iris borer	*Pyrethrins*	**Timing of pesticide treatment**: Treat when leaves are 5 to 6 inches tall. **Remarks**: Dispose of dry leaves and debris in the fall. **Biological controls**: Beneficial nematodes (heterorhabditis and steinernema) **Cultural controls**: Plant resistant varieties. Sanitation: remove plant debris and diseased plants. **Related fact sheet**: https://pubs.ext.vt.edu/ENTO/ENTO-140/ENTO-140.html

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Lacebugs	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Insecticidal Soap* *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: On evergreens, overwintering eggs hatch in mid- to late May. Treat in late May or early June and repeat at 3-week intervals. On deciduous hosts, adults emerge in May. Treat in late May and repeat at 3-week intervals. For imidacloprid, see "Bee Advisory Box" **Remarks**: Consult the label for host plants and specific pests listed under directions for use. Treatments must cover the undersides of the leaves thoroughly. Control of the first generations is most important to slow population buildup. Examine foliage for lacebugs into fall. **Biological controls**: Encourage natural predators: assassin bugs, lacewing larvae, lady beetles, spiders, pirate bugs, & predatory mites. **Cultural controls**: Maintain overall health of the plant. Mulch. Prune out damage. Plant resistant varieties or plant susceptible ones in partially shaded areas. Can spray infected plants with a high-pressure stream of water to knock insects off. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1581/3104-1581.html
Leafhoppers	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Insecticidal Soap* *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: When leafhoppers are first seen and before stippling on undersides of leaves becomes extensive. For imidacloprid, see "Bee Advisory Box" **Remarks**: Thorough coverage is essential on the undersides of the leaves. Check plants as soon as leaf buds open in spring; continue checking into early summer. **Biological controls**: Natural predators: spiders, lacewings, pirate bugs, lady beetles, predatory mites, bigeyed bugs, damsel bugs, & assassin beetles. **Cultural controls**: Maintain overall health of the plant and removed damaged plants. Avoid overfertilization. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1553/3104-1553.html
Leafminers Azalea leafminer	*Azadirachtin* Carbaryl	**Timing of pesticide treatment**: Treat in mid- to late-May or when mines are first seen on the plants. **Remarks**: Some varieties may be susceptible to plant injury. **Biological controls**: Encourage natural predators: parasitic wasps. **Cultural controls**: Maintain overall health of the plant. A healthy plant will outgrow damage. Prune out and destroy infested branches. Handpicking for small populations is effective. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1554/3104-1554.html
Boxwood leafminer	Avermectin B1 Carbaryl Clothianidin Deltamethrin Imidacloprid Malathion see table 4.7	**Timing of pesticide treatment**: Treat in April or early May when adults are active. For imidacloprid, see "Bee Advisory Box" **Remarks**: Numerous adults can be eliminated before eggs are laid. **Biological controls**: Encourage natural predators. **Cultural controls**: Handpicking for smaller populations is effective. Plant resistant varieties. Prune foliage before adult emergence. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1554/3104-1554.html
Holly leafminers	Carbaryl Deltamethrin Acephate & see table 4.7	**Timing of pesticide treatment**: Treat in mid-May when adults are active on the foliage. **Remarks**: Helps reduce feeding punctures on undersides of leaves but may not prevent all mines in the foliage. **Biological controls**: Encourage natural predators: parasitic wasps. **Cultural controls**: Plant resistant hollies: 'Blue Prince' and 'Blue Princess' varieties. Collect affected fallen leaves and destroy them. Handpick infested leaves off the plant for light infestations. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1554/3104-1554.html

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Leafminers (cont.) Oak leafminer	Carbaryl Deltamethrin see table 4.7	**Timing of pesticide treatment**: Treat when mines are first seen - less than 1/4 inch. Several generations occur each session. **Remarks**: Rake and destroy leaves in fall. **Biological controls**: None known at this time. **Cultural controls**: Remove leaves that are affected. Burn infested leaves in the fall. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1554/3104-1554.html
All other leafminers	Imidacloprid	**Timing of pesticide treatment**: Treat in mid- to late June after eggs have hatched. For imidacloprid, see “Bee Advisory Box” **Remarks**: These systemics are effective in eliminating miners; they are also effective later in the season, but mines will be present on the foliage. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1554/3104-1554.html
Leafrollers, leaf tiers	*Azadirachtin* *Bacillus thuringiensis* (Bt) *Canola oil* Bifenthrin Carbaryl Clothianidin Deltamethrin Esfenvalerate Fenpropanate Lambda-Cyhalothrin *Mineral oil* *Neem oil* Nylar Permethrin *Pyrethrins* Spinetoramat *Spinosyn* see table 4.7	**Timing of pesticide treatment**: Treat when insects are first seen. On some hosts, injury occurs in early spring when new buds are opening. **Remarks**: Consult the label for specific host plants listed. **Biological controls**: Encourage natural predators: lacewing, assassin bug, & parasitic wasps **Cultural controls**: Minimize plant stress by watering, fertilizing, etc.
Mealybugs	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* Insecticidal Soap *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: Treat in late spring, before new growth begins. For imidacloprid, see “Bee Advisory Box” **Remarks**: Forceful spray streams help penetrate cracks and crevices in the bark and waxy secretions that protect the mealybugs. Spray on warm days when the temperature remains above 40°F (5°C) for 12 to 24 hours. Do not spray sensitive plants listed on the label. **Biological controls**: Encourage natural predators: ladybeetles, ladybird beetles, lacewing, parasitoids, parasitic wasps, & spiders. **Cultural controls**: Inspect all new plants to ensure they are pest free. Control weeds, remove mummified fruits, and maintain general sanitation. Prune carefully. Keep good air flow, avoid overfertlization.

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Mites Hemlock rust mite, eriophyid mites	Avermectin B1 Carbaryl Fenpryoximate *Lime Sulfur* *Mineral oil* Petroleum hydrocarbons *Pyrethrins* Spirodiclofen Spiromesifen *Sulfur* see table 4.7	**Timing of pesticide treatment**: Treat in early spring before new growth develops. **Remarks**: Do not use on sensitive plants indicated on the label. **Biological controls**: Encourage natural predators: Phytoseiid mites, lacewings, lady beetles, & predatory mites. **Cultural controls**: Maintain overall plant health. Don't overfertilize.
Spider mites, including: spruce mite, southern red mite, box-wood mite	*Neem Oil* *Insecticidal Soap* *Dormant Oil* *Soybean Oil* *Sulfur*	**Timing of pesticide treatment**: Treat in late April or early May and/or in September and October, except for horticultural oil, which should be used in early spring, just before new growth starts. **Remarks**: Thoroughly wet all of the foliage and stems with a full coverage spray. Use Isotox only if it contains a miticide. **Biological controls**: Encourage natural predators: lady beetles, minute pirate bugs, predatory thrips, and phytoseiid mites. **Cultural controls**: Maintain overall health of the plant. Irrigate in dry weather and avoid overfertilization. Inspect new plants for signs of mites. Knock off mites with a forceful jet of water. Can wipe leaves off by hand, clean up infested areas with soap and water. **Related fact sheets**: https://pubs.ext.vt.edu/444/444-221/444-221.html https://pubs.ext.vt.edu/444/444-235/444-235.html https://pubs.ext.vt.edu/ENTO/ENTO-42/ENTO-42.html
Honey locust mite	Avermectin B1 Nissorun Spiromesifen *Insecticidal soap*	**Timing of pesticide treatment**: One application in late June or early July will prevent damage. Treat when mites occur to control established infestations. **Remarks**: Thoroughly wet the undersides of leaves with a full coverage spray. **Biological controls**: Encourage natural predators: ladybird beetle, minute pirate bugs, predatory thrips, & phytoseiid mites. **Cultural controls**: Maintain overall health of the plant. Irrigate in dry weather and avoid overfertilization. Inspect new plants for signs of mites. Knock off mites with a forceful jet of water. Can wipe leaves off by hand, clean up infested areas with soap and water
two-spotted spider mite	*Neem Oil* *Insecticidal Soap* *Dormant Oil* *Soybean Oil* *Sulfur*	**Timing of pesticide treatment**: Treat whenever mites first appear. Infestations may occur from spring to fall. Mite infestations are directly proportionate to increasingly warmer temperatures. **Remarks**: Thoroughly wet the foliage and stems with a full coverage spray. **Biological controls**: Encourage natural predators: predatory mites. **Cultural controls**: Maintain overall health of the plant. Irrigate in dry weather and avoid overfertilization. Inspect new plants for signs of mites. Knock off mites with a forceful jet of water. Can wipe leaves off by hand, clean up infested areas with soap and water. Reduce dust. **Related fact sheet**: https://pubs.ext.vt.edu/444/444-221/444-221.html

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Plant bugs, plant hoppers	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Insecticidal Soap* *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: Treat when insects or signs of damage first appear. Treat honeylocust as soon as new growth begins. For imidacloprid, see "Bee Advisory Box" **Remarks**: Control is difficult because plant bugs are active flyers and move around continuously. **Biological controls**: None known at this time. **Cultural controls**: Maintain overall health of the plant. Irrigate in dry weather and avoid overfertilization. Remove leaf litter. Reduce mulch thickness. Inspect new plants for signs of mites. Knock off mites with a forceful jet of water. Can wipe leaves off by hand, clean up infested areas with soap and water. Hand pick the nymphs off the plant for small infestations. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1568/3104-1568.html
Psyllids Boxwood psyllid, hackberry psyllid	Carbaryl see table 4.7	**Timing of pesticide treatment**: Treat in late April or early May as new growth begins to develop. **Biological controls**: None known at this time. **Cultural controls**: Prune out infested tips and destroy before nymphs hatch in mid-May.
Rose Slugs	Beta-Cyfluthrin Carbaryl Deltamethrin *Insecticidal soap* Permethrin *Tall oil soaps* see table 4.7	**Timing of pesticide treatment**: Spray when small larvae are first seen. Timing depends on the species and the host. Rose slugs, like most sawflies, are gregarious, working in groups, localized on certain braches of the host. **Remarks**: Roses are susceptible. **Biological controls**: None known at this time. **Cultural controls**: Handpick insects or use a a strong jet of water to remove insects.
Sawflies	*Azadirachtin* Clothianidin Dimethoate Imidacloprid *Insecticidal soap* Lambda-Cyhalothrin Permethrin Thiamethoxam see table 4.7	**Timing of pesticide treatment**: Treat when insects are first seen. Various species can occur throughout the growing season. Treat in April for Virginia pine sawfly. Larvae are gregarious, thus broods are clustered on one branch or localized on scattered trees. For imidacloprid, see "Bee Advisory Box" **Remarks**: A number of damaging species are not listed on labels. Ash, larch, pines, and spruces are listed. **Biological controls**: Encourage native predators: parasites, rodents and birds. **Cultural controls**: Maintain overall plant health and reduce tree stress. For small numbers, handpick insects off of plants. Use a strong water jet to knock insects off the plant. For small, accessible populations, shake them off or prune off damaged areas lightly. Remove competing vegetation. Remove egg clusters in late winter and destroy, or knock off clusters on limbs into soapy water. **Related fact sheet**: https://pubs.ext.vt.edu/2911/2911-1424/2911-1424.html

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Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Scale insects General	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Insecticidal Soap* *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: For horticultural oil, treat in late March or early April before new growth develops, and when temperatures are not likely to go below 40˚F (5˚C) for 12-24 hours. For other insecticides on list treat at crawler date. For imidacloprid, see “Bee Advisory Box” **Remarks**: Do not spray oil-sensitive plants listed under precautions on the label. Be sure to follow the dosage rates given on the label for the various scale species. Oils can also be used as summer sprays when indicated on the label. Imidacloprid may not control all types of scales. **Biological controls**: None known at this time. **Cultural controls**: Maintain overall plant health and reduce plant stress. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Azalea bark scale	Acetamiprid Imidacloprid Malathion *Paraffin oil*	**Timing of pesticide treatment**: Crawlers: June 5-30 Treat June 10-20. For imidacloprid, see “Bee Advisory Box” **Biological controls**: Encourage natural predators: Parasitic lady beetles and wasps. **Cultural controls**: Maintain overall plant health and reduce plant stress. Remove heavily infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. Light infestations can be scraped or wiped off branches. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Brown soft scale	Same as general	**Timing of pesticide treatment**: Treat when scale insects appear. Treat 2-3 times at 10-day intervals. **Remarks**: This scale insect does not winter out-of-doors in colder plant zones of Virginia. **Biological controls**: Encourage natural predators: lady beetles. Control ants that could be protecting the insects from other natural enemies. **Cultural controls**: Maintain overall plant health and reduce plant stress. Remove heavily infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. Small populations can be removed by handpicking individuals, or by scrubbing limbs with mesh sponge to remove adults. A high pressure water jet can also be used to knock insects off the plant. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Calico scale	Acetamiprid *Azadirachtin* Carbaryl Imidacloprid *Mineral oil* *Neem oil*	**Timing of pesticide treatment**: Crawlers: June 1-20. Treat June 10-15. For imidacloprid, see “Bee Advisory Box” **Biological controls**: Encourage natural predators: parasitic wasps, minute pirate bugs, lacewings, lady beetles, predaceous midges, & birds. **Cultural controls**: Maintain overall plant health and reduce plant stress. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Camellia scale	Imidacloprid	**Timing of pesticide treatment**: Crawlers: May 1-June 5 and September 15-30. Treat May 10-20 and/or September 10-20. For imidacloprid, see “Bee Advisory Box” **Biological controls**: Encourage natural predators: Ladybird beetles, parasitic wasps. **Cultural controls**: Ants visitations mean the infestation is not being controlled. If few insects, scrape off and dispose of. Handpick or pick off infested leaves if limited in number. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html

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Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Scale insects (cont.) Cottony camellia scale	See General Scale insecticide list	**Timing of pesticide treatment**: Crawlers: June 1-10. Treat June 10-20. **Biological controls**: Encourage natural predators: parasitic wasps, lady beetles. Control honeydew ants that might protect the insects from natural predators. **Cultural controls**: Maintain overall plant health and reduce plant stress. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Cottony maple leaf scale	See General Scale insecticide list	**Timing of pesticide treatment**: Crawlers: June 1-10. Treat June 15-30. **Biological controls**: Encourage natural predators: ladybeetles. **Cultural controls**: Maintain overall plant health and reduce plant stress. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. Hand remove females if it is a small number and within reach. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Cottony maple scale	Acetamiprid Imidacloprid *Mineral oil* *Paraffin oil*	**Timing of pesticide treatment**: Crawlers: June 5-25. Treat June 10-20. For imidacloprid, see "Bee Advisory Box" **Remarks**: Be sure to thoroughly cover stems and branches near the ground. **Biological controls**: Encourage natural predators: ladybeetles. **Cultural controls**: Maintain overall plant health and reduce plant stress. Institute a watering schedule. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. Hand remove females if it is a small number and within reach. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1011/2808-1011.html
Crape myrtle bark scale	Imidacloprid	**Timing of Pesticide Treatment:** Soil drench in spring as growth starts. **Biological Controls:** Lady beetles will feed on this scale **Cultural Control:** Maintain healthy plants, do not apply too much nitrogen fertilizer.
Euonymus scale	Acetamiprid *Lime Sulfur* Malathion Nylar *Paraffin oil*	**Timing of pesticide treatment**: Crawlers: first generation May 5-June 10; second July 1-25. Treat May 10-20 and July 5-15. **Biological controls**: Encourage natural predators: ladybird beetle. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. Plant resistant species: (*E. alatus, E. kiautschovicus*) Variegated varieties are more susceptible to infestations. **Related fact sheet**: https://pubs.ext.vt.edu/444/444-277/444-277.html
European elm scale	Acetamiprid *Mineral oil* *Paraffin oil*	**Timing of pesticide treatment**: Crawlers: June 5-25. Treat June 10-15. **Biological controls**: Encourage natural predators: ladybird beetles, parasitic wasps. Control ants that might protect the insects from these natural predators. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. Asiatic elms (Siberian elm, Chinese elm) are resistant. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html

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Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Scale insects (cont.) Fern scale	Buprofezin	**Timing of pesticide treatment**: Crawlers: first appear in mid-May. Treat at 2-week intervals as needed. **Biological controls**: Encourage natural predators: ladybird beetles, parasitic wasps, & lacewings. Control ants that might protect the insects from these natural predators. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Fletcher scale	Acetamiprid Dimethoate Malathion *Paraffin oil* Thiamethoxam see table 4.7	**Timing of pesticide treatment**: Crawlers: in early to mid-June. Treat June 10-20. **Remarks**: On Taxus and Arborvitae. **Biological controls**: Encourage natural predators: minute pirate bugs, lacewings, lady beetles, & predaceous midges. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Florida red scale	Acetamiprid Buprofezin Imidacloprid Malathion *Mineral oil* Nylar Spirotetramat	**Timing of pesticide treatment**: Crawlers: May 5-15. Treat May 15-30. For imidacloprid, see “Bee Advisory Box” **Biological controls**: None known at this time. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. Maintain overall health and pruning. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Florinia hemlock scale	See General Scale insecticide list	**Timing of pesticide treatment**: Crawlers: peak May 15-June 20, some produced throughout the season. Treat May 20-25 and June 5-10. **Biological controls**: None known at this time. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Forbes scale	Carbaryl Malathion *Mineral oil*	**Timing of pesticide treatment**: Crawlers: June 1-15. Treat June 5-10. **Remarks**: Label uses restricted to flowering fruits. **Biological controls**: None known at this time. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Gloomy scale	See General Scale insecticide list	**Timing of pesticide treatment**: Crawlers: peak June 10-20. Treat June 20-30. **Remarks**: Serious pest that is difficult to control. **Biological controls**: Encourage natural predators: lacewing, lady beetles, & predaceous midges. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/ENTO/ENTO-44/ENTO-44.html

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Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Scale insects (cont.) Japanese scale	see table 4.7	**Timing of pesticide treatment**: Crawlers: May 15 - June 10, August 5 - 10. Treat at 2-week intervals June-September. **Biological controls**: None known at this time. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Juniper scale	Malathion *Lime Sulfur* *Mineral oil* *Paraffin oil*	**Timing of pesticide treatment**: Crawlers: April 5-20 and June 5-20. Treat April 10-15 and/or June 10-15. **Remarks**: Crawler dates vary based on temperature. **Biological controls**: Encourage natural predators: lady beetles, predatory mites, & parasitic wasps. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Latania scale	Malathion *Mineral oil*	**Timing of pesticide treatment**: Crawlers: continuous from June through season. Treat 2-3 times at 10-day intervals. **Biological controls**: Encourage natural predators: ladybeetles, & parasitic wasps. Control ants that might protect the insects from these natural predators. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Lecanium scale	Carbaryl Imidacloprid *Neem oil* Nylar *Soybean oil* see table 4.7	**Timing of pesticide treatment**: Crawlers: May 25-June 25. Treat June 15-20. For imidacloprid, see "Bee Advisory Box" **Remarks**: Treat for oak lecanium June 1-10 in coastal areas. Lecanium crawlers from June 1-20. Treat June 10-15. **Biological controls**: Encourage natural predators: ladybird beetles and lacewings. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Magnolia scale	Malathion *Paraffin oil*	**Timing of pesticide treatment**: Treat September 1-20. **Biological controls**: Encourage natural predators: lady beetles. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/444/444-623/444-623.html
Oak kermes	Malathion *Paraffin oil*	**Timing of pesticide treatment**: Crawlers: June 1-20. Treat June 10-15. **Biological controls**: Encourage natural predators: parasitic wasps, lady beetles. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. Remove scales by hand (scrape off).

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Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Scale insects (cont.) Obscure scale	*Mineral oil* *Paraffin oil* *Soybean oil*	**Timing of pesticide treatment**: Crawlers: on red oak during July. Treat white oaks in mid-August. **Remarks**: Also treat with oil as a dormant spray. **Biological controls**: Encourage natural predators: lady beetles & parasitic wasps. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1583/3104-1583.html
Oystershell scale	Acetamiprid Buprofezin Carbaryl Imidacloprid *Lime Sulfur* Malathion *Mineral oil* *Paraffin oil*	**Timing of pesticide treatment**: Crawlers: May 1-20 and July 15-25. Treat May 5-10 and/or July 20-25. For imidacloprid, see "Bee Advisory Box" **Biological controls**: Encourage natural predators: twice stabbed ladybeetle, & predatory mites. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. Scrub scales off branches but do not injure bark. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Peony scale	See General Scale insecticide list	**Timing of pesticide treatment**: Crawlers: mid-May. Treat in late May. **Biological controls**: Encourage natural predators: lacewings, parasitic wasps, and lady beetles (twice-stabbed, multicolored asian). **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Pine needle scale	Acetamiprid *Azadirachtin* Bifenthrin Gamma-Cyhalothrin Lambda-Cyhalothrin *Lime Sulfur* Malathion *Mineral oil* Oxydemeton-methyl *Paraffin oil* Permethrin see table 4.7	**Timing of pesticide treatment**: Crawlers: April 20-May 30 and July 10-20. Treat May 5-20 and/or July 15-20. **Biological controls**: Encourage natural predators: twice-stabbed lady beetle & parasitic wasps. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2907/2907-1400/2907-1400.html
Pine tortoise scale	Gamma-Cyhalothrin Lambda-Cyhalothrin	**Timing of pesticide treatment**: Crawlers: June 10-July 5. Treat June 20-25. **Biological controls**: Natural predators: parasitic wasps, lady beetle, pirate bugs, and lacewings **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. Increase distance between plants. **Related fact sheet**: https://pubs.ext.vt.edu/3101/3101-1529/3101-1529.html

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Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Scale insects (cont.) Rose scale	Malathion *Lime Sulfur* *Mineral oil* *Paraffin oil* *see table 4.7*	**Timing of pesticide treatment**: Crawlers: late May-June 30, possible second generation in August. Treat June 5-10 and 20-25 and in mid-August. **Biological controls**: Encourage natural predators: lady beetles and parasitic wasps. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. Light infestations can be scraped off by hand. Remove weeds. **Related fact sheet**: https://pubs.ext.vt.edu/3104/3104-1565/3104-1565.html
San Jose scale	Same as general	**Timing of pesticide treatment**: Crawlers: at least 3 generations June, July, and September. Treat June 10-15, July 10-15, September 10-15. **Remarks***: Lime Sulfur* as dormant spray only. **Biological controls**: Encourage natural predators: lady beetle and parasitic wasps **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Tea scale	Acetamiprid Dimethoate Imidacloprid Malathion *Paraffin oil*	**Timing of pesticide treatment**: Crawlers: throughout season in overlapping generations. Treat 2-3 times at 10-day intervals when infested. For imidacloprid, see "Bee Advisory Box" **Biological controls**: Encourage natural predators: parasitic wasps. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Tuliptree scale	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Insecticidal Soap* *Spinosin* *Pyrethrins*	**Timing of the pesticide treatment**: Treat September 1-20. **Biological controls**: Encourage natural predators: lady beetles, predatory mites, and parasitic wasps. Control ants that might protect the insects from these natural predators. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid over-fertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Wax scale	Acetamiprid Buprofezin Malathion	**Timing of pesticide treatment**: Crawlers: June 1-25. Treat June 10-30. **Remarks**: Thoroughly wet foliage and bark with a full-coverage spray. **Biological controls**: None known at this time. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid overfertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. Handpick off scales for small populations. **Related fact sheet**: https://pubs.ext.vt.edu/444/444-622/444-622.html And http://pubs.ext.vt.edu/444/444-622/444-622.html

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Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Scale insects (cont.) White Prunicola Scale/White Peach Scale	Buprofezin Imidacloprid *Mineral oil* *Paraffin oil* *bifenthrin* Spirotetramat	**Timing of pesticide treatment:** Treat with dormant oil in early spring before bud break. Treat for crawlers in mid to late June with acephate, cyfluthrin, insecticidal soap, lambda-cyhalothrin, or neem oil. For imidacloprid, see "Bee Advisory Box" **Biological controls**: Encourage natural predators: ladybeetles and lacewings. **Cultural controls**: Maintain overall plant health and reduce plant stress. Avoid over-fertilization. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1012/2808-1012.html
Skeletonizers	*Bacillus thuringiensis (Bt)* Carbaryl	**Timing of pesticide treatment**: May or when damage starts. **Remarks**: Use *Bacillus thuringiensis (B.t.)* for Lepidoptera only. Use others for beetles and sawflies. **Biological controls**: Encourage natural predators: parasites. **Cultural controls**: Handpick to remove small populations.
Slugs and snails	*Boric acid* Deltamethrin *Ferric phosphate* *Insecticidal soap* Metaldehyde Silicon dioxide see table 4.7	**Timing of pesticide treatment**: Apply when pests are observed. **Biological controls**: Encourage natural predators: toads, snakes, some ground beetles, wild birds, and ducks. Toad is the most important. **Cultural controls**: Control weeds. Use a dusty, scratchy barrier (road dust, cinders, sawdust, gravel or sand). Handpick off plants at night and place slugs in soapy water or rubbing alcohol. Trap slugs: invert a melon, grapefruit peel or flower pot, wooden boards, asphalt shingles. Check daily.
Spittlebugs	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Insecticidal Soap* *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: Treat in early June if yellowing or damage occurs. For imidacloprid, see "Bee Advisory Box" **Remarks**: Rarely of economic importance. **Biological controls**: Encourage natural predators: pipunculid fly. **Cultural controls**: Maintain overall health of the plant with regular fertilization, mowing, thatch control, and proper collection and destruction of clippings. Avoid over-irrigation. For accessible spittlebugs, hand remove and drop in alcohol or use a strong water spray.

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Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Spotted Lanternfly	Dinotefuran Imidacloprid Carbaryl Bifenthrin Insecticidal soap Malathion *Pyrethrins* *Neem oil* *Spinosad* Zeta-cypermethrin	**Special Statement:** In Virginia, Spotted Lanternfly is currently found in over 19 Counties and Cities. Consult this map see if you are in and infested location: https://www.ento.vt.edu/4-H_Entomology/SpottedLanternfly/map.html If you are outside of those areas and think you have spotted lanternfly, submit a sample to your local Cooperative Extension Office. **Timing of pesticide treatment:** Contact insecticides should be applied to tree surfaces where SLF are found feeding and walking. Limit sprays to trees when and where SLF are actively found. SLF's occur on plants from May-October. Treat starting in May and repeat as needed with imidacloprid, dinotefuran, carbaryl, pyrethrin, or bifenthrin. Systemic insecticides are applied as a soil drench around the base of the tree, a bark application, or injected into the tree near the base. Tree injection will limit human exposure to the insecticide. However, a tree injection requires special equipment and a professional will need to be employed. Application should be made after the tree is done flowering for the season. This will limit unwanted negative impact to pollinators and other beneficial insects such as honey bees. "For information on control of SLF in residential yards, see: https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/ENTO/ento-322/ENTO-322.pdf" **Remarks:** Can be found on over 70 different trees and plants, but its preferred host is tree-of-heaven, *Ailanthus altissima* **Biological Controls:** None available at this time **Cultural controls:** Remove all tree-of-heaven from property. Herbicide treatments are the only effective method since cutting this tree will cause stump and root sprouts. See Virginia Cooperative Extension, publication 420-322 for methods of eliminating tree-of-heaven from yards, https://pubs.ext.vt.edu/420/420-322/420-322.html. For detailed management of SLF on trees and shrubs in back yards see table 2.X **Related web resources:** https://ext.vt.edu/spotted-lanternfly
Tent caterpillars	Bifenthrin Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Bacillus thruingensis (Bt)* *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: Treat in early spring as new growth is developing and when caterpillars are small. **Remarks**: Caterpillars leave the nests to feed on the foliage during the day. Apply full coverage spray to the entire tree. Forest tent caterpillar does not make a tent. **Biological controls**: Tachinid fly. **Cultural controls**: Avoid planting wild cherry, flowering crabapple, cherry. Prune out egg masses and destroy. Destroy tents by hand, or high-pressure water hose. Burning causes more damage. Kill caterpillars by crushing or dropping in warm soapy water; prune out tents in early morning. Caterpillars congregate in the tent at night. Prefers chokecherry, ash, basswood, birch, cottonwood, elm, maple, and oak. **Related fact sheet**: https://pubs.ext.vt.edu/444/444-274/444-274.html
Thrips	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Insecticidal Soap* *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: Treat in June when thrips are active on new foliage. For imidacloprid, see "Bee Advisory Box" **Biological controls**: Encourage natural predators: minute pirate bugs, predaceous mites (*Iphiseius degenerans,* Hypoaspis mites). **Cultural controls**: Maintain overall plant health, and sanitation, and avoid excessive fertilizing. Reduce excess soil. Control weeds (alternative hosts). Prune and destroy injured and infested branches. Use a strong spray of water to knock them off plants. Use row covers, and reflective mulch. **Related fact sheet**: https://pubs.ext.vt.edu/444/444-281/444-281.html

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Tip moths	Bifenthrin Carbaryl Dimethoate Esfenvalerate Fipronil Permethrin *Pyrethrins* *Spinosyn* see table 4.7	**Timing of pesticide treatment**: Treat with liquid formulation in mid-March, April, June, and July when moths are flying. For imidacloprid, see “Bee Advisory Box” **Remarks**: Spray entire tree to runoff. Two- and three-needle pines are susceptible to tip moth. Imidacloprid can be used as a soil drench. **Biological controls**: Encourage natural predators: predatory insects & birds. **Cultural controls**: Shear off damaged tips of light infestations below the dead section. Scavengers will eat them once on the ground. Inspect new seedlings for injured buds and twigs. American arborvitae is very susceptible, while western red cedar is rather resistant.
Treehoppers (Thornbugs)	Bifenthrin Carbaryl Deltamethrin Imidacloprid see table 4.7	**Timing of pesticide treatment**: Treat when nymphs are seen on twigs (usually in clusters) before adults are present to begin egg-laying, usually in late summer and fall. For imidacloprid, see “Bee Advisory Box” **Remarks**: Apply sprays to cover the small twigs thoroughly. Usually a minor pest. **Biological controls**: Few natural enemies. **Cultural controls**: Maintain overall plant health and reduce plant stress. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants.
Twig girdlers, twig Pruners	*Azadirachtin* Carbaryl	**Timing of pesticide treatment**: Gather and burn fallen branches and twigs in late fall. **Remarks**: Oak, hickory, and many trees and shrubs are susceptible. **Biological controls**: Two wasp parasitoids. Downy woodpecker, blue jay, and black-capped chickadee. Parasites: *Eurytoma magdalidis, Iphiaulax agrili,* and *Horismenus* sp., and a checkered flower beetle **Cultural controls**: Maintain overall plant health and reduce plant stress. Remove infested plant debris. Prune heavily infested limbs. Inspect new plants and buy only pest-free plants. Pick up loose twigs on the ground and destroy. **Related fact sheet**: https://pubs.ext.vt.edu/2911/2911-1423/2911-1423.html
Webworms Barberry Webworm	Bifenthrin Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Bacillus thruingensis* (Bt) *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment:** Treat in mid to late July when larvae are small and webs just starting to form. For imidacloprid, see “Bee Advisory Box” **Remarks:** Caterpillars are gregarious and infest areas within a plant. Apply full-coverage foliar spray to infested area, or entire shrub in years of high populations. **Biological controls:** Encourage natural predators: parasitic wasps, flies, & birds. **Cultural controls:** Prune out small infestations. Do not remove defoliated barberry shrubs, they will recover if healthy.
Cotoneaster webworm	*Bacillus thuringiensis* (Bt) Permethrin *Spinosyn*	**Timing of pesticide treatment**: Treat when larvae are first found. Timing not well established. **Remarks**: Apply a full-coverage spray, wetting foliage to the point of runoff. **Biological controls**: None known at this time. **Cultural controls**: Handpick or prune out and destroy pests. Remove overwintering eggs.

Italicized pesticides are organic control options.

Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Webworms (cont.) Fall webworm	Bifenthrin Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Bacillus thruingensis* (Bt) *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: Treat in late June or early July when larvae are small and webs just starting to form. Treat for second generation in August or early September. For imidacloprid, see "Bee Advisory Box" **Remarks**: Caterpillars are gregarious and infest individual branches. Apply full-coverage foliar spray to infested area, or entire tree in years of high populations. **Biological controls**: Encourage natural predators: parasitic wasps, flies, & birds. **Cultural controls**: If in reach, cut the webs out of the tree, remove and destroy. Strong water spray can dislodge tents. **Related fact sheet**: https://pubs.ext.vt.edu/2808/2808-1013/2808-1013.html
Juniper webworm	*Bacillus thuringiensis (Bt)* Permethrin *Spinosyn*	**Timing of pesticide treatment**: Treat in late July or in August when larvae are small. Spring treatments may be applied when plants are found to be infested. **Remarks**: Apply a forceful spray to penetrate severely webbed foliage. Thoroughly wet the foliage to runoff. **Biological controls**: Natural parasites: predaceous ground beetles, rove beetle, parasitic tachinid fly, parasitic braconid wasps, earwig, rove beetle, robber fly, & paper wasp. **Cultural controls**: Irrigate to help the plant grow out of damage. For turf, thatch removal. For small populations, handpick caterpillars, prune and destroy webs.
Mimosa webworm	Avermectin B1 *Bacillus thuringiensis (Bt)* Bifenthrin Carbaryl Deltamethrin *Pyrethrins* see table 4.7	**Timing of pesticide treatment**: Apply foliage sprays at 4- to 5-day intervals until the infestation is controlled. **Biological controls**: Encourage natural predators: insects and birds that feed on larvae. **Cultural controls**: Clear away leaf debris, pull down the webs, and drop caterpillars in soapy water. Use less susceptible honeylocust varieties (*Gleditsia tricanthos*): "Moraine", "Shademaster" and "Imperial". Sunburst is very susceptible. Thornless varieties of honeylocust suffer the most.
Pine webworm	*Azadirachtin* *Bacillus thuringiensis* (Bt) Permethrin	**Timing of pesticide treatment**: Treat in early June. **Biological controls**: Encourage natural predators: parasitic wasps (*Eulophidae, Braconidae, Chalcididae, Ichneumonidae*), parasitic flies, assassin bugs, & birds **Cultural controls**: Maintain overall plant health. For a few scattered nests prune out of trees before larvae pupate, or handpick and remove larvae.
Weevils Two-banded Japanese weevil, black vine weevil	*Azadirachtin* *Beauveria bassiana* Bifenthrin Clothianidin Cryolite Fluvalinate Imidacloprid *Metarhizium anisopliae* *Pyrethrins* see table 4.7	**Timing of pesticide treatment**: Apply in July as a full-coverage spray when foliar feeding is first observed. For imidacloprid, see "Bee Advisory Box" **Remarks**: Acephate is for black vine weevil adults. **Biological controls**: Entomopathogenic nematodes. **Cultural controls**: Shake or tap plant to dislodge beetles. Catch beetles in a sheet or paper underneath the plant. Don't jar the plant too badly. Destroy weevils by dropping them in a can of water with some soap or freeze them. Remove excessive mulch. **Related fact sheets**: https://pubs.ext.vt.edu/444/444-624/444-624.html https://pubs.ext.vt.edu/444/444-210/444-210.html

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Table 4.6 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Pesticides Approved	Recommendations
Weevils (cont.) Pales weevil	Efenvalerate (Asana) Permethrin	**Timing of pesticide treatment**: April **Remarks**: Treat stumps of trees cut less than 12 months ago and new seedlings. **Biological controls**: None known at this time. **Cultural controls**: Apply as a full coverage spray to seedlings immediately after planting. Dilute Asana in water. Thoroughly soak stumps and ground surface 1-2 feet around stumps or slash prior to mid- March. Only stumps or wood cut since previous summer needs treatment, First year stumps only. **Related fact sheet**: https://pubs.ext.vt.edu/2902/2902-1102/2902-1102.html
White pine weevil	Asana Avermectin B1 Bifenthrin Diflubenzuron dinotefuran Emamectin benzoate Imidacloprid	**Timing of pesticide treatment**: Apply sprays in the spring before adults lay eggs, normally prior to April 1-10. For imidacloprid, see “Bee Advisory Box” **Remarks**: Treat only the main terminal leaders of the tree down to the first whorl of branches. Thoroughly wet the bark. **Biological controls**: None known at this time. **Cultural controls**: Prune out infested branches below bark discoloration before adults emerge, and burn branches. Maintain good sanitation. Heavily clay soils and sodded fields have high weevil hazards. Remove older eastern white pine reservoirs in nearby forest stands. **Related fact sheet**: https://pubs.ext.vt.edu/444/444-270/444-270.html
Whiteflies	Bifenthrin Imidacloprid Permethrin Malathion Carbaryl Esfenvalerate *Neem Oil* *Insecticidal Soap* *Spinosin* *Pyrethrins* Soybean Oil	**Timing of pesticide treatment**: When whiteflies are found. Treat every 3 weeks until infestation is controlled. For imidacloprid, see “Bee Advisory Box” **Remarks**: See label. **Biological controls**: Encourage natural predators: spiders, wasps (*Encarsia, Eretmocerus*), bigeyed bugs, lacewing larvae, lady beetle larvae. **Cultural controls**: Check new plants for insects. Remove older leaves by hand on heavily infested plants when they are in nymphal and pupal stages. Vacuum up adults in the morning and place bag with insects inside another bag in the freezer for 24 hours. (best at the beginning of an infestation). Maintain good sanitation. Control weeds. Take care when the numbers are small. Do not ignore them. Yellow cards with tanglefoot or tack trap on surface will help control numbers. **Related fact sheet**: https://pubs.ext.vt.edu/444/444-280/444-280.html
Zimmerman pine moth	Bifenthrin Methoxyfenozide Permethrin Tebufenozide	**Timing of pesticide treatment**: Treat in early to mid-April and in early September. **Remarks**: Apply as full-coverage spray to the point of runoff. **Biological controls**: Parasitoid wasps. **Cultural controls**: Cut out pitch masses, destroy heavily infested trees and chip or burn parts in early August before adults emerge. Maintain sanitation.

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Table 4.7 - List of Common Insecticide Mixtures

Companies have been known to manufacture and market mixtures of chemicals as a single product. The following is a general list of common mixtures found and approved for sale in the state of Virginia. The amount of mixtures available is not limited to the list below. Be sure to read the pesticide label before application, especially if it contains a mixture of chemicals not listed below.

Acephate & Fenbutatin-oxide	Acephate & Synthrin	Acephate & Fenpropanate or Fenbutatin-oxide		
Basic copper sulfate & Cube resins with Rotenone	Basic copper & sulfate Carbaryl	*Basic copper sulfate* & Carbaryl (sevin)		
Beta-cyfluthrin & Sodium o-phenylphenate	Beta-cyfluthrin & Imidacloprid			
Bifenthrin & Imidacloprid or Zeta-Cypermethrin	Bifenthrin & Imidacloprid, Zeta-Cypermethrin & Clothianidin	Bifenthrin & Imidacloprid or Clothianidin	Bifenthrin & Clothianidin or Zeta-Cypermethrin	Bifenthrin & Imidacloprid, Clothianidin, Cyfluthrin & Zeta-Cypermethrin
Bifenthrin & Zeta-Cypermethrin	Bifenthrin & Clothianidin, Imidacloprid & Zeta-Cypermethrin	Bifenthrin & Clothianidin or Imidacloprid	Bifenthrin & Clothianidin	Bifenthrin & Imidacloprid, Clothianidin or Imidacloprid
Bifenthrin & Zeta-Cypermethrin, Clothianidin & Imidacloprid	Bifenthrin & Imidacloprid	Bifenthrin & Zeta-Cypermethrin		
Bioallethrin & Bifenthrin or Permethrin	Bioallethrin & Deltamethrin or *Pyrethrins*	Bioallethrin & Deltamethrin or Resmethrin		
Carbaryl & Cube resins with Rotenone	Carbaryl & Metaldehyde	Carbaryl & Cube resins, Rotenone & Malathion	Carbaryl & Malathion	Carbaryl & Malathion, Cube resins & Rotenone
Carbaryl & *Copper sulfate*	Carbaryl & Malathion, Cube resins, Rotenone, Sulfur, & Pyrethrins			
Clothianidin & Zeta-Cypermethrin	Clothianidin & *Bacillus firmus*	Clothianidin & Bifenthrin		
Cube resins & Rotenone	Cube resins & *Pyrethins*, Carbaryl & Rotenone	Cube resins, Rotenone & Carbaryl	Cube resins, Rotenone, *Pyrethrins*, & *Sulfur*	
Deltamethrin & Geraniol & *Oil of Thyme*	Deltamethrin & Bioallethrin			
Ferric phosphate & Spinosyn A				
Gamma-Cyhalothrin & Spinosyn A				
Imidacloprid & Fluvalinate	Imidacloprid & Clothianidin	Imidacloprid & Cyfluthrin	Imidaclopid & Bifenthrin	Imidacloprid & Bifenthrin, Fluvalinate & Cyfluthrin
Imidacloprid & Bifenthrin or Cyfluthrin	Imidacloprid & Fluvalinate or Cyfluthrin	Imidacloprid & Bifenthrin, Zeta-Cypermethrin & Bioallethrin	Imidacloprid & Bifenthrin or Fluvalinate	Imidacloprid & Bifenthrin or Cyfluthrin
Imidacloprid & Bifenthrin or Beta-cyfluthrin	Imidacloprid & Metalaxyl, Bifenthrin & Carboxin	Imidacloprid & Fluvalinate	Imidacloprid & Cyfluthrin or Beta-cyfluthrin	Imidacloprid & Fluvalinate, Cyfluthrin & Beta-cyfluthrin
Imidacloprid & Dicarbasulf, Fluvalinate, Beta-cyfluthrin, Cyfluthrin, Metalaxyl & Delsene				
Insecticidal soap & Sulfur	*Insecticidal soap & Sulfur or Pyrethrins*	*Insecticidal soap* & *Neem oil* & *Pyrethrins*	Insecticidal soap & Sulfur, *Pyrethrins* & *Neem oil*	*Insecticidal soap & Pyrethrins* or *Neem oil*
Insecticidal soap & *Pyrethrins* with *Neem oil*				

Table 4.7 - List of Common Insecticide Mixtures (cont.)

Lambda-Cyhalothrin & Thiamethoxam	Lambda-Cyhalothrin & Chlorantraniliprole			
Paraffin oil & Lime Sulfur				
Permethrin & Pyrethrin	Permethrin & Neem oil	Permethrin & Tetramethrin	Permethrin & Pyrethrins, Synergist 264, Nylar, Piperonyl butoxide, Tetramethrin & D-Allethrin	Permethrin & Mycobutanil, Pyrethrin, Piperonyl butoxide, & Tetramethrin
Piperonyl butoxide & *Pyrethrins* & Permethrin	Piperonyl butoxide & Zeta-Cypermethrin, *Pyrethrins & Neem oil*	Piperonyl butoxide & Zeta-Cypermethrin	Piperonyl butoxide & *Pyrethrins* or Synergist 264	Piperonyl butoxide & *Pyrethrins*
Piperonyl butoxide & Zeta-Cypermethrin, Synerist 264 & *Pyrethrins*	Piperonyl butoxide & *Pyrethrins* &/or Synergist 264	Piperonyl butoxide & *Pyrethrins,* Permethrin & *Neem oil*	Piperonyl butoxide & Pyrethrins, Zeta-Cypermethrin & *Neem oil*	Piperonyl butoxide & Prallethrin, Synergist 264, *Pyrethrins* & Zeta-cypermethrin
Piperonyl butoxide & Pyrethrins, Tetramethrin, Permethrin & Neem oil	Piperonyl butoxide, 2-Phenylethyl propionate, *Oil of Thyme*, Neem oil, Sulfur & Canola oil	Piperonyl butoxide & *Pyrethrins*, Nylar, Permethrin, Synergist 264, Prallethrin, Tetramethrin, Zeta-Cypermethrin, Silicon dioxide & *Neem oil*	Piperonyl butoxide & Permethrin, Tetramethrin, *Pyrethrins, Neem oil*, Zeta-Cypermethrin & Synergist 264	Piperonyl butoxide & *Pyrethrins or Neem oil*
Potassium laurate & Sulfur				
Pyrethrins & Piperonyl butoxide or Permethrin	*Pyrethrins* & Potassium laurate	*Pyrethrins*, Phenylethyl propionate, & *Oil of Thyme*	*Pyrethrins* & Neem oil	Pyrethrins & Insecticidal soap
Pyrethrins & Piperonyl butoxide, *Canola oil, Sulfur* & *Basic copper sulfate*	*Pyrethrins* & Piperonyl butoxide	*Pyrethrins* & Sulfur, Permethrin, Piperonyl butoxide & *Neem oil*	*Pyrethrins* & *Insecticidal soap, Canola oil*, Piperonyl butoxide & *Neem oil*	*Pyrethrins* & Piperonyl butoxide or *Canola oil*
Pyrethrins & Piperonyl butoxide, Sulfur, Tetramethrin, Permethrin, Canola oil & Neem oil	*Pyrethrins* & Cube resins, Rotenone & Piperonyl butoxide	*Pyrethrins* & *Canola oil*, Piperonyl butoxide, *Sulfur* & *Insecticidal soap*	*Pyrethrins & Sulfur, Insecticidal soap, Canola oil, Oil of Thyme*, *Neem oil* & Piperonyl butoxide	*Pyrethrins & Sulfur, Insecticidal soap,* Piperonyl butoxide *&* *Canola oil*
Pyrethrins & *Sulfur*, Piperonyl butoxide, *Insecticidal soap*, *2-Phenylethyl propionate*, *Oil of Thyme*, & *Neem oil*	*Pyrethrins & Sulfur, Canola oil, Neem oil & Insecticidal soap*	*Pyrethrins & Sulfur*, Permethrin, Piperonyl butoxide, *Oil of Thyme*, *Rotenone, Cube resins & Canola oil*	*Pyrethrins* & Piperonyl butoxide, Synergist 264, Permethrin, Nylar, *Insecticidal soap*, Silicon dioxide, *Oil of Thyme*, *Neem oil*, Cube resins, Rotenone & Deltamethrin	*Pyrethrin* & *Piperonyl butoxide, Neem oil* & *Insecticidal soap* Mixtures of Bifenthrin & Imidacloprid or Clothianidin
Pyrethrins & *Sulfur*, *Piperonyl butoxide, Canola oil, Phenylethyl propionate, Oil of Thyme*, & *Insecticidal soap*				
S-Methoprene & Hydramethylnon				
Synthrin & Bioallethrin	Synthrin & Acephate	Synthrin & *Paraffin oil*		
Systhane & Permethrin				
Tetramethrin & Phenothrin	Tetramethrin & Permethrin	Tetramethrin & Piperonyl butoxide, Permethrin & Phenothrin		
Thiamethoxam & Avermectin B1	Thiamethoxam & Avermectin B1 or Lambda-Cyhalothrin	Thiamethoxam & Chlorantraniliprole	Thiamethoxam & Mefenoxam, Fludioxonil, Chloratraniliprole & Lambda-Cyhalothrin	

Table 4.8 - Directions for Pesticide Usage

There are many formulations and distributors of various brands of chemicals, hence, there is considerable variation in the names and concentrations of formulations available. The following table is a guide to the more common formulations and amounts to use.

The product label is the final authority on uses and amounts to mix for treating plants.

Abbreviations:
G-granules, granular; W, WP-wettable, wettable powder; E, EC-emulsifiable concentrate;
S, SP-sprayable, sprayable powder; F-flowable; A-aerosol; D-dust; tbsp-tablespoon; tsp-teaspoon

Equivalents:
1 pound dry formulation per 100 gallons = 1 tablespoon per gallon
1 pint liquid formulation per 100 gallons = 1 teaspoon per gallon
3 teaspoons = 1 tablespoon = 1/2 fluid ounce = 14.8 cc
4 tablespoons = 1/4 cup = 2 fluid ounces = 59.2 cc
16 tablespoons = 1 cup = 8 fluid ounces = 1/2 pint = 236.6 cc
2 pints = 1 quart = 946.2 cc or 0.946 liter
8 pints = 4 quarts = 1 gallon = 3785 cc
1 liter = approx. 33 fluid ounces or 1 quart 1 fluid ounce

			Amount to Use in		
Chemical	**Formulation**	**Pests Controlled**	**1 gal**	**3 gal**	**Potential Plant Injury**
acephate (Orthene)	9.4% EC	aphids	2 tbsp	6 tbsp	elm, crabapple, maple, poplar, redbud, weigella, hibiscus, gloxina, salvia, philodendron
		other labeled uses	3 tbsp	9 tbsp	
Bacillus thuringiensis (Dipel, *B.t.*, Thuricide or Bactospeneine, etc.)	various	defoliating caterpillars	Amounts depend on product and formulation. See label for exact amounts for specific pests.		—
carbaryl (Sevin)	21.5% Liq.	all labeled uses	1 1/4 tbsp	4 tbsp	Plants in bloom, Boston ivy, English ivy, schefflera, Boston fern, *Peperomia* sp., aluminum plant, syngonium, (When adding a miticide on plants susceptible to mites, check phytotoxicity for dicofol.) May burn tender foliage when wet if humidity is high.
	50W	all labeled uses	2 tbsp	6 tbsp	
	5D	all labeled uses	Ready-to-Use		
horticultural oil	98%	For dormant use on specified plant and pests	5 1/3 tbsp	1 pint	Japanese maple, sugar and beech, birch, walnut, butternut, hickory, redbud, juniper, douglas fir, blue spruce
		For growing season use on specified plants and pests	2 2/3 tbsp	1 cup	
Knox Out	1A	all labeled uses	—	—	poinsettia, stephanotis, pilea, jade, adiantum, anthurium, asparagus ferns, begonia, cissus, *Hoya* sp., *Peperomia* sp., *Scindapsus* sp.
imidacloprid	various	See label	See label		See label
insecticidal soap	various	aphids, mealybugs, lacebug, psyllids, scales, thrips, whiteflies	Varies with Formulation		See label

Table 4.8 - Directions for Pesticide Usage (cont.)

Chemical	Formulation	Pests Controlled	Amount to Use in 1 gal	Amount to Use in 3 gal	Potential Plant Injury
Lime Sulfur	26% EC	All labeled uses	2 tsp	2 tbsp	See label for use as dormant spray.
malathion	various	aphids, mealybugs, 4- lined plant bugs, Japanese beetles, leaf-hoppers, tarnished plant bugs, thrips, scale insects, millipedes, springtails.	Varies with formulation		ferns, crassula, gloxinia, petunia, Canaert, red cedar, red carnations, roses, Saint paulia, viola, blos-soms on poinsettia, orchids, sweet peas, begonias, kalanchoe, cycla-mens, anthuriums, aralia cissus, *Ficus* sp., *Peperomia* sp., hibis-cus, pilea, schefflera, scindapsus, syngonium.
metaldehyde (bait)	3.25% Pellets	snails, slugs	Use 1 lb/1000 sq ft (100’x10’). Irrigate prior to application. Scatter on or beneath benches, around border, edges, etc. May be placed in pots if plants are well established. Apply to soil around plants, not to foliage.		—
permethrin	various	See label	See label	See label	See label
phosmet (Imidan)	12.5WP	elm spanworms, canker-worms, gypsy moths	3 tbsp	9 tbsp	See label
pyrethrins	various	See label	See label	See label	See label
resmethrin	23.4EC	aphids whiteflies	1 tsp	1 tbsp	See label
spinosad	various	See label	See label	See label	See label

Organic Controls for Insects of Home Ornamentals

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Table 4.9 - Organic Control Use

Product[1]	Insects Controlled	Remarks
Azadirachtin	Beetles, Aphids, Caterpillars, Others	Various trade names including AzaGuard, AzaMax, Azatin, AzaSol, etc.
Bacillus thuringiensis	Most caterpillars, loopers, hornworms and bagworms	This product, also known as *Bt*, is sold under many trade names
Beauveria bassiana	Beetles, Aphids, Others	Various trade names including BotaniGard, Mycotrol, and Naturalis
Gnatrol (Bt/H-14)	Fungus gnats	Used as a soil drench
Hot Pepper Wax	Aphid, Mite, Thrips	See label for precautions
Insecticidal soap	Works well on soft bodied insects in particular aphids, mites, lacebugs and mealybugs	
Kaolin clay	Beetles, Aphids, Caterpillars, Others	Various trade names
M-One (Bt/Sandiego)	Elm leaf beetle, willow leafbeetle	Two strains of *Bt* will control potato beetles: *Bacillus thuringiensis* ssp. *san diego* is genetically engineered and therefore is not allowed in certified organic production. On the other hand, *B. thuringiensis* ssp. *tenebrionis,* a form of *Bt* that is not genetically engineered, can be used by organic producers.
Neem	Broad sprctrum	See label for precautions
Mineral Oil	Caterpillar eggs and soft bodied insects such as aphids and thrips.	Only use products labeled for use on vegetable plants for pest control.
Pyrethrin	Broad spectrum, works on a wide variety of insects	Usually sold mixed with other botanical insecticides such as rotenone.
Pyrethrin/ Diatomaceous Earth	Whiteflies, fire ants	Follow all label precautions.
Spinosan	Caterpillar, Beetle	See label for precautions

[1]Botanical insecticides are derived from various plant parts and are commonly used in organic control situations. It is important to read the label and follow all precautions regarding protective clothing, mixing, and labeled plants. Just because it is derived from plants doesn't mean that safety can be disregarded. Biological control is in two major forms: microbial, which is a formulation containing a microorganism such as *Bacillus thuringiensis*; or the other form, which involves the release of predatory insects or mites, such as lady beetles. Use caution with insecticides when a release of predators is planned.

Table 4.9 - Organic Control Use (cont.)

Predators[2]	**Insects Controlled**	**Remarks**
Lady beetles	Feed on aphids and other soft bodied insects	*Hippodamia* and other lady beetles are sold for controlling aphids on outdoor plantings, but they may leave to find other prey. *Cryptolremus* for mealybug, *Delphastus* for whitefly.
Lacewings	Aphids, scales, mealy bugs and other soft bodied insects	Immature lacewings are called aphidlions. Most are *Chrysoperla.*
Parasitic wasps	Many insect pests on the foliage including caterpillars and whiteflies	*Trichogramma* wasps work well on many caterpil-lars. *Encarsia formosa* for greenhouse whitefly. *Diglyphus* for leafminer, *Aphytis* for armored scale.
Predatory mites	Mostly for control of spider mites.	Release approximately 2/square foot. *Phytoseiulus persimilis* will work in most situations, *Mesoseiulus and Amblyseius* work for greenhouse and interior scape.
Predatory nematodes	Many ground dwelling and boring insect pests	These nematodes will actively seek host prey and do not harm plants or humans. Exhibit for fungus gnats, grubs and weevils.

[1]Botanical insecticides are derived from various plant parts and are commonly used in organic control situations. It is important to read the label and follow all precautions regarding protective clothing, mixing, and labeled plants. Just because it is derived from plants doesn't mean that safety can be disregarded. Biological control is in two major forms: microbial, which is a formulation containing a microorganism such as *Bacillus thuringiensis*; or the other form, which involves the release of predatory insects or mites, such as lady beetles. Use caution with insecticides when a release of predators is planned.

[2] If interested in releasing them, you can check the Updated List of Commercial Suppliers and Insectaries/Laboratories Selling Predators and Parasitoids for Augmentative Biocontrol, ENTO-480 at https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/ENTO/ento-480/ENTO-480.pdf

Insects of Foliage and Houseplants

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Relatively few kinds of insects, mites, and related pests occur on foliage and houseplants. However, those few have an extensive host range and can be highly destructive to the wide variety of valuable plants grown in the home.

Cultural and mechanical control measures are very important. They are often more practical than insecticides. Relatively few individual plants are grown in the home, but may represent a variety of kinds that seldom are all infested with pests at any one time. The use of pesticides in the home is generally undesirable and messy. Also, the preparation of small quantities is employed. Chemical injury to plants (phytotoxicity) may be a potential problem since foliage plants and other houseplants vary widely in their susceptibility to sprays and pesticides.

Insecticides should be used primarily as corrective control treatments when pests are known to have become established, not as a regular preventive measure. However, treatments should be applied before infestations become severe. Before applying any pesticide, **be sure** to read **all** of the directions on the label as well as directions and precautions for each pest and plant in the control recommendations.

The major pests include: aphids, whiteflies, mealybugs, scale insects, and mites (spider mites, cyclamen mite, bulb mite). Less common are thrips, cutworms and other caterpillars, millipedes, and sowbugs. Fungus gnats and springtails are primarily nuisance pests, seldom causing serious damage.

Cultural Control

Prevention is the best way to protect house plants from insects. Once established, the more common pests are most difficult to eliminate, even with pesticides, and easily spread to nearby healthy plants. Cultural control includes the following important aspects of proper plant care.

A. Exclusion

Carefully inspect any plant to be purchased or propagated for evidence of pests.

Buy or propagate **only** pest-free plants.

Isolate new plants from the vicinity of existing plants for at least a month and look for evidence of pests before placing them among clean, healthy plants.

Remove and isolate any existing plant at the first suspicion of pest infestation.

Avoid placing plants close together to discourage pests from crawling from plant to plant.

Never permit compassion for a sick plant to justify bringing home diseased, pest-ridden plants to recover and hopefully become beautiful again. Discard infested, damaged plants.

B. Sanitation

Use clean pots, potting materials, soil mix components.

Use only sterilized soil or soil mixes.

Do not contaminate potting soil or pots with garden soil, compost, old soil from used pots, or cuttings from infested plants.

Eliminate weeds; they support pest populations.

C. Resistance (Plants not attacked by or that are less susceptible to pests)

Select plant types and varieties known to be relatively free from attack by insect and mite pests.

Avoid growing cultivars that are more prone to attack by pests.

Mechanical Control

When relatively few plants are lightly infested with insects or mites, several mechanical control methods may be used effectively. Usually a continued effort is necessary over a period of time and the job itself is time consuming. First isolate the plant from the non-infested area. (If plants are severely infested, see item 4).

1. **Washing** the plant with warm or tepid water, or water with a small amount of Insecticidal soap, is effective in removing aphids, mealybugs, mites, thrips, and to some extent scale insects and whiteflies. Lightly spray the leaves and stems, particularly where leaves and branches join the stems, with a gentle spray from a faucet or sink hose. The bases of the stems and the crowns of plants are difficult to wash, but often harbor the pests. Washing with a light spray of water alone is not as effective as a soap mixture, especially for mites, scale insects, and whiteflies.
2. **Wiping** or cleaning foliage and stems (both upper and lower leaf surfaces) with a very soft brush or cloth **dampened** with detergent washing solution or rubbing alcohol will remove most of the pests. This method is better for scale insects and mites. Those individuals along leaf veins are especially difficult to wipe away. Excessive alcohol may be injurious to the plant.
3. **Hand-removal** with a cotton swab or a cotton-tipped toothpick dipped in rubbing alcohol, or fine tweezers, is a convenient way to remove mealybugs, some scale insects, and aphids when only a few individuals are present. Be sure to check cracks and crevices where petioles and branches join the stems. Slugs and caterpillars can be picked off individually or brushed into a container of alcohol for disposal. Slugs and cutworms feed at night and are most easily found after the plant has been in the dark for an extended period of time.
4. **Plant trimming**. If plants become severely infested and have extensive damage, wash the plants to dislodge excess insects or mites, then prune away the most severely injured foliage and stems to permit regrowth and recovery. Repeat the washing process. This is a good time to repot the plant and renew the soil medium. Follow up with regular washing or insecticidal treatments. If entire plants are damaged, it is best to destroy them without contaminating other plants or planting areas. Remember that handling and moving severely infested plants often results in dislodging some of the pests or permitting them to drop, be brushed, or blown off the plants.

Chemical Control

Plants can be treated with insecticides or miticides by any method that conveniently but thoroughly covers **ALL** of the plant surfaces. Generally, the use of a pesticide is quicker and more convenient than mechanical control measures. However, dense plants with multiple stems and bushy foliage to the soil level almost defy good coverage. Applying materials can be messy and involves considerable handling. Certain plants are more difficult to wet with sprays than others. House plants may be variously susceptible to injury by pesticides. In treating relatively few plants, only small amounts of pesticides are needed, making measuring and mixing difficult. Despite these problems, plants must be treated with insecticides when it is necessary. It is best to apply treatments out-of-doors away from other plants when feasible or in a well-ventilated garage or basement.

Spraying

Spraying is usually the most effective and most convenient way to apply insecticides and miticides to plants, soil, pots, saucers, etc. Plants should be sprayed until thoroughly wet, but without excessive drip. Spray deposit decreases with runoff. Sprayers must be cleaned thoroughly and allowed to dry after each use. Most pesticide sprays are highly corrosive to metal. Some liquid formulations will dissolve certain types of plastic. Sprays may be applied in several ways:

Aerosols

Aerosols are available in small pressurized ready-to-use cans and pump spray bottles. These are most convenient, but more expensive than mixing dilute sprays from concentrates. Never hold the container close to the plants treated. Injury is likely to result from the propellent, solvent, or excess spray deposit nearest the can. Plants should NOT be thoroughly wetted with aerosols, unless so directed on the label.

Hand Atomizers

Hand atomizers are hand-pumped sprayers that have a 0.5 pint to 1.0 quart metal “tank” or are fitted to accommodate a standard screw-top jar. The most effective is a sprayer that delivers a continuous spray and that has an adjustable nozzle governing the direction of the spray upward or downward.

Hand Misters

Hand misters are available for “watering” plants by misting, or used containers from window or household cleaning products may be used as inexpensive, replaceable sprayers. A thumb-depressor pump atomizes the spray adequately enough for treating small numbers of plants.

Compressed Air Sprayers

Compressed air sprayers are the most effective, serviceable, and versatile. However, they are more expensive and generally larger than is necessary for a few small houseplants. If a compressed air sprayer is available, it still may be the most convenient way to treat even small numbers of plants if they are moved outside or to a garage or basement. Ready-to-use sprayers are also effective and useful for small numbers.

Tips and Precautions for Spraying

1. For hard to wet foliage, add a spreader-sticker to the spray according to the label directions or add 0.25 to 0.33 teaspoon of low-sudsing detergent (NOT SOAP) to a gallon of spray mix, or its equivalent in lesser quantities.
2. Do **not** dispose of excess spray material in household drains, outdoor catchbasins, near any water supplies or let runoff into streams. Spread or spray it out as much as possible away from gardens, children, and pet areas where it will not pose a hazard.
3. **Never** put or store insecticides in other than their original container, and **never** leave containers with or without contents outside of proper storage areas. Keep pesticide supplies in a separate storage area that is locked and labeled "Pesticides." Carefully dispose of empty containers in normal trash disposal.
4. Thoroughly wash yourself after spraying, and clean all equipment and sprayed areas.

Dipping

Dipping plants into a large container of an insecticide-water mixture is effective and avoids any atomized spray in the air. However, this technique requires a larger amount of pesticide mix and creates the problem of disposing of the excess. The mixture must be ample in a large enough container to accommodate the top of the largest plant to be inverted and dipped. Do **not** dispose of excess mixture into the sink or other drains that empty into sewage systems. Dispose of excess on or in the ground where runoff or other contamination is not likely. Do **not** use any container that is involved with food or personal use.

Dusting

Dusts are not as commonly available for use on house plants, but are effective. They tend to leave excessively evident residues, to be messy if used indoors, and to be easily washed off if plants are misted or watered from above. Dusts are available in small "squeeze" bottles or plastic containers, or can be put into used plastic bottles that have removable caps with small dispenser openings such as those holding lotions or shampoo. The most efficient is a commercial hand duster. Only a barely visible coating of dust is necessary to be effective. Do not coat the foliage.

General Information

Insecticides and Miticides

The basic insecticides and miticides used are available under a great many brand or trade names. Even with considerable knowledge about pesticides, the many product names, formulations, and ingredient statements are formidable and confusing. Individual pesticides are identified by their common names (such as malathion, diazinon, or resmethrin, for example) or trade name (such as Sevin, for example). Brand names (such as Isotox or Blue Dragon, for example) do not identify the pesticide in the container; the ingredient statement on the label should be consulted to determine the contents. In some cases, the contents are specified, unfortunately, only with the long chemical name.

Formulations

Pesticides are available in ready-to-use mixtures (push-button aerosols, pre-diluted sprays, and dusts) and as spray concentrates to be mixed with water. The latter include emulsifiable or sprayable concentrates, sometimes indicated as EC-emulsifiable concentrate, EL-emulsifiable liquid, E-emulsifiable, S-sprayable, F-flowable, and WP or W-wettable powder. The number preceding the letter indicates the percentage concentrate (2E, 4EC, etc.). In general, emulsion type sprays provide the most resistance to washing off, but the greatest hazard of plant injury. Wettable powders or flowable formulations are somewhat more readily washed off but are safer to apply on plants. They form suspensions in the spray "tank," however, and must be continually agitated to achieve uniform deposit of spray material. Dusts are readily washed off plants.

It is extremely important to follow label directions for mixing for each formulation used. **Use only the recommended amount**. Increasing the amount of concentrate in the spray mix will **not** make the spray more effective. It will increase the hazard to the person spraying and the likelihood of plant injury.

Active Ingredients

It is most economical and logical to apply only the insecticide and/or miticide that is needed and effective. The best indication of which material is effective against which pests is given in these recommendations and on the labels of the products. Certain insecticides work more effectively against some insects than others. Using the wrong chemical is ineffective and a waste of time and money. Always follow all of the directions on the label. Apply treatments only for the pests and plants listed on the label.

Although there are many different products in many combinations, and frustratingly few with houseplants specified by the name on the label, the insecticides and miticides listed in this publication are effective for the pests indicated. Be sure to note the potential plant injury reference. If pests infest plants that are not listed on the label, spray the recommended insecticide on a few leaves and observe if any injury results after a 3- or 4-day period.

Table 4.10 - Chemical Names and Potential Plant Injury

Familiar, Common, and Chemical Names	Formulation	Amount Per Gallon	Potential Plant Injury
Insecticidal soap	Various	See label	See label
malathion	50% EC	1.5 tsp	anthurium, aralia, *Asparagas plumosa spengeri,* begonia, *Cissus antarctica,* crassuala, dieffenbachia (dumb cane), *Fiscus* sp., *Peperomia* sp., *Pilea* sp., schefflera, syndapsis (pathos) syngonium.
Mesurol	2% Bait	—	None listed.
metaldehyde	3.25% Bait	—	None listed.
pyrethrins	0.3 A	—	See Label
resmethrin	24.3% EC	1.0 tsp	General injury may occur if plants are confined in small closed space at high temperature and humidity for longer than prescribed exposure periods.
Sevin (carbaryl or zeta-cypermethrin)	50% WP	2.0 tbsp	Boston ivy, English ivy, Boston fern, schefflera, *Peperomia* sp., *Pilea cadi-erri* (aluminum plant), syngonium.

Table 4.11 - Recommended Use

Pest	Pesticide	Remarks
Aphids	Permethrin, *Pyrethrin*, *Neem*, Malathion, *Insecticidal soap*, Imidacloprid, Acephate	Spray when aphids are first seen. Repeat when necessary. Imidacloprid effective in granular formulation.
Armyworms	Permethrin, *Pyrethrin, Neem*, Malathion	Hand picking may be adequate for just a few caterpillars. Wet the soil well while treating the foliage.
Broad mite	*Insecticidal soap*, Permethrin, *Pyrethrin, Neem*	Make 2-3 applications at 10-day intervals. For non-chemical control, plants may be immersed with their pots in water carefully maintained at 115° for 15 minutes.
Cutworms	Permethrin, *Pyrethrin, Neem*, Malathion, Sevin	Hand picking may be adequate for just a few caterpillars. Look for them after rooms have been darkened for a few hours; they feed at night. Wet the soil well while treating the plants.
Fungus gnats	Gnatrol, Permethrin, *Pyrethrin, Neem*	Treat the soil with a light watering.
Mealybugs	*Pyrethrin*, Malathion, Insecticidal soap, Permethrin, *Pyrethrin, Neem,* Acephate	Treat 2-4 times at 7- to 10-day intervals.
Millipedes	Malathion, Permethrin, *Pyrethrin, Neem*	Wet the soil and treat the bottom of pots. Millipedes stay in soil.
Scale insects	Acephate, Malathion, *Insecticidal soap*, Permethrin, *Pyrethrin, Neem, Sevin*	Treat 2-4 times at 7- to 10-day intervals. Severely infested plants are best discarded.
Slugs, snails	Mesurol, metaldehyde, Permethrin, *Pyrethrin, Neem*	Do not use mesurol around food plants. Evenly, but lightly, scatter bait on the soil surface; do not put the bait on the foliage. Apply only to established plants. Do not water for 24-48 hours.
Spider mites	*Insecticidal soap*, Permethrin, *Pyrethrin, Neem*	Treat 2-3 times at 10-day intervals. Insecticidal soap and spider mite aerosols or atomizers are effective.
Springtails	Malathion, Permethrin, *Pyrethrin, Neem*	Treat the soil with a light watering.
Whiteflies	Imidacloprid, Permethrin, *Pyrethrin, Neem,* Acephate	Treat 2-3 times at 7- to 10-day intervals. Imidacloprid used as a soil drench.

Weed Management in Home Ornamental Beds

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Overview

Weed management is necessary in flower beds and for shrub and tree plantings. Weeds reduce the aesthetic value of landscapes, and compete with desired plants for water, nutrients, and light. Weeds can also harbor insect and disease pests. Develop a year-round control program to manage both summer and winter weeds. Control weeds in lawns and other adjacent areas to limit the movement of weed seed or weed propagules into the beds. Prevent weeds from flowering, as this helps reduce the amount of weed seed in the soil over time. Remove any weeds from ornamental plants that will be planted into the landscape. Avoid planting invasive species, like bamboo, or make plans to contain the root system before planting. Control perennial weeds, especially perennial broadleaf weeds, before establishing a new flower bed, as selective control is not available in most cases after planting. For large landscape areas of one acre or more, consult the ornamentals section of the Horticultural and Forest Crops Pest Management Guide (Virginia Cooperative Extension Publication 456-017), a manual for commercial landscape firms and nursery producers.

When to Call a Professional

Hire a landscape maintenance or other appropriate firm to help get things under control if the property

- is infested with difficult-to-control weeds, like bamboo, beach vitex, English ivy, or phragmites;
- is adjacent to wetlands or other aquatic areas; or
- has large areas that cannot be easily maintained.

General Cultural Controls

Cultivation/Hoeing/Hand weeding: Control annual and perennial weeds by tilling before planting a new flower bed. Troublesome perennial weeds like bermudagrass, quackgrass, yellow nutsedge, and other creeping perennials need repeated tilling. Cut annual weeds at or slightly below the soil surface when hoeing to minimize soil disturbance. Deeper hoeing brings weed seed from greater depths in the soil to the surface where they can germinate. Controlling weeds before flowering reduces weed populations in future years by depleting the weed seed reservoir in the soil. Hoeing or hand pulling weeds controls annuals weeds, but will not control creeping perennials, like yellow nutsedge, which spread by underground structures such as rhizomes and tubers.

Organic mulches: Pine bark, hardwood bark, pine straw and wood chips are all good for mulching. Watch soil fertility as nitrogen tie-up can occur for mulches that are not fully composted. Organic mulches are a good choice because they conserve soil moisture and cool the soil. Spread mulch two to four inches deep and and avoid over mulching. Place newspaper on the soil surface before applying mulch to help suppress weeds. Organic mulches suppress or control annual weeds but not perennial ones. Shredded mulches encourage weed growth more than larger particle mulches. Use mulches that are free of weed seed and that do not have a rotten egg or ammonia odor. Improperly composted mulch can have a low pH and contain chemicals that injure crop plants.

Rock mulches: Lava rock, white marble, and other rock mulches can be used as an alternative to an organic mulch. Place a landscape fabric (described below) under the rock mulch to act as a soil separator. This reduces the amount of soil and weed seed that can move into the rock layer. Rock mulches provide better annual weed control than organic mulches. As organic mulches break down, they become a suitable growing medium for weeds. Rock mulches do not control perennial weeds.

Synthetic mulches: Use of solid black plastic or a landscape fabric improves weed control compared to an organic mulch alone. Solid black plastic is more effective for weed control than the available landscape fabrics, but water cannot pass through it. Solid black plastic could be used for annual flower beds, but landscape fabrics are more appropriate for tree and shrub beds, as these materials are porous. Place drip irrigation under solid black plastic to allow water to reach plant roots. Landscape fabrics allow for air and water movement but weed roots and shoots can penetrate through the openings in the material. Roots of ornamental plants may grow into the fabric, making it more difficult to remove the fabric later. Place the plastic or fabric on the soil surface, then cut an X or a hole into the material to plant the ornamentals. Place an organic or rock mulch above these materials. If organic mulch is placed over the landscape fabric, weeds may germinate in the mulch layer and then send roots through the fabric to the soil below. Hand weed the mulch layer when weeds are small. Black plastic and landscape fabrics control annual weeds and suppress perennial weeds, like yellow nutsedge. Control perennial weeds before spreading synthetic mulch. Do not use landscape fabrics when planting groundcovers or bulbs, since they inhibit spread of groundcovers and stop the upward movement of shoots from bulbs. Use landscape fabrics only in woody landscape beds.

Landscape fabrics overcome the porosity problem inherent to solid black plastic. Use a shallow mulch layer (1 inch) above the fabric. A rock mulch/fabric combination would be expected to provide greater weed control than an organic mulch/fabric combination. Fabric/mulch combinations improve weed control over mulch alone. Use a landscape fabric with limited open space. Certain weeds, such as yellow nutsedge, can penetrate through landscape fabrics.

General Biological Controls

There currently are no biological control options for weed control in ornamental beds.

General Chemical Controls

Organic

Preemergence: none recommended at this time

Postemergence: Acetic acid (Weed Pharm 20% acetic acid or other labeled formulation). Contact nonselective herbicide. Do not use unlabeled forms of acetic acid. Wear eye protection, a long-sleeved shirt, long pants, shoes, socks, and waterproof gloves since this product is corrosive. Cover the weed foliage thoroughly. Treat weeds when small, as large annual weeds may require retreatment. Perennial weeds need retreatment, as this is a contact herbicide and does not affect underground plant parts such as roots, bulbs, and rhizomes. Keep the spray off the foliage and stems of desired plants.

Conventional

Chemical Control

There is now a selection of herbicides for use in nursery stock. Selection of a given herbicide must be based on the particular weed and crop situation. Most of the herbicides listed in this section are available primarily to lawn service and landscape maintenance firms. Commercial recommendations are listed in Pest Management Guide 456-017 for horticultural crops. Many of the herbicides listed are not packaged in quantities suitable for the homeowner. The herbicide with the greatest utility to the homeowner is trifluralin (Preen Garden Weed Preventer, others) since it is safe on a wide range of ornamentals and is packaged in small quantities.

Tables in this section list which herbicides are registered for use on individual nursery species. Check herbicide labels to determine specific cultivars that can be treated. These registrations are only for liners or rooted cuttings planted into the field. Consult herbicide labels to determine which compounds can be used in propagation, be it seedbed or vegetative propagation. See VCE Publication 456-017 for a discussion of weed control in greenhouses.

None of the preemergent herbicides are effective against all weed species. Tank-mixing of herbicides often broadens the spectrum of weed control. If a chemical application kills all but one species, that species will multiply. This results in a shift in weed population and eventually weed control with that product becomes ineffective. Chemical rotation can reduce the buildup of a tolerant species. Use of directed sprays of a nonselective herbicide (glyphosate) or cultivation is usually necessary to give control of all species.

Applications should be made to limited areas until experience is gained with a given herbicide. Any application of a new herbicide should include an untreated area to allow observation of weed control and possible injury. Small and shallow-rooted plants are more easily injured than large established plants. Sandy soil and excessive watering also increase chances of injury. Irrigate after a granular herbicide application to wash the granules off the leaf surfaces. Certain granular herbicides will cause spotting of foliage.

It is wise to keep a separate sprayer for herbicides because certain ones are difficult to clean from the spray tank.

The selection of herbicides that can be used safely under landscape trees will be based on several considerations. Some residual herbicides cannot be applied under trees that have been recently transplanted. In many situations, desirable shrubs or turf beneath shade trees preclude the use of any residual-type herbicide in the immediate area. Residual herbicides should not be used where trees are planted in or are growing in a depressed area that prevents water from draining away from the tree. Likewise, herbicides should not be applied over exposed roots or be allowed to contact injured root or stem tissue. Mulching normally reduces weed control requirements while creating a better environment for rapid growth of newly planted trees. Since most herbicides used for preemergence weed control will not have activity on perennial weeds or vines, to control these pests a postemergence herbicide must be used that can be selectively applied to the low-growing weeds. In most situations, apply a preemergence herbicide prior to mulching.

Never apply herbicides in a circle around the tree. This results in a higher rate of application near the trunk of the tree which may cause injury. Uniform distribution is critical for effective weed control. Since many of the herbicides used for preemergence weed control require rainfall or irrigation for activation, they should be applied in early spring when rainfall is likely or the site can be irrigated, ideally immediately after a preemergence herbicide application. Do not apply residual herbicides where rainfall run-off will drain directly across desirable turf. A postemergence herbicide can often be tank-mixed with a residual herbicide to control existing weeds.

Herbicides should be applied using a low pressure (25-40 psi) sprayer and nozzle tips that do not produce a fine mist that may cause drift problems. **Prior** to herbicide application, the product label should be read and particular attention should be given to the **precaution** section on each label.

Table 4.12 - Recommended Use

Application[1]	Weed Problem	Chemical Rate/1000 sq ft	Remarks
Postplant, but preemergence to weeds	Annual grasses and certain broadleaf weeds	oryzalin 0.8-1.4 oz (Surflan 4AS 1.5-2.9 fl oz)	Can be applied overtop or as a directed spray on field and container-grown ornamentals. Will not control established weeds. Irrigation will improve weed control.
		pendimethalin 2.0-4.0 (Corral 2.68G 1.7-2.6 lb or Pendulum 2G 2.3-4.6 lb or Pendulum AquaCap 1.6-3.2 fl oz)	Apply prior to weed germination. Do not apply to moist foliage. Irrigate after application.
		prodiamine 0.26-0.5 oz (Barricade 65WG 0.4-0.8 oz, Barricade 4FL 0.5-1.1 fl oz)	Apply prior to weed germination in landscape ornamentals. Do not apply more than 0.8 oz Barricade 65WG or 1.1 fl oz Barricade 4FL/1000 sq ft/year.
		trifluralin 1.4 oz (Treflan 5G 1.8 lb or Preen Garden Weed Preventer 1.47G 6.2 lb or other labeled formulation)	Will not control established weeds. Use lower rate if incorporated or higher rate and irrigate after application. Apply as a directed spray. Consult label for use on specific soil types.
		isoxaben 0.18-0.36 oz (Gallery 75DF 0.25-0.5 oz, Gallery SC 0.3-0.7 fl oz)	Do not apply to new plantings until soil has settled and no cracks are present. Apply prior to weed germination. Combine with oryzalin for improved control of annual grasses.
		isoxaben + trifluralin (Snapshot 2.5TG 2.3-4.6 lb)	A prepackaged mixture of the active ingredients in Gallery and Treflan. Apply prior to weed germination.
		isoxaben + trifluralin (Preen Mulch with Extended Control Weed Preventer)	A herbicide-treated mulch for landscape ornamentals. A 2-cubic foot bag covers 12 square feet.
	Annual grasses and certain annual and perennial broadleaf weeds like dogfennel, lambsquarters, ragweed, smartweed, wild chrysanthemum (artemisia), dock, asters, wild carrot	dichlobenil 1.5-2.2 oz (Casoron, Barrier 4G 2.3-3.4 lb)	Apply in the late fall, winter, or early spring before seeds of annual weeds germinate, or after cultivation has removed all growing weeds. If dichlobenil remains on the soil surface during warm weather, activity will be lost. Do not apply until 4 weeks after transplanting. **Note:** Use higher rate for control of certain perennials in ornamentals established at least one year. Do not remove old weed growth before making a surface application in the fall for control of perennial weeds.
	Primarily annual grasses and yellow nutsedge	metolachlor 0.5-0.8 oz (Pennant Magnum 0.5-0.9 fl oz)	Apply to weed-free soil. Direct toward base of ornamentals established for at least 2 weeks.
	Annual grass and broadleaf weeds and yellow nutsedge	pendimethalin + dimethenamid 0.6-1.2 oz (Freehand 1.75G 2.3-4.6 lb)	Apply prior to weed germination. Do not apply more than 9.2 lb Freehand per 1000 sq ft per year.

[1]Apply only to species listed on the container label.

Table 4.12 - Recommended Use (cont.)

Application[1]	Weed Problem	Chemical Rate/1000 sq ft	Remarks
Postemergence to weeds	All weeds controlled	glyphosate (Roundup and other trade names; see label for rates)	Apply as a directed spray in established plantings. Also cleared for site preparation prior to planting nursery stock. Adjust rate of application to weed species according to label instructions. Do not contact bark or foliage of desired plants or severe systemic injury may occur.
	Annual weeds and certain perennial weeds	glufosinate (Finale 2-4 fl oz per gallon for spot treatment)	Apply as a directed spray in established plantings. Do not contact bark or foliage of desired plants.
	Annual and perennial grasses including bermudagrass, Japanese stiltgrass quackgrass, and johnsongrass	fluazifop-P-butyl 0.19 oz (Ornamec 2.5 fl oz plus 0.5 fl oz nonionic surfactant/gal)	Spot treatment for emerged grasses. May be applied overtop of selected conifer, broadleaf, and non-grass ornamentals but should be applied as a directed spray after budbreak through hardening of new growth. Treat annual grasses prior to tillering. Treat perennial grasses at the following stages of growth: bermudagrass, 4-8 inch runners: johnsongrass, 12-18 inches tall; quackgrass, 3-5 leaves, but not more than 10 inches tall. Apply only to actively growing grasses not under moisture stress. Repeat applications may be necessary on some perennial grasses.
	Annual and perennial grasses including Japanese stiltgrass (Microstegium)	sethoxydim 0.24 oz (Segment II 1.3 fl oz + 0.6 fl oz crop oil concentrate or 0.5 fl oz methylated seed oil per gal)	Spot treatment for emerged grasses. May be applied overtop of many conifer, broadleaf, and non-grass ornamentals to actively growing grasses. Treat annual grasses prior to tillering. Treat perennial grasses as follows: bermudagrass, 6 inch runners; johnsongrass, 12-20 inches tall; quackgrass, 6 inches tall; wirestem muhly, 6 inches tall. Repeat applications may be necessary on perennial grasses. Less than optimum results are likely if treatments are applied during moisture stress.
	Crabgrass, goosegrass, foxtails, Japanese stiltgrass (Microstegium)	fenoxaprop (Acclaim Extra , Bioadvanced Bermudagrass Control for Lawns, Bioadvanced Extreme Crabgrass Killer)	Apply to the foliage of young actively growing annual grassy weeds. Can be applied to a range of conifer, broadleaf, and non-grass ornamental species.
	Bamboo	imazapyr (Arsenal)	Leaf and root absorbed. Apply to the foliage of actively growing bamboo. Do not apply near desired trees and shrubs. Do not plant treated areas until the herbicide has dissipated. Best applied by a licensed pesticide applicator due to the potential for nontarget plant injury. Research has shown that glyphosate also controls bamboo. It can be added to imazapyr for broader-spectrum weed control.
	Kudzu	glyphosate (Roundup and other trade names; see label for rates)	Apply to the foliage of actively-growing kudzu. Keep off the foliage and bark of desired plants. Spray foliage when actively growing. Do not allow spray to contact desired plants.
		triclopyr (Bioadvanced Brush Killer Plus, Ortho Max Poison Ivy & Tough Brush Killer, or other labeled formulation)	Spray foliage when actively growing. Do not allow spray to contact desired plants. Triclopyr is also effective on other legume weeds, such as lespedeza and white clover.

[1]Apply only to species listed on the container label.

Table 4.12 - Recommended Use (cont.)

Application[1]	Weed Problem	Chemical Rate/1000 sq ft	Remarks
Postemergence to weeds (cont.)	Yellow nutsedge and certain broad-leaf weeds	bentazon (Basagran T/O 0.75 to 1.5 fl oz in 1.0-2.0 gal)	A second application 10-14 days later will generally be needed for acceptable yellow nutsedge control. Apply as a directed spray to small, actively growing young weeds. Minimize contact with foilage of desired trees and shrubs. Addition of an oil concentrate can improve control.
	Yellow and purple nutsedge	halosulfuron 0.7 g (SedgeHammer 0.9 g) (SedgeHammer+ 0.5 oz)	Mix 0.9 g SedgeHammer plus 2.0 tsp nonionic surfactant in 1.0-2.0 gal of water for spot treatment. No surfactant needed for SedgeHammer+. Lightly wet nutsedge foliage. Directed spray in established woody ornamentals only. Do not apply to herbaceous ornamentals.
	Poison ivy	triclopyr (Bioadvanced Brush Killer Plus, Ortho Max Poison Ivy Tough Brush Killer) or glyphosate (see above listing)	Apply to foliage of actively growing poison ivy or other undesired vines or brush. Do not allow spray to contact foliage or stems of desired broadleaf plants.
	Phragmites (common reed)	glyphosate (AquaMaster, GlyphoMate 41 or other labeled formulations) imazapyr (Arsenal) - see listing above	Use a formulation registered for aquatic use. Apply to foliage during active growth. Multiple applications will be required. Do not contact foiliage of desired plants. A surfactant needs to be added if the glyphosate formulation lacks one. Check to see if a permit and an aquatic pesticide license is required before treating in or around a body of water.

[1]Apply only to species listed on the container label.

Table 4.13 - Guide for Herbicide Selection - Annual and Perennial Flowers, Vines, and Groundcovers[1]

	Acclaim	Barricade	Freehand	Ornamec	Gallery	Pendulum 2G	Pennant	Segment	Surflan	trifluralin
Annual and Perennial Flowers										
Alyssum	-	-	F	-	-	F	F	F	-	F
Aster	-	F	-	-	-	F	F	-	-	F
Begonia	F	-	-	-	-	F	-	F	-	-
Chrysanthemum	F	-	-	-	-	F	F	F	F	F
Coleus	F	-	F	-	-	-	-	F	-	-
Daffodil	-	F	F	-	-	F	F	-	F	F
Dahlia	-	-	F	-	-	F	-	-	-	F
Daylily	F	F	F	F	-	F	F	F	-	-
Delphinium	-	-	-	-	-	-	F	-	-	-
Ferns	-	-	-	-	-	F	-	-	-	-
Forget-me-not	F	-	-	-	-	-	-	-	-	F
Four-o’clock	-	-	-	-	-	-	-	-	-	F
Geranium	F	-	-	-	-	-	F	F	F	-
Gladiolus	F	F	F	-	-	F	F	F	F	F
Hosta	F	F	F	F	F	F	F	F	-	-
Impatiens	-	-	-	-	-	F	-	F	F	F
Iris	F	F	F	-	-	F	F	F	F	F
Lily	-	F	-	-	-	F	F	-	-	-
Marigold	-	-	F	F	-	F	F	F	F	F
Nasturtium	-	-	-	-	-	-	-	-	-	F
Pansy	-	-	-	-	-	F	-	F	F	-
Peony	F	-	-	-	-	F	-	-	-	-
Periwinkle	F	-	F	-	-	F	-	F	-	-
Petunia	F	-	F	-	-	F	F	F	-	F
Phlox	F	-	F	-	-	F	F	-	-	F
Salvia	-	-	F	-	-	F	-	F	-	F
Shasta daisy	F	-	F	F	-	F	-	F	-	F
Snapdragon	F	-	-	-	-	F	F	F	-	F
Sunflower	-	-	F	-	-	F	-	-	-	F
Sweetpea	-	-	-	-	-	-	-	-	-	F
Sweet William	F	-	F	F	-	F	F	F	-	F
Tulip	-	F	-	-	-	F	F	-	F	F
Zinnia	F	-	F	F	-	F	F	F	F	F
Vines and Groundcovers										
Ajuga	F	-	-	-	-	F	F	-	-	-
Bamboo	-	-	-	-	-	-	-	-	-	-
Clematis	-	-	-	-	-	-	-	-	-	-
English ivy	F	F	-	F	F	F	F	F	F	F

[1]This table should be used only as a guide. An ‘F’ indicates the herbicide is registered for use on that species when field-grown or planted in landscapes. Check the herbicide label for special considerations such as variety, plant growth stage, rate adjustment, or application precautions prior to application.

Table 4.13 - Guide for Herbicide Selection - Annual and Perennial Flowers, Vines, and Groundcovers[1] (cont.)

	Acclaim	Barricade	Freehand	Ornamec	Gallery	Pendulum 2G	Pennant	Segment	Surflan	trifluralin
Vines and Groundcovers (cont.)										
Euonymus	-	F	-	F	-	F	F	-	F	-
Honeysuckle	-	F	-	-	-	-	F	-	-	-
Jasmine	-	-	-	-	-	F	-	-	-	-
Liriope	F	F	F	F	F	F	F	F	F	F
Pachysandra	-	-	F	F	F	F	F	F	-	F
Pampasgrass	-	F	-	-	F	F	F	-	-	-
Santolina	-	F	-	-	-	-	-	-	-	-
Sedum	-	F	F	-	-	F	F	-	-	F
Vinca (Periwinkle)	F	F	-	F	-	F	F	F	F	F
Yucca	-	F	-	F	-	F	F	-	F	-

[1]This table should be used only as a guide. An 'F' indicates the herbicide is registered for use on that species when field-grown or planted in landscapes. Check the herbicide label for special considerations such as variety, plant growth stage, rate adjustment, or application precautions prior to application.

Table 4.14 - Guide for Herbicide Selection - Narrowleaf and Broadleaf Evergreens[1]

Tolerant Species	Acclaim	Barricade	Casoron	Freehand	Pennant	Ornamec
Narrowleaf Evergreens						
Arborvitae	-	F	F	F	F	F
Cedar *(Cedrus)*	-	-	-	-	-	-
Chamaecyparis	-	F	-	-	-	-
Cryptomeria	-	-	-	-	-	-
Fir	-	F	-	F	F	F
Hemlock	-	F	-	F	F	F
Juniper	F	F	F	F	F	F
Leyland cypress	-	-	-	F	F	F
Pine	F	F	F	-	F	F
Spruce	-	F	-	F	F	F
Yew	F	F	F	F	F	F
Broadleaf Evergreens						
Aucuba	-	F	-	F	F	F
Azalea	F	F	F	F	F	F
Barberry	F	F	F	F	F	F
Bayberry	-	-	-	-	F	-
Boxwood	F	F	F	F	F	F
Camellia	-	-	F	F	F	F
Euonymus	F	F	F	-	F	F

[1]This table should be used only as a guide. An 'F' indicates the herbicide is registered for use on that species when field-grown or planted in landscapes. Check the herbicide label for special considerations such as variety, plant growth stage, rate adjustment, or application precautions prior to application.

Table 4.14 - Guide for Herbicide Selection - Narrowleaf and Broadleaf Evergreens[1] (cont.)

Tolerant Species	Acclaim	Barricade	Casoron	Freehand	Pennant	Ornamec
Broadleaf Evergreens (cont.)						
Holly	F	F	-	F	F	F
Leucothoe	-	-	F	-	F	-
Magnolia (Southern)	F	F	F	-	F	F
Mahonia	-	-	-	F	F	F
Mountain laurel	-	-	-	-	F	-
Osmanthus	-	F	F	-	F	-
Pittosporum	-	F	F	-	F	-
Pyracantha	F	F	F	-	F	F
Rhododendron	F	F	F	-	F	F
Tolerant Species	**Gallery**	**Segment**	**Pendulum**	**Snapshot**	**Surflan**	**trifluralin**
Narrowleaf Evergreens						
Arborvitae	F	F	-	-	F	F
Cedar *(Cedrus)*	F	-	F	-	-	-
Cryptomeria	F	-	F	-	F	-
Chamaecyparis	F	-	F	F	-	-
Fir	F	F	F	F	F	F
Hemlock	-	F	F	-	-	F
Juniper	F	F	F	F	F	F
Leyland cypress	-	F	F	-	-	-
Pine	F	F	F	F	F	F
Spruce	F	F	F	F	F	F
Yew	F	F	F	-	F	F
Broadleaf Evergreens						
Aucuba	-	-	F	-	-	-
Azalea	F	F	F	F	F	F
Barberry	F	F	F	F	F	F
Bayberry	-	-	-	-	-	-
Boxwood	F	F	F	F	F	F
Camellia	-	F	F	-	-	F
Euonymus	-	F	F	-	F	F
Holly	F	F	F	F	F	F
Leucothoe	-	-	F	-	F	-
Magnolia (Southern)	-	F	F	-	F	-
Mahonia	-	-	-	-	F	-
Mountain laurel	F	-	F	-	F	F
Osmanthus	-	F	F	-	F	F

[1]This table should be used only as a guide. An ‘F’ indicates the herbicide is registered for use on that species when field-grown or planted in landscapes. Check the herbicide label for special considerations such as variety, plant growth stage, rate adjustment, or application precautions prior to application.

Table 4.14 - Guide for Herbicide Selection - Narrowleaf and Broadleaf Evergreens[1](cont.)

Tolerant Species	Gallery	Segment	Pendulum	Snapshot	Surflan	trifluralin
Broadleaf Evergreens (cont.)						
Pittosporum	F	F	-	-	-	F
Pyracantha	F	F	F	-	F	F
Rhododendron	-	F	F	F	F	F

[1]This table should be used only as a guide. An 'F' indicates the herbicide is registered for use on that species when field-grown or planted in landscapes. Check the herbicide label for special considerations such as variety, plant growth stage, rate adjustment, or application precautions prior to application.

Table 4.15 - Guide for Herbicide Selection - Deciduous Trees and Shrubs[1]

Tolerant Species	Acclaim	Barricade	Casoron	Freehand	Pennant	Ornamec
Deciduous Trees						
Amelanchier (serviceberry)	-	-	-	-	-	-
Ash	-	-	F	-	F	F
Beech	-	-	-	-	F	-
Birch	-	-	F	-	F	F
Cherry	-	-	-	-	F	-
Crabapple	-	F	F	F	F	-
Dawn redwood	-	-	-	-	-	-
Dogwood	-	F	F	F	F	F
Elm	-	-	F	-	-	-
Ginkgo	-	-	-	-	F	-
Goldenchain tree	-	-	-	-	-	-
Goldenrain tree	-	-	-	-	-	-
Hawthorn	F	F	F	-	-	-
Honeylocust	-	-	F	F	F	F
Linden	-	-	-	-	-	-
Magnolia	F	F	F	F	F	F
Maple	F	F	F	F	F	F
Oak	-	F	F	F	F	F
Pear	-	F	-	-	F	-
Poplar	-	-	F	-	F	-
Redbud	-	-	F	F	-	F
Russian Olive	-	-	F	-	F	F
Sourgum (*Nyssa*)	-	-	-	-	-	-
Sourwood (*Oxydendron*)	-	F	-	F	-	-
Sweetgum	-	-	-	-	F	F
Sycamore	-	-	F	-	-	-
Tulip tree	-	-	F	-	F	-
Walnut	F	-	F	-	-	-

[1]This table should be used only as a guide. An 'F' indicates the herbicide is registered for use on that species when field-grown or planted in landscapes. Check the herbicide label for special considerations such as variety, plant growth stage, rate adjustment, or application precautions prior to application.

Table 4.15 - Guide for Herbicide Selection - Deciduous Trees and Shrubs[1] (cont.)

Tolerant Species	Acclaim	Barricade	Casoron	Freehand	Pennant	Ornamec
Deciduous Trees (cont.)						
Willow	F	-	F	-	F	F
Zelkova	-	-	-	-	-	-
Deciduous Shrubs						
Abelia	-	F	-	F	F	-
Cotoneaster	-	F	F	-	F	F
Crape myrtle	-	F	-	F	F	F
Deutzia	-	-	F	-	-	-
Euonymus	-	F	F	F	F	-
Flowering quince	-	-	F	F	-	F
Forsythia	-	F	F	F	F	-
Hibiscus	-	C	-	-	F	-
Honeysuckle	-	F	F	-	F	-
Hydrangea	F	F	-	F	F	-
Hypericum	-	-	-	-	F	-
Lilac	-	-	F	F	F	F
Nandina	F	F	F	F	F	-
Photinia	F	F	F	F	F	F
Privet	F	F	F	F	F	F
Rose	F	F	F	F	F	F
Spirea	-	F	F	F	F	F
Viburnum	F	F	-	F	F	F
Vitex	-	-	-	-	-	-
Weigela	F	F	F	F	F	F
Witchhazel *(Hamamelis)*	-	-	-	-	-	-
Tolerant Species	**Gallery**	**Segment**	**Pendulum**	**Snapshot**	**Surflan**	**trifluralin**
Deciduous Trees						
Amelanchier (serviceberry)	-	-	-	-	-	-
Ash	F	F	F	-	-	F
Beech	-	-	-	-	-	-
Birch	F	F	F	F	-	F
Cherry	F	F	F	-	F	F
Crabapple	F	F	F	-	-	F
Dawn redwood	-	-	F	-	-	-
Dogwood	-	F	F	F	-	F
Elm	F	-	F	F	-	-
Ginkgo	-	-	-	F	F	-
Goldenchain tree	-	-	-	-	-	-
Goldenrain tree	-	-	-	-	F	-
Hawthorn	-	-	F	-	-	-

[1]This table should be used only as a guide. An ‘F’ indicates the herbicide is registered for use on that species when field-grown or planted in landscapes. Check the herbicide label for special considerations such as variety, plant growth stage, rate adjustment, or application precautions prior to application.

Table 4.15 - Guide for Herbicide Selection - Deciduous Trees and Shrubs[1] (cont.)

Tolerant Species	Gallery	Segment	Pendulum	Snapshot	Surflan	trifluralin
Honeylocust	-	F	F	F	-	F
Linden	F	F	-	-	-	-
Magnolia	-	F	F	-	F	-
Maple	F	F	F	F	F	F
Oak	F	F	F	F	F	F
Pear	F	F	F	-	F	-
Poplar	-	F	F	-	-	-
Redbud	-	-	-	-	-	F
Russian olive	-	F	-	F	-	-
Sourgum *(Nyssa)*	-	-	-	-	-	-
Sourwood *(Oxydendron)*	-	-	F	-	-	-
Sweetgum	F	F	F	F	F	F
Sycamore	F	F	F	F	-	F
Tulip tree	-	F	F	-	-	F
Walnut	-	F	F	-	-	F
Willow	F	F	F	F	-	F
Zelkova	-	-	-	-	-	-
Deciduous Shrubs						
Abelia	-	F	F	-	F	-
Cotoneaster	F	F	F	F	F	F
Crape myrtle	-	F	F	F	F	-
Deutzia	-	-	F	F	-	F
Euonymus	-	F	F	F	F	F
Flowering quince	-	-	F	-	-	-
Forsythia	-	F	F	F	F	F
Hibiscus	F	F	F	-	F	-
Honeysuckle	-	F	-	-	-	F
Hydrangea	-	F	F	-	-	-
Hypericum	-	-	-	-	-	-
Lilac	F	F	F	-	F	F
Nandina	F	F	F	F	F	-
Photinia	F	F	F	F	F	-
Privet	-	F	F	F	F	F
Rose	F	-	F	F	F	F
Spirea	-	F	F	F	-	F
Viburnum	F	F	-	F	F	F
Vitex	-	-	-	-	-	-
Weigela	-	-	-	F	F	F
Witchhazel *(Hamamelis)*	-	-	-	-	-	-

[1]This table should be used only as a guide. An ‘F’ indicates the herbicide is registered for use on that species when field-grown or planted in landscapes. Check the herbicide label for special considerations such as variety, plant growth stage, rate adjustment, or application precautions prior to application.

Table 4.16 - Guide to Weeds that May Be Controlled by Preemergence Herbicides Approved for Use in Ornamentals

Weed	Barricade	Casoron	Freehand
Grasses And Sedges			
Annual bluegrass	G	G	G
Barnyardgrass	G	G	-
Bermudagrass	N	P	N
Cheat	-	-	-
Crabgrass	G	G	G
Fall panicum	-	G	G
Goosegrass	G	G	G
Johnsongrass (seedling)	-	G	-
Microstegium (Japanese stiltgrass)	G	-	-
Orchardgrass, fescue	N	G	N
Quackgrass	N	G	N
Small grains (volunteer)	-	-	-
Stinkgrass	-	-	-
Yellow nutsedge	N	G	F-G
Broadleaf Weeds			
Artemisia (wild chrysanthemum)	-	G	-
Bittercress	P	-	F-G
Canada thistle	-	-	-
Carpetweed	G	G	G
Chickweed	G	G	G
Dandelion	-	G	-
Dock	-	G	-
Dodder	-	G	-
Dogfennel	-	G	-
Eclipta	P	-	F-G
Filaree	-	-	-
Galinsoga (quickweed)	-	-	F
Groundsel, common	-	G	F
Henbit (deadnettle)	-	G	-
Horseweed (marestail)	-	G	-
Knotweed	-	-	-
Lambsquarters	-	G	-
Morningglory	-	G	-
Mustard	-	-	-
Nightshade	-	-	-

G = good control, F = fair, P = poor, N = no control, and - = no information.

Table 4.16 - Guide to Weeds that May Be Controlled by Preemergence Herbicides Approved for Use in Ornamentals (cont.)

Weed	Barricade	Casoron	Freehand			
Broadleaf Weeds (cont.)						
Pigweed	-	G	G			
Poison Ivy	N	N	N			
Prickly lettuce	-	-	-			
Prickly sida	-	G	-			
Purslane	-	G	-			
Pusley, Florida	-	-	-			
Ragweed	P	G	-			
Red sorrel	-	G	-			
Shepherd's purse	-	-	-			
Smartweed	-	G	-			
Sowthistle	-	-	F			
Spurge, spotted (prostrate)	G	-	G			
Velvetleaf	-	-	-			
Veronica (speedwell)	-	-	-			
Wild aster	-	-	-			
Wild carrot	-	G	-			
Yellow wood sorrel (*Oxalis*) (from seed)	G	G	G			
Weed	**Pennant**	**Gallery**	**Pendulum**	**Snapshot**	**Surflan**	**trifluralin**
Grasses and Sedges						
Annual bluegrass	-	P	G	G	G	-
Barnyardgrass	G	-	G	G	G	G
Bermudagrass	N	N	N	N	N	N
Cheat	-	-	-	-	-	-
Crabgrass	G	P	G	G	G	G
Fall panicum	G	-	G	G	G	G
Foxtails	G	-	G	G	G	G
Goosegrass	G	-	G	G	G	G
Johnsongrass (seedling)	-	-	G	G	G	G
Microstegium	-	-	G	-	G	-
Orchardgrass, fescue	N	N	N	N	N	N
Quackgrass	N	-	-	N	N	N
Small grains (volunteer)	-	-	-	-	-	-
Stinkgrass	-	-	-	-	-	-
Yellow nutsedge	G	N	N	N	N	N

G = good control, F = fair, P = poor, N = no control, and - = no information.

Table 4.16 - Guide to Weeds that May Be Controlled by Preemergence Herbicides Approved for Use in Ornamentals (cont.)

Weed	Pennant	Gallery	Pendulum	Snapshot	Surflan	trifluralin
Broadleaf Weeds						
Artemisia (wild chrysanthemum)	-	-	N	-	-	-
Bittercress	P	G	F	G	G	F
Canada thistle	-	-	N	-	N	N
Carpetweed	F	G	G	G	-	-
Chickweed	F	G	G	G	F	G
Dandelion	-	-	-	-	-	-
Dock	-	-	-	-	-	-
Dodder	-	-	-	-	-	-
Dogfennel	-	G	-	G	G	-
Eclipta	P	G	P	G	G	-
Filaree	-	-	-	-	-	-
Galinsoga (quickweed)	G	G	N	G	N	N
Groundsel, common	P	F	P	G	P	-
Henbit (deadnettle)	G	G	-	G	G	-
Horseweed (marestail)	-	F	-	G	-	-
Knotweed	-	-	-	-	-	-
Lambsquarters	P	G	F	G	G	F
Morningglory	N	P	P	-	N	N
Mustard	-	-	-	-	-	-
Nightshade	G	-	P	G	P	P
Pigweed	G	G	F	-	F	F
Poison Ivy	N	N	N	N	N	N
Prickly lettuce	-	-	-	-	-	-
Prickly sida	P	-	-	-	P	P
Purslane	F	G	F	G	F	F
Pusley, Florida	-	-	-	-	-	-
Ragweed	N	G	N	G	N	N
Red sorrel	-	-	-	-	-	-
Shepherd's purse	-	G	N	-	N	N
Smartweed	P	G	-	-	P	P
Sowthistle	-	-	F	-	-	-
Spurge, prostrate (spotted)	P	F	G	G	G	-
Velvetleaf	P	F	G	G	P	P
Veronica (speedwell)	-	-	-	-	-	-
Wild aster	-	-	-	-	-	-
Wild carrot	-	-	-	-	-	-
Yellow wood sorrel	P	F	G	G	F	-

G = good control, F = fair, P = poor, N = no control, and - = no information.

Table 4.17 - Guide to Weeds that May be Controlled by Postemergence Herbicides Approved for Use in Ornamentals

Weed	Acclaim	Basagran	Finale	Ornamec	Roundup	Segment
Grasses and Sedges						
Annual bluegrass	N	N	G	P	G	P
Bamboo	N	-	P	-	F	-
Barnyardgrass	-	N	G	G	G	G
Bermudagrass	F	N	F	G	G	F
Cheat	-	N	-	-	G	-
Crabgrass	G	N	G	G	G	G
Fall panicum	-	N	G	G	G	G
Foxtails	G	N	G	G	G	G
Goosegrass	G	N	G	G	G	G
Johnsongrass (seedling)	-	N	-	G	G	G
Microstegium (Japanese stiltgrass)	G	-	G	G	G	G
Orchardgrass, fescue	N	N	P	P-F	G	F
Quackgrass	P	N	P	G	G	G
Small grains (volunteer)	-	N	-	G	G	G
Stinkgrass	-	N	-	-	G	-
Yellow nutsedge	N	F	F	N	G	N
Broadleaf Weeds						
Artemisia (wild chrysanthemum)	N	-	-	N	F	N
Bittercress	N	G	-	N	G	N
Canada thistle	N	-	-	N	G	N
Carpetweed	N	-	-	N	G	N
Chickweed	N	-	G	N	G	N
Dandelion	N	-	G	N	G	N
Dock	N	-	-	N	G	N
Dodder	N	-	-	N	G	N
Dogfennel	N	-	-	N	G	N
Eclipta	N	G	G	N	G	N
Filaree	N	-	-	N	G	N
Galinsoga (quickweed)	N	-	-	N	G	N
Groundsel, common	N	F	G	N	G	N
Henbit (deadnettle)	N	-	G	N	G	N
Horseweed (marestail)	N	-	G	N	G	N
Knotweed	N	-	-	N	G	N
Lambsquarters	N	P	G	N	G	N

G=good control, F=fair, P=poor, N=no control, and -=no information

Table 4.17 - Guide to Weeds that May be Controlled by Postemergence Herbicides Approved for Use in Ornamentals (cont.)

Weed	Acclaim	Basagran	Finale	Ornamec	Roundup	Segment
Broadleaf Weeds (cont.)						
Morningglory	N	P	-	N	G	N
Mustard	N	-	G	N	G	N
Nightshade	N	-	-	N	G	N
Pigweed	N	P	G	N	G	N
Poison Ivy	N	N	-	N	G	N
Prickly lettuce	N	-	G	N	G	N
Prickly sida	N	G	-	N	G	N
Purslane	N	-	G	N	G	N
Pusley, Florida	N	-	-	N	G	N
Ragweed	N	G	G	N	G	N
Red sorrel	N	-	G	N	G	N
Shepherd's purse	N	-	G	N	G	N
Smartweed	N	G	G	N	G	N
Sowthistle	N	-	-	N	G	N
Spurge, prostrate (spotted)	N	N	G	N	G	N
Velvetleaf	N	G	G	N	G	N
Veronica (speedwell)	N	-	-	N	G	N
Wild aster	N	-	-	N	G	N
Wild carrot	N	-	-	N	G	N
Yellow wood sorrel (*Oxalis*)	N	N	G	N	G	N

G=good control, F=fair, P=poor, N=no control, and -=no information

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Lawn Diseases

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Overview

There are many diseases that occur on turfgrasses throughout the world. However, there are only a few diseases that consistently cause major concerns on lawns in Virginia. Diseases of lawn grasses are typically most common in the summertime for cool-season grasses, such as tall fescue or Kentucky bluegrass, or in the spring and fall for warm-season grasses, such as bermudagrass or zoysiagrass. This is largely due to the shift in growth habits of the grasses from active growth to survival, giving a competitive advantage to the pathogens responsible for diseases.

Tall fescue is the most common turfgrass species used in home lawns in Virginia. The most common and troublesome disease for tall fescue is brown patch. Brown patch occurs most frequently during warm and wet weather, but the lawn typically recovers in the fall when managed properly. However, heavy brown patch infestation in conjuction with drought or heat stress can cause total plant loss. Pythium blight and gray leaf spot can also be active at the same time as brown patch. Symptoms often overlap. Consult a professional, VCE Agent, or turf specialist if you are unsure which disease is developing as chemical control recommendations vary by disease.

Gray leaf spot has become increasingly problematic in late summer and early fall during prolonged periods of rainfall in association with warm temperatures. This disease can devastate a tall fescue lawn within a few days if conditions remain favorable for pathogen growth and reproduction. Curative applications for active gray leaf spot will only prevent infection of new plants while infected plants likely will not recover. The timing for severe gray leaf spot outbreaks has coincided with fall overseeding in recent years. This can cause additional problems as seedlings are more susceptible to the disease but are also watered more frequently during establishment.

Spring dead spot is the most common disease for bermudagrass and is most prevalent on intensively managed areas. Symptons include dead patches in the turf that appear in the spring as the turf emerges from winter dormancy. However, the pathogen responsible for this disease is most active in the root zone during the fall and winter. This disease is often unpredictable, but is usually found in high traffic or compacted areas and after severe winters.

General Cultural Controls

- **Fertility:** Turfgrass plants are healthier when steady supplies of nutrients are available, as opposed to spikes in nutrient levels that may result in rapid growth. The ideal time to fertilize is when conditions are optimal for root growth. Optimal conditions are usually in the fall for cool-season grasses and during the summer for warm-season grasses. A good fertilizer has nitrogen sources with around 30% water-insoluble nitrogen. Excessive readily-available nitrogen can increase the likelihood of brown patch, gray leaf spot, Pythium blight, and snow mold development. Conversely, insufficient nitrogen may cause diseases such as dollar spot, rusts, or general leaf spots to be more problematic. Have the soil tested and only apply other nutrients based on soil testing recommendations.
- **Irrigation:** It is impossible to control rainfall, but homeowners do have control over the frequency and duration of lawn irrigation. The ideal time to irrigate for minimizing disease is around sunrise. This decreases the leaf wetness period, which is critical for disease development, and rinses the leaves of dew and guttation water rich in sugars that attract fungi. Watering in the late morning or early evening prolongs leaf wetness and increases the likelihood of disease development. Lawns should not be irrigated excessively where water stands for prolonged periods of time in low-lying or poorly draining areas.
- **Mowing height:** In most cases, turfgrass that is cut too short is more susceptible to disease. Taller cut grasses can withstand more stress and recover faster after disease pressure subsides than turfgrass cut too short. Tall fescue lawns should be between three and four inches, especially during periods of heat and drought stress. Bermudagrass and zoysiagrass should be mowed around an inch and a half to two inches.
- **Air Movement:** Areas with poor air circulation have more turf diseases. Strategic pruning of trees and shrubs is a good way to improve air movement and allow additional sunlight into trouble areas.
- **Sanitation**: Wash mowing equipment to remove infested leaf clippings following each use. Many pathogens can survive on living and non-living plant debris and are later transported to new locations.

General Biological Controls

- **Disease resistant varieties:** Different varieties of turfgrass are susceptible to different kinds of diseases. Choose a variety of turfgrass that has performed well in the National Turfgrass Evaluation Program. Recent cultivar improvements have resulted in lower disease severity with many grasses. Specifically, there are new tall fescue varieties that are resistant to gray leaf spot and have reduced susceptibility to brown patch. Newer cold-tolerant bermudagrasses are less likely to be impacted by spring dead spot. Current varieties recommended in Virginia are available at the following link: https://www.pubs.ext.vt.edu/SPES/spes-421/spes-421.html.

- **Friendly insects, animals, and organisms:** There are a number of commercially available biological fungicides that may reduce the severity of turfgrass diseases. The majority of these products contain beneficial bacteria or fungi. No biological fungicides tested in Virginia provide complete control of turfgrass diseases. However, several fungicides suppressed diseases, such as brown patch and dollar spot, and aided in turfgrass recovery. The use of biological fungicides in conjunction with other integrated management strategies may result in adequate disease suppression.

When to Call a Professional

It is difficult to determine when turfgrass diseases can be handled at home or if a professional consultation is needed. In most cases, lawns recover with limited damage from disease if the above-mentioned practices are followed. However, when conditions remain favorable for a disease for long periods of time, damage can be quite extensive. Any subsequent stress that prevents the turf from recovering makes the problems worse. For example, if weather conditions remain warm and wet for several days or longer, brown patch can become more severe. In many cases, the turf dies if drought and heat stress follow the warm, wet weather. It is impossible to predict the weather accurately over a long period of time, and it is hard to know, season by season, what weather conditions the turfgrass will endure. Calling a professional may be the right thing to do if weather conditions make turfgrass diseases worse, especially if losing the turf is unacceptable.

Additionally, there are many more fungicides available to control common lawn diseases than what are listed. However, many of these fungicides can only be used by a certified applicator, or are not packaged in small enough quantities for a single homeowner's lawn. If listed chemicals do not provide adequate control or are difficult to find, additional products may be used by turf professionals.

The following table shows the most common active ingredients that can be found by end users at landscape specialty retail centers. Efficacy of each chemical is highly dependent on product formulation, active ingredient use rate, reapplication interval, and environmental conditions.

Table 5.1 - Common Active Ingredients

	azoxystrobin	fluoxastrobin	myclobutanil	propiconazole	pyraclostrobin + triticonazole	thiophanate-methyl
Brown patch	+	+	+	+	+	+
Dollar spot	-	+	+	+	+	+
Fairy ring	+	-	-	-	+	-
Gray leaf spot	+	+	-	+	+	+
Large patch	+	+	+	+	+	+
Melting-out/leaf spot	+	+	+	+	+	+
Microdochium patch (pink snow mold)	+	+	+	+	+	+
Pythium blight	+	+	-	-	+	-
Red thread	+	+	+	+	+	+
Rust	-	-	+	+	+	+
Spring dead spot	+	+	+	+	-	-
Summer patch	+	+	+	+	+	+

- *Active ingredient is (+) or is not (-) labeled for control of disease.*
- *If control level is not satisfactory, additonal products are available to certified professional applicators. Refer to PMG Horticulture and Forest Crops.*
- *Concentration of most fungicide active ingredients are much lower with consumer-packaged products than professional products. Application use rates may vary among consumer products. Always carefully read full label instructions before making any pesticide application.*

Timing of chemical applications: For optimal control, most fungicides should be applied preventatively when conditions become favorable for disease development. As noted above, most common diseases of cool-season lawns occur during the summer months; most common diseases of warm-season lawns occur during the spring and fall. When to reapply chemicals depends on active ingredients, product formulation, target pests, and environmental conditions. Systemic fungicides that move acropetally within the plant typically provide control for longer than contact fungicides.

Lawn Insects

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Overview

The best way to minimize insect pests is to maintain a healthy, dense, stress-free lawn. The occurrence of insect pests usually is sporadic throughtout the year. The damage to turfgrass caused by insect pests is influenced by several factors, including weather conditions. For instance, hot, dry summer conditions favor outbreaks of chinch bugs and/or sod webworm, while these same conditions during July may significantly reduce white grub populations. Also, the number of petsts necessary to cause visible damage depends on the growth rate and general health of the turfgrass; a lawn in good health can tolerate higher pest densities pests than one that is water-stressed. Local weather conditions influence the type of management practices that will be effective against turfgrass pests. For many biological control agents, exposure to hot temperatures or direct sunlight would be detrimental, so special considerations must be met when using these methods.

Proper identification and monitoring of pest populations is the best way to avoid the deployment of unnecessary or ineffective control tactics. Keeping detailed records of applied materials and the level of satisfaction with their results can aid a homeowner in year to-year choices of pest management tactics. By following the steps outlined below, homeowners will be able to make informed decisions about pest management that will decrease pest populations and be safe, cost-effective, and environmentally sound:

1. Is the damage caused by an arthropod pest and not drought, disease, poor soil fertility, or another cultural problem?

2. Identify the pest (find the actual insect) and learn about its biology. Contact your local Extension office if additional help might be needed.

3. Monitor for pests to make sure that control measures are necessary. Often, a pest population will not be high enough to justify control measures.

   The drench test described here is for monitoring cutworms, sod webworms, and armyworms.

   In table 5.2, a flotation sample is described for monitoring chinch bugs, and a digging method is described for monitoring white grubs.

   <u>Drench test for cutworms, sod webworms, and armyworms</u>: Mix 3-4 tablespoons of dishwashing liquid in 2 gallons of water. Pour evenly over 1 square yard of turf. Watch the area for 10 minutes, counting the caterpillars as they rise to the surface.

4. Determine optimum timing of management practices. Make sure that a management tactic will suppress the pest population to an acceptable level, and that suppression is necessary to limit further damage.

5. Consider several management strategies, including biological and cultural methods. Match the management strategy to the pest species. If the pest feeds on grass leaves (black cutworm, for example), any material should be applied to the above ground portion of the turf and not followed by watering. For white grubs that reside beneath the surface, any material used must be applied by injection or the application should be followed by a watering event.

General Cultural Controls

- When mowing, only cut one-third of the height of the lawn at a time.
- Turf more than 2.5 inches in height seldom requires treatment for cutworms or sod webworms.
- Also, when mowing insect-infested lawns remove clippings (adult cutworm moths lay eggs at the tip of grass blades).

General Biological Controls

- Some seed of many cultivars of fescue and perennial ryegrass contains a beneficial fungus. This "endophyte enhanced" seed helps reduce the likelihood of attack by many insect and disease pests.
- Insect pathogenic bacteria, fungi and nematodes are available for some lawn pests. When using a biological control product, be aware of the conditions under which these products will work properly.
- There are a number of naturally occurring beneficial insects, among them ground beetles, lady beetles, parasitic wasps and flies, spiders, and predatory mites that feed on lawn pests.

General Mechanical Controls

- Dethatch in spring or early fall if thatch (the brown layer between the grass blades and the soil surface) is greater than ½ inch deep.

General Chemical Controls

- Use narrow spectrum, less persistent pesticides whenever possible.
- Implement the management tactic as required by the pesticide's label instructions. For formulated insecticides, the label is the law.
- Record pertinent information for future management decisions, including: date of application, material applied, pre-treatment pest population levels, weather conditions during and following application, pest population levels following treatment, level of satisfaction with results.

Precautions

- Read the label and follow all safety precautions, application rates, and pesticide disposal instructions.
- Keep pesticides in their original containers and store them out of reach of children and pets.
- Pesticides applied to your lawn can drift or leach and contaminate neighboring property and water sources. To avoid this, avoid applying pesticides when it is windy or if rain is forecast, and never let pesticide runoff flow into storm drains.

When to Call a Professional

- Hire a licensed pest control service/professional if the problem is beyond your limitations. A pest control professional who practices integrated pest management can provide you with the safest and most effective management strategies.

Special Considerations

- Fire ants have recently spread to Virginia. Refer to the Insects in Recreation Areas and Nursery Crops: Insects sections of the Pest Management Guide for current information on fire ant management. You could also consult the Virginia Cooperative Extension (VCE) Red Imported Fire Ant Factsheet: https://pubs.ext.vt.edu/444/444-284/444-284.html

Guidance on How to Find Specific Recommendations

- See Table 5.2 for specific recommendations.

Links to Useful Sources of Information

- VCE Turf and Garden Tips: https://ext.vt.edu/lawn-garden/turfandgardentips/tips.html?content_list_start=0.
- VCE Spring and Summer Lawn Management Considerations for Cool-Season Turfgrasses (includes a section on common lawn insect pests): https://pubs.ext.vt.edu/430/430-532/430-532.html.
- VCE Japanese Beetle Factsheet: http://pubs.ext.vt.edu/2902/2902-1101/2902-1101.html.
- VCE Pest Monitoring Calendar for Home Lawns in Virginia (PDF file): https://pubs.ext.vt.edu/430/430-524/430-524.html.

Table 5.2 - Specific Insect Recommendations

Insect Pest	Active Ingredients	Recommendation
Ants	Beta-cyfluthrin Bifenthrin Clothianidin Cyfluthrin Cypermethrin Deltamethrin Esfenvalerate Imidacloprid Indoxacarb Lambda-cyhalothrin Permethrin	**Chemical Controls** Use as localized treatments to nesting area according to label directions. A general area application may not be necessary. The use of some other lawn insect controls may also influence ants. Apply during daylight. Consider using insecticidal baits. **Related Fact Sheet** Imported Fire Ant Factsheet: https://pubs.ext.vt.edu/444/444-284/444-284.html
Chinch Bugs	Azadirachtin *Beauveria bassiana* (insect pathogenic fungus) Beta-cyfluthrin Bifenthrin Chlorantraniliprole Clothianidin Cyfluthrin Cypermethrin Dinotefuran Imidacloprid Lambda-cyhalothrin Permethrin Trichlorfon	Sample using flotation: A cylinder with open ends is driven into the turf, and about 1 inch of water is maintained in the cylinder for 5-10 minutes. Chinch bugs will float to the top of the water. Chinch bugs can cause significant damage to turf when found in densities of 15-20 bugs/sq ft. Damage usually occurs to turf in sunny areas with a thick thatch layer. Two generations per year occur in Virginia. Insecticide treatment is often effective, but since the bugs are highly mobile, the area can be quickly recolonized. Do not mow or water turf for 2-3 days after treatment. **Cultural Controls** Reduce the use of fine (red) fescue in sunny areas, avoid spring fertilization with high nitrogen. **Biological Controls** If the insect-pathogenic fungus *Beauveria bassiana* is used as a control measure, do not apply fungicides immediately before or after application. **Related Fact Sheet** Chinch Bugs in Turfgrass: https://ohioline.osu.edu/factsheet/HYG-2503-11
Armyworms and Cutworms	Azadirachtin *Bacillus thuringiensis* var. kurstaki (Bt) Bifenthrin Chlorantraniliprole Clothianidin Cyfluthrin Deltamethrin Dinotefuron Entomopathogenic nematodes Halofenozide Lambda-cyhalothrin Permethrin Spinosad Trichlorfon	Sample using drench test as described in the Overview section. Cutworm populations of 3-8 worms per square yard may warrant treatment. Two generations can occur in Virginia. Armyworm populations above 9 per square yard may warrant treatment. **Biological Controls** Not all species of nematodes available commercially will provide adequate control. The species of nematode is provided on the product label under the “Active Ingredients” section. *Steinernema carpocapsae* is effective against black cutworms. **Chemical Controls** Apply materials in the early evening. Most insecticides used for armyworm and cutworm control are stomach poisons, and the larvae feed at night. Do not water the treatment in unless specified on the label and do not mow for several days after treatment. Armyworms and cutworms are highly mobile, so treated areas are likely to become reinfested from surrounding areas. **Related Fact Sheet** Fall armyworm in turfgrass: https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/spes/SPES-357/SPES-357.pdf

Table 5.2 - Specific Insect Recommendations (cont.)

Insect Pest	Active Ingredients	Recommendation
Mites (Clover mite)	Azadirachtin Diatomaceous earth Esfenvalerate Lambda-cyhalothrin	Clover mites are more nuisances than pests, though they may build up populations near building foundations that can cause silvering of turf. As their name suggests, they are not primarily feeding on grasses. When crushed they cause a red stain on the area. Populations high enough to warrant treatment occur in late winter or early spring, and occasionally in the fall. Control is usually only needed around the perimeter of structures – often only on the south side. **Mechanical Controls** Bare ground within 5 feet of the structure can be effective.
Sod Webworms	Azadirachtin *Bacillus thuringiensis* var. kurstaki (Bt) Bifenthrin Chlorantraniliprole Clothianidin Cyfluthrin Deltamethrin Entomopathogenic nematodes Halofenozide Lambda-cyhalothrin Permethrin Spinosad Trichlorfon	Sample using drench test as described in the Overview section. Webworm densities of 15 per square yard warrant treatment. Sod webworm problems on turf are most noticeable in high maintenance conditions where grass is kept short. Two generations per year occur in Virginia. Young larvae, which are most susceptible to treatment, can be expected in turf about 2 weeks after adults are present, late June and again in early September. **Biological Controls** Unfortunately, by the time damage is noticeable, the larvae are not susceptible to Bt products because they are too old. Spring and early summer treatments may be effective against the larvae that have overwintered. Do not mow for 1-3 days after treatment. **Related Fact Sheet** *Sod Webworm Tips For Your Lawn (Michigan State University):* http://www.canr.msu.edu/resources/sod_webworm_tips_for_your_lawn

Table 5.2 - Specific Insect Recommendations (cont.)

Insect Pest	Active Ingredients	Recommendation
White Grubs (Japanese beetle, masked chafer, Asiatic garden beetle, etc.)	Azadirachtin *Bacillus popilliae* (Milky Spore disease) for Japanese beetle only; not effective on other grub species *Bacillus thuringiensis galleriae* *Beauveria bassiana* (insect pathogenic fungus) Chlorantraniliprole Clothianidin Dinotefuran Entomopathogenic nematodes: Products with *Steinernema riobrave* or *Heterorhabditis* as active ingredient. Halofenozide Imidacloprid Trichlorfon	Sample by digging: Use a shovel to cut several 1 ft x 1 ft squares, 2-3 inches deep. Peel up the turf and count the white grubs. Population high enough to warrant treatment is 6-10 grubs/sq ft. White grubs are actually several species of scarab beetle larvae. **Biological Controls** When using these products, be aware that control is not immediate. Milky spore is a slow-acting disease agent; grubs will take up to 30 days to die. However, when the disease is established, control can be effective for years without further application; since the disease perpetuates and spreads by infecting and being transported by grubs. If another insecticide is applied to an area treated with milky spore, this will slow the spread of the disease and is therefore not desirable. If the insect-pathogenic fungus *Beauveria bassiana* is used as a control measure, do not apply fungicides immediately before or after application. White grubs can also be controlled by entomopathogenic nematodes. Not all species of nematodes available commercially will provide adequate control. The species of nematode is provided on the product label under the “Active Ingredients” section. Products with *Steinernema carpocapsae* in this section should not be used for grub control. Nematode products should be applied only when the pest is present, late in the day to avoid exposure to UV light damage, and soil temperature should be at least 60°F. Early spring treatments with nematodes are usually not effective because soil temperatures are too cold. Watering before and after application of beneficial nematodes provides the best results. **Chemical Controls** These products should be applied at the labeled rate and watered in with 1/2 inch of water. Timing is important; make sure the grubs are present. Most insecticides provide the best control when used against young grubs. **Related Fact Sheet** Beetlemania—White Grub Control in Lawns (VCE) https://ext.vt.edu/lawn-garden/turfandgardentips/tips/beetlemania.html

Lawn Weeds

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Overview

The first step in any lawn weed management program is to identify the problem. What is limiting the growth and density of the lawn's grass? What is competing for nutrients? High quality lawn grass kills seedling weeds and prevents large weed stands, which tend to decrease lawn aesthetics. Simply killing weeds is not enough. Without a healthy turf, weeds will return and invade the lawn. High quality lawns do not happen by accident. Quality turf depends on many factors, such as soil type, turfgrass variety, fertilization, irrigation, mowing, and pest management. The most important of these is good soil. As soil quality increases, the number of inputs required for a quality turf (fertilizers, water, and pesticides) decrease. Improving poor soils is among the most important factors to increase turf quality and achieve maximum weed prevention from the turfgrass. Although lawn grasses can be grown on almost any soil, everything is easier with quality topsoil. Any weed management program should start with a soil test. Retest the soil every three to four years to ensure that soil pH and nutrient levels are optimal for turfgrass growth.

The second step to lawn weed management is to identify the suspect weed. The beauty of a lawn is in the eye of the beholder. Wild plants appreciated by one person are weeds to another. Some weeds are only visible above the turf canopy for a few weeks each year, while others persist and multiply. Learn the weed's life cycle—when it emerges, when it flowers and how long it will live. Now decide what steps to take to fix the problem in the short and long term.

Herbicides are just one of many options to treat weed problems in the lawn. In the following sections, general management options are discussed and these may be used in lieu of or in combination with herbicide treatments. In the later section, specific herbicide recommendations are given for the most common lawn weed problems.

General Cultural Controls

Healthy lawn grass is the most powerful weed prevention available. Practices that promote turfgrass health are required for successful weed management in the lawn. In fact, most weed problems in Virginia can be attributed to a single mistake made by most homeowners: mowing the lawn too short. No other cultural input for lawns exceeds the effort given to mowing, so mowing correctly is critical for optimal turfgrass health and performance. Most lawns in Virginia are tall fescue or other cool-season grasses like Kentucky bluegrass, perennial ryegrass, and fine-leaf fescues. Optimal mowing heights for these grasses vary somewhat depending on the species but a minimum of three inches is a good rule of thumb for most situations. When growing cool-season grasses in the warmer climates of Virginia, the single most important thing to promote a higher-quality lawn is to raise the cutting height to three to four inches in mid-to late spring, before the onset of summer stress periods. This promotes a deeper root system and provides more leaf canopy to conduct photosynthesis. Many consumer mowers are not adjustable or will not mow turf taller than approximately two inches. Owners of these mowers must accept the fact that their lawns require more water, pesticide, and fertilizer to stay healthy. In addition to mowing height, mowing frequency and efficiency, such as having a sharp mower blade, are key to turfgrass health. Mow often enough so that no more than one-third of the total turfgrass height is removed. When a lawn maintained at a three-inch height reaches four inches, it needs to be mowed. During spring and fall, mow the cool-season lawn every four to 5 days. In summer, mow every 7 to 10 days. During periods of drought, do not mow the lawn until rains return. Since most grass blades do not grow during drought, ignore the occasional tall leaf blade and do not mow the lawn for extended periods. In addition to mowing properly, there are several other cultural practices that reduce weeds in the lawn. The following table details the most important steps to create a healthy lawn that resists weeds.

Table 5.3 - Cultural practices that promote turfgrass ability to suppress weeds or prevent weed introduction and expansion in cool-season and warm-season lawns.

Cultural practice*	Cool-season lawns (tall fescue, Kentucky bluegrass, perennial ryegrass, fine-leaf fescues, etc)	Warm-season lawns (bermudagrass, zoysiagrass, centipedegrass, St. Augustinegrass)
Mow height	Mow tall fescue at three to four inches, others at two- to three-and-a-half inches.	Mow St. Augustine grass at three to four inches, others at one to two inches
Mow frequency	Follow the one-third rule, mow every four to five days in spring and fall and seven to ten days in summer.	Follow the one-third rule, mow every four to five days in summer and seven to ten days in spring and fall.
Mower	Keep blades sharp; sharpen blades every four to six weeks during the mowing season. Zoysiagrass and tall fescue turfs require more frequent sharpening than others.	
Soil	Conduct soil tests every three-four years and improve poor soils by adding compost, topsoil, core aeration or adjusting pH to between 6.3 and 6.8	
Fertility	Depending on the grass, apply two to three pounds nitrogen (N) per thousand square feet once per year, mostly in the fall. Do not apply more than one pound of water soluble nitrogen in a single application. Excessive spring nitrogen applications reduce summer stress tolerance and can increase weed and disease pressure. Apply phosphorus (P) and potassium (K) as indicated by soil test results. Avoid applying phosphorus and potassium when weeds are expected to germinate.	Depending on the grass, apply one to four pounds nitrogen (N) per thousand square feet each year, primarily in late spring thru mid-summer. Do not apply more than one pound of water soluble nitrogen in a single application. Apply phosphorus (P) and potassium (K) as indicated by soil test results.
Irrigation	If supplemental irrigation is available or desired, irrigate deeply and infrequently, providing at least one inch of water per week, including rainfall, during summer stress periods. Irrigate in early morning hours to minimize leaf wetness periods and reduce disease pressure. Avoid supplemental irrigation during periods when weeds are expected to germinate. If no irrigation is available, allow lawn to go dormant during drought	
Clipping management	Return clippings, as they essentially serve as 'slow release fertilizer' to the lawn and provide up to one-third of its annual nutrient needs. Do not worry about returning weed seed in clippings to the lawn, as indigenous seed in the soil far outnumber weed seeds deposited by mowing. If clippings are removed, use the higher range of recommended fertility programs. Compost collected clippings with other lawn and garden debris and return the compost to the lawn in order to improve soil tilth.	
Variety selection	Choose adapted varieties, refer to http://www.ext.vt.edu and search for the "recommended list" to find the latest turfgrass variety suggestions. Change turfgrass species or variety in different environments, such as shade.	
Aeration	Test soil one day after rain by inserting a knife or screwdriver into the ground. If difficult to insert, that area of lawn needs aeration. Aerate cool-season lawns in spring and/or fall. Aerate warm-season lawns in summer.	
Exclusion	Prevent weeds from entering new areas. Inspect soil, manure, or any organic additives for invasive weeds. Target creeping weeds outside the lawn or develop strategies that limit invasion into the lawn. Use only certified grass seed that is free of weed seed.	
Improve conditions	Fix drainage problems, trim low tree limbs, and try to increase light quantity and wind movement where turfgrass is growing.	
Choose sites	Don't grow turfgrass in an area where it is not adapted. Deep shade or extremely poor soils are best suited to an inorganic mulch or plant species commonly used as ground covers that are better adapted to the environment.	

* There are numerous Virginia Cooperative Extension publications that provide much more extensive detail in overall best management practices in lawn care available at www.ext.vt.edu.

General Biological Controls

Although some biological organisms target weeds in turfgrass, none are available for home lawn use.

General Mechanical Controls

The primary means of mechanical weed control in lawns is hand weeding. Hand weeding is often overlooked as a viable option for lawn weed control. Tools are available to help remove weeds from the lawn without bending. A quick internet search will provide more information and vendors for these kinds of tools. Chemical sprays are often perceived as the easiest approach to weed control, but hundreds of weeds can be hand pulled in the time required to research and determine the appropriate chemical for the properly identified weed, purchase the chemical, mix the product in a calibrated applicator, and apply the product. Then it will take one to three weeks for the chemical spray to work. Hand pulling is arguably the easier choice. Plants like dandelion, plantain, ryegrass, annual bluegrass, crabgrass and goosegrass have few or no creeping stems, and are easier to pull than creeping plants like bermudagrass (wiregrass), nimblewill, and white clover. Although hand pulling creeping perennials like bermudagrass and nutsedge does not completely eradicate the population, such efforts are still beneficial to the turfgrass and limits population expansion of the weed. Always wait until after a rainfall or irrigation to hand pull weeds, as plants will then be easier to pull. Discard plants rather than leaving them to be mown into the lawn, as the pulled plants continue to grow and produce seed before they die, and stem fragments from some plants can take root in the lawn.

Remove mat-forming plants, like moss, by raking or vertical mowing. It is important to remove thick mats of biological material before seeding new turfgrass in the area. Some species of weeds may invade a lawn soon after establishment, but will not persist more than two to three years as they cannot compete in the presence of regular mowing. Thus, mowing acts as a mechanical control in a select few situations.

Solarization and shading are two other nonchemical approaches to control weeds. Unfortunately, these methods also kill desirable turfgrass. Solarization kills plants by covering them with a clear material and allowing solar radiation to heat the area to a temperature too high to support plant life. Shading removes the plants' ability to capture energy and eventually kills the plants. Both techniques take one to two months to kill plants. Then the area must be seeded or sodded back to desirable turfgrass.

In the natural life cycle of target weeds, many die with summer heat or winter frost. If these natural events kill the weed within a few weeks, costly chemicals are not needed. As mentioned earlier, large amounts of biological material left behind after these weeds die should be removed so turfgrass can grow.

General Chemical Controls

Both organic and synthetic chemicals can combat weeds. In both cases, safe handling procedures are important and these can be reviewed in Chapter 1. Granular and sprayable herbicides are available for use in home lawns. Granular products are strewn manually, scattered using specialized product containers, or applied using drop or rotary spreaders. There are two ways to calibrate the application of granular products. One is to measure the amount of product and apply all of that product uniformly to a given area of turf. The other is to calibrate the delivery rate of a machine and operate the machine until all desired area is covered. It is best to use the first method for home lawn application. Product bags often indicate the amount of area covered by one bag. For example, instructions may state that a bag of chemicals "covers 5000 square feet." The product in these bags is typically well blended, so use half the bag's contents to cover half the indicated area. The scientific way to partition product is by weight, but it is easier for homeowners to partition the product by volume. It is important that any measuring devices, such as cups, tin cans, etc. are filled the same way each time so volume measurements are accurate.

After measuring the product, determine the square footage of the area to be treated. Divide irregularly shaped areas into several rectangles or squares and determine the area of each. Simply multiply the length by the width of a given area to determine the area in square feet. For example, an area 15 feet by 25 feet contains 375 square feet. Repeat this process until the entire lawn has been measured and simply total the sum of all small areas into one number, which represents the square footage of the lawn. Let's say an area requires 75 percent of a bag of product. Place the product into the spreader, set the spreader on a low level, cover the entire lawn, then check the amount of product used. This is the easiest method to estimate how much product is needed to cover the lawn before the product is completely spread. If more than four times are needed, it is best to adjust the spreader to a slightly higher level and repeat the process. It is best to apply the product evenly to the lawn in two to four passes. By running the spreader over the entire lawn two to four times, the product application is spread uniformly across the lawn, and does not have any pattern associated with walking. Change walking patterns each time to improve product distribution.

To apply sprayable products, the primary equipment is the pump sprayer and the hose-end sprayer. Several products are sold in a container that serves as a hose-end sprayer. These are called "Ready-to-Spray" products. Regardless of the spray equipment, application techniques are similar. First calculate square footage. Next, determine the amount of product needed. The Ready-to-Spray products are just that, "ready to spray." Simply attach a garden hose and apply the product uniformly to the target area. After-market, hose-end sprayers are cheap and can be used to apply many different concentrate products. Place the concentrate in the siphon container, set the dial to the desired dispense rate, and spray the product over the lawn. It is best to cover the entire area at least twice in different directions, so adjust calibration to apply only half the desired rate. By covering the entire area twice, the spray pattern is more uniform.

To calibrate a pump sprayer, fill the sprayer with a known amount of clean water, mark off an area of 1000 square feet (such as 20 feet by 50 feet), and cover the area completely while spraying the clean water. Now check to see how much water was used in the test spray. This amount is the spray rate and should be near one to two gallons per thousand square feet. Once the spray rate is determined, it is easier to calculate the amount of concentrate product for each gallon of water and also know how much area it should treat.

Since most lawn herbicides are synthetic, they are covered under the specific recommendations later in this chapter. There are only a few organic weed control products available for use in lawns and those are summarized later in the chapter. Organic pesticides are chemicals that kill pests, just like synthetic pesticides. In many cases, organic pesticides share the same molecular structures as their synthetic counterparts. The difference is that organic pesticides are purified from naturally obtained material rather than being created synthetically. The public perception is that organic pesticides are safer than synthetic pesticides and a growing number of consumers desire organic, which are often labeled "nonchemical," alternatives. Unfortunately, only a few organic chemicals are available to fill this market niche for weed control in home lawns. Most organic weed control products also kill or severely injure desirable turf, and must be used for spot treatment of seedling weeds. Turf in the treated area quickly turns brown, but recovers in one to two weeks. Mature weeds also recover in about the same time period as turfgrass. These products are excellent for spot treating seedling weeds in gardens and ornamental beds but are of limited usefulness in lawns. Table 5.3 lists several organic weed control products on the market.

Corn gluten meal is one selective organic herbicide that exists for home lawns. Corn gluten meal contains alaninyl-alanine, a chemical that inhibits lateral root production in plants. When applied near the time of weed germination, survival of germinating weeds decreases due to a reduction in root vigor. Corn gluten meal also contains 9 percent nitrogen by weight and constitutes a nitrogen application rate of 1.8 pounds per thousand square feet of slow-release nitrogen, when the product is applied at the recommended 20 pounds per thousand square feet. This massive amount of fertilizer increases turfgrass competition in the short term and probably increases weed seedling mortality due to shading and other competitive effects of turfgrass. Alaninyl-alanine is short lived in soil, lasting on average about two or three weeks. If excess irrigation or rainfall occurs over extended periods, weeds may survive until alaninyl-alanine degrades in soil. For this and other reasons, corn gluten meal has performed inconsistently in Virginia's transition zone climate. More success has been seen with this herbicide in the northern US where cool-season lawn grasses are better adapted to the climate. In Virginia, applying 1.8 to 3.6 pounds of slow-release nitrogen from one to two treatments of corn gluten meal can spell disaster for lawn grasses when summer temperatures increase. Increased foliar growth from supraoptimal fertility in spring leaves turfgrass vulnerable to disease and drought later in summer. Thus, corn gluten meal has seldom been recommended in this Pest Management Guide. Current research at Virginia Tech is looking for more sustainable approaches to using corn gluten meal by reducing use rates to 10 pounds or less and adding synthetic herbicides at a fraction of their normal rates. These programs appear to maintain excellent turf quality, while exceeding weed control from corn gluten meal at full rates as well as drastically reducing pesticide use over conventional full rate pesticide treatments. When using corn gluten meal, reduce the rate to 10 pounds, and supplement the program by hand pulling escaped crabgrass and other weeds. This prevents turf harm from excess fertility and still avoids or reduces the use of synthetic herbicides.

Table 5.4 - Some organic weed control products marketed for use in lawns

Active ingredient	Product(s)	Uses
Acetic acid (vinegar)	Weed/Grass Killer, Natural Weed Control, Erath Earth, Maestro-Gro Blackjack 21, Burnout Weed & Grass Killer	Nonselective, seedling weed control.
Ammoniated soap of fatty acid	Garden Safe Weed & Grass	Nonselective, seedling weed control.
Cinnamon Bark	AgraLawn Crabgrass Killer, Garden Weasel	Crabgrass control in warm-season lawns.
Cinnamon oil, rosemary oil	Organic Weed Killer	Nonselective, seedling weed control.
Citric acid	Burnout 2, Natural Weed Control	Nonselective, seedling weed control.

Table 5.4 - Some organic weed control products marketed for use in lawns (cont.)

Active ingredient	Product(s)	Uses
Citrus oil (d-limonene)	Nature's Avenger, Worry Free Weed & Grass Killer	Nonselective, seedling weed control.
Clove oil	EcoSmart, Bioganic Weed & Grass Killer, Burnout 2	Nonselective, seedling weed control.
Corn gluten (Alaninyl-alanine)	Amaizeingly Green, Corn Weed Blocker, Espoma Green, Weed Man, WOW!, NaturO, Jonathan Green Organic Weed Control, Safe-T-Weed, Gard'n-Wise Organics, Dynaweed, Concern Weed Prevention Plus	Preemergence weed control in turfgrass. 9% slow-release nitrogen source by weight.
Ethanoic acid	Burnout Weed & Grass Killer	Nonselective, seedling weed control.
Thyme oil	Bioganic Weed & Grass Killer	Nonselective, seedling weed control.
Iron HEDTA	Weed Beater FE, Iron X, Fiesta Turf Weed Killer	Selective postemergence control or suppression of broadleaf weeds in turf

Precautions

When choosing lawn weed control products, know that most herbicides are relatively safe but still should be handled with respect and stored in a secure manner. Table 1.7 in Chapter 1 shows the relative toxicity of various pesticides. Most herbicides are far less toxic than insecticides or fungicides and have an LD_{50} value greater than 5,000 to 10,000 milligrams/kilograms. Those values are less than that of table salt (3,000). In fact, only a few herbicides are as toxic as caffeine (192) and aspirin (200) and these include paraquat (150) and diquat (231). Always follow label instructions on any pesticide product and use the product in a safe manner.

Although herbicides exhibit relatively little danger to humans, pets, and wildlife, they can cause serious injury to desirable ornamental plants. Herbicides should also be kept away from hardscapes, unless the herbicide is registered for such use, as they can move into streams and rivers through man-made drainage systems. Don't spray products when wind speeds are greater than five miles per hour, if possible, and use shields to protect spray from effects of wind. Similarly, many granular spreaders have deflector shields to minimize product delivery onto hardscapes. If granules are strewn onto sidewalks or pavement, sweep them up or blow them back onto the lawn. Never discard granules or liquids into any drain.

Don't apply any herbicide to areas saturated with water from frequent rains or irrigation. If soils are saturated and another rainfall occurs soon after herbicide application, the product will be highly prone to move in surface runoff water. This can injure plants away from the target site and the herbicide can move into storm water drains. Some herbicides can be tracked with shoes or tires to nontarget areas. Prevent traffic on treated areas until after rainfall or irrigation. Most herbicides are rain-fast within four to eight hours. Herbicides can also be irrigated to wash excess residue from leaves and prevent the product from being dislodged by foot or vehicle traffic.

Always read and follow the label instructions on the herbicide product. The information on the label is federal law, and to apply the product in any way other than what is specified on the label is a federal crime. These rules apply to handling, mixing, transporting, storing and applying the pesticide. For more information on safe use of pesticides, refer to Chapter 1 in this Pest Management Guide.

When to Call a Professional

Homeowners may waste more money and have fewer resources to draw from by trying to apply pesticides by themselves. Consumer pesticides have less active ingredient than products available to professionals. Consumer products are also more expensive per unit quantity, even if products are available in small quantities for a perceived low price. For example, a typical liquid broadleaf weed control product available to professionals is purchased in a minimum one gallon size for about $100. This container treats about two to four acres, or eight to 16 average sized lawns. To match the same amount of actual herbicide, the competitive consumer product requires 17 to 34 quart-sized containers at a cost of $260 to $520.

A general rule of thumb for hiring a professional is this: if you don't enjoy working in your lawn and landscape, hire a professional. Applying pesticides should only be attempted by one who is willing to take the time to learn basic pest management techniques. In the wrong hands, pesticides are a danger to the environment, people, and animals. They require secure storage, personal protection clothing, application equipment and other inputs that are best avoided if one does not intend to start a new hobby. Finally, many products are available only to professionals and work more effectively than consumer products.

Links to Useful Sources of Information

www.cdms.net Best source for pesticide labels and MSDS sheets

Specific Recommendations

Nearly 700 consumer herbicide products for lawns are registered for sale and use in Virginia. Consumer products may change in active ingredient composition or quantity at any time. There may be hundreds of specific products for a single active ingredient. Consumer products that are tested at universities and cooperative extension programs don't usually have recommendations that mention specific product names. Instead, active ingredients are recommended at rates representative of the scientific studies that evaluated their performance. The problem is that these rates are based on professional products that are not available to consumers. In addition, the common chemical names, such as "dicamba," are recommended in this section, while consumer products may not include these common chemical names anywhere on the package. Instead, consumer products list full chemical names, such as " Benzoic acid, 3,6-dichloro-2-methoxy," that may be expressed in several ways for each active ingredient. The use of active ingredients in these recommendations is inevitable, so this section tries to help consumers find the best products for their needs and choose them in a logical manner.

Many consumers believe that the subject of herbicide active ingredients is too complex and all references should be made to product names. However, it is impossible to reference several hundred product names in this section. Only 33 active ingredients are currently available in consumer products, and just 25 of those do not harm cool-season turfgrass. Just 11 active ingredients comprise the primary active ingredients in 85 percent of the products currently marketed in Virginia for consumer lawns. To find recommended active ingredients on consumer products, Table 5.5 contains the full chemical names for all active ingredients currently marketed for consumer lawn weed control in Virginia. Table 5.4 also lists the number of consumer products that contain each active ingredient and the most common use for these herbicides.

Recommendations in this section will be separated into eight categories based on the most common weed control problems in Virginia lawns. Within each category, herbicides are recommended based on active ingredient. Herbicide rate strongly influences product effectiveness, so a professional equivalency formula was created to reference the percentage active ingredient in various products to those in professional products tested at Virginia Tech. This formula allows consumers to select product from store shelves, find the active ingredients' percentage (A), total product weight or volume (B), and the area treated by the product in thousands of square feet (C). These three parameters are inserted into the formula (see Tables 5.6, 5.7, 5.8, and 5.9), which uses a professional equivalency constant to determine the fraction of the professional rate that would be applied when using the consumer product. For a step-by-step procedure for using this formula to calculate the professional equivalency of any consumer product, go to www.ppws.vt.edu/~saskew/PEC.ppt.

Table 5.5 - A list of the more common active ingredients found in consumer herbicides

Common Name	Number of Consumer Products	Most Common Use	Synonyms Often Found on Product Labels
2,4-D	173	Postemergence broadleaf control (bittercress, buttercup, wild carrot, chickweed, dandelion, mustards, plantain, thistles, wild garlic, and others).	2,4-D, dimethylamine salt 2,4-Dichlorophenoxyacetic acid compd. with N-methylmethanamine 2,4-Dichlorophenoxyacetic acid, dimethylamine salt Acetic acid, (2,4-dichlorophenoxy) Dimethylamine 2,4-dichlorophenoxyacetate Acetic acid, (2,4-dichlorophenoxy)-, 2-ethylhexyl ester 2,4-D, 2-ethylhexyl ester 2,4-Dichlorophenoxyacetic acid, 2-ethylhexyl ester 2-Ethylhexyl (2,4-dichlorophenoxy)acetate Triisopropanolamine 2,4-dichlorophenoxyacetate 2,4-D, triisopropanolamine salt 2,4-Dichlorophenoxyacetic acid, triisopropanolamine salt

Table 5.5 - A list of the more common active ingredients found in consumer herbicides (cont.)

Common Name	Number of Consumer Products	Most Common Use	Synonyms Often Found on Product Labels
2,4-DP	30	Postemergence broadleaf control (bittercress, buttercup, wild carrot, chickweed, dandelion, mustards, plantain, thistles, wild garlic, and others).	Dichlorprop-P (R)-2-(2,4-Dichlorophenoxy)propanoic acid, dimethylamine salt (+)-2,4-DP, dimethylamine salt 2,4-DP-p, DMA salt Dimethylamine salt of (+)-R-2-(2,4-dichlorophenoxy) propanoic acid Methanamine, N-methyl-,(R)-2-(2,4-dichlorophenoxy) propanoate N,N-Dimethylammonium (R)-2-(2,4-Dichlorophenoxy) propanoate Propanoic acid, 2-(2,4-dichlorophenoxy)-, (R)-,
Atrazine	17	For use in warm-season turf only and restricted use. Postemergence and preemergence control of grass and broadleaf weeds.	2-Chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine 1,3,5-Triazine-2,4-diamine, 6-chloro-N-ethyl-N'-(1-methylethyl)- 1-Chloro-3-ethylamino-5-isopropylamino-2,4,6-triazine 2-Chloro-4-(propylamino)-6-ethylamino-s-triazine 3-(N-Butyl-N-acetyl)aminopropionic acid S-Triazine, 2-chloro-4-(ethylamino)-6-(isopropylamino)-
Benefin	21	Preemergence control of crabgrass, annual bluegrass, and other annual grasses.	Benfluralin Benzenamine, N-butyl-N-ethyl-2,6-dinitro-4-(trifluoromethyl)- N-Butyl-2,6-dinitro-N-ethyl-4-(trifluoromethyl)aniline N-Butyl-N-ethyl-2,6-dinitro-4-(trifluoromethyl)benzenamine N-Butyl-N-ethyl-a,a,a-trifluoro-2,6-dinitro-p-toluidine P-Toluidine, N-butyl-N-ethyl-a,a,a-trifluoro-2,6-dinitro-
Bentazon	5	Postemergence sedge control and seedling broadleaf control.	Sodium bentazon 1H-2,1,3-Benzothiadiazin-4(3H)-one-2,2-dioxide, 3-isopropyl-, sodium salt 3-Isopropyl-1H-2,1,3-benzothiadiazin-4(3H)-one-2,2-dioxide, sodium salt
Carfentrazone	15	Kills seedling broadleaf weeds during turf seeding. Also adds fast symptoms when added to other products.	Benzenepropanoic acid, .alpha.-2-dichloro-5-{4-(difluoromethyl)-4,5-dihydro-3-methyl-5-oxo-1H-1,2,4-triazol-1-yl}-4-fluoro-, ethyl ester Ethyl 2-chloro-3-{2-chloro-4-fluoro-5-{4-(difluoromethyl)-4,5-dihydro-3-methyl-5-oxo-1H-1,2,4-triazol-1-yl}phenyl} propanoate Carfentrazone-ethyl
Dicamba	144	Postemergence broadleaf control (Knotweed, smartweed, curly dock, chickweed, ground ivy, spurge, clover, and others).	3,6-Dichloro-o-anisic acid, dimethylamine salt Dicamba, dimethylamine salt Benzoic acid, 3,6-dichloro-2-methoxy- Dimethylamine 3,6-dichloro-o-anisate 2,5-Dichloro-6-methoxybenzoic acid 2-Methoxy-3,6-dichlorobenzoic acid 3,6-Dichloro-2-methoxybenzoic acid MDBA O-Anisic acid, 3,6-dichloro-

Table 5.5 - A list of the more common active ingredients found in consumer herbicides (cont.)

Common Name	Number of Consumer Products	Most Common Use	Synonyms Often Found on Product Labels
Diquat	13	Nonselective. Fast acting, contact type herbicide. Less effective on mature perennial weeds.	6,7-Dihydrodipyrido(1,2-a:2',1'-c)pyrazinediium dibromide 1,1'-Ethylene-2,2'-dipyridylium dibromide 9,10-Dihydro-8a,10a-diazoniaphenanthrene dibromide Dipyrido(1,2-a:2',1'-c)pyrazinediium, 6,7-dihydro-, dibromide Diquat bromide Ethylene dipyridylium dibromide
Dithiopyr	101	Preemergence control of crabgrass, annual blue-grass, and other annual grasses.	3,5-Pyridinedicarbothioic acid, 2-(difluoromethyl)-4-(2-methylpropyl)-6-(trifluoromethyl)-, S,S-dimethyl ester S,S-Dimethyl 2-(difluoromethyl)-4-(2-methylpropyl)-6-(trifluoromethyl)-3,5-pyridinedicarbothioate
Fenoxaprop	2	Postemergence control of many grass weeds.	Propanoic acid, 2-{4-{(6-chloro-2-benzoxazolyl)oxy}phe-noxy}-, ethyl ester, (R)- (+)-Ethyl 2-(4-((6-chloro-2-benzoxazolyl)oxy)phenoxy) propanoate Fenoxaprop-p ethyl ester
Fluazifop	12	Postemergence control of many grass weeds.	Butyl (R)-2-(4-((5-(trifluoromethyl)-2-pyridinyl)oxy)phenoxy) propanoate Fluazifop-P-butyl Propanoic acid, 2-(4-((5-(trifluoromethyl)-2-pyridinyl)oxy)phe-noxy)-, butyl ester, (R)-
Glyphosate	103	Nonselective. For spot treating or weed control on driveways, patios, etc.	Glyphosate, isopropylamine salt Glycine, N-(phosphonomethyl)-, compd. with 2-propanamine (1:1) Glyphosate-isopropylammonium Isopropylamine glyphosate (N-(phosphonomethyl)glycine) N-(Phosphonomethyl)glycine, isopropylamine salt
Halosulfuron	1	Postemergence sedge control.	3-Chloro-5-(((((4,6-dimethoxy-2-pyrimidinyl)amino)carbonyl) amino)sulfonyl)-1-methyl-1H-pyrazole-4-carboxylic acid, methyl ester 1H-Pyrazole-4-carboxylic acid, 3-chloro-5-(((((4,6-dimethoxy-2-pyrimidinyl)amino)carbonyl)amino)sulfonyl)-1-methyl-, methyl ester Methyl 3-chloro-5-(4,6-dimethoxypyrimidin-2-yl carbamoylsulfamoyl)-1-methyl pyrazole-4-carboxylate Halosulfuron-methyl
Imazapic	3	Nonselective. Used to extend residual control.	imazapic-ammonium 3-Pyridinecarboxylic acid, 2-(4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl)-5-methyl-, monoammo-nium salt, (.+-.)-
Imazapyr	5	Nonselective. Used to extend residual control.	2-(4,5-Dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl)-3-pyridinecarboxylic acid with 2-propanamine (1:1) 2-(4-Isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)nicotinic acid with isopropylamine (1:1) Imazapyr, isopropylamine salt

Table 5.5 - A list of the more common active ingredients found in consumer herbicides (cont.)

Common Name	Number of Consumer Products	Most Common Use	Synonyms Often Found on Product Labels
Imazaquin	2	For warm-season turf only. Also used to extend residual control of nonselective products.	3-Quinolinecarboxylic acid, 2-(4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl)-, monoammonium salt Ammonium salt of imazaquin Imazaquin, monoammonium salt
Isoxaben	8	Preemergence control of broadleaf weeds.	N-(3-(1-Ethyl-1-methylpropyl)-5-isoxazolyl)-2,6-dimethoxybenzamide Benzamide, N-(3-(1-ethyl-1-methylpropyl)-5-isoxazolyl)-2,6-dimethoxy- Benzamizole N-3-(1-Ethyl-1-methylpropyl)-5-isoxazolyl-2,6-dimethoxybenzamide
MCPA	7	Postemergence broadleaf control (clovers, chickweed, lespedeza, and others).	2-Ethylhexyl 2-methyl-4-chlorophenoxyacetate ((4-Chloro-o-tolyl)oxy)acetic acid, 2-ethylhexyl ester 2-Methyl-4-chlorophenoxyacetic acid, 2-ethylhexyl ester Acetic acid, (4-chloro-2-methylphenoxy)-, 2-ethylhexyl ester MCPA, 2-ethylhexyl ester (4-Chloro-2-methy(phenoxy)acetic acid with N-methylmethanamine 2-Methyl-4-chlorophenoxyacetic acid, dimethylamine salt Acetic acid, (4-chloro-2-methylphenoxy)-, compd. with N-methylmethanamine Dimethyl amine salt of 2-methyl-4-chlorophenoxyacetic acid Dimethylamine 2-methyl-4-chlorophenoxyacetate
MCPP	152	Postemergence broadleaf control (clovers, chickweed, lespedeza, and others).	Mecoprop-P MCPP-p DMAS MCPP-p, DMA salt Propanoic acid, 2-(4-chloro-2-methylphenoxy)-, (R) (+)-(R)-2-(4-Chloro-2-methylphenoxy)propanoic acid
Mesotrione	13	Postemergence control of grass weeds (crabgrass, foxtail, seedling goosegrass, nimblewill, others) and suppression of bermudagrass, sedges, and some broadleaf weeds	2-{4-(methylsulfonyl)-2-nitrobenzoyl}- 1,3-cyclohexanedione
Oryzalin	5	For warm-season turf or mature tall fescue only. Preemergence control of annual grasses and some broadleaves.	3,5-Dinitro-N4,N4-dipropylsulfanilamide 3,5-Dinitro-N',N'-dipropylsulfanilamide 4-(Dipropylamino)-3,5-dinitrobenzenesulfonamide Benzenesulfonamide, 4-(dipropylamino)-3,5-dinitro- N(sup4),N(sup4)-Dipropyl-3,5-dinitrosulfanilamide Sulfanilamide, 3,5-dinitro-N4,N4-dipropyl-
Oxadiazon	27	Preemergence control of crabgrass, goosegrass, and other annual grasses.	2-tert-Butyl-4-(2,4-dichloro-5-isopropoxyphenyl-delta2-1,3,4-oxadiazoline-5-one 1,3,4-Oxadiazol-2(3H)-one, 3-?2,4-dichloro-5-(1-methylethoxy)phenyl-5-(1,1-dimethylethyl)-

Table 5.5 - A list of the more common active ingredients found in consumer herbicides (cont.)

Common Name	Number of Consumer Products	Most Common Use	Synonyms Often Found on Product Labels
Oxyfluorfen	6	Nonselective weed control. Used for spot treating on driveways, patios, etc where residual control is needed.	2-Chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl) benzene 2-Chloro-.alpha.,.alpha.,.alpha.-trifluoro-p-tolyl 3-ethoxy-4-nitrophenyl ether 2-Chloro-4-trifluoromethyl-3'-ethoxy-4'-nitrodiphenyl ether Benzene, 2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)-
Pelargonic acid	2	Nonselective.	Nonanoic acid
Pendimethalin	36	Preemergence control of crabgrass, annual bluegrass, and other annual grasses.	N-(1-Ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine 3,4-Xylidine, 2,6-dinitro-N-(1-ethylpropyl)- Aniline, 3,4-dimethyl-2,6-dinitro-N-(1-ethylpropyl)- Benzenamine, 3,4-dimethyl-2,6-dinitro-N-(1-ethylpropyl)- N-(1-Ethylpropyl)-3,4-dimethyl-2,6-dinitroanaline
Penoxsulam	5	Postemergence control of hard-to-kill broadleaf weeds.	Benzenesulfonamide, 2-(2,2-difluoroethoxy)-N-(5,8-dimethoxy[1,2,4]triazolo[1,5-c]pyrimidin-2-yl)-6-(trifluoromethyl)-
Prodiamine	135	Preemergence control of crabgrass, annual bluegrass, and other annual grasses.	2,4-Dinitro-N3,N3-dipropyl-6-(trifluoromethyl)-1,3-benzenediamine 1,3-Benzenediamine, 2,6-dinitro-N1,N1-dipropyl-4-(trifluoromethyl)- N3,N3-Dipropyl-2,4-dinitro-6-(trifluoromethyl)-1.3--phenylenediamine Toluene-2,4-diamine, alpha,alpha,alpha-trifluoro-3,5-dinitro-N4,N4-dipropyl-
Quinclorac	21	Postemergence crabgrass control.	3,7-Dichloro-8-quinolinecarboxylic acid 8-Quinolinecarboxylic acid, 3,7-dichloro-
Sethoxydim	7	Not registered in all turfgrasses. Kills weedy grasses.	2-(1-(Ethoxyimino)butyl)-5-(2-(ethylthio) propyl)-3-hydroxy-2-cyclohexen-1-one 2-Cyclohexen-1-one, 2-(1-(ethoxyimino)butyl-5-(2-(ethylthio) propyl)-3-hydroxy-
Siduron	13	Preemergence crabgrass control while seeding turf.	1-(2-Methylcyclohexyl)-3-phenylurea Urea, N-(2-methylcyclohexyl)-N'-phenyl-
Simazine	5	Warm-season turf only for post- and preemergence control of annual bluegrass and other weeds.	2-Chloro-4,6-bis(ethylamino)-s-triazine 1,3,5-Triazine-2,4-diamine, 6-chloro-N,N'-diethyl- S-Triazine, 2-chloro-4,6-bis(ethylamino)-
Sulfentrazone	29	Postemergence sedge control. Excessive rates may injure turfgrass.	Methanesulfonamide, N-(2,4-dichloro-5-(4-(difluoromethyl)-4,5-dihydro-3-methyl-5-oxo-1H-1,2,4-triazol-1-yl)phenyl)- 1-(2,4-Dichloro-5-(Nsub2-methylsulfonylamino)phenyl)-3-methyl-4-difluoromethyl-deltasupr2-1,2,4-triazolin-5-one 1-(2,4-Dichloro-5-methylsulfonylamidophenyl)-4-difluoromethyl-4,5-dihydro-3-methyl-1H-1,2,4-triazol-5-one 2-(2,4-Dichloro-5-methylsulfonylamidophenyl)-4-difluoromethyl-2,4-dihydro-5-methyl-3H-1,2,4-triazol-3-one

Table 5.5 - A list of the more common active ingredients found in consumer herbicides (cont.)

Common Name	Number of Consumer Products	Most Common Use	Synonyms Often Found on Product Labels
Triclopyr	34	Postemergence control of hard-to-kill broadleaf weeds.	Triethylamine triclopyr 3,5,6-Trichloro-2-pyridinyloxyacetic acid, TEA salt Acetic acid, ((3,5,6-trichloro-2-pyridinyl)oxy)- Triclopyr, triethylamine salt Triethylammonium triclopyr
Trifluralin	18	Preemergence control of crabgrass, annual bluegrass, and other annual grasses.	a,a,a-trifluro-2,6-dinitro-N,N-dipropyl-p-toluidine Benzenamine, 2,6-dinitro-N,N-dipropyl-4-(trifluoromethyl)-

I. Preemergence Control of Crabgrass, Goosegrass, and Other Summer Annual Grass Weeds

There are eight active ingredients that comprise 345 consumer products for preemergence control of annual grasses (Table 5.6). All of these herbicides work by creating a barrier of herbicide on the soil surface through which seedling weeds must grow when they germinate. Germinating seedlings have shallow roots and are sensitive to effects of these herbicides, while emerged plants are generally not susceptible. The following are important factors that determine effectiveness of these herbicides.

- *RATE* - Product rate is always important when using herbicides. As rate of preemergence herbicides decrease, the duration of effective weed prevention decreases. At full professional rates, most products prevent weed emergence for about two months. Only in special environmental conditions do these products exceed two months of activity. If excessive rates are applied, desirable turf may be injured or the herbicide persists for several months and may prevent turfgrass seedling establishment for renovation. Many consumer products are equivalent to one-half to three-quarters times that of the professional product rates. In a quality, dense lawn grass with minimal history of crabgrass problems, these rates are fine. In a lawn with persistent crabgrass problems, two to three applications may be needed to extend crabgrass control throughout the season. Don't exceed label rates or annual use limitations as stated on product labels.

- *TIMING* - Much debate has been waged related to timing of preemergence crabgrass herbicides. Most extension recommendations suggest applying the products just before crabgrass emergence. Crabgrass emerges when soil temperatures are above 55 F for several days or growing degree days at base 55˚ F reach a cumulative 70 to 100 units. Biological indicators of crabgrass emergence include forsythia bush and daffodil. Crabgrass emerges when approximately half of forsythia blooms have fallen and after most daffodil blooms have faded. So herbicides should be applied during full forsythia and daffodil bloom. While not as effective as spring application, fall application is also an acceptable approach to spring crabgrass control. Herbicides do still degrade in winter, but at a much slower rate than in summer. In a warmer, wet winter, over half of the herbicide will be lost between fall application and spring. In a cold dry winter, less than half of the herbicide may be lost in the same time period. Field dissipation studies show that half of applied pendimethalin degrades in about 44 days during summer temperatures. The time required to lose half of applied pendimethalin in winter (average 50˚ F) is 101 days. It is not unreasonable to expect half of applied pendimethalin to be lost over the 150 to 180 days of fall and winter if the herbicide is applied in October and crabgrass emerges in March or April. Applying herbicides in the fall may also help control of some winter weeds, but the disadvantage is that crabgrass control will not last as long into the summer when compared to spring application.

- *'WATER- IN' THE PRODUCT* - Preemergence herbicides must be incorporated onto the soil surface through irrigation or rainfall before the products can affect target weeds. A light rain or irrigation is sufficient. Crabgrass herbicides are highly susceptible to photodegredation, which means they can be destroyed by light between application and incorporation. It is important to water them within a few days of treatment.

- *UNIFORM APPLICATION* - These products work by creating a barrier, and are only as effective as the uniformity of that barrier. Sprayable products allow for more uniform application than granules, but both types can be applied uniformly by setting the applicator to half or quarter rates and covering the entire area two or four times.

Table 5.6 - Herbicides that prevent emergence of crabgrass and other annual grasses. A professional equivalency formula is provided to allow comparison of active ingredients and rates of consumer products to the rates proven to work at Virginia Tech and used by professionals.

Active Ingredient(s)	No. of Consumer Products in VA	Average Percent Active Ingredient in Consumer Products[1]	Professional Equivalency Constant (use formula)[2]	Special Notes
Benefin + Trifluralin	34	1.03 + 0.52	6.9	
Benefin + Oryzalin	1	1.0 + 1.0	6.9	Only apply to mature tall fescue or warm-season grasses. Excessive rates injure turf.
Dithiopyr	94	0.16	0.57	Controls emerged crabgrass up to the tillering growth stage.
Dithiopyr + Oxadiazon	2	0.125 + 1.0	N/A[3]	Excessive rates injure turf.
Oryzalin	4	0.92	4.6	Only apply to mature tall fescue or warm-season grasses. Excessive rates injure turf.
Oxadiazon	22	1.07	6.9	Among the most effective on goosegrass. Excessive rates injure turf.
Pendimethalin	33	1.04	4.6	
Pendimethalin + Oxadiazon	2	1.25 + 2.0	N/A	Excessive rates injure turf. Improved goosegrass control.
Prodiamine	116	0.34	3.4	
Prodiamine + Oxadiazon	1	0.2 + 1.0	5.5	Excessive rates injure turf. Improved goosegrass control.
Prodiamine + Sulfentrazone	13	0.18 + 0.1	1.7	Also controls sedges if applied as a second treatment after May 15. Excessive rates injure turf.

How to use professional equivalency constants:

(Go to https://turf.spes.vt.edu/content/dam/turf_spes_vt_edu/presentations/PEC.pdf. for more information)

What is needed:

A = the sum of all active ingredients found under the "Active Ingredients" section of the product label (if the product contains 0.2% prodiamine and 1.0% oxadiazon, enter "1.2")

B = total product weight in pounds (for example, for a 16 pound bag, enter "16")

C = the area treated by the product expressed in thousands of square feet (i.e., if the bag treats 5800 square feet, enter 5.8)

Place these parameters into the following formula: Fraction of Professional rate =

$$\frac{\left(\frac{A \times B}{C}\right)}{\text{Equivalency Constant}}$$

[1] These numbers represent the average percentage of active ingredient when combining all consumer products in Virginia that contain the same active ingredients. When selecting a product, examine the percentage active ingredient and compare to these averages. A larger number means more herbicide per unit weight but the actual amount applied to the lawn depends on the recommended rate expressed on the product label.

[2] The result of these constants when used in the formula represents the fraction of the professional rate tested at Virginia Tech and found to work. For example, a product that contains 0.77% benefin plus 0.38% trifluralin and covers 4000 square feet with a 16 pound bag will be found to be 0.67 times the professional rate using the formula. It is against the law to increase the consumer product rate above that recommended on the product label. To combat this problem, one can either apply the product more frequently (if the label allows) or buy another product to make up the difference. Just because the product exhibits a lower rate than that tested by Virginia Tech does not necessarily mean it will not work. By using the professional equivalency formula, however, one can make intelligent decisions regarding product choice. Choose the product that is closest to the professional rate (gives a value in the formula closest to 1.0).

[3] This active ingredient combination is only available in consumer products so comparison to professional products is not applicable.

II. Postemergence Control of Crabgrass, Goosegrass, and Other Summer Annual Grass Weeds

There are only four active ingredients that can selectively control emerged crabgrass and other annual grass weeds found in consumer lawn products (Table 5.7). These include fenoxaprop, fluazifop, quinclorac, and sethoxydim. Apply these products to actively growing crabgrass. Younger plants are easier to control than older plants. It is important to accurately identify the grass weed being targeted. For example, quinclorac is the most common active ingredient for postemergence crabgrass control and it does not control goosegrass or bermudagrass. The following are the most important rules to follow when targeting annual grass weeds with postemergence herbicides:

- *IDENTIFY THE LAWN GRASS* - Some herbicides are safe to use on one species of turfgrass but will severely injure or kill another species of turfgrass. These differences often occur between warm-season and cool-season turfgrasses, but are not limited to this trend. Identify all species of turfgrass in the lawn and confirm that the product used is safe on these species.

- *IDENTIFY THE GRASSY WEED* - Many grass weeds look alike and herbicides are often specific to the ones they control.

- *AVOID STRESS* - Drought, heat, frost, or any other stressful situation that reduces the growth rate of target grass weeds severely reduces the effectiveness of selective grass weed killers.

- *USE ADJUVANT* - Most consumer products are prepackaged with appropriate adjuvants, but some selective grass herbicides may need other additives, such as surfactants, to make them work. Read and follow the herbicide label.

- *MIX CAUTIOUSLY* - All selective grass herbicides, except quinclorac, have serious problems when mixed with other herbicides. Don't mix these with broadleaf herbicides, insecticides, or other products unless the mixture is known to be effective.

- *REPEAT TREATMENT* - Typically products need to be applied at two to four week intervals for complete control.

- *WATCH THE RATE* - Selective grass herbicides have a high possibility of injuring desirable turfgrass. Accurately calibrate sprayers and do not apply excess product, or the turfgrass will be injured severely.

- *AVOID "OLD" RTU PRODUCT* - Concentrate products are designed to have a shelf life of five to 10 years but "ready-to-use, RTU" products have a shorter shelf life, as they are already mixed with water. Avoid buying any RTU product that has been sitting on a shelf for over six months and expect product performance to decline over time when stored at home.

Table 5.7 - Herbicides that control emerged crabgrass and other annual grasses in the lawn. A professional equivalency formula is provided to allow comparison of active ingredients and rates of consumer products to the rates proven to work at Virginia Tech and used by professionals.

Active Ingredient(s)	No. of Consumer Products in VA	Average Percent Active Ingredient in Consumer Products[1]	Professional Equivalency Constant (use formula)[2]	Special Notes
Fenoxaprop	2	0.41	4.24	Only kills grasses. Expect some turfgrass injury. Also controls Japanese stiltgrass.
Fluazifop	12	0.48	2.81	Only kills grasses. Expect some turfgrass injury. Also controls Japanese stiltgrass.
Mesotrione	13	40	7.3	Controls many annual and perennial grassy weeds. Suppresses sedges and several broadleaf weeds.
Quinclorac + 2,4-D + Dicamba + Sulfentrazone	3	5.3 + 9.19 + 1.1 + 0.53	24.77	Controls crabgrass, sedges, and broadleaf weeds.
Quinclorac + 2,4-D + dicamba	21	2.5 + 5.6 + 0.58	24.77	Kills broadleaf weeds and crabgrass.
Sethoxydim	4	15.8	N/A[3]	Only kills grasses. Expect some turfgrass injury. Also controls Japanese stiltgrass.

How to use professional equivalency constants:

(Go to https://turf.spes.vt.edu/content/dam/turf_spes_vt_edu/presentations/PEC.pdf for more information)

What is needed:

A = the percentage of fenoxaprop, fluazifop, mesotrione, quinclorac, or sethoxydim found under the "Active Ingredients" section of the
product label; ignore other ingredients (if the product contains 0.029% dicamba, 0.313% 2,4-D, and 0.104% quinclorac, enter "0.104")

B = total product volume in fluid ounces (for a 1 quart bottle, enter "32")

C = the area treated by the product expressed in thousand square feet (for example, if the bottle treats 5800 square feet, enter 5.8; for "ready-to-use" products assume a 24 ounce bottle treats 200 square feet, and enter 0.2)

Place these parameters into the following formula: Fraction of Professional rate = $\dfrac{\left(\dfrac{A \times B}{C}\right)}{\text{Equivalency Constant}}$

[1] These numbers represent the average percentage of active ingredient when combining all consumer products in Virginia that contain the same active ingredients. When selecting a product, examine the percentage active ingredient and compare to these averages. A larger number means more herbicide per unit weight but the actual amount applied to the lawn depends on the recommended rate expressed on the product label.

[2] The result of these constants when used in the formula represents the fraction of the professional rate tested at Virginia Tech and found to work. For example, two products are chosen that each treat 5000 square feet with 32 fluid ounce bottles. One product contains 0.41% fenoxaprop and the other contains 1.79% quinclorac. Using the formula, we find that the maximum rate of the fenoxaprop product is 0.62 times the professional rate and that of the quinclorac product is 0.46 times the professional rate. It is against the law to increase the consumer product rate above that recommended on the product label. To combat this problem, one can either apply the product more frequently (if the label allows) or buy another product to make up the difference. Just because the product exhibits a lower rate than that tested by Virginia Tech does not necessarily mean it will not work. By using the professional equivalency formula, however, one can make intelligent decisions regarding product choice. Choose the product that is closest to the professional rate (gives a value in the formula closest to 1.0).

[3] This active ingredient combination is only available in consumer products for use on lawns so comparison to professional products is not applicable.

III. Preemergence Control of Annual Bluegrass and Winter Broadleaf Weeds

Annual bluegrass and other winter weeds germinate when air temperatures fall below 75 F for extended periods as autumn approaches. Controlling these weeds with preemergence herbicides is similar to controlling crabgrass with preemergence herbicides, except products are applied in late summer or early fall instead of early spring. Refer to the section on "Preemergence Control of Crabgrass, Goosegrass and Other Summer Annual Grass Weeds" for specific products. Annual bluegrass germinates around the same time desirable cool-season turfgrass is seeded for lawn renovation or establishment. Avoid applying preemergence herbicides for annual bluegrass control before any lawn seeding. Seeding must be delayed for two to four months following herbicide application. Herbicides may typically be applied after the second mowing on new turfgrass, with some exceptions. Read and follow herbicide label. Also, avoid fertilizing the lawn with phosphorus fertilizer in early fall, as it promotes survival of germinating annual bluegrass seedlings.

IV. Postemergence Control of Annual and Roughstalk Bluegrass

Few selective herbicides exist to control annual bluegrass (*Poa annua*) and roughstalk bluegrass (*Poa trivialis*) in cool-season lawns and none are available to homeowners. Annual bluegrass should be targeted with preemergence herbicides and hand weeded or spot treated with nonselective herbicides. Roughstalk bluegrass should be spot treated and hand weeded. Postemergence herbicides for annual bluegrass control are available to professionals but none exist for postemergence control of roughstalk bluegrass.

V. Postemergence Control of Broadleaf Weeds

There are over 200 consumer broadleaf herbicides available for lawn weed control in Virginia. These are represented by 16 unique combinations of active ingredients (Table 5.8). Broadleaf weeds can be controlled anytime weeds are actively growing. Annual broadleaf weeds are best controlled when weeds are young. Perennial broadleaf weeds are best treated in the fall when weeds are moving energy reserves to roots in preparation for winter dormancy. The following points are important when controlling broadleaf weeds in the lawn:

- *IDENTIFY THE LAWN GRASS* - Some herbicides are safe to use on one species of turfgrass, but will severely injure or kill another species of turfgrass. These differences often occur between warm-season and cool-season turfgrasses but are not limited to this trend. Identify all species of turfgrass in the lawn and confirm that the product used is safe on these species.

- *IDENTIFY THE WEEDS* - Some broadleaf weeds die in summer or winter and may not need treatment. Others may require special active ingredients to insure complete control.

- *ACTIVELY GROWING WEEDS* - Avoid stressful periods, like drought, heat, and cold, so that weeds are growing when treated.

- *GET THE HERBICIDE IN* - Most broadleaf herbicides enter through foliage and require good coverage with foliar sprays, or the presence of dew on foliage, to dissolve granules and allow herbicide to enter the plant.

- *REDUCE DRIFT* - Broadleaf herbicides harm desirable ornamental shrubs and flowers, so don't apply them in windy conditions. Take steps to make sure the herbicide does not drift onto nontarget sites.

- *HARD-TO-KILL* - Some perennial broadleaves, like ground ivy, wild violet, common lespedeza, wood sorrel, and Virginia buttonweed, are difficult to kill. Use products that contain triclopyr or penoxsulam and expect to treat these weeds repeatedly, regardless of the product used.

- *AVOID "OLD" RTU PRODUCT* - Concentrate products are designed to have a shelf life of five to 10 years but "ready-to-use (RTU)" products have a shorter shelf life, as they are already mixed with water. Avoid buying any RTU product that has been on store shelves for over six months, and expect product performance to decline over time when stored at home.

Table 5.8 - Herbicides that selectively control broadleaf weeds in lawn grasses. A professional equivalency formula is provided to allow comparison of active ingredients and rates of consumer products to the rates proven to work at Virginia Tech and used by professionals.

Active Ingredient(s)	No. of Consumer Products in VA	Average Percent Active Ingredient in Consumer Products[1]	Professional Equivalency Constant (use formula)[2]	Special Notes
2,4-D + MCPP	11	1.1 + 0.54	$2.8_{Granular}$ 42.2_{Liquid}	Both granular and spray products available. Must have dew on turf for granular application.
2,4-D + Dicamba + MCPP	74	5.0 + 0.65 + 1.9	$2.4_{Granular}$ 52.3_{Liquid}	Both granular and spray products available. Must have dew on turf for granular application.
2,4-D + Dicamba + MCPP + Carfentrazone	10	19.1 + 1.1 + 3.6 + 0.36	52.3	Spray products only. Provides symptoms within 48 hours.
2,4-D + Dicamba + MCPP + Sulfentrazone	9	3.0 + 0.27 + 1.0 + 0.07	$3.5_{Granular}$ 53.7_{Liquid}	Both granular and spray products available. Also controls sedges.
2,4-D + Dicamba + MCPP + Dithiopyr	4	0.64 + 0.06 + 0.14 + 0.16	2.4	Granular products only. Also provides residual control of crabgrass and annual bluegrass.
2,4-D + Dicamba + MCPP + Isoxaben	4	4.73 + 0.52 + 1.1 + 2.63	52.3	Spray products only. Also provides residual broadleaf control.
2,4-D + Dicamba + Quinclorac	17	4.76 + 0.45 + 1.64	67.2	Spray products only. Also controls crabgrass.
2,4-D + Dicamba + Quinclorac + Sulfentrazone	3	9.19 + 1.1 + 5.3 + 0.53	65.9	Spray products only. Also controls sedges.
2,4-DP + 2, 4-D + MCPP	30	0.62 + 1.44 + 0.63	$4.8_{Granular}$ 73.9_{Liquid}	Both granular and spray products available. Must have dew on turf for granular application.
Dicamba + MCPP + MCPA + Carfentrazone	3	0.02 + 0.07 + 0.34 + 0.002	92.8	Spray products only. Provides symptoms within 48 hours.
Triclopyr	23	4.05	45.3	Spray products only. Kills brush, aids in control of perennial weedy grasses.
Triclopyr + 2.4-D + Dicamba	2	0.084 + 0.74 + 0.072	N/A[3]	Spray products only. Improved control of hard-to-kill broadleaf weeds.
Triclopyr + dicamba + MCPA	3	1.56 + 1.35 + 13.72	83.2	Spray products only. Improved control of hard-to-kill broadleaf weeds.
Penoxsulam	2	0.04	N/A[3]	Granular products only. Aids in control of hard-to-kill broadleaf weeds; use in conjunction with other broadleaf herbicide for broad-spectrum control.
Penoxsulam + Dicamba	1	0.03 + 0.07	N/A[3]	Granular products only. Improved control of hard-to-kill broadleaf weeds.
Penoxsulam + 2.4-D + Dicamba	2	0.01 + 1.04 + 0.08	N/A[3]	Granular products only. Improved control of hard-to-kill broadleaf weeds.

How to use professional equivalency constants:

(Go to https://turf.spes.vt.edu/content/dam/turf_spes_vt_edu/presentations/PEC.pdf for more information)

What is needed:

A = the sum of all active ingredients found under the “Active Ingredients” section of the product label (if the product contains 1.37% 2,4-D, 0.13% dicamba and 0.31% MCPP, enter “1.81”)

B = total product weight in pounds for granules or volume in fluid ounces for liquids (for a 16 pound bag, enter “16” and for a 32 ounce bottle, enter “32”)

C = the area treated by the product expressed in thousand square feet (i.e., if the bag treats 5800 square feet, enter 5.8)

Place these parameters into the following formula: Fraction of Professional rate = $\dfrac{\left(\dfrac{A \times B}{C}\right)}{\text{Equivalency Constant}}$

[1] These numbers represent the average percentage of active ingredient when combining all consumer products in Virginia that contain the same active ingredients. When selecting a product, examine the percentage active ingredient and compare to these averages. A larger number means more herbicide per unit weight but the actual amount applied to the lawn depends on the recommended rate expressed on the product label.

[2] The result of these constants when used in the formula represents the fraction of the professional rate tested at Virginia Tech and found to work. For example, a concentrate product that contains 7.59% 2,4-D plus 0.84% dicamba plus 1.83% MCPP and covers 8000 square feet with a 32 fluid ounce bottle will be found to be 0.78 times the professional rate using the formula. It is against the law to increase the consumer product rate above that recommended on the product label. To combat this problem, one can either apply the product more frequently (if the label allows) or buy another product to make up the difference. Just because the product exhibits a lower rate than that tested by Virginia Tech does not necessarily mean it will not work. By using the professional equivalency formula, however, one can make intelligent decisions regarding product choice. Choose the product that is closest to the professional rate (gives a value in the formula closest to 1.0).

[3] This active ingredient combination is only available in consumer products so comparison to professional products is not applicable.

Table 5.9 Broadleaf Weed Control in Bluegrass, Tall Fescue, Perennial Ryegrass, and Common Bermudagrass

Weed	Classification	Response to Herbicides: 2,4-D + dicamba	2,4-D + MCPP	2,4-D + Dicamba+ MCPP	2,4-D + Dicamba+ Triclopyr	2,4-D + Dicamba + Penoxsulam	Preferred Time to Treat
Bedstraw	[1]A	[2]S	I	R-I	S	I-S	Spring
Bindweed - Field	P	S	I-S	S	S	S	Spring
Hedge	P	S	I-S	S	S	S	Spring
Bittercress	WA	S	S	S	S	S	Fall
Black Medic	SA & P	S	I	S	S	S	Spring & Fall
Buttercup	WA & P	S	S	S	S	S	Spring & Fall
Buttonweed - Virginia	P	R-I	R	R-I	I-S	I-S	Spring Sequentially
Carpetweed	SA	S	S	S	S	S	Spring
Carrot - Wild	B	S	S	S	S	S	Fall
Catsear Dandelion	P	S	S	S	S	S	Fall
Chickweed - Common	WA	S	S	S	S	S	Spring & Fall
Mouseear	WA & P	S	I-S	S	S	S	Spring & Fall
Chicory	P	S	S	S	S	S	Fall
Cinquefoil - Common	A	S	S	S	S	S	Spring
Clover - Crimson	SA	S	S	S	S	S	Spring
Hop	SA	S	S	S	S	S	Spring
White	P	S	S	S	S	S	Spring & Fall
Daisy - Oxeye	P	I	I	I	I-S	S	Spring & Fall
Dandelion	P	S	S	S	S	S	Spring & Fall
Dichondra	P	I-S	I-S	I-S	I-S	I-S	Spring & Fall
Dock	P	I-S	I	I-S	I-S	I-S	Spring
Dogfennel	P	I	R-I	I	I-S	I-S	Spring & Fall
Garlic - Wild	P	I	I	I	I	I	Fall
Geranium - Carolina	WA	S	S	S	S	S	Spring & Fall
Ground ivy	P	I	I	I	I-S	I-S	Spring
Hawkweed	P	I	I	I	I-S	I-S	Fall
Healall	P	S	I-S	S	S	S	Fall
Henbit	WA	I-S	I	S	S	S	Fall
Honeysuckle	P	S	I-S	S	S	S	Spring & Summer
Horsenettle	P	I	R-I	I	I	I	Spring
Horseweed	WA & SA	I-S	I-S	I-S	S	I-S	Spring & Fall
Knapweed	B	I	I	I	I-S	I-S	Fall
Knawel	WA	I	I	I	I-S	I-S	Fall
Knotweed	SA	I	I	I	I-S	I-S	Spring & Summer
Lambsquarters	SA	S	S	S	S	S	Spring & Summer
Lespedeza	SA	I	I	I	I-S	I	Spring

Table 5.9 Broadleaf Weed Control in Bluegrass, Tall Fescue, Perennial Ryegrass, and Common Bermudagrass (cont.)

Weed	Classification	Response to Herbicides: 2,4-D + dicamba	2,4-D + MCPP	2,4-D + Dicamba+ MCPP	2,4-D + Dicamba+ Triclopyr	2,4-D + Dicamba + Penoxsulam	Preferred Time to Treat
Mallow	SA	I-S	I	I-S	I-S	I-S	Spring & Summer
Mugwort	P	R-I	R-I	R-I	I	I	Spring
Mustards	WA & B	I-S	I	S	S	S	Fall
Onion - Wild	P	I	I	I	I	I	Fall
Pennycress	A	S	S	S	S	S	Fall
Pepperweed	WA	S	S	S	S	S	Fall
Pigweed	SA	S	S	S	S	S	Spring & Summer
Plantains	P	S	S	S	S	S	Spring & Fall
Poison ivy	P	I-S	I	I-S	I-S	I-S	Summer & Fall
Poorjoe	A	I	I	I	I-S	I-S	Spring & Summer
Spurge - Prostrate	SA	R-I	R-I	R-I	R-I	I-S	Summer
Spotted	SA	R-I	R-I	R-I	R-I	I-S	Summer
Purslane	SA	S	I-S	S	S	S	Spring & Summer
Red Sorrel	P	I	I	I	I-S	I-S	Fall
Shepherd's Purse	WA	S	S	S	S	S	Fall
Smartweed	SA	I-S	I	I-S	I-S	I-S	Spring & Summer
Sowthistle	WA	S	S	S	S	S	Fall
Speedwell - Corn	WA	R	R	R	I	--	Spring
Persian	WA	R	R	R	I	--	Spring
Star-of-Bethlehem	P	R	R	R	R	--	Spring
Strawberry - Wild	P	I	R-I	I	I	I	Fall
Teasel - Common	B	I-S	I-S	I-S	S	I-S	Spring
Cutleaf	B	I-S	I-S	I-S	S	I-S	Spring
Thistle - Bull	B	I-S	I-S	I-S	I-S	R-I	Fall
Canada	P	I	R-I	I	I	R-I	Fall
Musk	B	S	S	S	S	S	Spring
Plumless	B &P	S	S	S	S	I-S	Spring
Violet	P	R-I	R	R-I	I-S	I-S	Spring Sequentially
Wood sorrel - Creeping	WA & P	R-I	R-I	R-I	I-S	--	Spring
Yellow	A	I	I	I	I-S	--	Spring
Yarrow	P	I	I	I	S	--	Fall
Yellow Rocket	B & P	S	I-S	S	S	I-S	Fall

[1]A = annual (summer or winter); B = biennial; P = perennial; SA = summer annual; WA = winter annual.
[2]R = resistant in most instances, poor control usually less than 50%; I = intermediate tolerance, good control at times with high rates, may require multiple treatments; S = weed susceptibility, often good control 70% or higher.

VI. Postemergence Control of Perennial Grass Weeds

The most common perennial grass weeds in Virginia are bermudagrass (wiregrass), dallisgrass, nimblewill, orchardgrass, and quackgrass. In most cases, the only control is to hand weed the grass or spot treat with a nonselective herbicide that contains glyphosate. In recent years, research studies have led to selective control measures for bermudagrass in cool-season lawns. Consumer products that contain fenoxaprop, fluazifop, mesotrione, and topramezone can be used as recommended to control bermudagrass. More effective control can be achieved by mixing triclopyr (Turflon Ester contains 61.6% triclopyr and is mixed to apply 0.73 fluid ounce per gallon to treat 1000 square feet). Triclopyr should not be applied during summer on Kentucky bluegrass or hard fescue. Selective bermudagrass control requires four to eight treatments per year depending on rate. Start treating when targeted bermudagrass starts to produce shoots and leaves in late spring and treat at three to four week intervals until frost. If the product label does not allow this many treatments, supplement with another product and apply in sequence or hand weed bermudagrass during mid-summer and limit treatments to spring and fall. Lawn grasses will be temporarily injured when targeting bermudagrass with these herbicides. Delay treatment if lawn grass has not completely recovered prior to the next normally-scheduled treatment. If turfgrass injury is a concern, treat only in spring and fall and discontinue treatments during mid-summer. Do not exceed maximum use rates or number of applications specified on product labels.

VII. Postemergence Control of Sedges

Yellow nutsedge is the most common sedge problem in Virginia. Sedges emerge in early summer and are present from June until frost. Most sedges are perennials and enter dormancy during winter. Sedges are not controlled by selective grass killers or preemergence herbicides that are used to prevent crabgrass. Sedges thrive in wet or hot summers and often require more than one herbicide treatment for season-long control. Yellow nutsedge produces small nutlets underground that sprout at some time in the future. It is important to hand pull small populations of sedge plants to reduce production of these nutlets. Hand pulling does not remove nutlets that are already produced, but helps reduce population expansion by preventing mature plants from making more nutlets. Herbicides kill some, but not all, nutlets attached to parent plants. Sedge problems won't be solved in one or two seasons, and require constant vigilance.

Table 5.10 - Herbicides that selectively control sedges in lawn grasses. A professional equivalency formula is provided to allow comparison of active ingredients and rates of consumer products to the rates proven to work at Virginia Tech and used by professionals.

Active Ingredient(s)	No. of Consumer Products in VA	Average Percent Active Ingredient in Consumer Products[1]	Professional Equivalency Constant (use formula)[2]	Special Notes
Bentazon	5	44	N/A[3]	Requires good coverage and repeat treatment after two weeks.
Halosulfuron	1	75	N/A[3]	Avoid stress, add surfactant, repeat treatment after four weeks if needed.
Sulfentrazone + 2,4-D + Dicamba + MCPP	9	0.07 + 3.0 + 0.27 + 1.0	3.5_{Granular} 53.7_{Liquid}	Both granular and spray products available. Also controls broadleaf weeds.
Sulfentrazone + Prodiamine	13	0.18 + 0.1	1.7	Also provides residual control of crabgrass, goosegrass, and other annual grasses.
Sulfentrazone + 2,4-D + Dicamba + Quinclorac	3	0.53 + 9.19 + 1.1 + 5.3	65.9	Also controls broadleaves and crabgrass.

How to use professional equivalency constants:

(Go to https://turf.spes.vt.edu/content/dam/turf_spes_vt_edu/presentations/PEC.pdf for more information)

What is needed:

A = the sum of all active ingredients found under the “Active Ingredients” section of the product label (if the product contains 0.1% sulfentrazone and 0.2% prodiamine, enter “0.3”)

B = total product weight in pounds for granules or volume in fluid ounces for liquids (for a 16 pound bag, enter “16” and for a 32 ounce bottle, enter “32”)

C = the area treated by the product expressed in thousand square feet (for example if the bag or bottle treats 5800 square feet, enter 5.8)

Place these parameters into the following formula: Fraction of Professional rate = $\dfrac{\left(\dfrac{A \times B}{C}\right)}{\text{Equivalency Constant}}$

[1] These numbers represent the average percentage of active ingredient when combining all consumer products in Virginia that contain the same active ingredients. When selecting a product, examine the percentage active ingredient and compare to these averages. A larger number means more herbicide per unit weight but the actual amount applied to the lawn depends on the recommended rate expressed on the product label.

[2] The result of these constants when used in the formula represents the fraction of the professional rate tested at Virginia Tech and found to work. For example, a concentrate product that contains 3.74% 2,4-D plus 0.43% dicamba plus 1.79% quinclorac plus 0.22% sulfentrazone and covers 5000 square feet with a 32 fluid ounce bottle will be found to be 0.60 times the professional rate using the formula. It is against the law to increase the consumer product rate above that recommended on the product label. To combat this problem, one can either apply the product more frequently (if the label allows) or buy another product to make up the difference. Just because the product exhibits a lower rate than that tested by Virginia Tech does not necessarily mean it will not work. By using the professional equivalency formula, however, one can make intelligent decisions regarding product choice. Choose the product that is closest to the professional rate (gives a value in the formula closest to 1.0).

[3] Both bentazon and halosulfuron are available to consumers at agricultural cooperatives, distributors of professional turfgrass products, and high-end nurseries in small containers. The formulations and labels of these are the same as used by professionals so a professional equivalency constant is not needed.

VIII. Weed Control at Seeding

Seedling emergence is the most delicate stage of the turfgrass life cycle. Only a few herbicides can be applied to young turfgrass or be used for residual weed control while turfgrass is germinating.

When planning to seed new turfgrass:

- *KILL THE OLD* - Use a nonselective herbicide, such as glyphosate, to kill existing vegetation where a complete lawn renovation is desired. Apply glyphosate at least a week in advance of seeding, but longer is better. If bermudagrass or other hard-to-kill perennials are present allow four weeks or more for repeat treatment of escaped plants.

- *SOIL TEST* - If renovating the lawn, take the opportunity to conduct a soil test and add the appropriate soil amendments before seeding the new lawn grass.

- SEED-TO-SOIL CONTACT - Do seeding preparations, such as vertical mowing, raking, or tilling, before applying siduron for crabgrass prevention during seedling establishment.

- *KNOW HERBICIDE HISTORY* - Most herbicides require a 30 day wait before turfgrass seeding is allowed. Turfgrass seeding may be restricted for 60 to 120 days following treatment with preemergence crabgrass preventers. Check herbicide labels for seeding restrictions when planning to seed.

- *SEED IN FALL* - Seeding in fall avoids summer annual weeds, like crabgrass, from choking out desirable turfgrass seedlings. If seeding in spring, seed as early as possible and use one of the 13 products marketed in Virginia that contain siduron.

- *CONTROL WEEDY GRASSES IN SPRING* - Siduron and mesotrione are preemergence herbicides that controls crabgrass and many other summer annual grasses without harming germinating cool-season turfgrasses. Siduron and mesotrione kill warm-season turfgrass seedlings. Siduron does not control annual bluegrass and is typically not needed when fall seeding. Apply siduron or mesotrione the same day as seeding. Many products include siduron or mesotrione can be combined with starter fertilizer for convenience. Look for product names like "Seed Starter" or "Starter Fertilizer with Tupersan , or Turf Builder Starter Food for New Grass + Weed Prevente," and check that the product contains contains siduron or mesotrione in the active ingredients section.

- *CONTROL BROADLEAF WEEDS* - Carfentrazone is an active ingredient often added to broadleaf herbicides to provide rapid symptoms on weeds. Unfortunately, most broadleaf herbicides can't be applied to young turfgrass seedlings, but carfentrazone can be applied to seedling turf. Quicksilver is a professional product that only contains carfentrazone and is sold in small, affordable packages. Quicksilver controls seedling broadleaf weeds (under three inches tall) and will not harm emerging turfgrass. If Quicksilver can not be found, wait until the second mowing of newly-established turfgrass and then use one of many broadleaf herbicides registered for use in the lawn. Check the label for specific restrictions on when to apply after seeding.

Index

Symbols

2,4-D 5-14, 5-22, 5-24, 5-25, 5-28, 5-29
2,4-DP 5-15

A

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Ammoniated soap of fatty acid 5-12
Ants 5-5
Armyworms 5-3
Atrazine... 5-15

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Bacillus thuringiensis galleriae 5-7
Beauveria bassiana 5-5, 5-7
Bedstraw 5-26
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This chapter was not reviewed in 2022.

Insects in Recreation Areas

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Red Imported Fire Ants

Quarantine Information: Red Imported Fire Ant (RIFA) colonies can be found throughout the south eastern United States from Texas through Florida. RIFA has more recently expanded it's range to the west, so that scattered colonies can now be found in New Mexico, Arizona, and California. More long-term established populations have also spread to the north, into the states of Oklahoma, North Carolina and Virginia. In 2009, several counties in Virginia were placed under the Federal Fire Ant Quarantine. These counties included James City, and York, and the independent cities of Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach and Williamsburg. In 2019, survey data indicated that the RIFA populations had spread further in the state of Virginia so the quarantine locations were expanded to include the Counties of Brunswick, Greenville, Isle of Wight, Mecklenburg, Southhampton, and the cities of Emporia and Franklin. What this quarantine means is that the Virginia Department of Agriculture and Consumer Services (VDACS) will no longer be responsible for treating fire ant mounds found in these cities and counties. Fire ant control will now be the responsibility of those citizens living in the quarantine locations. A current map of all RIFA quarantine locations in Virginia may be viewed at https://www.vdacs.virginia.gov/pdf/fire-ant-quar-map.pdf. However, it is important to note that not all RIFA populations occur in the quarantine area. RIFA colonies have also been documented in the city of Richmond and as far west as Montgomery County.

Note that RIFA infestations occurring outside of the quarantined areas in Virginia should still be reported to the VDACS Office of Plant & Pest Services at (804) 786-3515, or visit the VDACS website at http://www.vdacs.state.va.us/. Individuals and commercial pest control operators residing outside of the quarantined area should not attempt to treat fire ant infestations.

Warnings: RIFA are a common nuisance around dumpsters, trash cans, kitchen gardens, and areas where pets are fed and watered. Fire ants can also be a threat to small, young or confined pets. Puppies and kittens playing outdoors should be supervised in locations where fire ants are present. Likewise, dogs tied in the yard must have enough lead to allow them to move 10 or more yards in any direction to escape a fire ant attack. Dogs confined in runs should never be tied up.

Habitat

Fire ants prefer to construct mounds in areas that are open and exposed to the sun. They are often found in cultivated fields or pastures. They are rarely found in wooded locations with heavy tree canopy. In urban areas, they will nest in cemeteries, parks, playing fields, and yards. Disturbing the mound may cause workers to remove the queen(s) and even the entire colony to another location. Colonies have also been found inside cars, tractors, and recreational vehicles. RIFA are attracted to electrical currents and will nest in and around heat pumps, junction boxes, traffic lights, and similar devices. Nesting RIFA have been known to cause electrical fires because they often chew on electrical wiring.

RIFA mounds in the yard are unsightly and will spread within a few months if there is no effort to eliminate them. However, the mounds must be treated properly or else the mound disturbance may cause the colony to split, resulting in two or three mounds. If you believe you have discovered a RIFA nest and live in the quarantine area, we recommend that you contact a pest control company immediately. Failure to eradicate an entire nest will result in the local establishment and spread of RIFA in a very short period of time.

Chemical Control

The following section describing RIFA control techniques is to be used for fire ant control in the quarantine areas of Virginia. Individual mound treatments and baiting can both be employed to mitigate infestations in small areas (e.g., the area surrounding a single building or an urban playground). Whatever product you might choose to apply, please read and follow the label directions exactly. Improper pesticide applications have been responsible for a significant percentage of fire ant spread within the U.S.

Mound Treatments

When treating individual fire ant mounds, it is extremely important that the mound remain undisturbed prior to treatment. Drenches, dusts or granules must come in direct contact with the ants to be effective. Disturbing the mound may cause the workers to move the replace with queen(s) or even the entire colony to another location.

Individual mound treatments may take the form of a drench, where the mound is flooded with a large volume of liquid insecticide labeled for this purpose. This is the fastest acting method of fire ant management. Unfortunately, the queen may be located too deep in the soil to be killed by the insecticide, in which case control will only be temporary. Injection devices to aid in the deep penetration of liquid insecticide are readily available for professional pest control personnel, but these devices are not designed for homeowner use.

Baiting

Fire ant baiting has been used to treat individual mounds, and even entire fields where the bait is broadcast across the landscape to address multiple fire ant colonies within the same area. For baiting individual mounds it is important to lightly apply the bait around the mound to avoid disturbing the colony. In this way foragers leaving the mound will immediately encounter the bait and transport it back into the mound for consumption by the queen(s) and other members of the colony. Broadcast baits are usually granular formulations that are put into a spreader and applied over a large infested area. Thus, foraging ants from multiple colonies can pick up the bait granules and bring them back into the nest.

For more detailed information see the Red Imported Fire Ant (RIFA) publication: http://pubs.ext.vt.edu/444/444-284/444-284.pdf

Table 6.1 - Recommended Insecticide and Control Use

Pests	Pesticide		Application and Remarks
Outdoor Ants	For colony control, ant species must be identified before a proper bait can be selected. Ants are finicky eaters and may prefer either a sweet or protein-based bait. Once the ant is identified, put out an appropriately labeled bait where foraging ants are seen.		Recent studies have indicated that non-repellent perimeter spray applications, combined with granular bait application around structure but several feet away from the spray application, have been very successful for preventing pest ant entry into structures.
Chiggers	bifenthrin Lambda-cyhalothrin	Bifen I/T (7.9 %) Demand EZ 2.43%	Most effective when directed into "hot spots" where chiggers and their animal hosts are known to be abundant. A single application in early spring is often all that is required, although in severe infestations, treatment may need to be repeated in June. The ground and vegetation up to a height of about three feet should be thoroughly wetted with the insecticide and applied according to label instructions. Children and pets should be kept off treated areas until the vegetation is completely dry.
	carbaryl	Sevin (22.5% Concentrate) Sevin (5% Dust)	Treat grassy areas, especially those not regularly mowed. Spray sites where pest is present. Mow areas around house. Spray every 4 to 8 weeks, as needed. Repellents will prevent attack; apply to socks and/or pants, cuffs, and sleeves.
	cypermethrin[1]	Demon EC (0.1%)	Usually best as emulsion. Need thorough and uniform distribution. Apply to outside surfaces and cracks and crevices where chiggers may hide. Also apply along fence lines and around sheds, barns, carports, and other outdoor structures. Avoid spraying plants with cypermethrin. Indoor control using sprays or fogs is generally not the recommended method for treatment. Building exclusion is very important. Ensure that screening on windows and doors does not have rips or holes.
Blood-feeding Flies (Deer Flies, Black Flies)	resmethrin	Ortho Outdoor Insect Fogger (0.25%)	**Outdoors:** Good sanitation and tight screens are sound preventive control measures. Use of the fly swatter is still practical. Do not contaminate food or utensils with insecticides. Repellents containing DEET, picaridin, oil of lemon eucalyptus or IR3535 can be applied to the skin and permethrin-based repellents can be used to treat clothing. Light colored clothing and protective mesh outdoor wear may be of some value in reducing annoyance from biting flies. In extreme cases, hats with mesh face and neck veils and neckerchiefs may add some protection.
	tralomethrin 0.03%	Real Kill Home Insect Control (0.03%)	
	bifenthrin 0.05%	Ortho Home Defense MAX (0.05%, 0.0125% Zeta-cypermethrin)	
Mosquito Adults	**Repellents for personal protection** d phenothrin	 Summit Outdoor Mosquito Repellent Coils (0.2%)	Repellents containing DEET, picaridin, oil of lemon eucalyptus or IR3535 can be applied to exposed skin and permethrin-based repellents can be use to treat clothing.
	Yard Sprays cyfluthrin Lambda-cyhlothrin bifenthrin	 Bayer Advanced PowerForce Multi-Insect Killer (0.75%) Demand EZ (2.43%) Bifen I/T (7.9 %)	Mosquitoes prefer to rest in protected sites during the day so removal of tall weeds and overgrowth is part of an integrated mosquito management program. To further reduce biting mosquitoes, insecticides can be applied to the lower limbs of shade trees, shrubs, and other shaded areas, such as under decks and along foundations. A hose-end sprayer is usually most effective and convenient for such applications.

[1]Professional Use: These products are not restricted use but are designated as professional use because they are more potent and require specialized training, application equipment, or personal protective equipment that make them unsuitable for homeowner applications.

Table 6.1 - Recommended Insecticide and Control Use (cont.)

Pests	Pesticide		Application and Remarks
Mosquito Adults (cont.)	**Aerosol Sprays**		
	permethrin	Hot Shot Flying Insect Killer (0.15%, d-trans allethrin 0.25%)	
Mosquito Larvae	temephos	Abate EC (43%) Abate 1 SG Granules	**Apply larvicides based on inspection of breeding sites and not on a routine basis.** Open bodies of water, such as large ponds and streams, are not mosquito-breeding areas and should not be treated. Polluted water usually requires a higher rate of pesticide than required for clean water. Temephos is harmful to fish; keep out of lakes, ponds, and streams. Use methoprene in small bodies of water not known to be fish habitats. Small backyard ponds should be checked for mosquito larvae. **Remove outdoor breeding sites:** water-holding containers such as old tires, cans, and buckets. Change water in bird baths and pet dishes frequently. Make sure gutters are not clogged.
	methoprene	Aquaprene Tossits (1.8%) Altosid XR Briquets (2.1%) Altosid SR 20 Liquid Concentrate (20%) Altosid XR-G Granules (1.6%)	
	Biologicals: *Bacillus thuringiensis* (Bt), methoprene Gambusia fish		
Red Imported Fire Ants	If you live outside of these locations (Brunswick, Greensville, Isle of Wight, James City, Mecklenburg, Southampton and York counties or the cities of Chesapeake Emporia, Franklin, Hampton, Newport News, Norfolk, Poquoson Portsmouth, Suffolk, Virginia Beach and Williamsburg) do not attempt to treat fire ants yourself but call the Department of Agriculture Office of Plant and Pest Services immediately (804/786-3515 in Richmond or 757/562-6637 in Franklin). If you live within those counties and cities listed above, you are in the fire ant quarantine area and may treat the fire ants yourself.		Baits must be kept cool and dry. Do not store baits next to repellent or smelly insecticides or cleaning agents. Apply baits carefully according to the label directions. Be sure to apply the bait around the mound rather than on top of it. Fire ants forage out from the sides of their mound and will collect the bait near their foraging tunnels. Placing bait on top of the mound will incite the ants' defense response. The ants will attack aggressively but will not pick up the bait. Do not attempt using home remedies (applications of boiling water, diesel fuel, grits, gasoline, etc.) to kill a fire ant mound. Most home remedies will only disrupt the fire ant colony, causing it to split. This results in two additional mounds springing up right next to the treated mound a month or two after treatment. If home remedies were effective, we would not have fire ants infesting the entire southeastern United States. The Ortho product is applied as drench treatment to individual mounds. Read the product label for directions. For at least two decades USDA researchers have made heroic efforts to identify biological control agents that might slow or eliminate the spread of Red Imported Fire Ants in the US. There are currently three biological control agents under field investigation: a parasitic fungus, *Kneallhazia solenopsae*; a virus, *Solenopsis invicta virus-3* (SINV-3); and two species of fire ant decapitating phorid flies. While the phorid flies have been used as biological control agents for a number of years, the fungus and RIFA specific virus are relatively new. These agents are intended to be used in combination but their efficacy in the field is still under investigation.
	fipronil	MaxForce FC Fire Ant Bait (0.00045%)[1]	
	indoxacarb	Advion Fire Ant Bait[1] (0.045%)	
	hydramethylnon	Amdro Fire Ant Bait Granules (0.73%) Amdro Kills Fire Ants Yard Treatment Bait (0.036%, methoprene 0.0172%) Extinguish Plus Fire Ant Bait 0.36% methoprene 0.25%	
	pyriproxyfen	Esteem Fire Ant Bait (0.5%)	
	acephate	Ortho Orthene Fire Ant Killer (50%)	
	Zeta-cypermethrin	Amdro® QuickKill Fire Ant Mound Drench (0.35%)	
Spiders	**Indoors:** Insecticidal dusts **Outdoors:** Pesticide sprays have been proven to have very limited efficacy. Use a vacuum or broom to eliminate webs and remove spiders.		**Indoors:** Spiders, egg sacs, and webs can be removed with a vacuum. Dispose of vacuum bag immediately. **Outdoors:** Turn off outdoor lights that attract spider food (insects). Practically all spiders in Virginia are harmless. The only exceptions are the black widow and brown recluse spiders (a non-native species that can be imported into the state of Virginia), which are poisonous. However, these spiders hide and are not often affected by sprays.

[1]Professional Use: These products are not restricted use but are designated as professional use because they are more potent and require specialized training, application equipment, or personal protective equipment that make them unsuitable for homeowner applications.

Table 6.1 - Recommended Insecticide and Control Use (cont.)

Pests	Pesticide		Application and Remarks
Ticks (outdoor areas)	esfenvalerate	Conquer (3.48%) Eliminator Ant, Flea & Tick Killer II Concentrate (0.425%)	Sprays can be applied to grassy and bushy areas near the house or kennels, the edges of lawns and gardens, and under porches. **Outdoors (area control of ticks):** Do not spray plants with cypermethrin. Mow areas around the house, to reduce tick habitat. Ticks require high humidity to survive and thus are most often found in grassy, brushy, wooded, and shaded areas. Reducing the humidity in these areas by keeping grass well clipped, removing brush, and pruning trees to allow more sunlight to penetrate to the soil surface will discourage ticks from becoming established in these areas. Insecticide sprays can be applied but modifying the habitat is a more long-term approach to tick management.
	permethrin	Martin's Permethrin SFR (36.8%) Bonide® Ant, Flea & Tick Killer Granules (0.25%)	
	bifenthrin	Bifen I/T (7.9 %) Eliminator Ant, Flea & Tick Killer Plus Granules (0.1%)	
	cypermethrin[1]	Demon® Max (25.3%)	
	carbaryl	Sevin® Concentrate Bug Killer (22.5%)	
Yellow jackets (ground nests)	prallethrin	PT Wasp-Freeze II (0.1%)	**Above-ground nests:** Aerosols can be used for a quick knockdown of the nest. You can spray as far away as 15-20 feet. These quick-kill wasp aerosols have oily bases, so care should be taken to not stain surfaces. **Outdoors/Indoors:** Locate nest entrance during daylight hours. Apply pesticide at night when most insects will be in the nest. Wear protective clothing. Remove above-ground nests when activity ceases. **Below-ground nests:** Treat the nest first with aerosols. When aerosol is dry, apply an insecticidal dust in the opening. The dust will prevent future yellow-jacket emergence. Check the nest the following day to see if the insects are dead (can be verified by lack of activity). Repeat if necessary. **Outdoors/Indoors:** Apply insecticide to the nest entrance at night. Do not cover the nest with soil. Wear protective clothing (and a bee veil) at all times during treatment. **Baits and Lures:** Baited traps can be used when pesticide application is undesirable. Traps should be checked and cleaned daily. Lure traps can be used to reduce the number of localized foraging workers. The most common lure in traps, heptyl butyrate, attracts primarily the western yellow jacket and not other species. Meat such as chicken can be added as an attractant and will improve catches of the German yellow jacket and *Vespula vulgaris*. The meat must be replaced frequently because yellow jackets aren't attracted to rotting meat. Lures need to be replaced periodically; follow trap directions regarding replacement. To reduce the number of yellow jackets foraging in specific areas such as patios, picnic tables, concession stands, and dumpsters, place the traps around the periphery. In large areas such as parks, place traps about 200 feet from the area to be protected and about every 150 feet along the circumference. In backyards, place them along the edge of the property line as far away from patios or other protected areas as possible.
	tetratmethrin	Wasp-X Wasp & Hornet Spray (0.5%. Etofenprox 0.5%, piperonyl butoxide 1%) Bonide Wasp & Hornet Killer (0.1%, permethrin 0.25%, piperonyl butoxide 0.5%)	
	geraniol	EcoEXEMPT Jet (2.0%, 2-phenethyl propionate 3.0%)	
	cyfluthrin	Tempo® Dust (1.0%)	
	pyrethrins (wasps only)	PT 565 Plus XLO® (0.5%, piperonyl butoxide 1.0%, n-Octyl bicycloheptene dicarboximide 1.0%) CB 80 Extra (0.5%, piperonyl butoxide 4.0%)	

[1]Professional Use: These products are not restricted use but are designated as professional use because they are more potent and require specialized training, application equipment, or personal protective equipment that make them unsuitable for homeowner applications.

This chapter was not reviewed in 2022.

Wood-Destroying Insects

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Control of wood-infesting insects is best accomplished by a professional pest control operator. The information below is intended to provide a homeowner with some understanding of the control methods and materials, but not all the steps are included. Read product labels. Most termite control chemicals are only available to professionals. For information on identifying termite infestations see the publication: Signs of Subterranean Termite Infestation (http://pubs.ext.vt.edu/444/444-501/444-501.pdf). For information on choosing a termite control option see the publication: Subterranean Termite Treatment Options (http://pubs.ext.vt.edu/444/444-500/444-500.pdf). Information on selecting a pest control company can be found in Section 1 of this guide.

Table 6.2 - Recommended Insecticide Use

Pests	Pesticide		Application	Nonchemical Control and Remarks
Termites (subterranean)	**Soil Treatment:**		Soil adjacent to the house foundation must be saturated with termiticide. A “V”-shaped trench is dug against the foundation at least 1 foot deep to get total insecticidal penetration to the footing. Concrete floors, patio, walks, etc., are drilled at 12-inch intervals and the chemical injected under pressure. Caution must be taken not to damage heat pipes, vapor barriers, etc., located under the slab. Note that for most liquid termiticide formulations the label application rate (applied in the trenches) is 4 gallons per 10 liner feet, per foot of depth to the footer (or to a minimum of 4 feet if the footer is below 4 feet). This means that 4 gal of solution/10 linear ft per foot of depth to the footer is applied on each side of the foundation walls and around all piers in a basement or crawlspace. However, Termidor HE (High Efficiency) is a new product that only requires an application rate of 2 gallon per 10 linear feet, per foot of depth to the footer (or to a minimum of two feet). For preconstruction treatment of soil that is to be covered by a concrete slab, the termiticide application volume for all products is still 1 gallon per 10 square feet of soil surface.	Subterranean termites feed on materials containing cellulose and have strict moisture requirements. Prevent infestations by eliminating food and moisture resources surrounding the structure. • Repair structural and plumbing leaks. • Pull all mulch and landscaping back at least 6 inches from the foundation. • Remove piles of trash and debris from around the home. • Remove dead tree stumps from the yard. • Keep firewood stacked away from the structure. • Make sure downspouts are long enough to direct water away from the foundation. • Keep gutters clean. • Avoid direct wood-to-ground contact when building porches or decks. • Siding, brick veneer, or foam insulation should not extend below the soil grade. Termite control is a job for professional pest control operators. Homeowners do not have the training, experience, or equipment.
	fipronil	Termidor SC (9.1%)[1] Termidor HE (8.73%)[1]		
	imidacloprid	Premise 75 (75%)[1]		
	indoxacarb	Arilon (20%)[1]		
	cypermethrin	Demon Max (25.3%)[1]		
	Permethrin	Prelude (25.6%)[1]		

[1] Professional Use: These products are not restricted use but are designated as professional use because they are more potent and require specialized training, application equipment, or personal protective equipment to be effective. Thus they are not appropriate for homeowner use.
[2] Used with Sentricon Termite Baiting System
[3] Used with Hex-Pro Termite Baiting System

Table 6.2 - Recommended Insecticide Use (cont.)

Pests	Pesticide		Application	Nonchemical Control and Remarks
Termites (subterranean) (cont.)	**Baits:**		Subterranean termite baits are contained inside of plastic stations that are inserted into the soil around the perimeter of a structure. The bait is formulated in a cellulose matrix so that it is attractive to the foraging termites and they carry it back to the nest and feed the rest of the colony. Termite baits may take several months to work because the termites have to encounter them while foraging through the soil. They is no way of directing their foraging behavior. Termite baits tend to work best in shallow, sandy soil where the termites foraging tunnels do not run below the bait stations (~10 "). Termite bait formulations contain active ingredients known as chitin synthesis inhibitors (CSI). These insecticides disrupt the insect's ability to molt properly so that they die in the process of shedding their skins during their growth period. The ultimate result is colony eradication.	Bait station are typically placed around the perimeter of a structure at 10-foot intervals. The intervals may be less in locations where termite activity is known or suspected. Termite stations should be checked on a regular basis (quarterly during the warmer seasons) to determine if a station has been "hit" and additional stations or more bait is needed.
	diflubenzuron	Advance (0.25%)		
	novaluron	Trelona ABTS (0.50%)		
	hexaflumuron	Shatter (0.5%)		
	noviflumuron	Recruit IV (0.5%) Recruit HD (0.5%) Recruit IV AG (0.5%)		
Powderpost beetles (and old house borers)	disodium octaborate tetrahydrate	BoraCare (40%) Tim-bor (98%) Jecta (40%)	If the infestation is confined to a small area, removal and replacement of the infested wood is recommended. It the infestation is widespread, a professional pest control operator can apply a surface treatment or injection treatment. With surface treatment, liquid insecticide is applied to unfinished wood or emergence holes where wood dust is seen. Surface application will kill adult beetles and the insecticide formulation will continue to penetrate the wood to kill larvae. Injection treatment consists of drilling the wood and injecting the product into the drilled holes. The injection treatment will kill beetle larvae in the wood and will deter re-infestation for several years.	Controlling powderpost beetle and old house borer infestations is a job for a professional pest control operator. Painting wood surfaces will prevent beetles from reinfesting wood but will not prevent existing larvae from continuing to feed inside the wood and later emerging as adults.

[1] Professional Use: These products are not restricted use but are designated as professional use because they are more potent and require specialized training, application equipment, or personal protective equipment to be effective. Thus they are not appropriate for homeowner use.
[2] Used with Sentricon Termite Baiting System
[3] Used with Hex-Pro Termite Baiting System

Table 6.2 - Recommended Insecticide Use (cont.)

Pests	Pesticide		Application	Nonchemical Control and Remarks
Carpenter ants	**Baits, aerosols, insecticide sprays:**		Outdoor nests are typically found in hollow trees, wood piles, or landscaping timbers near the home. Nests in structural wood are often found in moist areas like basements and crawl spaces. If the nest is found and can be exposed with minimal damage to the structure, insecticide sprays can be used to destroy the colony. If the nest cannot be located or exposed, baiting is the most effective means of carpenter ant control.	The most specific and effective carpenter ant baits are available only from a professional pest control operator. However, boric acid bait formulations labelled for carpenter ant control (Terro®; 5.4%) can significantly reduce the foraging population.
	abamectin	B- Advance Granular (0.011%)		
	thiamethoxam	Optigard ant gel bait (0.01%)		
	fipronil	Combat Max gel bait (0.001%)		
	Perimeter treatments:		Apply a perimeter spray around the base of a structure. The spray typically is applied ~3 or more feet up the side of the structure, and to the soil or landscaping ~3 or more feet around the structure. However, the application area will change by product so you must read the label.	The perimeter spray should be applied by a pest-management professional with the proper equipment. The application should be made in the early spring when ant populations are low. One application should last all season. Note that perimeter pesticide application laws have recently changed to protect ground water and pollinating insects. Pesticide can no longer be applied along concrete surfaces where there is risk of storm run-off. Also pesticides cannot be applied when pollinators are present. Read all pesticide labels carefully.
	indoxacarb	Arilon (20%)[1]		
	fipronil	Termidor 80 WG (80%)[1]		
	imidacloprid	Premise 75 (75%)[1]		
	lambda-cyhalothrin	Demand CS (9.7%)[1]		
Carpenter bees Note: Male bees cannot sting. Female bees will only sting if intentionally provoked.	**Sprays and dusts:**		Apply insecticide to the entry holes or galleries as soon as bee activity is observed (spring and early summer).	Leave treated galleries open for 24 to 48 hours to ensure adult bees contact treated galleries. Afterward (48 hours), gallery entrance holes can be sealed with putty or caulk.
	cyfluthrin	Tempo 1% Dust (1%)[1]		
	lambda-cyhalothrin	LambdaStar UltraCap (9.7%)[1]		
	imidacloprid	Premise 2 (21.4%)[1]		
	Site Treatment:		Apply spray to areas known or suspected to be targets of carpenter bees (e.g. soffits and eaves). Be aware that we are trying to protect our pollinators so when applying any type of insecticide for bee control, be careful not to let any pesticides drift onto flowers or other locations where non-carpenter bees will visit.	The Premise label allows for preventative application to building surfaces (soffits, eaves, trim, etc.) as part of an exterior spot treatment. Carpenter bees are territorial, often returning to wood that they infested in previous years. Therefore, applications should be made to these areas in early summer, or as soon as bee activity is observed. Contact your professional pest control company if you have a recurring infestation.
	deltamethrin	Delta Dust (0.05%) and D-Fense Dust (0.05%)		
	lambda-cyhalothrin	Cyzmic CS (9.3%) and PT221L (0.05%)		
	disodium octoborate tetrahydrate	Tim-Bor Dust (98%)		

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[2] Used with Sentricon Termite Baiting System
[3] Used with Hex-Pro Termite Baiting System

This chapter was not reviewed in 2022.

Household Insects

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Improving the sanitation and maintenance in and around the home is the best way to prevent household insect and spider pests. Outdoor clutter and debris that harbor pests should be removed. Pest entry should be reduced by sealing holes and cracks around plumbing lines and windows. Indoors, proper sanitation, food storage, reducing clutter, and waste removal will deprive pests of food and water resources. All of these measures will make the home inhospitable to pests thus limiting their population growth.

Bat Bugs

Prevention: Bat bugs inside a structure are typically the result of bats or birds roosting in the attic. If the bat bug population becomes very large, bugs will start to become a nuisance inside the home. Frequently, however, bat bugs become a problem after a bird or bat population has been removed from a structure. Bat bugs remaining in the empty roost no longer have a host to feed on so they move into the living space to feed on people. The best way to prevent a bat bug infestation is by eliminating access points around the structure to keep bats or birds from roosting inside. If a population of bats or birds has to be removed from a home, an effort should be made to clean out the nests and droppings (guano) left behind. Cleaning should only be performed while wearing a respirator because of the toxic fungal spores and bacteria associated with bat guano and bird droppings.

Control: Inspect locations where bat bugs have been seen, starting with electrical connections coming through the ceilings, then around the edges of the carpet, between the floorboards, and in drop ceilings, if applicable. Caulk and seal all openings that would allow bat bugs access to human living space. Vacuum the floors and closets thoroughly. Treat all areas where bat bugs are found with a labeled insecticide. A combination of insecticide products should be used simultaneously. Diatomaceous earth dust or another desiccant dust combined with a crack and crevice treatment is the best approach. All of these treatments should be applied by a professional.

Bed Bugs

Prevention: Bed bugs are becoming an increasingly serious problem in the United States. Home infestations typically result from traveling and staying in hotels (even five-star hotels), motels, and camps or lodges and bringing the bed bugs home in luggage or clothes. To prevent infestations that might result from travel, or even staying at a friend's home, always inspect the mattress in your sleeping room for signs of bed bug infestation (live bugs or black speck-like feces in the mattress seams and tufts) prior to unpacking or sleeping in the bed. In the home, the removal of clutter will inhibit bed bug population growth and help to prevent bed bugs from becoming well established. Although bed bug populations cannot be eliminated by removing clutter alone, the removal of hiding places will make the environment less hospitable for bed bugs and much easier to treat with insecticides. It is essential that furniture, clothing, boxes, or other personal effects NOT be moved from an infested location to an uninfested location. Moving these items will simply spread the infestation because it is very difficult to determine if an item is free of all immature bed bugs and bed bug eggs. It is also important that you not bring other people's furniture, used furniture, or other peoples' belongings into your home unless you know they are bed bug free.

Control using heat: Because bed bugs and their eggs are unable to withstand temperatures above 122˚F, properly executed heat treatments are very effective in killing bed bugs and controlling infestations. Heat treatments can be applied as whole-room, whole-home, and chamber treatments. Unfortunately, many of the smaller whole home heat treatment systems have proven to be inadequate when it comes to producing enough heat to kill all bed bugs in the home. In addition, the most effective whole homes heat systems are prohibitively expensive for smaller pest management companies to purchase. Therefore, it is very important for resident to require a detailed temperature report (taken from heat sensors placed in hard to heat locations and showing that those areas reached 122 degrees F), as documentation of their heat treatment efficacy.

Control in beds and bedding: All bedding should be dried in a clothes dryer for at least 30 minutes at a high temperature (130˚F). Mattresses can be steam-cleaned or washed thoroughly with soap and water and left outside to dry. If washing or steam-cleaning is not possible, insecticide products that are labeled for mattress treatment can be applied to the mattress to kill the bed bugs. After cleaning or treating a mattress with an insecticide, it should be encased in a bed bug-proof mattress encasement to prevent any surviving bed bugs from getting off the mattress and biting. Encasing the mattress will also prevent it from becoming reinfested with any bed bugs still in the room. Box springs are a popular harborage for bed bugs. To treat the box springs, remove and discard the cloth backing to provide access to the inner frame. Then, you can treat the inside of the wood frame and along the slats and bedsprings with a labeled insecticide. Cover box springs with a bed bug-proof mattress encasement after treatment. Inspect the headboard and bed frame for bed bugs. Remove (either by vacuuming or with an adhesive lint roller) or kill any live bugs that are found, then treat the headboard and bed frame with an desiccant dust insecticide, following all label instructions.

Control in infested rooms: Inspect the room thoroughly by looking around the edges of the carpet, between the floorboards, behind photos or posters on the wall, along the door frames around closets, inside shoes that are worn infrequently, and in any other crack or crevice where bed bugs could be hiding. Remove or kill any live bed bugs that are found (either by vacuuming or with an adhesive lint roller). In areas where bed bug evidence (cast skins, feces, or live bugs) is found, remove all clothing and linens, placing them in a sealed plastic bag until they can be put into a hot dryer. Carefully inspect all personal items from areas where you found bed bug evidence. Portable heat chambers are now available for treating personal items and pieces of furniture. Dispose of unnecessary or unsalvageable items by taking them outside and prepare the rest for cleaning or treatment with an appropriately labeled insecticide. Treat furniture and other areas with a labeled insecticide. It is recommended that a combination of insecticide products be used simultaneously. A crack and crevice treatment and a long term residual desiccant dust insecticide in wall voids is the best approach. The infested location should be treated at least three times at two-week intervals. All of these treatments should be applied by a professional.

Keep in mind that bed bug treatment is very difficult. Most pest management professionals have only recently learned how to treat for bed bugs. Also, there are a limited number of products labeled for bed bug treatment and many only work by spraying the bed bug directly. There are even fewer low toxicity products that can be applied to mattresses or bedding. Bed bugs are hard to locate, hard to kill, and can live for several months without feeding so clutter removal, vigilance (monitoring), and patience are absolutely necessary when attempting to control this pest.

Red Imported Fire Ants (RIFA)

Red imported fire ants (RIFA) rarely nest indoors, but if they do, you should call a professional pest control operator immediately. It has been documented that RIFA tend to enter structures during periods of heavy precipitation. RIFA are extremely aggressive and respond rapidly to any disturbance of the nest or a food resource. RIFA in structures can be very dangerous for small children or the elderly. A number of deaths have resulted from children or bedridden elderly adults being stung repeatedly by fire ants. Nursing homes and day care center need to be particularly vigilant about keeping fire ants controlled both indoors and out (See Insects in Recreational Areas).

Red imported fire ant (RIFA) colonies can be found throughout the southeastern United States from Texas through Florida, extending as far north as Oklahoma and Virginia. In 2009, cities (Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach and Williamsburg) and several counties (James City and York) in Virginia were placed under the Federal Fire Ant Quarantine. In 2019, this quarantine was expanded to include the counties of Brunswick, Greensville, Isle of Wight, Mecklenburg, Southhampton; and the cities of Emporia and Franklin. This quarantine means that the Virginia Department of Agriculture and Consumer Services (VDACS) will no longer be responsible for treating fire ant mounds in those areas. Fire ant control will now be the responsibility of those citizens living in the quarantine locations. A map (as of 2017 only) of all quarantined locations within the U.S. may be viewed at https://www.aphis.usda.gov/plant_health/plant_pest_info/fireants/downloads/fireant.pdf. In Virginia, RIFA colonies are now established throughout Hampton Roads. Individual RIFA colonies have also been documented in the greater Richmond area and as far west as Montgomery County. Note that RIFA infestations occurring outside of the quarantined areas in Virginia should still be reported to the VDACS Office of Plant & Pest Services at (804) 786-3515 or visit the VDACS website at https://www.vdacs.virginia.gov/plant-industry-services-fire-ant-suppressioneand-eradication.shtml.

For more detailed information see the Red Imported Fire Ant (RIFA) publication: https://www.pubs.ext.vt.edu/444/444-284/444-284.html.

Controlling Insects

Table 6.3 - Recommended Use

Pests	Prevention	Pesticide		Application
Ants	Eliminate food materials that attract ants into home. Follow good sanitary practices. Perimeter sprays and granular bait formulations applied by a professional pest control operator will significantly reduce pest entry.	**Perimeter Sprays:** fipronil imidacloprid indoxacarb lambda-cyhalothrin	 Termidor 80 WG (80%)[1 2] Premise 75 (75%)[1 2] Arilon (0.1%)[1] Demand CS (9.7%)[1]	**For colony control:** Identify the type of ant and use a bait labeled for that species. Ants are finicky and may prefer a sweet or a protein-based bait. **Indoors**: Spray baseboards, cracks, door frames, and window sills.

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[2] Professional Use Outdoors

[3] Home Use

Table 6.3 - Recommended Use (cont.)

Pests	Prevention	Pesticide		Application
Asian lady beetles	Seal all possible routes of entry, screen vents, and install door sweeps. Vacuum up live lady beetles that make their way indoors and dispose of the bag outdoors.	**Micro-cap formulation:**		Pesticide applications to lady beetle entry points outside of the home need to be made the first week of October to be effective. If lady beetles are already entering the home, pesticide applications will not prevent their entry although they may die once inside.
		fipronil	Termidor 80 WG	
		imidacloprid	Premise 75 (75%)[1,2]	
		indoxacarb	Arilon (0.1%)[1]	
		lambda-cyhalothrin	Demand CS (0.03%)[1]	
Bat bugs	The best way to prevent a bat bug infestation is by eliminating access points around the structure to keep bats or birds from roosting inside. Bat bugs can become a problem after a bird or bat population has been removed from a structure. Bat bugs remaining in the empty roost no longer have a host to feed on so they move into the living space to feed on people. See previous pages for more information.	**Professional-use Residual Products**		All of these treatments should be applied by a professional. Treat all areas where bat bugs are found with a labeled insecticide. A combination of insecticide products should be used simultaneously. A desiccant dust combined with a crack and crevice treatment is the best approach.
		Baseboard sprays:		
		bifenthrin	Talstar P (0.06%)[1]	
		deltamethrin	Suspend SC (0.06%)[1]	
		lambda-cyhalothrin	Demand CS (0.03%)[1]	
		Crack and crevice:		
		bifenthrin	Talstar P (0.06%)[1]	
		deltamethrin	Suspend SC (0.06%)[1]	
		lambda-cyhalothrin	Demand CS (0.03%)[1]	
		Wall Voids:		
		diatomaceous earth	MotherEarth D (100%)	
		silica gel	CimeXa (100%)	
Bed bugs	Although bed bugs cannot be eliminated by removing clutter, limiting the available hiding places will make the environment less hospitable for bed bugs and much easier to treat with insecticides. It is essential that furniture, clothing, boxes, or other personal effects NOT be moved from an infested location to an uninfested location. Moving these items will simply spread the infestation as it is very difficult to determine if an item is free of all immature bed bugs and bed bug eggs. See previous pages for more information.	**Professional-use Residual Products**		At this time, there is no single control product for bed bugs that will eliminate an infestation except fumigation, with sulfuryl fluroide. Bed bug treatment requires a variety of sanitation and exclusion methods as well as insecticide products be applied to infested rooms. These treatments will need to be applied multiple times, and at regular intervals. Use pitfall type monitors (Climbup) to monitor for bed bugs where people are getting bitten but no bugs are seen.
		Crack and crevice:		
		bifenthrin	Talstar P (0.06%)[1]	
		deltamethrin	Suspend SC (0.06%)[1]	
		beta-cyfluthrin	Tempo SC Ultra (0.05%)[1]	
		lambda-cyhalothrin	Demand CS (0.03%)[1]	
		Beauveria bassiana	Aprehend (2.0%)	
		Combination products:		
		acetamiprid bifenthrin	Transport GHP (0.11%)[1]	
		imidacloprid phenothrin	Bedlam Plus (0.4%; 0.05%)[1]	
		lambda-cyhalothrin thiamethoxam	Tandem (0.13%)[1]	
		beta-cyfluthrin	Temprid SC (0.15%)	
		imidacloprid metoflutrin, clothianidin, PBO	Crossfire (1.42%)	
		Pressurized insecticides:		
		dinotefuran	PT Alpine	
		chlorfenapyr	PT Phantom	
		phenothrin	Bedlam (0.4%)[1]	
		Desiccant dusts:		
		diatomaceous earth dinotefuran	PT Alpine	
		diatomaceous earth	MotherEarth D (100%)	
		silica gel	CimeXa™ (100%)	

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[2] Professional Use Outdoors

[3] Home Use

Table 6.3 - Recommended Use (cont.)

Pests	Prevention	Pesticide		Application
Boxelder bugs	Collect in vacuum cleaner or by broom and dust pan, and destroy. Plug openings in window sashes to prevent entry. Caulk cracks, etc. Spray only in areas inaccessible to children and pets.	**Biopesticides:** *Beauveria bassiana* **Perimeter applications:** lambda-cyhalothrin fipronil deltamethrin indoxacarb	 Aprehend 2.0% Demand CS (0.03%)[1] Termidor 80 WG (0.06%)[1 2] Suspend SC (0.06%)[1] Arilon (0.1%)[1]	**Indoors:** Vacuum individual insects when they appear. **Outdoors:** Apply preventative perimeter spray mid to late August. Note that perimeter pesticide application laws have recently changed to protect ground water and pollinating insects. Pesticide can no longer be applied along concrete surfaces where there is risk of storm run-off. Also pesticides cannot be applied when pollinators are present. Read all pesticide labels carefully.
Brown marmorated stink bugs (BMSB)	Stink bugs begin aggregating on structures soon after the first cool day in September. Prior to September, plug openings in windows and vents that could provide the bugs with entry to the structure.	**Perimeter applications (1st week of September):** indoxacarb bifenthrin acetamiprid	 Arilon (0.1%)[1] Transport GHP (0.11%)[1]	**Indoors:** Vacuum up individual insects, but be aware stink bugs will make the vacuum smell strongly of their odor. **Outdoor:** Well-timed perimeter applications may help to reduce bugs indoors, but cannot eliminate entry in most cases. Note that perimeter pesticide application laws have recently changed to protect ground water and pollinating insects. Pesticide can no longer be applied along concrete surfaces where there is risk of storm run-off. Also pesticides cannot be applied when pollinators are present. Read all pesticide labels carefully.
Carpet beetles	Follow good housekeeping practices. Most infestations result from spilled dry pet food in cupboards and other storage locations. Clean hot air registers and cold air ducts. Use vacuum cleaner regularly. Frequently remove and destroy disposable vacuum cleaner bag. Never allow clothing, rugs, etc., to lie in a pile neglected over a period of time.	**Preventative:** Naphthalene residual Pyrethroid microencapsulation or wettable powder	 0.015-0.03%	**Indoors:** Treat rugs and carpets (including baseboards) evenly and lightly in areas of infestations. Store only previously cleaned clothing, etc., in air-tight closets or containers.
Clothes moths	Follow good housekeeping practices. Clothing should be throroughly brushed and hung outside in the sunlight. Dry-cleaning kills these pests. Prevent dust and lint from accumulating. Clean hot air registers and cold air ducts. Use vacuum cleaner regularly. Frequently remove and destroy disposable vacuum cleaner bag. Never allow clothing, rugs, etc., to lie in a pile neglected.	**Preventative:** Naphthalene residual		**Indoors:** Store only previously cleaned clothing in air-tight closets and containers. Use moth crystals, balls, or flakes in garment bags and closets where clothes are kept. Replace periodically.

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[2] Professional Use Outdoors
[3] Home Use

Table 6.3 - Recommended Use (cont.)

Pests	Prevention	Pesticide		Application
Clover mites	**Indoors:** Clover mites should be removed with a vacuum to reduce red smears and stains. **Outdoors:** A 5-ft band of bare soil around the foundation will discourage mite infestation. .	**Perimeter Spray:** indoxacarb lambda-cyhalothrin fipronil imidacloprid b-cyfluthrin	 Arilon (0.1%)[1] Demand CS (0.03%)[1] Termidor 80 WG (0.06%)[1 2] Temprid SC (0.15%)	**Indoors:** Direct spray onto mites in cracks and other areas where they hide. **Outdoors:** Prepare a 5-ft wide strip of bare soil next to the house foundation the first week of May. Apply to the bare soil as a barrier completely around the house. Note that perimeter pesticide application laws have recently changed to protect ground water and pollinating insects. Pesticide can no longer be applied along concrete surfaces where there is risk of storm run-off. Also pesticides cannot be applied when pollinators are present. Read all pesticide labels carefully.
Cluster flies	Seal all possible routes of entry, screen vents, and install door sweeps. Vacuum or trap flies with light traps or sticky traps.	**Perimeter Spray:** indoxacarb lambda-cyhalothrin fipronil imidacloprid b-cyfluthrin	 Arilon (0.1%)[1] Demand CS (0.03%)[1] Termidor 80 WG (0.06%)[1, 2] Temprid SC (0.15%)	Early autumn application should be made to the perimeter of the structure to prevent adult fly entry. Note that perimeter pesticide application laws have recently changed to protect ground water and pollinating insects. Pesticide can no longer be applied along concrete surfaces where there is risk of storm run-off. Also pesticides cannot be applied when pollinators are present. Read all pesticide labels carefully
Cockroaches	Using a vacuum is ideal for removing cockroaches and their debris when doing an intitial clean out. Sticky traps can be used to monitor cockroach populations and detect infestations. Increasing sanitation will also prevent cockroaches from becoming established.	Gel baits Bait stations Boric acid powder Aerosol sprays Desiccant dusts		**Indoors:** Apply in cracks and crevices and in other out-of-sight areas. Treat areas where pipes go through walls or floors. Treat cockroach runways under sinks and behind appliances. Place bait and desiccant dusts in cracks and crevices where cockroaches hide.
Crickets	Eliminate moist harborage areas near structures. Crawl spaces should be ventilated and dry. Entry points should be sealed.	**Perimeter Sprays:** indoxacarb lambda-cyhalothrin fipronil imidacloprid b-cyfluthrin **Indoors:** Aerosol Sprays	 Arilon (0.1%)[1] Demand CS (0.03%)[1] Termidor 80 WG (0.06%)[1, 2] Temprid SC (0.15%)	**Indoors:** Use aerosol to knockdown and kill individual crickets. **Outdoors:** Spray windows, doorways, and other entry sites. Apply to foundation interior walls, window wells, subfloor crawl spaces, under garbage cans, at door thresholds, etc.

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[2] Professional Use Outdoors

[3] Home Use

Table 6.3 - Recommended Use (cont.)

Pests	Prevention	Pesticide		Application
Drain Flies	Sanitation is the best control measure. Clean away the gelatinous film (biofilm) from inside drains; clean garbage containers regularly. Do not allow wet lint to accumulate under washing machines. Avoid moist organic debris of any nature, especially in the basement.	Aerosol sprays **Drain cleaners:** Bacterial foam products		**Indoors:** Use aerosols for adult fly control. For control of fly larvae in infested drains, use a bacterial drain treatment product to eliminate breeding sites. To clean drains after treatment, use a stiff brush and hot water to remove any remaining biofilm. Bacterial biofoam products are ideal for use because the foam can fill fly breeding spaces that brushes and gels cannot access. Leave the foam in place for several hours prior to rinsing.
Earwigs	Remove excessive clutter from the ground around the outside of house. Items such as tarps, boards, and firewood provide harborage for earwigs. Bait areas where earwigs are found most commonly. If a number of earwigs are found aggregating indoors, remove them with a vacuum and clean the area with soap and water. Cleaning will remove the pheromone chemicals that will attract other earwigs.	**Perimeter Spray:** indoxacarb lambda-cyhalothrin fipronil imidacloprid b-cyfluthrin	 Arilon (0.1%)[1] Demand CS (0.03%)[1] Termidor 80 WG (0.06%)[1, 2] Temprid SC (0.15%)	Remove all mulch, plant debris, and organic material from around foundation to reduce moisture.
Fleas Note: Resistance to spot-on products is starting to become more prevalent in fleas; however, treating the pet is still the most effective method of flea control at this time.	Spot-on treatments and oral tablets for pets are by far the most effective way of eliminating fleas and ticks. Regular applications (1/month) will often eliminate indoor flea problems. NEVER APPLY DOG FLEA PRODUCTS ON CATS. THIS CAN RESULT IN DEATH.	**Spot-on treatments (available at local animal clinics)** spinetoram, Cheristin fipronil (s)-methoprene selamectin **Tablets:** nitenpyram ***Dogs only:*** afoxolaner sarolaner sarolaner, moxidectin, and pyrantel lotilaner fluralaner **Collars:** flumethrin imidacloprid **Indoors:** (Insect growth regulators) Nylar™ (s)-methoprene pyriproxyfen Desiccant dusts **Outdoors:** pyriproxyfen esfenvalerate	 Advantage II Fronline Plus Revolution Capstar (cats & dogs) NexGard Simparica Simparica Trio Credelio Bravecto Seresto Surge (1.3%) Precor IGR Concentrate (1.2%) Archer (1.3%) Archer (1.3%) Virbac Yard Spray (0.44%)	**Indoors:** Apply insect growth regulators to carpets in rooms where flea infestation is apparent. Apply desiccant dusts in larval habitats like carpet edges and pet bedding. Apply in animals' sleeping quarters and replace old bedding with clean, fresh, untreated bedding. **Outdoors:** Treat infested areas of lawn, under dog houses (thoroughly clean the inside of dog houses regularly), and under porches with an insect growth regulator.

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[2] Professional Use Outdoors
[3] Home Use

Table 6.3 - Recommended Use (cont.)

Pests	Prevention	Pesticide	Application
Flies	Good sanitation and tightly fitting screens and garbage can lids are sound preventative control measures. Use of fly swatter is still practical. Do not contaminate food or utensils with insecticides. Bag pet waste before putting in garbage pails.	**Residual formulations:** microencapsulated or wettable powder **Quick knockdown:** labeled pyrethroid aerosol sprays	**Indoors:** Use an aerosol spray in the air when flies are present. Fly lights should be used in commercial kitchens. **Outdoors:** Apply to walls adjacent to dumpsters or other breeding sites. Light traps used outdoors will catch flies, but they also may attract flies in from other areas.
Flour, Grain beetles	Discard infested foods and keep uninfested food in containers with tightly-fitting lids. .	None	**Indoors:** Thoroughly clean infested shelves. Cover shelves with clean, fresh shelf paper or foil.
Long-horned beetle	These beetles frequently hitchhike into the home via firewood. It is wise to store firewood outdoors to prevent beetle emergence in the home.	None	**Indoors:** Usually, individual beetles can simply be picked up with a vacuum cleaner and then discarded.
Millipedes	**Indoors:** Millipedes that stray into the home can be picked up with the vacuum, or they can be collected with a broom and dust pan, and then discarded. **Outdoors:** Remove sources of moisture such as excessive mulch, decaying grass, leaves, etc., from around the house foundation. Double-sided tape placed along entryways can limit access into the structure**.**	microencapsulations wettable powder dusts in drier areas	**Indoors:** Use aerosol sprays on individual millipedes. **Outdoors:** Spraying pest entry sites may help, but outdoor applications during a mass millipede migration will do little to stop their numbers.
Mosquitoes	Maintain good, tight-fitting screens on windows and doors. Remove or frequently empty any containers on the premises that may hold rainwater. Clean out clogged roof gutters holding stagnant water. Backyard garden ponds can be stocked with predatory fish that feed on mosquito larvae.	Aerosol sprays Repellents for personal protection	**Indoors:** Use aerosol sprays according to label directions. **Repellent:** Use Deet or ethyl hexanediol aerosol according to the directions. **Outdoors:** Homeowner applications of mosquito control measures outdoors are discouraged due to concerns over water contamination and the impact on non-target animals.

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[2] Professional Use Outdoors

[3] Home Use

Table 6.3 - Recommended Use (cont.)

Pests	Prevention	Pesticide		Application
Pantry and stored-food pests	Either throw away the infested items or kill the insects by placing the food item in a heated oven (130 degree F) for 30 min. Alternatively, infested food can be placed in a freezer (0 degrees F) for 4 days. Store un-infested foods in plastic or glass containers with tight fitting lids.	Aerosol sprays Boric acid powder		**Indoors:** Remove all items from the infested location and thoroughly clean shelves. Labeled insecticides may be sprayed into cracks and crevices. Cover shelves with clean, fresh paper or foil before placing packages or food in the cupboard.
Red imported fire ants (RIFA)	RIFA rarely nest indoors, but if they do, call a pest management professional immediately. .	**Outdoors:** Baits		For colony control outdoors: See Insects in Recreational Areas, p. 6-1. For indoor infestation, call a pest management professional immediately.
Silverfish	Remove potential sources of food and moisture. Seal cracks and crevices. Remove books, papers, and boxes that have been stored for long periods.	**Residual formulations:** Pyrethroid sprays		Infestations tend to be localized. Apply treatment to suspected harborage areas. Habitat modification can greatly enhance control.
Sowbugs	Reduce or eliminate moist areas around the home. Remove leaf piles, grass clippings, old boards, and excess ground cover. Caulk cracks around home foundation.	Dessiccant dusts		**Indoors:** desiccant dusts may be used along exterior doorways and basement windows (on the inside) to prevent entry".
Spiders	Spiders can be successfully kept out of the house by careful screening, secure caulking, etc. Practically all spiders in Virginia are harmless. Exceptions are the black widow and brown recluse spiders, which are poisonous. Note that the brown recluse spider is not native to Virginia." Bites (and other wounds) of many kinds are often misdiagnosed by medical doctors as brown recluse spider bites.	Repellents for personal protection Vacuum		**Indoors:** Remove spiders, egg sacs, and webs with a vacuum. Seal and dispose of the bag immediately. Appropriately labeled dusts may be used if desired. **Outdoors**: Remove clutter and debris in the yard where spiders can hide. Turn off outdoor lights at night. Lights attract insects that spiders use as food.
Ticks	Keep grass cut to 3 inches or less. Trim vegetation along yard edges, paths, and trails. Remove garbage and wood piles to discourage rodent activity.	carbaryl pyrethroid sprays fipronil permethrin	Sevin Dust (5.0%) Tick Box Tick Control System tick tubes	**Outdoors:** Treat under dog houses. Applications to large outdoor areas are impractical because ticks are often concentrated in spot locations.
Wasps and hornets	Remove nest when no activity is observed.	Aerosol sprays Wasp and hornet killer		**Outdoors:** Locate nest entrance during the day. Treat nest at night when most insects are inside. Wear protective clothing.

[1] Professional Use: These products are not restricted use but are designated as professional use because they are more potent and require specialized training, application equipment, or personal protective equipment that make them unsuitable for homeowner applications.
[2] Professional Use Outdoors
[3] Home Use

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Dog and Cat External Parasites

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Because of the increased difficulty in managing fleas, some general information is included for pet owners. Fleas pass through four stages of development: egg, larva, pupa, and adult. Female fleas lay their eggs on the animal, which usually fall off the animal where it sleeps. These eggs hatch into larvae within a few days and develop in about two weeks. A mature larva spins a tiny cocoon in which it pupates. Adult fleas emerge from the cocoon in about a week. They must feed on blood in order to live and lay eggs. However, adults can survive for several weeks without feeding.

Management of fleas on animals and where they live is necessary to prevent infestations in homes, animal quarters, and yards. Carpets should be vacuumed regularly and animal bedding should be washed frequently as long as fleas are an indoor problem. The contents of a vacuum should be carefully disposed in order to prevent fleas from escaping back into the home or elsewhere. Choose a recommended control method from Table 7.1 and use it in conjunction with vacuuming and laundering.

Treatments available for sale online and delivered to Virginia may not be approved by VDACS for use in Virginia. Follow all label directions regarding use of a product on sick, debilitated, pregnant, or nursing animals. Even healthy pets may be sensitive to a product generally approved for use. If a pet develops an adverse reaction to a treatment, promptly follow these steps. 1) Remove the flea collar if the pet is wearing one. 2) Quickly bathe or wipe down the pet to remove as much insecticidal spray, dusts, dips, ointments, and recently applied topical materials as possible. Do not use insecticidal shampoo to bathe pet. 3) Promptly take the pet to a veterinarian. Take the packaging of any insecticidal treatment suspected of causing the symptoms with you to show the vet.

Table 7.1 - Recommended Insecticide Use

Pests	Insecticide Active Ingredient [% A.I. in product]	Mixing and Application Information	Precautions
Dusts			
Flea powders are not as popular as they once were. Many materials previously available as flea powder are no longer approved for use in Virginia or now come in packaging inconvenient for homeowner use. Product labels should specifically state on the label that they are appropriate for flea control on dogs or cats. New product labels may not include direct application to an animal. Some products are only labeled for application to an animal's bedding, sleeping area, or other places where fleas are found. Always follow the label regarding application.			
fleas, ticks, lice	diatomaceous earth (silicon dioxide)	No mixing necessary. Follow label regarding minimal age of pet, how to apply, and wait time before reapplying.	Do not directly apply to animal unless stated on label. For cats and dogs at least 12 weeks old. May dry skin.
fleas, ticks, lice	permethrin [0.25%]	No mixing necessary. Use gloves and avoid getting in eyes. Follow label regarding minimal age of pet, how to apply, amount to apply based on pet's weight, and wait time before reapplying.	Generally for dogs at least 12 weeks old. Do not apply to cats unless specified on product label.
fleas, ticks, lice	pyrethrins with synergists	No mixing necessary. Dust pet beginning at head and working back, getting material down to skin. Can be used on bedding.	Generally for dogs or cats at least 12 weeks old.
fleas, ticks, lice	gardona (tetrachlorvinphos) [3.3%]	No mixing necessary. Dust pet beginning at head and working back, getting material down to skin. Follow label regarding dosage by animal size, treatment of bedding and wait time before reapplying.	For dogs or cats at least 12 weeks old. Follow label restrictions regarding cholinesterase inhibiting drugs and other pesticides or chemicals.
fleas	botanical oils such as thyme oil, lemongrass oil, and rosemary oil	No mixing necessary. Dust pet beginning at head and working back, getting material down to skin. Can be used on bedding.	For dogs and cats at least 6 weeks old. Do not use on nursing animals.

Table 7.1 - Recommended Insecticide Use (cont.)

Pests	Insecticide Active Ingredient [% A.I. in product]	Mixing and Application Information	Precautions
Chewable tablets			
Various flea and tick treatments are now available as chewable tablets that contain afoxolaner, fluralaner, lufenuron, spinosad, and/or other active ingredients. These tablets are considered veterinary drugs and require a prescription. Other chewable tablets containing imidicloprid or nitenpyram may be available without a prescription, but they are not under the scope of this guide. Consult your veterinarian for more information.			
Collars			
Use gloves when handling collars. Place collar around animal's neck and adjust to fit. Tight collars may irritate skin and strangle the animal. Collar should be loose enough to move freely around the animal's neck with 2-3 inches of slack. Cut off excess collar length and dispose in the trash. Always wash hands after handling the collar. Insecticidal dusts may form on collars during storage. This dust is harmful if swallowed; do not get in eyes or mouth. Follow any other precautions listed on collar label. Replace collar as directed on label. Collar may not protect against all pests listed on the label for the same length of time.			
fleas, ticks	deltamethrin with or without other materials	May need 2-3 weeks after placement to reach full effectiveness.	For dogs at least 12 weeks old. Do not use on cats.
fleas, ticks	botanical oils such as geraniol, cinnamon oil, lemongrass oil, clove oil, cedarwood oil, peppermint oil, etc.	Choose appropriate collar size based on size of dog's neck. Universal collar size for cats. May take 2-3 weeks after placement to reach full effectiveness.	For dogs and cats. See label for age restrictions of animal.
fleas, ticks	flumethrin [4.5%] + imidacloprid [10%]	If for dog, choose collar according to size of dog's neck and weight. Universal collar size for cats.	For dogs at least 7 weeks old and cats at least 10 weeks old.
fleas, ticks	gardona [14.55%] with or without (S)-methoprene [1.02%]	Choose collar size based on dog's neck size. Universal collar size for cats.	See label for age restrictions.
Sprays and Dips			
mange mites	benzyl benzoate [29%]	Ready-to-use spray. Clip hair from affected area, bathe animal, and let dry before spraying. Do not use in mouth, eyes, ears, nose, or genitals.	For dogs at least 12 weeks old. Do not use on pregnant or nursing dogs. Do not use on cats.
fleas, ticks, mosquitoes	botanical oils and/or extracts such as cedar oil, peppermint oil, lemongrass oil, etc.	Ready-to-use spray. Mist animal's back, shoulders, sides, stomach, legs, and neck, then comb through to skin. For head, apply spray to washcloth and gently wipe fur on head. Avoid animal's eyes, face, and genitals.	See label for age restrictions. **Use commercial sprays; homemade preparations are not recommended.** Some essential oils are toxic; use only on the pet species listed on label.
fleas, ticks, sometimes other insects or mites. See product label for details.	fipronil [0.29%] with or without [S]-methoprene	Ready-to-use spray. Mist animal's back, shoulders, sides, stomach, legs, and neck. For head, apply spray on gloved hand and gently wipe fur on head. Do not get product in animal's eyes or mouth. See label for complete details, including wait time before reapplying.	For cats and dogs at least 8 weeks old. See label for restrictions on age and/or weight of animal. Wear eye protection and latex gloves when applying.
ticks	isopropyl myristate [50%]	Ready-to-use spray for cats and dogs. Apply to ticks directly when found on pet. Follow label directions on tick disposal.	Cover animal's eyes. Follow label directions if tick has not dropped off within 3 hours after application.

Table 7.1 - Recommended Insecticide Use (cont.)

Pests	Insecticide Active Ingredient [% A.I. in product]	Mixing and Application Information	Precautions
fleas, ticks, sometimes biting flies and mites	pyrethroids, with or without pyrethrins, synergists, insect growth regulators, etc. Possible ingredients include permethrin, etofenprox, [S]-methoprent, etc.	Various sprays and dips are available with pyrethroids and other materials. Follow directions on product labels regarding mixing, application, and wait time before reapplication.	Follow label directions regarding animal's weight and age. Use on cats only if specified on label.
fleas, ticks, lice, sometimes biting flies	pyrethrins, with or without [S]-methoprene, synergists, repellents, insect growth regulators, etc.	Various sprays and dips are available with pyrethrins and other materials. Do not spray eyes, mouth, ears, nose, or genitals. Follow directions on product labels regarding mixing, application, and wait time before reapplication.	Usually for dogs and cats at least 12 weeks old. Follow label directions regarding animal's weight and age.
fleas, ticks	gardona (tetrachlorvinphos) [1.08%] with or without (S)-methoprene [0.07%]	Ready-to-use spray. Mist animal's back, shoulders, sides, stomach, legs, and neck. For head, apply spray on gloved hand and gently wipe fur on head. Do not get product in animal's eyes or mouth. See label for complete details, including wait time before reapplying.	Usually for dogs and cats at least 12 weeks old. Use only on animal listed on product label.
Shampoos			
fleas, ticks	botanical oils and/or extracts such as cedar oil, peppermint oil, rosemary oil, clove oil, etc.	Follow label directions. Avoid animal's eyes, face, and genitals.	See label for age restrictions. Use commercial preparations. Homemade preparations not recommended. Some essential oils are toxic; use only on the pet species listed on label.
fleas, ticks, sometimes lice	pyrethroids, with or without synergists, insect growth regulators, etc.	Follow label directions regarding wait time for reapplication.	For dogs at least 12 weeks old. Do not use on cats.
fleas, ticks, sometimes lice	pyrethrins, with or without synergists, repellents, insect growth regulators, etc.	Follow label directions regarding application to cats or dogs, including wait time for reapplication.	For dogs and cats at least 12 weeks old.
Roll-on, Wipe-on, and Ointments			
mange mites	sulfur [28%]	Ready-to-use ointment for local application.	For dogs at least 12 weeks old. Do not use on cats.
fleas, ticks	Botanical oils and/or extracts such as cedar oil, peppermint oil, etc.	Ready-to-use wipes. Follow label directions on application.	Generally for dogs and cats at least 12 weeks old. See label for age restrictions.

Table 7.1 - Recommended Insecticide Use (cont.)

Pests	Insecticide Active Ingredient [% A.I. in product]	Mixing and Application Information	Precautions
Spot On Topical Treatments			
Many spot on treatments for fleas and ticks are widely available on the market without a prescription. These are ready-to-use topical treatments that are usually applied in 1-2 spots on the animal's neck or back. Applications for dogs are typically available in multiple dosage sizes based on the animal's weight. Read the product label carefully for directions on how to apply the material. Pay particular attention to any restrictions on the age and weight of the animal to be treated. **Materials labeled for dogs should never be applied to cats. Some materials approved for dogs are potentially fatal to cats**. Some breeds of dogs, such as collies and other herding dogs, may be particularly sensitive to some materials. Consult your veterinarian for more information, especially if a treated animal shows any sensitivity to a product. Topical treatments containing selamectin, fluralaner, and/or other active ingredients are considered veterinary drugs and require a prescription. Consult your veterinarian for more information.			
fleas, ticks, sometimes other insects or mites. See product label for details.	fipronil, with or without pyrethroids, insect growth regulators, synergists, or other insecticides Possible ingredients included with fipronil in various combinations include: (S)-methoprene cyphenothrin etofenprox permethrin	Ready-to-use topical treatment. Dosage based on weight of dog. Read label for use as different products have different instructions. Available in multiple dosage sizes based on dog's weight. In general, hold tube upright and snap applicator tip away from face and body. Place tip through animal's fur to bare skin on neck or between shoulder blades. Follow directions regarding application placement.	Do not use on cats unless labeled for cats. Usually for dogs at least 8 weeks old or cats at least 12 weeks old, but check label for age and weight restrictions.
fleas, ticks, lice, biting flies	dinotefuran with or without other insecticides, insect growth regulators, etc.	Ready-to-use topical treatment. May be available in multiple dosage sizes based on animal's weight.	For dogs and cats at least 8 weeks old. Follow weight restrictions on label. Only use product labeled specifically for the species of pet.
fleas, ticks, mosquitoes	etofenprox with or without insect growth regulators, synergists, other insecticides, etc.	Ready-to-use topical treatment. Apply as directed on label. Available in multiple dosage sizes based on dog's weight.	Usually for dogs and cats at least 12 weeks old. Follow weight restrictions on label. Only use product labeled specifically for the species of pet.
fleas, ticks, mosquitoes	cyphenothrin with or without insect growth regulators, synergists, other insecticides, etc.	Ready-to-use topical treatment. Apply as directed on label. Available in multiple dosage sizes based on dog's weight.	For dogs at least 12 weeks old. Do not use on cats.
fleas, ticks, lice	imidacloprid with or without permethrin, insect growth regulators, or other materials	Ready-to-use topical treatment. Apply as directed on label. Available in multiple dosage sizes based on dog's or cat's weight.	For dogs at least 7 weeks old and cats at least 8 weeks old. Only use product labeled specifically for the species of pet.
fleas; also ticks if with permethrin	indoxacarb with or without permethrin	Ready-to-use topical treatment. Apply as directed on label. Available in multiple dosage sizes based on dog's or cat's weight.	For dogs and cats at least 8 weeks old. Do not use on cats unless specified on label.

Table 7.1 - Recommended Insecticide Use (cont.)

Pests	Insecticide Active Ingredient [% A.I. in product]	Mixing and Application Information	Precautions
fleas, ticks, lice, biting flies	permethrin with or without pyrethrins, insect growth regulators, or other materials	Ready-to-use topical treatment. Apply to skin beginning between shoulder blades and along back to base of tail. Available in multiple dosage sizes based on dog's weight.	Follow label regarding dogs's weight and age. Do not use on cats.
fleas	spinetoram [15%]	Ready-to-use topical treatment. Apply to skin at base of head.	For cats at least 8 weeks old and at least 1.8 lbs. Do not use on dogs.
fleas, ticks, mosquitoes	botanical oils and/or extracts such as peppermint oil, cinnamon oil, lemongrass oil, clove oil, thyme oil, etc.	Ready-to-use topical treatment. Available in multiple dosage sizes based on dog's weight. Apply between back of head and the shoulder blades.	For dogs and cats at least 12 weeks old. Do not use on cats unless specified on the label. Use commercial products. Homemade preparations not recommended as some essential oils can be toxic.
Ear Drops			
There are several treatments effective for ear mites that are available by prescription. These veterinary drugs may contain selamectin, imidacloprid, or other active ingredients. Consult your veterinarian for more information.			
ear mites, ear ticks	Synergized pyrethrins	Ready-to-use drops for dogs or cats. Consult label for proper dosage and timing for reapplication.	For cats and dogs at least 12 weeks old. Do not contaminate feed or water.

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Other Animals: Conflicts with Vertebrates

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A vertebrate is an animal that has a backbone or spinal column. Mammals, birds, reptiles, amphibians, and fish are all vertebrates.

It is important to recognize that all animals have value, whether it is ecological, aesthetic, or economic. Nevertheless, people often disagree about when an animal becomes a problem. In Virginia, most complaints about problematic vertebrates involve birds and mammals. Vertebrates become problematic when they damage property, agriculture, and/or natural resources or when they threaten human health and safety. Additionally, purposeful actions intended to attract "desirable" wild animals to your property can pose risks to your family, to the animals, and potentially to your neighbors. All interactions with wildlife have consequences and, as much as you may believe that your actions are benign (e.g., feeding wildlife), unintended negative repercussions can and often do emerge as a result.

The important guiding principle in human-wildlife conflict resolution is to minimize or eliminate damage by identifying and attacking its true underlying cause rather than simply killing offending animals. Conflicts rarely are solved just by removing a perceived culprit — if nothing else is done to change or rectify the conditions that led to creating the conflict in the first place, another animal will respond to those same opportunities and soon replace the one removed. When damage has been managed effectively, people usually become more tolerant in situations of human-wildlife interaction. Therefore, prevention must become a key objective.

Other important considerations:

- In many places and situations, it may not be safe or legal to use certain damage management tactics.
- Some human-wildlife problems are best handled by professionals. Personal, one-on-one assistance regarding questions about human-wildlife interactions or recommended actions to take in a human-wildlife conflict can be obtained by calling (toll-free) the Virginia Wildlife Conflict Helpline at (855) 573-9003.

Laws Regulating Resolution of Human-Wildlife Conflicts

The Code of Virginia, the Virginia Administrative Code (VAC), and the Code of Federal Regulations (CFR) all contain restrictions designed to protect wildlife. The Code of Virginia includes wildlife laws passed by the General Assembly and, in general, carries more authority than regulation. State agencies cannot modify these laws on their own; they must seek legislative action to modify, adjust, or eliminate items promulgated as Code of Virginia. In contrast, the VAC is a collection of regulations passed by state agencies that have specific legal authority to do so. The Virginia Department of Wildlife Resources (DWR) is the regulatory agency responsible for most state wildlife regulations. The U.S. Congress or designated federal agencies have passed federal laws and regulations that protect some wildlife species. These are listed in the CFR. Finally, in some communities, local ordinances may regulate or impose further limitations on methods used to manage human-wildlife conflicts. Local communities cannot override or eliminate federal and state standards, but they can extend or strengthen such limitations.

It is challenging to keep current on all these laws and regulations. This is one reason to consult with local and state authorities regarding human-wildlife conflict issues. You should consider hiring a professional if the most appropriate and legal conflict management approach requires the use of special equipment or possession of mandatory certifications.

Nuisance Species

Although the Code of Virginia, the VAC, and the CFR contain laws and regulations that protect most animals, they do not protect nuisance species. In Virginia, the term "nuisance species" has specific legal meaning, and refers to an animal, primarily a non-native, exotic, or introduced species, that may be controlled without the need to obtain a state or federal permit. Animals that meet the definition of being a nuisance species may be "taken" at any time, but take must be conducted by lawful means. Virginia has classified the European starling, house sparrow, and rock pigeon to be "nuisance" birds; the U.S. Fish and Wildlife Service (USFWS) also has removed protection under the Migratory Bird Treaty Act for the monk parakeet and the mute swan (85 Federal Register 21262).

In addition to those specifically listed, other animals may be considered "nuisance species" only in certain situations (Code of Virginia §29.1-100). Brown-headed cowbirds, red-winged blackbirds, and common grackles may be considered "nuisance species" when they damage ornamental or shade trees, agricultural crops, wildlife, livestock, or other property. They also may be considered nuisance species when they congregate in such numbers that they cause a health hazard (50 CFR 21.43). Where shooting these birds is deemed necessary, it must be done only with a "depredation order" (50 CFR 21.42 and 21.43), and only at sites where use of a firearm is legal and safe.

Permits Required for Trapping and Shooting

It is legal to trap or shoot wildlife classified as "game" and "furbearer" species during established hunting and trapping seasons for those who possess a valid license. The type of damage, the species involved, and the person who conducts the trapping or shooting determines whether a special permit is required. The following information reviews permit information.

Although property owners are granted certain authority to trap wild animals on lands they own, especially in situations involving damage caused by wildlife, how such trapping is conducted and, more importantly, what can be done with any animals captured via trapping are restricted by statute and regulation (4VAC15-30-10; §29.1.521). Of particular concern to those contemplating trapping are regulations pertaining to the disposition of wildlife held in live capture traps. Currently, a landowner has 3 disposition options: (1) release the animal at the point of capture (i.e., elsewhere on property that individual owns), (2) if the animal exhibits evidence of injury or need for care, the landowner can transport the animal to a licensed wildlife rehabilitation facility, but only upon prior notification of the facility's willingness to accept the animal, or (3) the animal must be euthanized humanely. Wild animals cannot be held in possession, transported off the property, or released on land not owned by the individual conducting the trapping. Justification to support restrictions on moving wildlife includes:

- Low survival among translocated animals: for many species, survival following relocation often is less than 25% due to the animal's unfamiliarity with the habitat into which it was placed, competition with other animals of the same species already in the area, late or delayed onset of the effects of stress from the trauma of being trapped, handled, and translocated, and mortality that often occurs as the animal attempts to return to its original home range (e.g., through predation, roadkill, etc.);
- Disease transmission: the probability of spreading a disease carried by the trapped individual to a new or uninfected area can be high, even if the animal is not exhibiting obvious outward symptoms at the time of release;
- Likelihood of infection or injury: due to lack of experience and training in handling wildlife, those attempting to capture and relocate a wild animal place themselves in danger of being bitten, scratched, or injured and potentially exposed to a transmissible disease.

Currently in Virginia, there is a continuous open season to trap beaver (4 VAC 15-60-20), muskrat (4 VAC 15-140-20), opossum (4 VAC 15-160-31), and raccoon (4 VAC 15-210-51) within the incorporated limits of any city or town in the Commonwealth. These regulations also extend to the counties of Arlington, Chesterfield, Fairfax, Henrico, James City, Loudoun, Prince William, Spotsylvania, Stafford, Roanoke, and York.

In Virginia, groundhogs (woodchucks), nutria, and coyotes can be "taken" at any time. There is a continuous open season to take striped skunks (4 VAC 15-220-10). Landowners and their tenants may take spotted skunks when they are committing or are about to commit depredation (4 VAC 15-220-20). Landowners can kill (or hire someone else to kill) foxes on their own property at any time (4 VAC 15-110-80) without a permit. However, if an individual performing the "take" is not the landowner or an immediate family member, he or she must possess a valid hunting or trapping license.

There are several sections in the Code of Virginia that relate to the "take" of problematic wildlife species. In some cases, these provisions partly overlap or appear to contradict those provided by VAC regulations. For example, landowners (including their agents or tenants) can kill beavers at any time and without need for a permit if the animals are damaging crops or lands (Code of Virginia 29.1-518). This is more permissive than the regulation that restricts year-round trapping of beavers only to incorporated cities and towns. Code also allows landowners to shoot or trap other furbearing animals on their own land during closed season when these animals are causing damage to crops or property, or are posing a threat to human health or safety, or are otherwise causing a nuisance (Code of Virginia 29.1-517 and 29.1-530). **This specific provision applies to landowners only, not their agents or designees.**

Landowners and tenants (with written permission of the landowner) may kill rabbits and squirrels for their own use (i.e., consumption) during the closed season (Code of Virginia 29.1-516). However, where these animals are damaging fruit trees, gardens, crops, or other property, landowners must obtain a permit from a conservation police officer if they are having someone else perform the removal before "take" occurs. In areas that prohibit discharge of firearms, landowners or agents may trap and "dispose of" (i.e., euthanize) problematic squirrels at any time (Code of Virginia 29.1-530).

Although Virginia laws and regulations are permissive regarding "nuisance species," this does not apply universally to all wildlife. A conservation police officer can provide specific information on and assistance with other common wildlife conflicts where special permits would be required, such as the following:

- Killing bear and deer (and most other game animals) outside of established seasons requires a kill permit.
- It is illegal in Virginia to kill any species of snake (4 VAC 15-360-10), unless the snake poses an imminent health or safety threat. Landowners are allowed capture and possess no more than one LIVE snake. However, captured snakes must be released alive at the point of capture within 30 days of capture.
- Non-game animals, such as bats, may be taken without a permit ONLY if there are so many that they pose a health hazard or other nuisance. However, with bats, it is possible that endangered or threatened animals may exist within the colony, and special precautions must be implemented to identify and avoid harming any endangered or threatened species before a colony is removed (Code of Virginia 29.1-564; 29.1-568).
- Individuals who regularly perform nuisance wildlife trapping services need a Commercial Nuisance Animal Permit. This permit, available from DWR, eliminates the need for some site-specific damage permits. It allows wildlife managers to trap certain wildlife outside the trapping season without a permit. It also permits managers to transport live captured animals to a euthanasia site. For homeowners, information on locating and obtaining assistance from a certified nuisance wildlife trapper can be found on the Department of Wildlife Resources web site (https://www.dwr.virginia.gov/wildlife/nuisance/trappers/).

Laws and regulations regarding the "take" of problematic wildlife can be quite confusing. Contact DWR with any questions, or hire a professional.

Migratory Birds and Endangered Species

Certain animals are protected by restrictions that require special permits for their control. These animals include:

- migratory birds
- threatened and endangered species.

For more information about permits to "take" protected mammals and non-migratory birds, contact the nearest office of Law Enforcement within DWR (https://dwr.virginia.gov/about/offices/). To learn about permits to take migratory birds, contact USDA-Wildlife Services or the USFWS.

Migratory Birds

Migratory birds are birds that move substantial distances each year from their northern breeding areas to southern wintering grounds. Examples of migratory birds include most perching songbirds, blackbirds, waterfowl and many birds of prey (e.g., hawks, owls, vultures). Migratory birds are protected by the USFWS, the Migratory Bird Treaty Act, and Migratory Bird Treaties.

The Migratory Bird Depredation Order (50 CFR 21.43) allows the "taking" of blackbirds, cowbirds, grackles, crows, and magpies without a permit if they are "committing or about to commit depredations upon ornamental or shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance." However, before the use of lethal methods are allowed, demonstration must be made that non-lethal methods have been attempted, but failed to produce satisfactory resolution. Additionally, anyone using the Depredation Order also must submit an annual report to the regional Migratory Bird Permit Office that provides summary information on outcomes of its use (see https://www.govinfo.gov/content/pkg/CFR-2013-title50-vol9/pdf/CFR-2013-title50-vol9-sec21-43.pdf for details). In Virginia, this order covers ONLY red-winged blackbirds, brown-headed cowbirds, crows, and grackles. In most circumstances, to "take" any other birds protected by the Migratory Bird Treaty Act, a migratory bird depredation permit from the USFWS is needed.

Because resident Canada geese have become such a problem, in August 2006, the USFWS issued the Resident Canada Goose Nest and Egg Depredation Order (50 CFR 21.50), that allows landowners, homeowners' associations, and local governments to destroy the nests and eggs of resident Canada geese without need for a federal permit. However, before performing such activities, landowners must register online with the USFWS (https://epermits.fws.gov/eRCGR). An annual report that summarizes all actions taken to destroy eggs or nests is required. Landowners or their agents may oil, puncture, or addle (shake) the eggs and physically destroy or remove the nests containing these eggs.

This depredation order was supplemented in 2009 with the Agricultural Depredation Order (50 CFR 21.51), which allows landowners engaged in commercial agricultural production to "take" resident Canada geese that are causing damage on land under their direct ownership. "Take" under this order may occur only during the period of May 1 to August 31, but use of attraction tactics typically used in recreational hunting (e.g., use of decoys or calls) is prohibited. Before attempting any "take" of geese, landowners must register with the USDA-Wildlife Services to obtain this no-fee permit. Similar to the Nest and Egg Depredation Order, permit holders are required to file an annual report that summarizes how many geese were destroyed on their property that year.

Birds without federal protection include European starlings, pigeons, monk parakeets, mute swans, and house sparrows. Be aware of current state and federal laws and regulations before using a control method on any animal.

Threatened and Endangered Species

Threatened species are animals heading toward endangerment and possible extinction. Endangered species are animals that are likely to become extinct. The federal Endangered Species Act of 1973 and the Virginia Endangered Species Act protect threatened and endangered species. It is illegal to take a species designated as threatened or endangered without a permit. Contact the USFWS for lists of federally threatened and endangered animals and a list of migratory birds. DWR and the Virginia Department of Conservation and Recreation (DCR) maintain online databases of threatened or endangered species (http://www.dcr.virginia.gov/natural_heritage/infoservices.shtml#lists). Final decisions on approval and limitation of pesticide applications regarding threatened and endangered species are the responsibility of the Environmental Protection Agency.

Decision Making

Good decision-making is critical for effective resolution of human-wildlife conflicts. To properly address a problem, follow these five steps:

Identify and assess the problem. Identify the offending species involved and determine if the conflict warrants some kind of applied control.

Evaluate potential control methods. Where intervention is deemed necessary, assess the suite of legally available options and consider the impacts of each. When deciding which methods to use, consider the following:

- Which method has the fewest harmful consequences?
- Which method is the most cost-effective?
- Which method has the greatest public acceptance?

Discover what permissions are necessary to apply the management tactic(s) you are considering. Seek professional help to handle the problem if necessary.

Implement one or more control method(s). Select and carry out the most suitable method(s), but only after having obtained all necessary permits or authorizations.

Monitor the results. Evaluate whether the action was effective. Decide if and when another treatment is necessary.

Table 8.1 - Recommendations for Homeowners on Managing Wildlife Conflicts

Species	Comments	Cultural control	Mechanical control	Chemical controls (repellents, toxicants)[1]
Mammals:				
Bats	Beneficial for nuisance insect control	No effective methods	Exclusion; repellents; trapping	Yes[2]
Bears		Eliminating access to food; sanitation	Fencing; frightening devices; aversive conditioning methods; legal harvest; shooting[3]	Yes
Beavers		No effective methods	Fencing; water leveling; legal harvest; trapping; shooting[3]	No
Chipmunk		Eliminate access to food; sanitation, especially around bird feeders nd stored dry goods	Exclusion; trapping	Yes[2]
Coyotes		Protecting pets and young livestock; eliminating access to food	Fencing; corrals (night penning); frightening devices; trapping; shooting[3]; destruction of den	No
Deer		Selective planting; early harvesting	Fencing; frightening devices; legal harvest; shooting[3]	Yes
Flying squirrels (southern)		No effective methods	Exclusion; trapping	Yes[2]
Foxes		Eliminate access to food, especially pet food; protecting pets and other domestic animals	Fencing; corrals (night penning); frightening devices; legal harvest; trapping; shooting[3]; destruction of den	Yes* **for gray fox only*[2]
Groundhogs		No effective methods	Fencing; legal harvest; trapping; shooting[3]	Yes[2]
Moles		Packing the soil; killing white grubs[2]	Fencing; trapping	Yes[2]
Muskrats		Drawdown; covering dams in concrete or riprap	Fencing; legal harvest; trapping; shooting[3]	No
Opossums		Sanitation; plugging burrows	Fencing; trapping; shooting[3]	No
Rabbits		Selective planting; early harvesting	Fencing; legal harvest; trapping; shooting[3]	Yes
Raccoons		Eliminating access to food; sanitation	Exclusion; frightening devices; legal harvest; trapping; shooting[3]	Yes[2]
Skunks (striped)		Rodent-control program; sanitation	Exclusion; trapping; shooting[3]	Yes[2]
Tree squirrels		Tree pruning	Exclusion; trapping; shooting[3]	Yes
Voles		Selective planting; grounds maintenance; removal of synthetic weed barriers; limit amount of mulch applied to landscaped beds to no more than 1 inch	Exclusion; trapping	Yes[2]

[1] Properly-certified commercial pesticide applicators who work for-hire are able to apply pesticides not available to homeowners, including toxicants and mating disrupters. Firms using pesticides when providing control services must have a VA Pesticide Business license and employ VA-certified applicators.

[2] Repellent is registered for the animal, but is largely ineffective or has not been proven effective.

[3] Observe ordinances concerning the discharge of a gun and heed DWR hunting regulations (if applicable). Obtain all *necessary permits.*

Species	Comments	Cultural control	Mechanical control	Chemical controls (repellents, toxicants)[1]
Birds:				
Blackbirds		Planting main crops away from roost; timing of harvest	Exclusion; frightening devices; trapping	Yes
Canada geese	Subject to Migratory Bird Treaty Act protections	Eliminate all supplemental feeding: egg addling and/or nest destruction* (*with proper authorization/ permit)	Harassment {including dogs}; installation of vegetation barriers; frightening devices; fencing;water spray devices; legal harvest.	Yes
Crows		Sanitation; decoy foods; thinning trees	Exclusion; frightening devices; trapping; shooting[3]	Yes
European starlings		Sanitation; habitat modification	Exclusion; frightening devices; trapping	Yes
Gulls		Sanitation; removing food sources; habitat management	Exclusion; frightening devices; egg treatment; trapping[3]	Yes
House sparrows		Habitat alteration; roosting site destruction; nest destruction	Exclusion; egg treatment; trapping; shooting[3]; catwalks	Yes
Pigeons		Sanitation; nest destruction	Exclusion; egg treatment; frightening devices; trapping; shooting[3]	Yes
Vultures		Sanitation; removing food sources; protecting pets and livestock	Exclusion; frightening devices; trapping; shooting[3]; physical harassment	No
Other Waterfowl		Timing harvest; discourag-ing feeding; lure crops; habitat modification	Exclusion; frightening devices; trapping*; shooting[3] (*applies only to domestic waterfowl)	Yes
Woodpeckers		Siding color and material selection	Exclusion; frightening devices; harassment	Yes[2]
Reptiles:				
Snakes	State laws protect snakes except when they consti-tute a health hazard	Eliminating hiding places/ref-uges.Cleaning or removing brush piles, rock piles, and other debris. Keeping shrubs away from building foundations and cutting high grass. Eliminating snakes' source of food (especially mice and rats). To get rid of rodents, remove their food and harbor-age. Mow grass short to expose rodent runs.	Trapping, and shooting; however, note that in most sites and situations, snakes are protected animals. Fencing: In an area infested with poisonous snakes, install a snake-proof fence around a backyard or livestock pen. To do this, bury galvanized hardware cloth 6 inches in the ground. The cloth should be 36 inches wide with 1/4-inch mesh. Slant the hardware cloth outward at a 30° angle. Keep all vegetation away from the fence.	Yes[2]
Snapping turtles		Turtles are attracted to heavily mulched landscaped beds or areas of soft soil during seasonal egg-laying.	Stout fencing or other significant physical barrier to block access	No

1 Properly-certified commercial pesticide applicators who work for-hire are able to apply pesticides not available to homeowners, including toxicants and mating disrupters. Firms using pesticides when providing control services must have a VA Pesticide Business license and employ VA-certified applicators.

2 Repellent is registered for the animal, but is largely ineffective or has not been proven effective.

3 Observe ordinances concerning the discharge of a gun and heed DWR hunting regulations (if applicable). Obtain all *necessary permits*.

Selective Planting Recommendations for Deer Management

Planting trees, shrubs, and ornamental flowers that deer don't like to eat frequently is suggested as a way to reduce deer foraging damage. Although this may provide temporary relief where deer populations are low, it will not provide relief where deer density is moderate to high. Nevertheless, homeowners may want to experiment with different plantings to reduce damage, but don't be surprised if a plant found on the "less likely to eat" lists is eaten.

Marigolds, daffodils, chrysanthemums, barberry, potentilla, American holly, boxwood, ornamental grasses, junipers, and some spruce and pine trees (see Table 8.2), are less palatable to deer. Azaleas, pansies, peonies, hostas, roses, and fruit trees (see Table 8.3) are deer favorites. Deer are quite selective and will seek out plants that are the most palatable or provide vital nutrients first. Harvesting garden crops as early as possible also reduces the time that they are exposed to deer. In addition, consider planting palatable crops and ornamentals as far away from wooded areas as possible.

Table 8.2 - Ornamental plants less palatable to deer

Common name	Scientific name
Barberry	*Berberis* spp.
Beautybush	*Kolkwitzia amabilis*
Beech (European)	*Fagus sylvatica*
Birch (paper, European white)	*Betula papyrifera, B. pendula*
Boxwood (common)	*Buxus sempervirens*
Carolina allspice	*Calycanthus floridus*
Cherry (Japanese flowering)	*Prunus serrulata*
Chrysanthemum	*Chrysanthemum* spp.
Daffodil	*Narcissus* spp.
Dogwood (flowering, red osier, kousa)	*Cornus florida, C. sericea, C. kousa*
Drooping leucothoe	*Leucothe fontanesiana*
Enkianthus (redvein)	*Enkianthus campanulatus*
Ferns	*Phylum Pteridophyta*
Forsythia	*Forsythia* spp.
Hawthorne (English)	*Crataegus laevigata*
Holly (American, Chinese, inkberry)	*Ilex opaca, I. cornuta, I. glabra*
Japanese pieris	*Pieris japonica*
Juniper (Chinese)	*Juniperus chinensis*
Lilac (common)	*Syringa vulgaris*
Locust (honey)	*Gleditsia triacanthos*

Table 8.2 - Ornamental plants less palatable to deer (cont.)	
Marigold	*Tagetes erecta, T. patula*
Ornamental grasses (True grasses, sedges, rushes)	Families Gramineae (Poaceae), Cyperaceae, Juncaceae
Peony	*Paeoniaceae* spp.
Pine (Austrian, pitch, mugo, red, scotch)	*Pinus nigra, P. ridgida, P. mugo, P. sylvestris*
Potentilla	*Potentilla fruticosa*
Russian olive	*Elaegnus angustifolia*
Sassafras (common)	*Sassafras albidum*
Spirea (bluebeard)	*Spirea* spp.
Spruce (Colorado blue, Norway, white)	*Picea pungens, P. abies, P. glauca*
Willow (corkscrew)	*Salix matsudana "Tortuosa"*

Table 8.3 - Ornamental plants often damaged by deer

Common name	**Scientific name**
Apple	*Malus* spp.
Arborvitae (American)	*Thuja occidentalis*
Atlantic white cedar	*Chamaecyparis thyoides*
Azalea (evergreen, pinxterbloom)	*Rhododendron periclymenoides (nudiflorum)*
Burning bush	*Euonymus alatus*
Cherry, plum	*Prunus* spp.
Clematis	*Clematis* spp.
Daylily	*Hemerocallis* spp.
Dogwood (Cornelian)	*Cornus mas*
Fir (balsam, fraser)	*Abies balsamea, A. faseri*
Hosta	*Hosta* spp.
Hydrangea (panicle, smooth)	*Hydrangea arborescens, H. paniculata*
Kerria	*Kerria japonica*
Lilies (Asiatic)	*Lilium* hybrids

Table 8.3 - Ornamental plants often damaged by deer (cont.)	
Maple (Norway)	*Acer platanoides*
Mountain ash (European)	*Sorbus aucuparia*
Pansy	*Viola x wittrockiana*
Redbud (eastern)	*Cercis canadensis*
Rhododendron	*Rhododendron* spp.
Rose (hybrid tea)	*Rosa x hybrid*
Rose of Sharon	*Hibiscus syraicus*
Viburnum (doublefile, Korean spice, leatherleaf)	*Viburnum plicatum* var. *tomentosum,* *V. carlesii,*
Wintercreeper	*Euonymus fortunei*
Yew	*Taxus* spp.

Link to Useful Sources of Information

http://pubs.ext.vt.edu/tags.resource.html/pubs_ext_vt_edu:wildlife

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