

PEST MANAGEMENT GUIDE

HORTICULTURAL & FOREST CROPS

2014

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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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Safe and Effective Use

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Introduction

The Pest Management Guide Series

The Virginia Pest Management Guide (PMG) series provides the latest options for control of major pests: diseases, insects, nematodes, and weeds. Each guide is revised annually. These guides are produced by Virginia Cooperative Extension. PMG recommendations are based on research conducted by the Research and Extension Division of Virginia Tech, in cooperation with other land-grant universities, the USDA, and the pest management industry.

These guides are not a comprehensive control plan for all pests in Virginia. However, they do provide management tactics for major pest problems. For specific recommendations beyond the scope of these guides, please contact the Extension specialist(s) associated with the particular commodity or specialty area.

Chemicals listed in the PMG's are registered by the U.S. Environmental Protection Agency (EPA) and the Virginia Department of Agriculture and Consumer Services (VDACS). When used in accordance with label directions, residues should be within tolerance limits set by the EPA. Pesticide users must follow label directions with regard to application site(s), rates of application, number of applications, and minimum time interval between application and harvest. Violation of label directions may result in unsafe residues, fines to the applicator and grower, crop seizure, and loss of public confidence and product marketability.

Use pesticides only on labeled sites, and follow all label directions to the letter!

How To Get Help with a Pest or Pesticide Management Problem

The first rule in solving any problem is to identify the cause before you seek a solution. This rule is especially true for pest management. You **MUST** identify the pest before you make any attempt to control it. If you need assistance with pest identification, there is help available as close as your local Extension office. Local Extension offices are listed in the telephone directory. There is also a list of Virginia Cooperative Extension offices at www.ext.vt.edu/offices/ on the Internet.

Extension offices are located in local county or city governmental units throughout Virginia. The agents and staff members of these units are dedicated professionals. They are part of a unique alliance between the United States Department of Agriculture, Virginia's land-grant universities, and local government.

If a pest is especially difficult to identify or if you need more information, your agent will send a specimen and/or samples to Virginia Tech. Services available include: the Plant Disease Diagnostic Clinic, the Insect Identification Laboratory, the Weed Identification Laboratory, the Soil Testing Laboratory, and the Forage Testing Laboratory. All samples should be sent by your local Extension office. One or more of these services may help to solve pest—or pesticide—management problems.

Alternative Pest Controls

Pest management includes more than the use of pesticides. Virginia agriculture employs a number of non-chemical methods. Alternative controls are an integral part of any cropping system. However, where chemical controls are necessary, they must be used in such a way as to provide for a safe food supply, a clean and healthy environment for humans and wildlife, and a productive and profitable agricultural industry.

Integrated Pest Management (IPM)

Integrated Pest Management (IPM) is an ecological approach to pest control, based on the life cycle and habitat of the pest. It combines all appropriate pest management techniques into a single, unified program or plan. The goal of any IPM program is to reduce pest populations to an acceptable level in a way that is practical, cost-effective, and safe for people and the environment.

Virginia Tech has developed a number of specific IPM programs with precise monitoring (scouting) tactics and thresholds. Each is based on scientific studies of local pest populations and the crops/sites these pests damage. Specific IPM protocols take time and resources to generate; as a result, there is not a prescribed program for each and every pest + site combination

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in the commonwealth. However, an experienced pest manager can apply IPM principles to any situation by: identifying the pest; learning about its life cycle, basic needs, and the environmental conditions that influence its population size and activity; assessing pest population size and distribution by monitoring (scouting); deducing what attracted or brought the pest to the site; acquiring accurate information about management tactics, both chemical and non-chemical; and making long-term plans to prevent or suppress this pest in years to come. For more information about IPM, contact your local Extension agent.

Pesticide Management in Virginia

Virginia Cooperative Extension offers educational programs for the public in pest management and pesticide safety. Examples are commodity production meetings and pesticide safety workshops, including pesticide applicator training and recertification.

Issues and programs such as farmworker protection, recordkeeping, endangered species protection, food and water quality, and re-registration of pesticides mean additional state and federal regulations impacting pesticide users. In Virginia, the Virginia Pesticide Control Act and regulations promulgated under the act affect growers and commercial pesticide applicators. State and federal pesticide laws and regulations are enforced by the Virginia Department of Agriculture and Consumer Services, Office of Pesticide Services.

Growers and applicators are responsible for meeting all requirements imposed by state and federal agencies. For more information about programs, laws, and regulations, contact your local Extension office and/or VDACS/OPS.

Pesticide Applicator Certification

In Virginia, certification is required for most commercial pesticide users, all aerial applicators, and growers who use restricted-use pesticides. The Virginia Pesticide Control Act and regulations drafted under the act define “pesticide use” as actual application, supervision of an application, or commercial recommendation of a pesticide. This includes the routine activities that are part of a pesticide application, such as mixing, loading, clean-up, and disposal. Handling, transfer, or transport after the manufacturer’s original seal is broken is considered “use.” (Pesticide handling typically managed by persons other than the mixer/loader/applicator, such as long-distance transport, long-term storage, or ultimate disposal, is not considered part of routine use.)

Before preparing for certification, you must first decide if you plan to become a Private Applicator, Commercial Applicator, or Registered Technician. Private and Commercial Applicators must be certified in one or more categories, based on the type(s) of pesticide use planned.

Types of Pesticide Applicators

Two general types of certified pesticide applicator are recognized by the Commonwealth of Virginia. Each is described below. Persons engaged in several sorts of pesticide-related activities may need to be certified as both a private and a commercial applicator.

Certified Private Applicator

A certified applicator who uses or supervises the use of any restricted-use pesticide (RUP) to produce an agricultural commodity. Applications must be made on property owned or rented by the user or his/her employer; or, if applied without compensation other than trading of personal services between producers of agricultural commodities, on the property of another person. Noncertified applicators employed by agricultural producers may use RUPs only when under the direct supervision of a certified Private Applicator. Direct supervision, in this case, means the RUP is used by a competent person who is acting under the instructions and control of a certified Private Applicator. The certified Private Applicator is responsible for the actions of the uncertified farmhand. The certified Private Applicator who is in charge of the pesticide use must either be in close proximity to the pesticide user or within telephone or radio contact.

Commercial Applicator

A person using any pesticide for any purpose on the job other than as described for a Private Applicator (production of an agricultural commodity on property the grower owns or leases). Most commercial applicators must be certified. There are two certification options: Commercial Applicator or Registered Technician.

Certified Commercial Applicator

A person who has fulfilled the competency requirements set for Commercial Applicators in Virginia to use or supervise the use of any pesticide for any purpose or on any property on the job other than as described for a Private Applicator.

Certified Registered Technician

An individual who performs services similar to those of a certified Commercial Applicator. Such a person has completed training and demonstration of those competency standards required for Registered Technicians but not the requirements for Commercial Applicator certification. (Registered Technician trainees receive general pesticide safety training and job-specific instruction in pesticide use.) Registered Technicians may use general-use pesticides without supervision. They may use restricted-use pesticides under the direct supervision of a certified Commercial Applicator. Registered Technicians who work for hire must work for a licensed Pesticide Business.

Pesticide Applicator Training Manuals

Pesticide applicator training manuals are sold by Virginia Tech. Orders can be placed online: www.vtpp.ext.vt.edu or vtpp.org. Alternatively, print out an online order page, listing items and shipping cost, and mail it with payment to the address below. (Payment for mail orders: check, money order, or government purchase order.)

Virginia Cooperative Extension
Distribution Center
112 Landsdowne Street
Blacksburg, VA 24060-5814

Certification procedures differ for Private Applicators, Commercial Applicators, and Registered Technicians. For the most up-to-date information about certification requirements, categories, initial certification procedures, and how to keep a certificate in force, contact your local Extension office, Virginia Tech Pesticide Programs, or VDACS Office of Pesticide Services.

Pesticide Laws, Regulations, and Restrictions

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) has been amended several times since it was passed in 1947. The amendments to this act are some of the most significant laws impacting American agriculture.

The 1972 amendment is known as the Federal Environmental Pesticide Control Act (FEPCA). FEPCA stipulates that the use of any pesticide inconsistent with its labeling is prohibited; that violations of FEPCA by growers, applicators, and dealers can result in heavy fines and imprisonment; that pesticides must be classified for either general use or for restricted use; that anyone using or purchasing restricted-use pesticides must be certified by their state of residency; that pesticide manufacturing plants must be inspected by the EPA; that states may register pesticides on a limited basis for special local needs; that all pesticides must be registered by the EPA; that all product registrations must be backed by scientific evidence to control the pests on the label; not injure people, crops, animals, or the environment; and not result in illegal residues in food and feed when used according to label directions.

The 1978 amendment was designed to improve the registration processes. It stipulates that efficacy data can be waived and that generic standards can be set for active ingredients rather than for each product. Re-registration of older products is required to make certain that scientific data exists to back them. Pesticides can be given a conditional registration prior to full registration. Registrants can use supporting data supplied from other companies if paid for. Trade secrets are to be protected. States have primary enforcement responsibility for both federal and their own state pesticide laws and regulations. States can register pesticides under a Special Local Needs (SLN or 24C) label. Finally, the phrase “to use any registered pesticide in a manner inconsistent with its labeling” was defined in detail.

It is illegal to use a pesticide in any way not permitted by the labeling. A pesticide may be used only on the plants, animals, or sites named in the directions for use. You may not use higher rates or more frequent applications. You must follow all directions for use, including directions concerning safety, mixing and loading, application, storage, and disposal. You must wear the specified personal protective equipment. Pesticide use directions and label instructions are not advice, they are legal requirements. Persons who derive income from the application, recommendation, sale, or distribution of pesticides CANNOT make recommendations which call for uses inconsistent with labeling.

However, federal law does allow you to use some pesticides in ways not specifically mentioned in the labeling. You may: apply a pesticide to control a pest not listed on the label (as long as the application is made in accordance with label directions); use any appropriate equipment or method of application not specifically prohibited by the label; mix two or more pesticides if not prohibited by one or more labels and all the dosages are at or below the label rate; and mix a pesticide or pesticides with fertilizer if the mixture is not prohibited by the labeling.

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A major change to FIFRA, provided by the 1988 amendment, requires EPA to accelerate the re-registration of all pesticide products registered prior to 1978. As a result, some older pesticide registrations and/or product uses are being dropped.

The Food Quality Protection Act (FQPA) of 1996 amends both the Federal Food, Drug, and Cosmetic Act (FFDCA) and FIFRA. FQPA provides a unified, comprehensive health-based plan for pesticide residues. Because it requires the EPA to consider pesticide use and safety data in new ways, it will result in significant changes in U.S. pesticide use patterns.

In 2006, EPA initiated a program to re-evaluate all pesticide registrations on a regular cycle. Re-registration and FQPA will impact pesticide availability and labels.

The Virginia Pesticide Control Act

The Virginia Pesticide Control Act is enforced by the Virginia Department of Agriculture and Consumer Services (VDACS). The act and regulations which support it affect pesticide use in Virginia. Information concerning regulatory changes impacting pesticide use is available from Virginia Tech, VDACS Office of Pesticide Services, and your local Extension office.

Responsibilities of Pesticide Applicators in Virginia

I. Follow the Pesticide Label

The pesticide label is a legal agreement between the Environmental Protection Agency (EPA), the product manufacturer, and the user. Pesticide product labels provide instructions for all stages/phases of use. Applicators must read, understand, and follow label directions carefully. Pesticides may not be applied to any site not listed on the product label. Materials may not be applied more often, or at rates higher, than the label directs. Pesticide applicators must follow all label directions for transport, mixing, loading, application, storage, and disposal of pesticide products and containers. State and federal laws prohibit the use of any pesticide in a way that is not consistent with its label. There are state and federal penalties for violations.

II. Adhere to Certification Requirements

Pesticide use means actual application and/or supervision of an application. “Use” includes the routine activities that are part of a pesticide application, such as mixing, loading, cleanup, and disposal. Handling, transfer, or transport after the manufacturer’s original seal is broken is considered “use.” (Pesticide handling typically managed by persons other than the mixer/loader/applicator—such as long-distance transport, long-term storage, or ultimate disposal—is not considered part of routine use.)

Private Applicators:

- In Virginia, a private applicator is a person engaged in producing an agricultural commodity on private property (owned, rented, or leased by the producer).
- Growers using restricted-use pesticides (RUP) must be certified or work under the direct supervision of a certified private applicator.

Commercial Applicators:

- The Virginia Pesticide Control Act defines a person who, as part of his or her job duties, uses or supervises the use of any pesticide for any purpose (other than production of agricultural commodities on private land) as a commercial pesticide applicator.
- Certification options for commercial applicators:
 - registered technician
 - commercial applicator
- Certification requirements depend on the commercial applicator class and scope of pesticide use. In addition, The Virginia Business License Regulation requires that people who make recommendations for-hire be certified. There are four classes of commercial applicator:
 - *Government employees* must be certified to use any pesticide for any purpose.
 - *For-hire* commercial applicators must be certified to use any pesticide for any purpose, and to make recommendations for hire (ex. as a crop consultant).

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- *Not-for-hire* commercial applicator certification requirements vary. People who do not work for hire but do use pesticides on the job must be certified if:

- Using restricted-use pesticides, or
- Using pesticides on the sites in the following list:
 - on any area open to the public at the following establishments:
 - * Educational institutions,
 - * Health-care facilities,
 - * Day-care centers, or
 - * Convalescent facilities;
 - where open food is stored, processed or sold; or
 - on any recreational land over five acres.

- *Inactive* status is a way to maintain certified applicator status while not employed as a pesticide user.

The Virginia Department of Agriculture and Consumer Services (VDACS) is responsible for the certification of applicators and for all enforcement aspects of the Virginia Pesticide Control Act and its regulations.

Certificates may be suspended or revoked if the holder, in the eyes of VDACS, presents a substantial danger or threat of danger to public health and safety or to the environment. A suspension may be issued on an emergency basis, and a certificate may be revoked after a hearing has taken place. If a person's certificate is revoked, he or she may not reapply for Virginia certification for two years.

Persons who have a history of repeat violations of any federal, state, or local pesticide law may not apply for certification. In addition, persons who have had a Virginia applicator certificate revoked may not be granted certification within a two-year period following that action. However, persons in either of these circumstances may petition for certification.

III. Keep Your Certificate in Force

A. Renewal of Certificates

Commercial: Commercial applicator certificates must be renewed every two years. They expire June 30 of the second year after issue. VDACS Office of Pesticide Services will send each commercial applicator a renewal notice when it is time to renew. Return the notice with the \$70 renewal fee on or before June 30 to avoid a \$14 penalty. No late renewals will be accepted after August 29. (See the last paragraph in this section for special conditions for certified applicators who work for federal, state, or local government.)

Applications for renewal will not be processed unless the applicator has met the requirements for recertification credit in the proper category or categories (see section B, which follows). If you allow your certificate(s) to lapse by more than 60 days, you must retest in both the core material and the specific category or categories to reinstate your certificate(s).

All applicators must inform the VDACS-OPS/Certification, Licensing, Registration, and Training Section if their mailing address or employment status changes.

Commercial applicators who work for hire will not be issued renewed certificates unless they have, or work for someone who has, a valid Virginia pesticide business license.

Government applicators do not have to pay application and renewal fees. For this reason, VDACS Office of Pesticide Services does not send renewal notices to government employees who are certified Commercial Applicators and Registered Technicians. Government employee applicators who have met their recertification requirements will receive their renewed certificates automatically.

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Private: Private applicator certificates are automatically renewed biennially at recertification. There is no fee. Private applicator certificates expire on December 31, two years following issue. Late renewals will not be accepted after March 1.

B. Recertification

Private and commercial applicators and registered technicians must participate in an ongoing pesticide education program. At a minimum, commercial applicators and registered technicians must attend at least one fully approved recertification session, per category, every two years. Private applicators must accumulate three credits per category every two years before their certificate expires. Applicators may accumulate up to four years of recertification credit. Persons who fail to recertify will not be able to renew their certificates.

Virginia Cooperative Extension (VCE), pesticide-related trade and professional organizations, and others offer recertification courses. A listing of all Virginia-approved courses may be obtained from:

Virginia Cooperative Extension offices or
Virginia Tech Pesticide Programs (VTPP) Unit:
www.vtpp.ext.vt.edu/ (private applicator courses; searchable database)

VDACS/OPS/Certification, Licensing, Registration, and Training Unit:
www.vdacs.virginia.gov/pesticides/categories.shtml (commercial applicator courses)

Program availability varies by time of year and by category. Most courses are offered between September and March. Applicators are advised to keep in touch with Virginia Cooperative Extension and/or professional organizations to avoid missing recertification opportunities.

Certified applicators based out of state may be able to become certified and recertify in Virginia by reciprocity. Contact the Virginia Department of Agriculture and Consumer Service Office of Pesticide Services for more information.

Failure to maintain a certificate, either due to failure to respond to the renewal notice or failure to recertify, will result in expiration. Persons who allow their certificate(s) to lapse (for more than 60 days) must retest.

Applicators must inform VDACS/OPS if their address changes.

IV. Supervise Employees

A. Registered Technicians by Commercial Applicators

Certified commercial applicators must provide on-the-job training, instruction, and supervision of registered technicians employed by them or assigned to them by their employer. Registered technicians may use restricted-use pesticides only under the direct supervision of a commercial applicator. The supervising commercial applicator must either be physically present or be where the registered technician may contact the applicator by telephone or radio. Certified applicators are responsible for the work of registered technicians under their supervision and must provide the registered technicians with clear, specific instructions on all aspects of pesticide use. A registered technician may apply general-use pesticides unsupervised.

Uncertified persons may apply pesticides commercially while in training to become registered technicians *only* when under the direct, *on-site* supervision of a properly certified commercial applicator.

B. Uncertified Handlers by Private Applicators

Uncertified but competent persons may apply restricted-use pesticides in the production of agricultural commodities on private property when under the direct supervision of a certified private applicator. The certified private applicator is responsible for the actions of the uncertified person.

Direct supervision means the act or process by which the application of a pesticide is made by a competent person acting under the instructions and control of a certified applicator who is responsible for the actions of that person. The certified applicator must be accessible to the applicator by being nearby or within reach by telephone or radio.

V. Handle Pesticides Safely

Although there are no specific storage and disposal regulations in Virginia, unsafe use/handling/storage/disposal practices can be cited under the enforcement regulation: 2 VAC 20-20-10 through 20-220 (VAC is the Virginia Administrative Code).

Provisions to Note:

Handling and Storage:

“No person shall handle, transport, store, display, or distribute pesticides in a manner which may endanger humans or the environment, or food or feed or other products...”

Disposal:

“No person shall dispose of, discard, or store any pesticide or pesticide containers in a manner that may cause injury...or pollute...”

Application Equipment:

“...must...be in good working order...dispense the proper amount of material...be leakproof...have cutoff valves and backflow prevention...”

Service Container Labeling:

Containers other than the original registrant’s or manufacturer’s containers used for the temporary storage or transportation of pesticide concentrates or end-use dilutions must have abbreviated labeling for identification.

A. Pesticide Concentrate:

1. If the pesticide to be temporarily stored or transported is a concentrate to be further diluted, the container shall bear a securely attached label with the following information:
 - a. Product name or brand name from product label;
 - b. EPA registration number from the product label;
 - c. Name and percentage of active ingredient(s) from the product label; and
 - d. Appropriate signal word; i.e., Poison, Danger, Warning, Caution (from the product label).
2. The above labeling is required for concentrate service containers, regardless of container type, size, or capacity. (Note: If possible, keep pesticides in their original container.)

B. Pesticide End-Use Dilutions or End-Use Concentrates:

1. If the pesticide to be temporarily stored or transported will be applied without further dilution, its container must bear a securely attached label with the following information:
 - a. Product name (brand name from product label) preceded by the word “Diluted” or “End-Use Concentrate”;
 - b. EPA registration number from the concentrate product label;
 - c. Name of active ingredient(s) and percentage(s) of end-use dilution; and
 - d. Appropriate signal word; i.e., Poison, Danger, Warning, Caution (from the product label).
2. Exemptions: abbreviated service container labeling is not required for:
 - a. End-use dilution containers not exceeding 3 gallons liquid or 3 pounds dry capacity, when such containers are used as application devices; i.e., hand-held sprayers, dusters, puffers, etc.
 - b. Containers used by farm-supply dealers for the temporary storage or transportation of pesticide concentrate or end-use dilution, provided that sales invoices or delivery tickets adequately identifying the pesticide(s) accompany each shipment or delivery.

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- c. Farm concentrate or end-use dilution containers or application equipment used for the temporary storage or transportation of such pesticides for agricultural use.
- d. Aircraft-mounted containers used for temporary storage or transportation of concentrate or end-use dilution pesticides, provided that aircraft logs or other documents on board adequately identify the pesticide(s).

VI. Keep Accurate Records

A. Commercial Applicators

Virginia regulations require all commercial applicators to keep records of all pesticide applications. These records must be maintained for two years following the pesticide use. Commercial applicator records must contain the following information:

1. Name, address, and telephone number (if applicable) of the treatment site property owner, and address/location of the application site, if different;
2. Name and certification number of the person making or supervising the application;
3. Date of application (day, month, year);
4. Type of plants, crops, animals, or sites treated;
5. Principal pest(s) to be controlled;
6. Acreage, area, or number of plants or animals treated;
7. Identification of pesticide used:
 - Brand name or common name of pesticide used, and
 - EPA product registration number;
8. Amount of pesticide concentrate and amount of diluent (water, etc.) used, by weight or volume, or the volume and concentration applied to a structure as defined in #6; and
9. Type of application equipment used.

Commercial applicators and WPS compliance:

Commercial applicators who apply pesticides to agricultural commodities on farms, forests, nurseries, and greenhouses should be sure their record data elements conform to those required by both the **Worker Protection Standard (WPS)** and the **Food, Agriculture, Conservation, and Trade (FACT) Act**, also known as the 1990 Farm Bill.

- If a grower hires a commercial applicator to apply an RUP, the commercial applicator is responsible for making and maintaining the application records required by the FACT Act.
- If a grower with farm-worker or pesticide-handler employees hires a commercial applicator to apply any pesticide, the commercial applicator must provide the grower with information about the application in advance. This is necessary so that the grower can comply with WPS notification, restricted-entry, and record-keeping requirements.

A sample commercial applicator record-keeping form follows at the end of this section.

B. Private Applicators

The Food, Agriculture, Conservation and Trade (FACT) Act of 1991, also known as the 1990 Farm Bill, requires certified private pesticide applicators to record applications of restricted-use pesticides (RUPs). RUP applications made by a private applicator must be recorded within 14 days and maintained for a period of two years. Private Applicator records must contain the following nine data elements:

1. The restricted-use pesticide brand or product name;
2. The EPA registration number;

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3. The total amount of the restricted-use pesticide product applied;
4. The month, day, and year of application;
5. The location of the treated area;
6. The crop, commodity, stored product, or site to which the restricted-use pesticide was applied;
7. The size of area treated;
8. The name of the certified applicator who applied or supervised the application of the restricted-use pesticide; and
9. The certificate number of the person named in number 8, who made or supervised the application.

Records of spot-treatments may require less information. A spot application is a treatment of an area totalling less than one-tenth of an acre made on the same day. For spot applications record:

1. Brand or product name;
2. EPA registration number;
3. Total amount applied;
4. Month, day, and year of application; and
5. Location of treated area, designated as a “spot application” (with a brief but concise description of the site).

Recording the name and certificate number of the certified private applicator who made or supervised the RUP spot treatments is recommended, although it is not required by federal law.

(Note: Nursery and greenhouse RUP applications do NOT qualify as spot treatments. Greenhouses and nurseries must record all required recordkeeping data elements.)

Certified applicators are required to make records available, upon request, to any Federal or State agency that deals with pesticide use or any health or environmental issue related to the use of restricted-use pesticides. In addition, medical professionals need access to records in the event of an exposure.

The certified applicator who applies a RUP is responsible for making and maintaining the application records required by the FACT Act. However, if a grower hires a commercial applicator to apply a RUP, the commercial applicator is responsible for the FACT Act recordkeeping.

The FACT Act requires commercial applicators to provide a copy of a restricted-use pesticide application record to the person for whom the application was made within 30 days of the application. However, if a private applicator has employees, he/she should obtain the record information prior to any for-hire application — RUP or not — to ensure compliance with WPS posting and notification requirements.

The Federal Worker Protection Standard (WPS) also involves some recordkeeping. Growers who employ field workers or pesticide handlers must display pesticide use and safety information at a central location. WPS requires growers who employ agricultural workers to make, maintain, and post pesticide application records. WPS application records must be kept for every pesticide used on the farm, not just for those that are restricted-use. Growers must post information about each planned application in advance, and for at least 30 days after the expiration of the restricted-entry interval (REI). A WPS application list must record:

1. Brand or product name;
2. EPA registration number;
3. Active ingredient(s) of the product used;
4. Location of the treated area;
5. Time and date the application is scheduled; and
6. Restricted entry interval for the pesticide (duration and expiration).

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WPS application records must be completed prior to the application. They must be displayed for 30 days following the application. WPS application records are part of a broader requirement to provide safety information for agricultural employees at a central location. This includes pesticide use information (in the form of an up-to-date application list), emergency information, and an EPA-approved pesticide safety poster.

Please keep in touch with your local Extension agent for the latest information on record keeping. Your agent will also know about WPS and other pesticide laws and regulations affecting agricultural producers. A sample record-keeping form for producers follows at the end of this section.

Table 1.1 - Pesticide Application Record for Agricultural Producers in Virginia

Note: WPS requires posting of all pesticide application information at a central location for 30 days after the restricted-entry interval expires. USDA records of restricted-use pesticide applications must be kept for two years.

¹ Year Mo/Date	² Crop or Commodity	³ Location & Description of Treated Area	³ Brand or Product Name	¹ Active Ingredient Common Name	³ EPA Registration Number	² # of Units or Acres Treated	² Total Amount of Product Used (oz., lb., pt., qt., gal.)	² Applicator Information: (Name & Certificate No.)	¹ Restricted-Entry Interval (REI)	
									Duration (Hours)	Expiration (Mo/Date/ Time)

¹Required for Worker Protection Standard
²Required for Federal Pesticide Recordkeeping Requirements, USDA
³Required for Worker Protection Standard and Federal Pesticide Recordkeeping Requirements
 Prepared by Virginia Cooperative Extension and VDACS (Virginia Department of Agriculture and Consumer Services), Office of Pesticide Services, 1999.

Table 1.2 - Commercial Applicator Pesticide Application Record

Note: The Commonwealth of Virginia requires commercial applicator records of pesticide applications to be kept for two years.

Name, Address, and Telephone Number of Property Owner	Address and Location of the Application Site <small>(if different than recorded in left column)</small>	Certified Applicator's Name and Certificate Number	Date: <small>(Month, Day, Year)</small>	Type of Plants, Crops, Animals, or Sites Treated	Principal Pest to be Controlled	Acreage, Area, or Number of Plants or Animals Treated	Brand or Common Name of Pesticide	EPA Product Registration Number	Total Amount of Product and Diluent of Diluent <small>(if used)</small>	Type of Application Equipment

VII. Report Pesticide Accidents

Pesticide accidents or incidents that constitute a threat to any person, to public health or safety, and/or to the environment must be reported. Telephone notification is required within 48 hours. A written report describing the accident or incident must be filed within 10 days of the initial notification.

Telephone contacts and written reports should be directed to:

Virginia Department of Agriculture and Consumer Services
Office of Pesticide Services/Enforcement and Field Operations
P. O. Box 1163, Richmond, VA 23218
(804) 371-6560

In the event of an emergency release, notify local authorities immediately, and contact the Virginia Department of Emergency Management (VDEM) Operations Center at 1-800-468-8892.

If the accident or incident involves a spill which may pose a threat to people and/or the environment, the applicator should contact VDACS/OPS to determine whether the release is governed under SARA Title III (the Community Right-to-Know Law). The chemical hazard and the volume of the released chemical determine reporting under SARA Title III, which involves notifying the National Response Center at 1-800-424-8802.

VIII. Obtain a Pesticide Business License

Certified commercial applicators working *for hire* must have a pesticide business license or work for someone who does. Registered technicians working *for hire* must work for a properly licensed pesticide business.

The Virginia Department of Agriculture and Consumer Services is responsible for all enforcement aspects of the Virginia Pesticide Control Act and its regulations. Business licenses may be suspended or revoked if the holder, in the eyes of VDACS, presents a substantial danger or threat of danger to public health and safety or to the environment.

IX. Ensure Financial Responsibility

The commercial applicator *for hire*, or his/her employer, must provide VDACS with evidence of financial responsibility protecting persons who may suffer legal damages as a result of use of any pesticide by the applicator. The coverage must provide for liability that may result from the operation of a pesticide business and for liability relating to completed operations (for businesses that *apply* pesticides). The Commonwealth insures Virginia's state employees for activities performed as official job duties.

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Sources of Information

Questions regarding federal and state pesticide regulations, the legal responsibilities of pesticide users, and certificate/license status:

Virginia Department of Agriculture and Consumer Services (VDACS)
Office of Pesticide Services (OPS)
P.O. Box 1163
Richmond, VA 23218

(804) 371-6558

www.vdacs.virginia.gov/pesticides/

Questions regarding federal and state pesticide regulations, legal responsibilities of pesticide users, pesticide management techniques, and sources of approved preparatory training sessions and recertification workshops:

Virginia Cooperative Extension (VCE)
Virginia Tech Pesticide Programs
302 Agnew Hall (0409)
Virginia Tech
Blacksburg, VA 24061

(540) 231-6543

www.vtpp.ext.vt.edu/ or vtpp.org

Pest management information available on the World Wide Web from Virginia Tech:

Department of Entomology: www.ento.vt.edu

Department of Plant Pathology, Physiology, and Weed Science: www.ppws.vt.edu/

The Hazard Communication Standard

As of May 23, 1988, all employers must adhere to restrictions under the OSHA Hazard Communication Standard. This standard is a worker right-to-know law, which requires employers to train and inform all workers who may be exposed to hazardous chemicals in the workplace. The new law especially targets operations, including agricultural operators, with 10 or more employees. These employers must file a Hazard Communication Plan in their offices and inform their employees of the content of this plan. These employers must obtain and file Material Safety Data Sheets (MSDS) for all chemicals used by their employees. In addition, employers must provide training on the information in the plan, the MSDS, and chemical labeling to each employee who may be potentially exposed to a chemical hazard. This training is very specific to each operation and therefore must be conducted by the employer. Also, when new chemical hazards are introduced into the workplace, the employer must provide new training to protect the employee.

For agricultural operators with fewer than 10 employees, it is not necessary to develop and file a Hazard Communication Plan. However, MSDS and Labeling should be maintained, and employees must be informed of proper use and safe handling according to the MSDS and labeling information. For more information on the standard, contact your local Extension office or the Virginia Department of Labor and Industry.

Community Right To Know (SARA Title III)

The Superfund Amendments and Reauthorization Act of 1986 (SARA Title III) was drafted to require industries and others producing or storing hazardous chemicals to provide communities with the identity and amounts of chemicals located in their vicinity. The law also addresses the need for communities to establish emergency response plans to follow in the event of an emergency.

Section 302 requires a facility to send a one-time written notification to the Virginia Emergency Response Council (VERC) and its jurisdictional local Emergency Planning Committee (LEPC) if the presence of an Extreme Hazardous Substance (EHS) at the facility, at any time, exceeds or equals the threshold planning quantity (TPQ) for that material. For more information, visit this section of the Virginia Department of Environmental Quality website: <http://www.deq.state.va.us/sara3/302.html>

The amount of formulated product that may be stored but not reported depends on the active ingredient itself and percent active ingredient in the product. If a product was 10 percent active ingredient and the TPQ was 10 pounds, then you could store up to 100 pounds of the formulated product before you would be required to report to local authorities.

In the event of a spill, contact local authorities immediately. For help with spill management, contact the Virginia Department of Emergency Management's Operations Center at (800) 468-8892. Spills that pose a threat to people and/or the environment must be reported to VDACS Office of Pesticide Services at (804) 371-6560. If the spill is of a reportable quantity (information available from VDACS), then contact the National Response Center (800) 424-8802.

Worker Protection Standard for Agricultural Pesticides

The EPA's Worker Protection Standard for Agricultural Pesticides (WPS) was developed to protect workers and pesticide handlers from exposures to agricultural pesticides, thus reducing the risks of pesticide poisonings and injuries. The WPS targets workers who perform hand-labor operations in agricultural fields, nurseries, greenhouses, and forests treated with pesticides. It also impacts employees who handle pesticides (mix, load, apply, etc.) for use in those locations. Labels of pesticides used in agricultural plant production, nursery/greenhouse operations, and forestry refer to WPS requirements.

WPS has requirements referenced (**but NOT explained in detail**) on pesticide labels. You will find general information about WPS in the Virginia Core Manual: *Applying Pesticides Correctly*. For comprehensive information, consult the EPA manual: *The Worker Protection Standard for Agricultural Pesticides – How to Comply*. In addition, a WPS Summary Guide produced by VDACS Office of Pesticide Services is available on the agency's website. It provides a great deal of compliance assistance information, including a self inspection checklist. If you have questions about the WPS, please contact your local Extension agent or call the Virginia Department of Agriculture and Consumer Services/Office of Pesticide Services at (804) 786-4845.

Groundwater Restrictions

The EPA and Congress have placed special emphasis on protection of water resources. Water quality programs are being implemented in education and research programs throughout the country. Federal and state efforts to protect groundwater are resulting in revised pesticide product label instructions and new use restrictions. Applicators should expect a continued emphasis on protection of water supplies.

As an applicator and landowner, you must adhere to label restrictions and should follow the best management practices in handling pesticides. Particular attention should be given to prevention of spills, backsiphoning, and disposal of pesticides. Applicators can do much to prevent contamination by following label directions and maintaining and calibrating application equipment. In Virginia, it is against the law to use equipment in poor repair or to fill tanks directly from a water source without an anti-siphon device in use on the spray equipment.

For more information on anti-siphon devices, sometimes referred to as back-flow preventers, contact your local water authority. (*Note: most check valves do not qualify as "anti-siphon" devices because they do not break the siphon.*)

Endangered Species Pesticide Use Restrictions

Under the authority of the Endangered Species Act and FIFRA, the U.S. Fish and Wildlife Service and the EPA may restrict pesticide use where such use jeopardizes a federally listed threatened or endangered species.

The EPA's Endangered Species Protection Program (ESPP) is designed to protect federally listed endangered and threatened species from exposure to pesticides. The program's goal is to ensure that pesticide use does not adversely affect the survival, reproduction, and/or food supply of listed species.

The agency will inform users of enforceable use limitations by means of ESPP Bulletins. Bulletins will provide product users with information about geographically-specific pesticide use restrictions. Bulletins will be referenced on pesticide product labels and available on the internet at www.epa.gov/espp or by calling 1-800-447-3813. (Internet search tip: At the main ESPP page, click on "Bulletins Live!" to view pesticide use limitations for a specific county or active ingredient.)

Applicators using a product with an ESPP reference on the label must check for—and access—a bulletin no more than 6 months prior to applying this pesticide. Failure to follow label-referenced bulletin instructions and provisions, whether or not that failure results in harm to a listed species, is subject to enforcement under the misuse provisions of FIFRA and state law.

Note that not all pesticide active ingredients will have restrictions, and not all pesticide uses are banned in restricted areas.

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Please observe pesticide labeling for changes and keep up to date on this topic. Information is available through your local Extension office or the Virginia Department of Agriculture and Consumer Services.

Guidelines for Disposal of Pesticides and Empty Containers

Always dispose of pesticides and empty containers so they pose no hazard to humans or the environment. Follow label directions and consult your local Extension agent if you have questions. The best solution to the problem of what to do with excess pesticide is to avoid having any. Waste minimization strategies include:

- Buy only the amount needed for a year or a growing season.
- Minimize the amount of product kept in storage.
- Calculate how much diluted pesticide you will need for a job, and mix only that amount.
- Apply pesticide with properly calibrated equipment.
- Use all pesticides in accordance with label instructions.
- Purchase pesticide products packaged in such a way as to minimize disposal problems, or packaged in containers that have legal disposal operations available in your area.

The best disposal option for excess usable pesticide is to find a way to apply the material as directed by the label. Please note that the total amount of active ingredient applied to a site, including all previous applications, must not exceed the rate and frequency allowed by the labeling.

Other pesticide waste disposal options include:

- Follow valid label disposal directions.
- Return product to the dealer, formulator, or manufacturer.
- Participate in a federal indemnification program for canceled/suspended products.
- Employ a professional waste-disposal firm.
- Participate in a state or local “clean day,” such as the Virginia Pesticide Control Board-sponsored Pesticide Disposal Program.

Pesticide wastes that cannot be disposed of right away should be marked to indicate the contents and then stored safely and correctly until legal disposal is possible.

EPA container and containment regulations require registrants to place instructions for container cleaning on product labels. In addition, users should read the label to learn if a container is refillable or non-refillable. One-way, non-refillable containers will have guidelines for proper cleaning and disposal.

Federal law (FIFRA) requires pesticide applicators to rinse “empty” pesticide containers before discarding them. Pesticide containers that have been properly rinsed can be handled and disposed of as non-hazardous solid waste. However, the containers of some commonly used pesticides are classified as hazardous waste if not properly rinsed. Proper disposal of hazardous waste is highly regulated. Improper disposal of a hazardous waste can result in high fines and/or criminal penalties.

A “drip-drained” pesticide container contains product. Immediate and proper rinsing generally removes more than 99 percent of container residues. Properly rinsed pesticide containers pose minimal risk to people and their environment.

There are two methods for proper rinsing:

- Triple Rinsing, and
- Pressure Rinsing.

Pesticide containers should be rinsed as soon as they are emptied. So, the time to rinse is during mixing/loading. If containers are rinsed as soon as they are emptied, the rinse water (rinsate) can be added to the spray tank. This avoids the problem of rinsate disposal and makes sure that nothing is wasted. If containers are rinsed immediately, residues do not have time to dry inside. Dried residues are difficult (or impossible!) to remove. Never postpone container rinsing!

Be sure to wear protective clothing when rinsing pesticide containers. See the product label for information on what to wear.

Pesticide Phone Sales – Buyers Beware

Telephone solicitation of pesticides is a chronic problem for growers and applicators in Virginia. As a general rule, applicators should be wary about buying pesticide products “sight unseen.” Here is a general description of problems often associated with telephone sales offers:

1. The product actually contains a very low percentage of pesticide active ingredient per unit volume. So, it is actually quite expensive to use on a per-area basis.
2. Often, weed control products contain a small proportion of herbicide formulated with diesel fuel or some other petroleum product. These are generally not recommended and not usable in many situations.
3. The product name is similar to the trade name of another well-known pesticide product or sounds like one from a major pesticide manufacturer’s line.
4. The solicitor gives an EPA establishment number but not an EPA registration number. In many cases, this is because the product is not registered with EPA.
5. The product is not registered with VDACS, despite being offered for sale in the commonwealth. This is an illegal practice.

If the potential buyer wishes to follow up on a telephone sales solicitation, he/she should ask for the following information: company name, address, and telephone number; name of salesperson; product name; product registration number; percent active ingredient(s) per unit volume; use site(s); and use rate(s). It is wise to ask for a copy of the label and product MSDS before making a commitment to purchase. If a telephone salesperson does not provide the information you request, the “bargain” is better passed by.

Information given over the telephone can be verified, and the claims for the product can be compared to industry standards or known performance data for the product’s active ingredient(s). To check federal and state product registrations, call:

VDACS/Office of Pesticide Services (804) 371-6558 or VCE/Virginia Tech Pesticide Programs (540) 231-6543

If you receive what you suspect to be an improper sales offer, you’re encouraged to get as much information as possible and make a complaint to VDACS Office of Pesticide Services by calling (804) 371-6558.

Based on the difficulties associated with telephone solicitations, pesticide users are advised to buy from established dealers and from sellers they know.

Pesticide Use Precautions

Efficient and economical control of insects, plant diseases, and weeds is a factor in the production of all crops. Both management costs and losses resulting from inadequate control can reach tremendous proportions. The use of today’s pesticides requires a great degree of precision. In some instances, rates are given in ounces per acre. This requires that pesticide users know how to calibrate equipment and follow detailed directions on product labels.

All pesticides should be used with care. The following suggestions will help minimize the likelihood of injury (from exposure to such chemicals) to people, animals, and non-target plants and animals.

Read the Label: Before buying and applying pesticides, always read all label directions. Follow them exactly when you handle and apply the product. Notice warnings and cautions before opening the container. Repeat the process every time, no matter how often you use a pesticide. The label directions for pesticides often change. Apply materials only on crops specified, at the rate(s) and times indicated on the product label.

Store Pesticides Properly: A suitable storage site for pesticides protects:

- People and animals from accidental exposure.
- The environment from accidental contamination.
- Stored products from damage (from temperature extremes and excess moisture).
- The pesticides from theft, vandalism, and unauthorized use.

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All pesticides should be stored under lock and key, outside the home. Storage facilities should be well-ventilated and well-lit. Pesticide storage areas should be located away from water sources such as ponds or wells. However, a supply of clean water for decontamination is recommended. Use non-porous materials for flooring and shelving. It is important to arrange materials in the storage site so cross-contamination does not occur. Do not store pesticides with food, feed, seed, or fertilizer. An emergency plan should be worked out with local authorities, notifying them of the contents of pesticide storage facilities. If substantial quantities of highly toxic pesticides are stored, you must notify (according to law) your local Emergency Response Council. Proper records should be maintained to provide an up-to-date list of contents at all times. Always store pesticides in their original containers and keep them tightly closed. Never keep pesticides in unmarked containers.

Avoid Physical Contact with Pesticides: Never smoke, eat, chew tobacco, or use snuff while handling or applying pesticides. Use the protective clothing and equipment the label requires. Protect your eyes from pesticides at all times. Avoid inhaling sprays or dusts. Do not spill pesticides on skin or clothing. If they are accidentally spilled, remove contaminated clothing immediately and wash exposed skin thoroughly. Wash hands and face and change to clean clothing after applying pesticides. Wash protective clothing, separate from the family laundry, each day, before re-use. Do not spray with leaking hoses or connections. Do not use the mouth to siphon liquids from containers or to blow out clogged lines, nozzles, etc. **See a doctor if symptoms of illness occur during or after the use of pesticides.** A list of Poison Control Centers located in and around Virginia is included in this guide.

Apply Pesticides Carefully: Successful pest control requires application of the correct amount of pesticide uniformly over a targeted area. Pesticide application is a precise operation requiring reliable, properly calibrated equipment. For example, many herbicides have narrow ranges of selectivity. At the suggested rates of application, they will generally control weeds without damaging the crop, but at a slightly higher rate they may damage or kill the crop.

Dispose of Pesticides Correctly: All pesticides should be disposed of according to container directions. All empty containers should be triple rinsed (or equivalent), crushed, and disposed of as directed by the product label. Rinsate should be placed in the spray tank at the time of mixing. Leftover diluted pesticides should be used according to label directions. Leftover concentrates should be disposed of according to EPA guidelines only after exhausting other options. Amounts of chemicals that do not qualify for disposal under these guidelines must be disposed of by an approved hazardous-waste handler.

Protect Pets, Fish, and Wildlife: To protect fish and other wildlife, do not apply pesticides to streams or areas where drainage may be expected to enter waterways unless the product is labeled for use in such areas. Incorporate all granular pesticides into the soil to prevent birds and other animals from eating particles. Scout fields for dead animals and birds before and after application. Remove any carcasses to prevent poisoning of birds-of-prey and scavengers. Report any wildlife poisonings to the Virginia Department of Game and Inland Fisheries. Be aware of bee cautions; see section to follow on protecting honeybees from pesticides.

Cover food and water containers when treating around livestock or pet areas. Do not discard leftover materials into drainage channels. Confine chemicals to the property and crop being treated.

Prevent Drift: Drift can be a problem with any pesticide. However, herbicide drift is the most commonly encountered cause of pesticide damage to susceptible crops. No pesticide can be applied by either aerial or ground equipment without some drift. Spray drift is influenced by air movement, droplet size, and distance traveled by spray before reaching the target area.

To minimize particle drift, application should be made as close to the ground as possible using spray nozzles which produce large droplets and eliminate "fines." In some instances, spray additives may be used to reduce drift.

Some highly volatile herbicide products are capable of causing injury to off-target plants by movement in the vapor phase after the spray has dried. Use low-volatility formulations and avoid making spray applications when the temperature is high and humidity is low to reduce the possibility of vapor drift.

The farmer and the applicator are liable for damages caused by particle drift or volatility.

Select Pesticide Products Wisely: Two or more pesticides may be equally effective in a given situation. Also, the same active ingredient may be available in a variety of formulations. Your selection of a pesticide and its formulation will be determined by the:

1. Site/crop to be treated.
2. Pest species involved.
3. Product availability.

4. Equipment availability.
5. Hazards to humans, domestic animals, wildlife, and desirable plants.
6. Time of application.
7. Relative total costs of materials and application.

All recommended rates of application are based on the amount of active ingredient in a given product. Many commercial products vary in the percentage of active ingredient. The label will give the exact amount of active ingredient in the container and the amount of product to be used in a given area.

To make an accurate cost comparison, it is wise to calculate the cost per area. In general, concentrated products are more economical. However, they may require more handling (measuring, mixing, and loading) than ready-to-use products.

Poisonings

The procedure to be followed *in case of suspected poisoning*:

- (1) Call a physician immediately. If a doctor is not available, take the exposed person to the nearest hospital emergency room along with the product label and safety data sheet. (If you take a label affixed to a product container, do not carry it in the passenger compartment of a vehicle.)
- (2) If necessary, the attending physician will call the nearest poison control center for further information on toxicity of the suspected agent, treatment, and prognosis. The EPA publication *Recognition and Management of Pesticide Poisonings* is an invaluable resource and can be viewed, downloaded, or ordered online.
- (3) You may call a poison control center for information. However, don't delay seeking medical attention.

NOTE: This information is correct to the best of our knowledge. Listings below were checked for this revision. Please note that this information is subject to change. You should confirm locations and phone numbers of nearby emergency contacts now rather than at the time of a poisoning incident.

Poison Information and Treatment Resources For Virginians

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/

Regional Poison Control Center

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

CHARLOTTESVILLE, VA.

Blue Ridge Poison Center

University of Virginia Health Systems

Jefferson Park Place

1222 Jefferson Park Avenue

Charlottesville, VA 22903

(434) 924-0347 or (800) 222-1222

www.medicine.virginia.edu/community-service/centers/brpc

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Area Poison Control Centers

Hospitals with staff who will provide poison information by telephone. Hospitals equipped for most toxicologic emergencies.

WASHINGTON, D.C.

National Capital Poison Center

3201 New Mexico Ave., NW, Suite 310

Washington, DC 20016

(800) 222-1222

www.poison.org/

CHARLESTON, W.V.

West Virginia Poison Center

3110 MacCorkle Ave., SE

Charleston, WV 25304

(800) 222-1222

www.wvpoisoncenter.org/

RICHMOND, VA.

Virginia Poison Center

Virginia Commonwealth University Medical Center, VCU Health System

1250 East Marshall Street

PO Box 980522 - Richmond, VA - 23298-0522

(804) 828-9123 (for possible exposure)

(Calls from Central and Eastern Va. only)

www.virginiapoison.org

A complete list of Poison Control Centers is available on the World Wide Web at *www.aapcc.org/*

General Information

General Information about pest identification and management and about pesticide safety and use patterns	Virginia Tech Your Local Extension Office www.ext.vt.edu/offices/ Virginia Tech Pesticide Programs (0409) Blacksburg, VA 24061 www.vtpp.ext.vt.edu/	(540) 231-6543
Regulatory Information including certificate or license status	Virginia Dept. of Agriculture and Consumer Services Office of Pesticide Services 102 Governor Street P.O. Box 1163 Richmond, VA 23218 www.vdacs.virginia.gov/pesticides/	(804) 371-6558
Community Right-to-know Environmental Programs	Department of Environmental Quality 629 East Main Street P.O. Box 1105 Richmond, VA 23218 www.deq.state.va.us/	(804) 698-4000 (800) 592-5482
EPA Cooperator for general pesticide information	National Pesticide Information Center (NPIC) Ag. Chemistry Extension Oregon State University 333 Weniger Hall Corvallis, OR 97331-6502 npic.orst.edu/	(800) 858-7378 M-F 10:30 am – 6:30 pm ET
Citizen's Assistance general consumer-related information and complaints	Virginia Dept. of Agriculture and Consumer Services Office of Attorney General Consumer Protection Section 900 East Main Street Richmond, VA 23219 www.vdacs.virginia.gov/consumer/ U.S. Consumer Product Safety Commission 4330 East West Highway Bethesda, MD 20814 www.cpsc.gov/	(804) 786-2042 in the Richmond area (800) 552-9963 outside the Richmond area M - F: 8:30 am - 5:00 pm (800) 638-2772 TTY (301) 595-7054 8:00 am – 5:30 pm
Animal Poisonings Assistance	Va.-Md. Regional College of Veterinary Medicine 265 Duck Pond Drive Virginia Tech (0442) Blacksburg, VA 24061 www.vetmed.vt.edu/	(540) 231-4621 (hospital) Ask your veterinarian to call on your behalf
	ASPCA Animal Poison Control Center \$65.00 consultation fee, credit cards accepted University of Illinois at Urbana-Champaign College of Veterinary Medicine 2001 S. Lincoln Ave. Urbana, IL 61802 www.aspcapro.org/poison	(888) 426-4435
RCRA & Superfund Industry Assistance Hotline	EPA - Resource Conservation Recovery Act (Superfund regulations) www.epa.gov/rcraonline/	(800) 438-2474
Toxicology Information	Virginia Dept. of Health Division of Environmental Epidemiology/Toxicology Program 109 Governor Street P.O. Box 2448 Richmond, VA 23218 www.vdh.virginia.gov/	(804) 864-8127 (toxic substance information)

General Information (cont.)

EPA Safe Drinking Water Hotline	For information on drinking water regulations and pesticides in drinking water. www.epa.gov/safewater/	(800) 426-4791 M-F 10:00 am-4:00 pm
Hazard Communication/OSHA Compliance Information	Virginia Dept. of Labor & Industry 600 East Main Street Suite 207 Richmond, VA 23219 www.doli.virginia.gov/	(804) 371-2327 M-F 8:15 am – 5:00 pm

Industry Associations

Croplife America 1156 15 th St., N.W. Washington, DC 20005		(202) 296-1585 www.croplifeamerica.org/
Virginia Crop Production Association, Inc. (VCPA) 6442 Cross Keys Road Mt. Crawford, VA 22841		(540) 234-9408 www.vacropproduction.com
Responsible Industry for a Sound Environment (RISE) 1156 15th Street, N.W., Suite 400 Washington, DC 20005		(202) 872-3860 www.pestfacts.org/
National Pest Management Association (NPMA) 10460 North Street Fairfax, VA 22030		(703) 352-6762 (800) 678-6722 www.pestworld.org/ (consumer info.) www.npmapestworld.org (PMPs)
Virginia Pest Management Association (VPMA) 102 Bell Road Fredericksburg, VA 22405 P. O. Box 7161 Fredericksburg, VA 22404-7161/		(540) 374-9200 (877) 875-8722 www.vpmaonline.com/
Professional Landcare Network (PLANET) 950 Herndon Parkway, Suite 450 Herndon, VA 20170		(800) 395-2522 (703) 736-9666 www.landcarenetwork.org
Virginia Turfgrass Council (VTC) P.O. Box 5989 Virginia Beach, VA 23471		(757) 464-1004 www.vaturf.org/
Virginia Nursery and Landscape Association 383 Coal Hollow Road Christiansburg, VA 24073-6721		(800) 476-0055 (540) 382-0943 www.vnla.org/

This directory neither endorses the groups listed nor intends to exclude those not listed. To be included in future revisions contact P.A. Hipkins, Virginia Tech Pesticide Programs, 302 Agnew Hall (0409) Virginia Tech, Blacksburg, VA 24061, telephone: (540) 231-8957.

Protective Clothing and Equipment

Dermal exposures account for most of all handler exposures that occur during liquid spray applications. Wearing protective clothing will prevent pesticides from coming into contact with the skin. Any body covering will provide some protection, because dermal absorption is reduced to some degree by a fabric barrier. Protective clothing may be classified according to the part of the body it protects; i.e., feet (boots and shoes), hands (gloves), eyes (goggles and faceshields), head (hats and hoods), and trunk and arms and/or legs (jackets, shirts, pants, coveralls, overalls, and raincoats).

Because of its comfort, conventional work clothing is worn most often. Wearing cotton clothing with a stain-repellent finish provides some protection from dusts and spray mists. However, cotton fabric will provide little or no protection from accidental spills of concentrated pesticides.

Use chemical-resistant garments when handling pesticide concentrates and applying liquids. Adjust work habits and take precautions to prevent heat exhaustion.

Cleaning/Laundering Recommendations

Laundering Information for Pesticide-contaminated Clothing - Before laundering, read the pesticide label. Key words on all pesticide labels identify the toxicity of the product: **DANGER POISON** (highly toxic), **WARNING** (moderately toxic), and **CAUTION** (slightly toxic). Wear waterproof gloves when handling pesticide-contaminated clothing and equipment.

1. **Cotton or Denim Fabric** - Hold and wash contaminated clothing separately from the family wash. Pesticide residues may be transferred from contaminated clothing to other clothing in a hamper, and clothing worn when handling pesticides requires extra washing steps.

Note: Regular laundering will not clean fabric contaminated with highly toxic and/or concentrated pesticide. Clothing saturated with either should be discarded, after slashing/cutting to make the item unusable.

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

1. Pre-soaking in a suitable container.
2. Pre-rinsing with agitation in an automatic washing machine.
3. Spraying/hosing garments outdoors.
4. Pretreating soiled areas with heavy-duty liquid detergent or a stain-removal product.

Clothing worn while using slightly toxic pesticides may be effectively laundered in one machine washing. It is strongly recommended that multiple washings be used on clothing worn while applying more toxic pesticides. Also, multiple wash cycles are recommended for protective clothing treated with starch or water/stain repellents.

When machine-washing, use a full tank of hot water. Choose heavy-duty liquid detergent. Heavy-duty detergents are particularly effective in removing oily soils (the kind emulsifiable concentrate formulations make). In addition, their performance is not affected by water hardness. Increasing the amount of detergent used is recommended, especially if the fabric has been treated with a stain/water repellent finish.

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

Clothing exposed to pesticides should be laundered daily. 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 may retain residues, which are then released in following loads. Rinse the washing machine with an "empty load," using hot water, the same detergent, and machine settings and cycles used for laundering contaminated clothing.

Line drying is recommended for these items. Many pesticides break down when exposed to heat and sunlight. Line drying eliminates the possibility of residues collecting in the dryer.

When dry, apply fabric starch or stain repellent on clothing.

2. **Vinyl-coated fabric, neoprene, or rubber** - This type of outer protective clothing should be pan-washed in warm water 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. Wash after each use.
3. **Gloves and boots** should be rinsed before taking them off, then pan-washed inside and out using a good detergent with several rinses. Remember, gloves must be clean inside because the inner surface will be in contact with your skin. Wash rubber boots the same as gloves.
4. **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.
5. **Goggles** should be washed with a mild detergent so as not to scratch the lens.

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

Chemical Resistance

Many pesticide labels require the use of specific personal protective equipment (PPE) — clothing and devices that protect the body from contact with pesticides or pesticide residues. Some labels call for **chemical-resistant** PPE — items that the pesticide cannot pass through during the time it takes to complete the task. The labels of a few pesticides, such as some fumigants, prohibit the use of chemical-resistant PPE. Please refer to specific product labels for details.

Most chemical-resistant PPE items are plastic or rubber. But not all these materials are equally resistant to all pesticides and under all conditions.

Three factors affect a material's chemical resistance: the exposure time, the exposure situation, and the chemical properties of the pesticide product to which the material is exposed.

Unless the pesticide label directs otherwise, do not use items that are made of — or lined with — absorbent materials such as cotton, leather, or canvas. These materials are not chemical-resistant, and they are difficult or impossible to clean after a pesticide gets on them. Even dry formulations can move quickly through woven materials and may remain in the fibers.

Look for PPE items whose labels state that the materials have been tested using American Society for Testing Materials (ASTM) test methods for chemical resistance, such as test method F739-91. Footwear — and in most cases, gloves — should be at least 14 mils thick.

Pesticides can leak through stitching holes and gaps in seams. For chemical resistance, PPE should have sealed seams.

Any waterproof material is resistant to dry and to water-based pesticides.

Dry pesticides include dusts, granules, pellets, wettable powders, dry flowables (water-dispersible granules), microencapsulated products, soluble powders, and some baits. Water-based pesticides include soluble powders and some solutions.

The type of material that is resistant to non-water-based liquid pesticides depends on the contents of the formulation.

Liquid pesticides that are not water-based may be emulsifiable concentrates, ultra-low-volume and low-volume concentrates, flowables, aerosols, dormant oils, and invert emulsions. Common solvents are xylene, fuel oil, petroleum distillates, and alcohol.

Choosing Chemical-Resistant PPE

Materials are not listed on label.

If the pesticide label requires the use of chemical-resistant PPE but does not indicate the types of materials that are resistant to the product, select sturdy barrier-laminate, butyl, or nitrile materials. Then watch for signs that the material is not resistant to the product. If it is not, it may:

- Change color.
- Become soft or spongy.
- Swell or bubble.
- Dissolve or become jelly-like.
- Crack or get holes.
- Become stiff or brittle.

If any of these changes occur, discard the item and choose another type of material for the task.

Chemical-Resistance Category Listed on Label.

If the pesticide label specifies the PPE materials that **must** be worn when using the product, follow those instructions.

Some labels may list **examples** of PPE materials that are highly resistant to the product. The label may say, for example: "Wear chemical-resistant gloves, such as barrier laminate, butyl, nitrile, or viton." You may choose PPE items made from any of the listed materials.

Pesticide labels sometimes specify a chemical-resistance category (A through H) for PPE to use when working with the product. This allows you to consult an EPA chemical-resistance chart (see below) for PPE material options.

Table 1.3 - EPA Chemical Resistance Category Selection Chart

For use when PPE section on pesticide label lists chemical resistance category

Selection Category Listed On Pesticide Label	Type Of Personal Protective Material							
	Barrier Laminate ≥ 14 mils	Butyl Rubber ≥ 14 mils	Nitrile Rubber ≥ 14 mils	Neoprene Rubber ≥ 14 mils	Natural Rubber ¹	Polyethylene	Polyvinyl Chloride (PVC) ≥ 14 mils	Viton ≥ 14 mils
A (dry and water-based formulations)	high	high	high	high	high	high	high	high
B	high	high	slight	slight	none	slight	slight	slight
C	high	high	high	high	moderate	moderate	high	high
D	high	high	moderate	moderate	none	none	none	slight
E	high	slight	high	high	slight	none	moderate	high
F	high	high	high	moderate	slight	none	slight	high
G	high	slight	slight	slight	none	none	none	high
H	high	slight	slight	slight	none	none	none	high

¹Includes natural rubber blends and laminates

HIGH: Highly chemical resistant. Clean or replace PPE at end of each day’s work period. Rinse off pesticides at rest breaks.

MODERATE: Moderately chemical resistant. Clean or replace PPE within an hour or two of contact.

SLIGHT: Slightly chemical resistant. Clean or replace PPE within ten minutes of contact.

NONE: No chemical resistance. Do not wear this type of material as PPE when contact is possible.

When choosing an appropriate material, consider the dexterity needed for the task and whether the material will withstand the physical demands of the task. The PPE will protect you if:

- the item is in good condition, and no punctures, tears, or abrasions allow pesticide to penetrate the material, and
- pesticide does not get inside the PPE through careless practices, such as allowing pesticide to run into gloves or footwear or putting the PPE on over already-contaminated hands or feet.

Highly Resistant PPE

A rating of **high** means that the material is highly resistant to pesticides in that category. PPE made of this type of material can be expected to protect you for an 8-hour work period. The outside of the PPE, especially gloves, should be washed at rest breaks — about once every 4 hours. Highly resistant PPE is a good choice when handling pesticides, especially concentrates, for long periods of time.

Moderately Resistant PPE

A rating of **moderate** means that the material is moderately resistant to pesticides in that category. PPE made of this type of material can be expected to protect you for 1 or 2 hours. After that, replace the PPE with clean chemical-resistant PPE or thoroughly wash the outside of the PPE with soap and water. Moderately resistant PPE may be a good choice for pesticide handling tasks that last only a couple of hours.

Slightly Resistant PPE

A rating of **slight** means that the material is only slightly resistant to pesticides in that category. PPE made of this type of material can be expected to protect you for only a few minutes after exposure to the pesticide product. Slightly resistant PPE is not a good choice for most pesticide handling tasks.

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Inexpensive disposable gloves or shoe covers, such as those made from polyethylene, may be useful for such brief tasks as:

- Adjusting contaminated parts of equipment.
- Unclogging or adjusting nozzles.
- Opening pesticide containers.
- Moving open pesticide containers or containers with pesticides on the outside.
- Handling heavily contaminated PPE.
- Climbing in and out of cabs or cockpits where the outside of the equipment is contaminated.
- Operating closed systems.

These disposable PPE items should be used only once, for a very short-term task, and then discarded. At the end of the task, it is a good idea to wash the outside of the gloves or shoe covers first, and then remove them by turning them inside out. Discard them so they cannot be reused.

Table 1.4 - Tables of Weights and Measures

<p>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</p> <p>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</p>	<p>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</p> <p>Length Of Row Required For One Acre: <i>Row Spacing Length or Distance</i> 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</p>
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Table 1.5 - Abbreviations For Pesticide Formulations

A = Aerosol	M = Microencapsulated
B = Bait	P = Pellet
C = Concentrate	RTU = Ready to Use
D = Dust	S = Solution
DF = Dry Flowable (see WDG)	SP = Soluble Powder
E or EC = Emulsifiable Concentrate	ULV = Ultra Low Volume
F = Flowable	W or WP = Wettable Powder
G = Granule	WDG = Water Dispersible Granule (see DF)
H/A = Harvest Aid	WS = Water Soluble
IE = Invert Emulsion	WSP = Water Soluble Packet
LC = Liquid Concentrate	

Calibration Tables And Information

Table 1.6 - Travel Speed Chart

Time Required in Seconds to Travel			
Miles per Hour	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 1.7 - Equivalent Quantities of Liquid Materials (Emulsifiable Concentrates, Etc.) for Various Quantities of Water

Water	Quantity of Material					
	100.0 gal ¹	0.5 pt	1.0 pt	2.0 pt	3.0 pt	4.0 pt ¹
50.0 gal	4.0 fl oz	8.0 fl oz	1.0 pt	24.0 fl oz	1.0 qt	2.5 pt
5.0 gal	0.4 fl oz (1.0 tbsp) ²	0.8 fl oz	1.6 fl oz	2.4 fl oz	3.2.0 fl oz	4.0 fl oz
1.0 gal ¹	0.08 fl oz (0.5 tsp) ²	0.16 fl oz (1.0 tsp) ²	0.32 fl oz (2.0 tsp) ²	0.48 fl oz (3.0 tsp) ²	0.64 fl oz ¹	0.8 fl oz (5.0 tsp) ²

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

²Approximate figure.

Table 1.8 - Pounds of Active Ingredients per Gallon, Pounds per Pint of Liquid, and the Number of Pints for Various per Acre Rates

Pounds of Active ingredients in one gallon of commercial product	Pounds of active ingredients per pint ¹	Pints of commercial product needed each acre to give the following pounds of active ingredient					
		0.25 lb/A	0.50 lb/A	0.75 lb/A	1.0 lb/A	1.50 lb/A	2.0 lb/A
2.00	0.25	1.00	2.00	3.00	4.00	6.00	8.00
2.64	0.33	0.75	1.50	2.25	3.00	4.50	6.00
3.00	0.375	0.67	1.33	2.00	2.67	4.00	5.33
3.34	0.42	0.60	1.20	1.80	2.40	3.60	4.80
4.00	0.50	0.50	1.00	1.50	2.00	3.00	4.00
6.00	0.75	0.33	0.67	1.00	1.33	2.00	2.67

¹1 pint = 16 liquid ounces.

Table 1.9 - Available Commercial Materials in Pounds Active Ingredients per Gallon Necessary to Make Various Percentage Concentrate Solutions

Pounds of active ingredients in one gallon of commercial product	Pounds of active ingredients per pint ¹	Liquid ounces of commercial product per one gallon of solution to make:				
		1/2%	1%	2%	5%	10%
2.00	0.25	2.68	5.36	10.72	26.80	53.60
2.64	0.33	2.02	4.05	8.10	20.25	40.44
3.00	0.375	1.78	3.56	7.12	17.80	35.58
3.34	0.42	1.59	3.18	6.36	15.90	31.96
4.00	0.50	1.34	2.67	5.33	13.34	26.69
6.00	0.75	0.89	1.78	3.56	8.90	17.79

¹Based on 8.34 pounds per gallon (weight of water).

Table 1.10 - Converting Pounds Active Ingredients per Acre to Smaller Units for Small Plots

<i>Liquid</i>																
Cubic centimeters (ml) per 100 square feet necessary to apply the following pounds of active ingredients per acre																
Concentrate lbs/A																
lbs/gal	1/8	1/4	1/2	3/4	1	2	3	4	5	6	7	8	9	10	11	12
8.00	0.14	0.27	0.54	0.81	1.08	2.16	3.24	4.32	5.40	6.48	7.56	8.64	9.72	10.80	11.88	12.96
7.00	0.16	0.31	0.62	0.93	1.24	2.48	3.72	4.96	6.20	7.44	8.68	9.92	11.16	12.40	13.64	14.88
6.66	0.16	0.33	0.65	0.99	1.30	2.60	3.91	5.21	6.51	7.80	9.10	10.40	11.70	13.03	14.30	15.60
6.00	0.18	0.36	0.72	1.10	1.45	2.89	4.34	5.78	7.23	8.70	10.15	11.60	13.05	14.46	15.95	17.40
5.00	0.22	0.44	0.87	1.31	1.74	3.47	5.21	6.94	8.68	10.44	12.18	13.92	15.66	17.35	19.14	20.88
4.00	0.27	0.54	1.09	1.64	2.17	4.34	6.51	8.68	10.85	13.02	15.19	17.36	19.53	21.69	23.87	26.04
3.33	0.33	0.65	1.31	1.97	2.61	5.21	7.82	10.42	13.03	15.66	18.27	20.88	23.49	26.06	28.71	31.32
3.00	0.36	0.72	1.45	2.16	2.89	5.78	8.67	11.56	14.45	17.34	20.23	23.12	26.01	28.90	31.79	34.68
2.50	0.43	0.87	1.74	2.61	3.47	6.94	10.41	13.88	17.36	20.82	24.29	27.76	31.12	34.71	38.17	41.64
2.00	0.54	1.09	2.17	3.25	4.34	8.68	13.01	17.35	21.69	26.04	30.38	34.72	39.06	43.38	47.74	52.08
1.00	1.08	2.17	4.34	6.51	8.68	17.35	26.03	34.71	43.39	52.08	60.76	69.44	78.12	86.76	95.48	104.16

<i>Dry</i>												
Grams per 100 square feet necessary to apply the following pounds of active ingredient per acre												
% Active ingredients	lbs											
	1/2	3/4	1	2	3	4	5	7.5	10	20	50	
100.0	0.52	0.78	1.04	2.08	3.12	4.15	5.19	7.79	10.39	20.77	51.94	
90.0	0.58	0.87	1.15	2.31	3.46	4.62	5.77	8.66	11.54	23.08	57.71	
80.0	0.65	0.97	1.30	2.60	3.90	5.19	6.49	9.74	12.98	25.97	64.92	
75.0	0.69	1.04	1.38	2.77	4.15	5.54	6.92	10.39	13.85	27.70	69.25	
50.0	1.04	1.56	2.08	4.15	6.23	8.31	10.39	15.58	20.77	41.55	103.87	
25.0	2.08	3.12	4.15	8.31	12.46	16.62	20.77	31.16	41.55	83.10	207.75	
22.5	2.31	3.46	4.62	9.23	13.85	18.46	23.08	34.62	46.17	92.33	230.83	
20.0	2.60	3.90	5.19	10.39	15.58	20.77	25.97	36.37	51.94	103.87	259.69	
18.5	2.81	4.21	5.61	11.23	16.84	22.46	28.07	42.11	56.15	112.30	280.74	
12.5	4.15	6.23	8.31	16.62	24.93	33.24	41.55	62.32	83.10	166.20	415.50	
10.0	5.19	7.79	10.39	20.77	31.16	41.55	51.94	77.91	103.87	207.75	519.37	
7.5	6.92	10.39	13.85	27.70	41.55	55.40	69.25	103.87	138.50	277.00	692.50	
5.0	10.39	15.58	20.77	41.55	62.32	83.10	103.87	155.81	207.75	415.50	1038.74	
4.0	12.98	19.48	25.97	51.94	77.91	103.87	129.84	194.76	259.69	519.37	1298.43	
2.0	25.97	38.95	51.94	103.87	155.81	207.75	259.69	389.53	519.37	1038.74	2596.86	
1.0	51.94	77.91	103.87	207.75	311.62	415.50	519.37	779.06	1038.74	2077.49	5193.72	

Table 1.11 - Determination of Product Rate per Acre from Active Ingredient Rate

(Liquid Formulations)

Active Ingredient per gallon					
Active Rate lb/A	1.5 lb	2.0 lb	3.0 lb pt/A	4.0 lb	6.0 lb
0.25	1.33	1.0	0.83	0.5	0.33
0.5	2.67	2.0	1.33	1.0	0.67
1.0	5.33	4.0	2.67	2.0	1.33
2.0	10.67	8.0	5.33	4.0	2.67
3.0	16.00	12.0	8.00	6.0	4.00
4.0	21.33	16.0	10.67	8.0	5.50
5.0	27.00	20.0	13.33	10.0	6.67

Table 1.12 - Determination of Product Rate per Acre from Active Ingredient Rate

(Dry Formulations)

Percentage of Active Ingredient in Product										
Active Rate lb/A	5	10	20	25	50	65	70	75	80	90
	lb/A									
0.25	5.0	2.5	1.2	1.0	0.5	0.37	0.36	0.32	0.3	0.28
0.5	10.0	5.0	2.5	2.0	1.0	0.75	0.72	0.65	0.6	0.55
1.0	20.0	10.0	5.0	4.0	2.0	1.50	1.40	1.30	1.2	1.10
2.0	40.0	20.0	10.0	8.0	4.0	3.00	2.90	2.60	2.4	2.20
3.0	60.0	30.0	15.0	12.0	6.0	4.50	4.30	3.90	3.6	3.30
4.0	80.0	40.0	20.0	16.0	8.0	6.00	5.80	5.20	4.8	4.40
5.0	100.0	50.0	25.0	20.0	10.0	7.50	7.20	6.50	6.0	5.50

Calibration of Boom Sprayers

Be sure to calibrate your sprayer properly. NEVER exceed the labeled rate. Using too much pesticide is illegal and may injure your crop. Using too little may result in little or no pest control. Pressure, nozzle orifice size, spacing of nozzles, and speed all affect the application rate. Be sure that all of your spray equipment is in good working order and your sprayer is configured properly.

Large-area Method

1. Measure and stake off one acre (43,560 sq ft) in the field to be treated.
2. Fill sprayer tank with water.
3. Maintain constant pressure and speed while spraying the acre. Mark pressure, throttle, and gear settings.
4. Measure the amount of water used. The amount of water necessary to refill the tank is equal to gallons per acre applied.
5. Make up the spray solution with the correct amount of chemical, based on the amount of water applied per acre.
6. Make the application at pressure, throttle, and gear settings used in calibrating.

“Ounce” Method

1. Mark off a test course, based on the chart below.
(Measure nozzle spacing for booms; row spacing for directed and band rigs.)
2. Fill your tank half full (average weight). Set the throttle for spraying. Get a running start. Drive the test course three times while operating the equipment under field conditions. Record driving times (# of seconds) for each trial.
3. Calculate the average time in seconds required to drive the measured distance.
4. Run the equipment for the average time it took to drive the course, using the same settings (RPMs, pressure). Catch output during that time in a container marked in ounces. (If you are using a boom sprayer, catch the output from one nozzle. If you are using a directed/band rig, catch the spray from all nozzles per row for the prescribed time.)
5. Output in ounces = gallons per acre (GPA) applied.

Table 1.13 - “Ounce” Method Distances

Row Width or Nozzle Spacing (inches)	Distance (feet)	Row Width or Nozzle Spacing (inches)	Distance (feet)
48	85	30	136
46	89	28	146
44	93	24	170
42	97	20	204
40	102	18	227
38	107	15	272
36	113	10	408

This method works because the test course is 1/128th of an acre, and an ounce is 1/128th of a gallon — the proportions are the same.

A word of caution: Be sure to use the right nozzle (and pressure) for the job. Check ALL nozzles (or sets of nozzles, in the case of banding/directed applications) to be sure the pattern and output from each one (or each set) is the same. To check pattern, use a tray designed for this purpose or spray a hard surface and observe how the wetted area dries. Check output with a flow meter, or by catching the output from each for a short time (ex. 10 seconds). Replace any nozzles that do not match the pattern and flow rate of the one(s) you used in the calibration test.

For more information and/or for guidance on calibration methods for other types of equipment, contact your local Extension agent.

Chemical Information Chart

This section contains a chart listing commonly used pesticides (chemical name/trade name), their manufacturers, their actions, and their acute toxicity rating (oral LD₅₀). Pesticides which have been canceled are given only as a reference to their toxicity and should not be used.

This list is for information purposes only and was not meant to endorse or exclude any manufacturers or their products. The names are correct to the best of our knowledge. If mistakes were made, they were unintentional. Please notify the authors if corrections or additions are needed for the next edition.

Names

The common chemical name is the approved name given a pesticide by the American National Standards Committee. An active ingredient may have many trade names, given to a pesticide by the manufacturers/producers.

Action

The specific actions of the pesticides listed are abbreviated as follows:

A	- acaricide	IGR	- insect growth regulator
Anti	- antibiotic	M	- molluscicide
Av	- avicide	Mi	- miticide
B	- bactericide	N	- nematocide
F	- fungicide	PGR	- plant growth regulator
Fum	- fumigant	R	- rodenticide
H	- herbicide	Rep	- repellent
H A	- harvest aid (defoliant)	V	- vertebrate control
I	- insecticide		

Toxicity

Toxicity is the quality, state, or degree of being poisonous. The toxicities listed here are oral. Oral LD₅₀ (mg/kg) is the dosage in milligrams per kilogram of body weight required to kill 50 percent of test animals when given as a single dose by mouth. A milligram/kilogram (mg/kg) is equal to 1 part per million (1 lb in 500 tons). The lower the LD₅₀, the higher the toxicity. Dermal LD₅₀ ratings are in most cases higher (lower in toxicity) than oral ratings.

When registering pesticides, the Environmental Protection Agency (EPA) uses acute LD₅₀ values to determine the toxicity category, words, and symbols that must be placed on the label. For this purpose the test animals are usually mice, rats, or rabbits. The letters LD stand for lethal dose.

Table 1.14 - Toxicity Categories

Toxicity Category	Signal Words* Required on Label by EPA	Oral LD ₅₀ (mg/kg)	Probable Lethal Adult Human Dose
I Highly Toxic	DANGER and POISON, plus skull and crossbones symbol	0 to 50	A few drops to 1 teaspoon
II Moderately Toxic	WARNING	50 to 500	1 teaspoon to 2 teaspoons
III Slightly Toxic	CAUTION	500 to 5,000	1 ounce to 1 pint (1 pound)
IV Almost non-toxic	CAUTION	more than 5,000	1 pint (1 pound)

***Please note:** certain products may use signal words which do not correlate with LD₅₀ ratings due to some special property of the chemical. For example, chlorothalonil has a very low toxicity (LD₅₀ 10,000 mg/kg) yet has DANGER and WARNING signal words on many of its formulations, due to a possibility of an extreme allergic reaction in some people. Also, toxicity (LD₅₀) is relative to the concentration of active ingredient in question and the body weight of the victim.

All LD₅₀ ratings listed here are for technical grade compounds; however, pesticide products are not sold as 100 percent concentrations. To find the LD₅₀ for a specific pesticide product – which takes into account the toxicity of the active ingredients, its concentration, and all other components in the formulation – consult the MSDS. Remember that, if misused, any pesticide can be highly toxic to humans, domestic animals, and wildlife.

Restricted-Use Pesticides (¹)

Those active ingredients having some or all products designated as **restricted use** are marked with a **superscript one** (¹) in Table 1.15. Products that are restricted usually have a higher toxicity, concentration, or other property which makes them more hazardous than products which are designated for general use. Refer to the product label as a guide. Applicators must be certified to use or purchase restricted-use pesticides. Contact your local Extension agent for information on how to become a certified applicator.

Table 1.15 - Chemical Information Chart

Common Name or Designation (¹ =restricted use)	Trade Names Other Names	Action	Company	Acute LD ₅₀ Values for White Rats- Oral (mg/kg) Technical
abamectin ¹	Abba, Agri-Mek, Avid, Greyhound, various	I/Mi	Arborsystems, Syngenta	300
acephate	Orthene, Payload, Pinpoint	I	Dow AgroSciences, MicroFlo, Scotts, Valent	866-945
acetamiprid	Assail, Tristar	I	Cerexagri, Cleary	314-417
acetic acid	vinegar	H	various	331
acetochlor ¹	Cadence, Confidence, Degree, Harness, Surpass, Topnotch	H	Dow AgroSciences, Loveland, Monsanto	2,953
acifluorfen	Blazer, Storm	H	United Phosphorus	2,025
<i>Agrobacterium radiobacter</i>	Galltrol-A, NoGall	B	Agbiochem, Becker-Underwood	low toxicity
alachlor ¹	Intro, Lasso, Micro-Tech Partner	H	MicroFlo, Monsanto	~1,000
aldicarb	Meymik, Temik	I	Ag Logic, Bayer	1
allethrin	various	I	various	680-1,000
allyl isothiocyanate	Bugitol, Dazitol, Get Away	Rep	Champon, Woodstream	151
aluminum phosphide ¹	Fumitoxin, Gastoxin, Phosfume, Phostoxin, Weevil-Cide	Fum	Bernardo, Degesch, Douglas, Pestcon, United Phosphorus	0.3
ametryn	Evik	H	Syngenta	1,110
aminocyclopyrachlor	Method, Capstone, Forefront	H	Dupont	> 5,000
aminopyralid	Milestone, Radar; Chaparral, Opensight	H	Dow AgroSciences	> 5,000
amitraz ¹	Ovasyn, Taktic	H	Bayer, Interbet	800
ammonium nonanoate	Racer	H	Falcon	low toxicity
ancymidol	A-Rest	PGR	Sepro	4,500
anthraquinone	Avipel, Flight Control	Rep/V	Airepel, Arkion Life Science, Sepro	> 5,000
asulam	Asulox	H	Bayer	5,000
atrazine ¹	Aatrex	H	Syngenta, various	3,080
avitrol ¹	Avitrol	AV	Avitrol Corp.	20
azadirachtin	Amazin, Aza-Direct, Azatin, Azatrol, Ecozin, Ornazin	IGR, I, F, Rep	Amvac, Certis, Gowan, Olympic, PBI Gordon, Sepro	> 5,000
azinphos-methyl ¹	Guthion	I	Bayer, Gowan, MicroFlo	5-20
azoxystrobin	Abound, Dynasty, Heritage, Quadris	F	Syngenta	> 5,000
<i>Bacillus cereus</i>	Pix Plus	PGR	Arysta	> 5,000
<i>Bacillus firmus</i>	Vovito	N	Bayer	low toxicity
<i>Bacillus licheniformis</i>	Ecoguard	F	Novozymes	> 5,000
<i>Bacillus pumilus</i>	Ballad, Sonata, Yield-Shield	F	Agraquest, Bayer	> 5,000

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation (¹ =restricted use)	Trade Names Other Names	Action	Company	Acute LD ₅₀ Values for White Rats- Oral (mg/kg) Technical
<i>Bacillus sphaericus</i>	Vectolex	I	Valent	> 5,000
<i>Bacillus subtilis</i>	Companion, Serenade, Rhapsody	F	AgraQuest, Becker-Underwood, Growth Products	> 5,000
<i>Bacillus thuringiensis</i>	DiPel, various	I	various	> 5,000
<i>Beauveria bassiana</i>	Botaniguard, Naturalis	I	Emerald Bio, Troy Biosciences	> 5,000
benefin (benfluralin)	Balan, Team	H	Dow AgroSciences, various	> 10,000
benzamide	Recruit, Shatter	I, IGR	Dow AgroSciences	116
bensulide	Prefar	H	Gowan, various	770
bentazon	Basagran, Rezult	H	BASF, various	1,100
bifenazate	Acramite, Floramite	Mi	Crompton	> 5,000
bifenthrin ¹	Talstar, various	I	FMC, various	54.5
borax	various	I	various	4,500-6,000
Bordeaux Mixture	Copper/Sulfur	F	various	low toxicity
boric acid	various	I	various	low toxicity
brodifacoum ¹	Final, various	R	Bell Labs, various	0.27
bromacil	Hyvar, various	H	DuPont, various	5,200
bromadiolone ¹	Contraq, various	R	Bell Labs, various	0.56-0.84
bromethalin	Assault, Fastrac, various	R	Bell Labs, various	2.0
bromoxynil	Buctril, various	H	Bayer	190
buprofezin	Applaud, Talus, various	IGR	Nichino, Sepro	180-400
butralin	Butralin, Stifle	H, PGR	Crompton	890-1,540
butylate	Butan, Sutan	H	HelmAgro	4659
capsaicin	Hot Sauce, various	Rep	various	> 2,500
captan	Captan, various	F	various	9,000
carbaryl	Sevin, various	I/Mi	various	850
carbendazim	Fungisol, Imisol	F	J.J. Mauget	> 15,000
carbofuran ¹	Furadan	I/N	FMC	11
carboxin	Vitavax	F	various	3,820
carfentrazone-ethyl	Aim	H	FMC	> 5,000
chlorethoxyfos ¹	Fortress	I/Mi	Amvac	1.8-4.8
chlorfenapyr	Phantom, Pylon	I/Mi	BASF, OHP	441
chlorimuron ethyl	Classic, Skirmish	H	Dupont, FMC	4,102
chloroneb	Catapult, Teremec	F	Agrilience, PBI Gordon	> 5,000
chlorophacinone ¹	Rozol	R	Liphatech	3.15
chloropicrin ¹	Chlor-O-Pic	Fum	Great Lakes	250
chlorothalonil	Bravo, Chloronil, various	F	Syngenta, various	> 10,000
chlorpropham	Decco	H, PGR	Cerexagri	3,800
chlorpyrifos ¹	Dursban, Lorsban	I	Dow AgroSciences, various	135-163
chlorsulfuron	Telar	H	DuPont	5,545
chlorthal	Dacthal	H	Amvac	3,000

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation (¹ =restricted use)	Trade Names Other Names	Action	Company	Acute LD ₅₀ Values for White Rats- Oral (mg/kg) Technical
clethodim	Arrow, Envoy, Select, Volunteer	H	Valent, various	1,630
clofentezine ¹	Apollo, Ovation	Mi	Makhteshim-Agan, Scotts-Sierra	> 5,200
clomazone	Command	H	FMC	2,077
clopyralid	Lontrel	H	Dow AgroSciences	> 4,300
cloransulam-methyl	Amplify, FirstRate	H	Dow AgroSciences, Monsanto	> 5,000
clothianidin	Arena, Belay, Celerio, Clutch, Poncho	I	Arysta, BASF	> 5,000
cholecalciferol	Agrid 3, Terad 3	R	Bell	352
copper chelate	Cutrine, various	H(aq)	Applied Biochemists, PBI Gordon	0.50-2.00
copper hydroxide	Kocide, various	H(aq)	Griffin	1,000
copper sulfate	Bluestone, various	H(aq)	various	470
coumaphos ¹	Co-Ral	I/A	Bayer	56-230
m-cresol	Gallex	B	Agbiochem	242
creosote ¹	coal tar	F/I	Koppers	high toxicity
cryolite	Kryocide, Prokil	I	Cerexagri, Gowan	> 10,000
cycloate	Ro-Neet	H	HelmAgro	2,000-3,190
cyfluthrin ¹	Baythroid, Tempo	I	Bayer	400
(gamma-) cyhalothrin ¹	Proaxis, Prolex	I	Helena	50
(lambda-) cyhalothrin ¹	Demand, Karate, Warrior	I	Syngenta	79
cymoxanil	Curzate, Tanos	F	DuPont	1,100
cypermethrin ¹	Ammo, Demon, Prevail	I	various	250-4,150
cyproconazole	Alto	F	Syngenta	1,020
cyprodinil	Vanguard	F	Syngenta	> 2,000
cyromazine	Citation, Trigard	IGR	Syngenta	3,387
2,4-D	various	H/PGR	various	300-700
2,4-DB	various	H	various	370-1,500
DCPA	see chlorthal	—	—	—
daminozide	B-Nine	PGR	Crompton	8,400
dazomet	Basamid, various	Fum	BASF, various	520
decanol	royaltac, various	PGR	Crompton, various	18,000
deet	OFF, various	Rep	SC Johnson, various	8,500
deltamethrin ¹	Decis, various	I/Mi	Bayer, various	> 5,000
desmedipham	Alphanex	H	United Phosphorus	> 10,000
diazinon ¹	Diazion	I	various	300-4
dicamba	Banvel, Vanquish, various	H	BASF, Syngenta, various	1,707-6,764
dichlobenil	Casoron	H	Crompton	> 3,160
1,3-dichloropropene ¹	Telone	Fum	Dow AgroSciences	250-500
dichlorvos	Vapona, various	I	various	56-80
diclofop-methyl ¹	Hoelon, Illoxan	H	Bayer	563

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation (¹ =restricted use)	Trade Names Other Names	Action	Company	Acute LD ₅₀ Values for White Rats- Oral (mg/kg) Technical
dicloran	Allisan, Botran	F	Gowan	> 5,000
dicofol	Dicofol 4E	A	Makhteshim-Agan	595
dicrotophos ¹	Bidrin, Inject	I	Amvac, Mauget	22
difenacoum	various	R	Liphatech	<1
difenoconazole	Dividend, Inspire	F	Syngenta	1,453
difethialone	Sorex, various	R	Whitmire	1-7
diflubenzuron ¹	dimilin	IGR	Crompton	> 4,640
diflufenzopyr-sodium	no stand-alone products	H	BASF	> 5,000
dikegulac sodium	Atrimmec, Pinscher	PGR	Arbor Systems, PBI Gordon	18,000-31,000
dimethipin	Harvade	PGR	Crompton	1,180
dimethoate	Cygon, Dimethoate	I	various	290-325
dimethomorph	Acrobat, Forum, Stature	F	BASF, Sepro	3,900
diphacinone ¹	Ditrac	R	Bell Labs	3
diquat dibromide	Enforcer, Weedtrine-D	H	various	231
dithiopyr	Dimension	H	Dow AgroSciences, various	3,600
diuron	Ginstar, Karmex, Topsite	H	BASF, various	3,400
dodecyl acetate	GBM Sprayable	IGR	3-M	> 5,000
dried blood	Shot-gun, Rabbit-Ridder	Rep	Bonide, Ferti-Lome	low toxicity
egg solids	Deer-Away, Deer-Off	Rep	Woodstream, various	34,600
emamectin ¹	Denim, Proclaim	I	Syngenta	76-89
endosulfan	Thiodan	I	various	40
endothall	Accelerate, Aquathol	H/H(aq)	Cerexagri	51
EPTC	Eptam	H	Syngenta	1,630
esfenvalerate ¹	Asana	I	DuPont	75-458
ethalfuralin	Sonalan	H	Dow AgroSciences	> 10,000
ethephon	Cerone, Ethrel, Florel	PGR	Bayer, various	4,000
ethofenprox	Zenivex	I	Wellmark	> 40,000
ethofumesate	Prograss	H	Bayer	6,400
ethoprop (ethoprophos) ¹	Mocap	I/N	Bayer	62
etoxazole	Tetrasan, Zeal	A, I, IGR, Mi	Valent	> 5,000
etridiazole	Banrot, Terrazole, Truban	F	Crompton, Scotts-Sierra	1,077
fatty acid salts	Hinder, M-Pede, "soaps"	I/Mi, H, Rep	various	50 - > 5,000
fenarimol	Rubigan, Vintage	F	Dow AgroSciences, Gowan	2,500
fenazaquin	Magus	I/Mi	Gowan	134
fenbuconazole	Indar	F	Dow AgroSciences	> 2,000
fenbutatin-oxide (hexakis) ¹	Vendex	A	Griffin	2,630
fenhexamid	Elevate	F	Arvesta	> 2,000

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation (*=restricted use)	Trade Names Other Names	Action	Company	Acute LD ₅₀ Values for White Rats- Oral (mg/kg) Technical
fenoxaprop-ethyl	Acclaim	H	Bayer	4,670
fenoxycarb	Award	IGR	Syngenta	> 10,000
fenpropathrin ¹	Danitol, Tame	A/I	Valent	70
fenpyroximate	Akari, Fujimite, Portal	I/Mi	Nichino, Sepro	480
ferbam	Ferbam	F	Taminco	> 17,000
ferric sodium EDTA	Slug and Snail Killer	M	Safer	low toxicity
fipronil ¹	Frontline, Regent, Termidor	I/Mi	Bayer	336
flonicamid	Aria, Beleaf	I	FMC	> 2,000
fluazifop-P-butyl	Fusilade	H	Syngenta, various	3,680
fluazinam	Omega	F	Syngenta	> 5,000
flubendiamide	Belt, Synapse, Turismo, Vetica	I	Bayer, Nichino	> 2,000
fludioxonil	Maxim, Medallion	F	Syngenta	> 5,000
flufenacet	Define	H	Bayer	589-1,617
flumetralin	Prime +	PGR	Syngenta	> 5,000
flumetsulam	Python	H	Dow AgroSciences	> 5,000
flumiclorac-pentyl	Resource	H	Valent	> 5,000
flumioxazin	Broadstar, Gangster, Payload, SureGuard, Valor	H	Valent	> 5,000
fluometuron	Cotoran, Meturon	H	Griffin	6,416-8,900
fluopicolide	Presidio, Stellar	F	Valent	> 5,000
fluridone	Avast, Sonar	H (aq)	Griffin, Sepro	> 10,000
fluroxypyr	Spotlight, Starane, Vista	H	Dow AgroSciences	> 2,405
flurprimidol	Cutless	PGR	Sepro	709-914
fluthiacet-methyl	Blizzard, Cadet	H	Chemtura, FMC	> 5,000
flutolanil	Contrast, Moncut, Prostar	F	Bayer, Gowan, Scotts-Sierra	> 10,000
flutriafol	Topguard	F	Cheminova	1,140
fluvalinate	Apistan, Mavrik	I	Wellmark	260-280
fomesafen	Flexstar, Reflex	H	Syngenta	1,250-2,000
formic acid	For-Mite	Mi	Apicure, Mann Lake Ltd.	110
fosamine ammonium	Krenite	H	DuPont	10,200
fosetyl-Al	Aliette, Signature	F	Bayer	5,800
gibberellic acid	Gib Gro, Pro-Gibb	PGR	various	630
<i>Gliocladium virens</i>	Soil Gard	F	Certis	low toxicity
glufosinate-ammonium	Derringer, Finale, Ignite, Liberty, Remove, Rely	H	Bayer	1,620-2,000
glyphosate	Accord, Rodeo, Roundup	H	Monsanto, various	4,050-5,600
halosulfuron-methyl	Sandea, Sedgehammer	H	Gowan, Monsanto	1,287
harpin protein	Messenger, Proact	B, I, F, N, PGR	Eden Bioscience	low toxicity
hexaflumuron	Recruit, Shatter	I	Dow AgroSciences	> 5,000

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation (¹=restricted use)	Trade Names Other Names	Action	Company	Acute LD₅₀ Values for White Rats- Oral (mg/kg) Technical
hexazinone	Velpar	H	DuPont	1,690
hexythiazox	Hexygon, Savey	Mi	Gowan	> 5,000
hydramethylnon	Amdro, Seige, Subterfuge	I	BASF, various	1,131-1,300
hydroprene	Gentrol, various	IGR	Bayer, S.C. Johnson, Wellmark	> 34,600
IBA	Hormodin, various	PGR	Geiger, MicroFlo, various	100 (mice)
imazalil	Fungaflor	F	Whitmire	227-343
imazamox	Clearmax, Raptor	H	BASF	> 5,000
imazapic	Cadre, Plateau	H	BASF	> 5,000
imazapyr	Arsenal, Chopper, Contain, Habitat, Stalker	H	BASF	> 5,000
imazaquin	Image, Scepter	H	BASF	> 5,000
imazethapyr	Pursuit	H	BASF	> 5,000
imidacloprid	Admire, Advantage, Merit, various	I/A	Bayer, Cheminova	450
indoxacarb	Advion, Avaunt, Steward	I	DuPont	268-1,732
iodosulfuron	Autumn	H	Bayer	2,678
ipconazole	Acceleron, Rancona, Vortex	F	Monsanto, Chemtura, BASF	> 5,000
iprodione	Rovral	F	Bayer	3,500
isoxaben	Gallery	H	Dow AgroSciences	> 10,000
kinoprene	Enstar	IGR	Wellmark	4,900-5,000
kresoxim-methyl	Cygnus, Sovran	F	BASF	> 5,000
lactofen	Cobra	H	Valent	> 5,000
linuron	Linex, Lorox	H	Griffin	1,500-4,000
magnesium phosphide ¹	Fumi-Cel, Fumi-Strip, Magtoxin	Fum	Degesch	0.3
malathion	Cythion, Fyfanon, Malathion, various	I	various	1,375-2,800
maleic hydrazide	MH-30, various	H/PGR	various	6,950
mancozeb	Dithane, Fore, Manzate, various	F	various	> 5,000
MCPA	MCPA	H	various	700-800
mecoprop	MCPP, MecoMec	H	PBI/Gordon, Riverdale, Scott's	930
mefenoxam	see metalaxyl-M	—	—	—
mefluidide	Embark, Sta-Lo	H/PGR	PBI/Gordon, various	> 4,000
mesotrione	Callisto, Tenacity	H	Syngenta	> 5,000
metaflumizone	Siesta	I	BASF	> 5,000
metalaxyl-M (mefenoxam)	Apron, Mefenoxam, Subdue	F	various	1,040
metaldehyde	Deadline, various	M	various	630
metam-sodium ¹	Vapam, various	Fum	Amvac, various	1,800
metconazole	Caramba, Quash, Tourney	F	BASF, Valent	660
methanone	Disarm, Evito	F	Arysta	> 5,000
methanone	Frequency, Huskie, Impact	H	Amvac, BASF	> 2,000

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation (¹ =restricted use)	Trade Names Other Names	Action	Company	Acute LD ₅₀ Values for White Rats- Oral (mg/kg) Technical
methiocarb ¹	Mesurool	I/M/Rep	Gowan	15-35
methomyl ¹	Lannate, Larvin, various	I/N	Bayer, DuPont, various	17-24
methoprene	Altosid, various	IGR	Wellmark Intl., various	34,600
methoxyfenozide	Intrepid	I	Dow AgroSciences	> 5,000
methyl anthranilate	BirdShield, ReJex-iT	Rep	Becker-Underwood, various	> 5,000
methyl bromide ¹	Bromo-O-Gas, Metabrom, Meth- O-Gas	Fum	Great Lakes, various	200 (vapor)
metiram	Polyram	F	Loveland	> 10,000
metolachlor	Cinch, Dual, Pennant	H	Syngenta, various	2,780
metribuzin	Metribuzin, Sencor, Tricor	H	Bayer, various	1,100-2,300
metsulfuron-methyl	Ally, Escort	H	DuPont, various	> 5,000
mineral oil	Volck Oil Spray, various	I/A	various	low toxicity
myclobutanil	Eagle, Laredo, Nova, various	F	Dow AgroSciences, various	1,600-2,290
NAA	Dip-N-Grow, RootMaster	PGR	various	1,000
NAD	Amid-Thin, Rootone	PGR	Amvac, Bayer	1,000
naled	Dibrom, Trumpet	I	Amvac	430
naphthalene	"moth balls"	Fum// Rep	various	50-500
napropamide	Devrinol	H	United Phosphorus	5,000
naptalam	Alanap	H	Crompton	8,200
neem	see azadirachtin	—	—	—
nicarbazin	Ovocontrol	Av	Innolytics, LLC	10,000
nicosulfuron	Accent	H	DuPont	> 5,000
norflurazon	Predict, Solicam, Zorial	H	Syngenta	> 9,400
novaluron	Diamond, Pedestal, Rimon	I	Crompton	> 5,000
noviflumuron	Recruit	IGR	Dow AgroSciences	> 5,000
oryzalin	Surflan, various	H	United Phosphorus, various	> 10,000
oxadiazon	Ronstar, various	H	Bayer, various	> 8,000
oxamyl ¹	Vydate	I/N	DuPont	5.4
oxydemeton-methyl ¹	MSR	I, Mi	Gowan	65-75
oxyfluorfen	Goal, various	H	Dow AgroSciences, various	> 5,000
oxytetracycline	Mycoject, Mycoshield, Treotech	F	various	low toxicity
paclobutrazol	Bonzi, Cambistat, Piccolo, Profile, Trimmit	PGR	Crompton, Rainbow Treecare, Sepro, Sci Reg, Syngenta	5,346
paradichlorobenzene	"moth balls"	I/Rep	various	500-5,000
paraquat ¹	Gramoxone	H	Syngenta	150
pendimethalin	Pendulum, Prowl, various	H	BASF, Scott's, various	1,250
pentachloronitrobenzene	PNCB, Terraclor	F	Amvac, Crompton	1,650-12,000
permethrin ¹	Ambush, Pounce, various	I	Amvac, FMC, various	4,000
phenimedipham	Spin Aid	H	Bayer	> 4,000

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation (¹ =restricted use)	Trade Names Other Names	Action	Company	Acute LD ₅₀ Values for White Rats- Oral (mg/kg) Technical
phorate ¹	Thimet	I	BASF, various	2-4
phosmet	Imidan	I	Gowan	147-316
phosphine gas ¹ (hydrogen phosphide)	Eco 2 Fume, VapoPh30s	I/Mi, Fum	Cytec Ind.	0.3
phostebupirim ¹	Aztec ¹ (w/cyfluthrin)	I	Amvac, Bayer	2.9-3.6
picaridin	Cutter, Off	Rep	S.C. Johnson, Spectrum	4,743
picloram ¹	Tordon K	H	Dow AgroSciences	8,200
pinoxaden	Axial	H	Syngenta	> 5,000
piperalin	Pipron	F	Sepro	2,500
piperonyl butoxide	(used as a synergist)	I	various	> 7,500
pirimiphos-methyl	Actellic	I	Agrilience	> 2,000
potassium bicarbonate	Armicarb, Kaligreen, Milstop, Remedy	F	Agrivert, Helena, Viaworks	500-5,000
primisulfuron-methyl	Beacon	H	Syngenta	5,050
prodiamine	Barricade, Endurance, various	H	Syngenta, various	> 5,000
profenofos ¹	Curacron	I, A	Syngenta	358
prohexadione calcium	Apogee	PGR	BASF	> 5,000
prometon	Pramitol, various	H	various	2,980
prometryn	Caparol, Cotton-Pro, various	H	Syngenta, various	5,235
pronamide ¹ (propyzamide) ¹	Break-Up ¹ , Kerb (Kerb WSP/50WSP only ¹)	H	Dow AgroSciences, United Phosphorus	5,620-8,350
propamocarb hydrochloride	Banol, Previcur, Stellar	F	Bayer, Prokoz, Valent	8,600
propargite	Comite, Omite, Ornamite	A	Crompton	2,200
propiconazole	Alamo, Banner, Orbit, Tilt	F	Syngenta	1,517
propoxur	Baygon, various	I/Mi	Bayer, various	95-104
propyzamide ¹	see pronamide	—	—	—
prosulfuron	Peak	H	Syngenta	4,360
prothioconazole	Proline	F	Bayer	> 6,200
pymetrozine	Endeavor, Fulfill	I	Syngenta	5,820
pyraclostrobin	Cabrio, Headline, Insignia	F	BASF	500-> 2,000
pyrazon	Thiadiazuron	H	Arysta	2,200
pyrethrum	Pyrethrins	I	various	584-900
pyridaben	Nexter, Sanmite	I/Mi	Gowan	820-1,350
pyrithiobac-sodium	Staple	H	DuPont	4,000
pyroxsulam	PowerFlex	H	Dow AgroSciences	> 2,000
quinclorac	Drive, Paramount	H	BASF	> 2,610
quinoxifen	Quintec	F	Dow AgroSciences	> 5,000
quizalofop-p-ethyl	Assure II, Targa	H	DuPont, Gowan	1,182-1,210
resmethrin ¹	various	I	Bayer, Bonide, various	> 2,500
rimsulfuron	Matrix, Resolve, Shadeout, Tranxit	H	DuPont	> 5,000

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation (¹ =restricted use)	Trade Names Other Names	Action	Company	Acute LD ₅₀ Values for White Rats- Oral (mg/kg) Technical
rotenone ¹	various	I	Bonide, Dragon, various	132-1,500
saflufenacil	Heat, Integrity, Optill, Sharpen, Treevix, Verdict	H	BASF	> 2,000
sethoxydim	Poast, Vantage, various	H	BASF	2,676-3,200
siduron	Tupersan, various	H	various	> 7,500
silica gel	various	I	various	3,160
simazine	Princep, various	H	Syngenta, various	> 5,000
sodium chlorate	various	H	various	1,200
sodium chloride	TABLE SALT	H	Morton	3,320
sodium cyanide ¹	M-44	V	USDA-APHIS-ADC	6.4
sodium fluoroacetate ¹	1080	V	USDA-APHIS-ADC	0.22
spinetoram	Delegate, Radiant	I	Dow AgroSciences	> 5,000
spinosad	Blackhawk, Conserve, SpinTor, Tracer	I/Mi	Dow AgroSciences, various	> 5,000
spirotetramat	Kontos, Movento	I	Bayer	> 2,000
streptomycin sulfate	Agri-Mycin, various	F	various	> 10,000
sulfentrazone	Authority, Spartan	H	DuPont, FMC	2,855
sulfometuron-methyl	Oust	H	DuPont, various	> 5,000
sulfosulfuron	Certainty, Maverick, Outrider	H	Monsanto	> 5,000
sulfoxaflor	Closer, Transform	I	Dow Agro Sciences	1,000
sulfur	Brimstone, Thiolux	F, I/Mi	Syngenta, various	low toxicity
sulfuryl fluoride ¹	Profume, Vikane, Zythor	Fum	Dow AgroSciences, Ensystem II	100
tebuconazole	Elite, Folicur, Orius, various	F	Bayer, various	4,000
tebufenozide	RH 5992	I	Dow AgroSciences	> 5,000
tebupirionfos ¹	see phostebupirim ¹	—	—	—
tebuthiuron	Spike	H	Dow AgroSciences	579
tefluthrin ¹	Force	I	Syngenta	20-35
tembotrione	Laudis	H	Bayer	> 2,000
temephos	Abate	I	Clarke	8,600-13,000
terbacil	Sinbar	H	DuPont	> 5,000
terbufos ¹	Counter	I	BASF	1.6
tetrachlorvinphos	Rabon	I	various	4,000-5,000
tetraconazole	Domark, Eminent, Mettle	F	Valent, Sipcam Agro, Isa Agro	1,248
tetramethrin	various	I	various	4,640
thiabendazole	Arbotect, Mertect	F	Syngenta	3,810
thiencarbazone-methyl	no stand-alone products	H	Bayer	> 2,000
thiamethoxam	Actara, Centric, Cruiser, Platinum	I/Mi	Syngenta	1,563
thidiazuron	Dropp, Ginstar, Leafless	HA	Bayer, Uniroyal	> 5,000
thifensulfuron-methyl	Harmony, Pinnacle	H	DuPont	> 5,000
thiodicarb	Larvin	I/Mi	Bayer	66

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation (¹ =restricted use)	Trade Names Other Names	Action	Company	Acute LD ₅₀ Values for White Rats- Oral (mg/kg) Technical
thiophanate methyl	3336, Spectro, Topsin	F	Cerexagri, Cleary, various	7,500
thiram	Spotrete	F/Rep	Cleary, various	780
topramezone	Armezon, Frequency, Impact	H	BASF, Amvac	> 2,000
tralkoxydim	Achieve	H	Syngenta	934-1,324
tralomethrin ¹	Saga, Scout X-TRA	I	AgrEvo, Bayer	1,000-1,250
triadimefon	Bayleton	F	Bayer	317-568
triadimenol	Baytan	F	Gustafson	700-1,200
tribenuron-methyl	Express	H	DuPont	> 5,000
tribuphos (tribufos)	Def 6, Folex 6	HA	Aventis, Bayer, Micro-Flo	250
tributyltin ¹	various	B, F, M	various	46
trichlorfon	Dylox	I	Bayer	560-630
<i>Trichoderma harzianum</i>	Plantshield, Rootshield, Turfshield	F	Bioworks	low toxicity
triclopyr	Garlon	H	Dow AgroSciences, various	713
trifloxystrobin	Compass, Flint, Gem	F	Bayer	> 4,000
trifloxysulfuron-sodium	Envoke, Monument	H	Syngenta	> 5,000
triflumizole	Procure, Terraguard	F	Crompton	2,230
trifluralin	Preen, Treflan, Tri-4, various	H	BASF, Dow AgroSciences,	> 10,000
triforine	Funginex	F	Scotts	> 16,000
trinexapac-ethyl	Primo	PGR	Syngenta	> 5,000
uniconazole	Sumagic	PGR	Valent	2,020
vinclozolin	Ronilan	F	BASF	> 10,000
warfarin	Rodex	R	Bell, Haco, various	186
zinc phosphide ¹	Gopha-Rid, various	R	Bell, various	45.7
ziram	Ziram	F	Cerexagri	1,400
zoxamide	Zoxium	F	Dow AgroSciences	> 5,000

Protecting Honey Bees

Brenna Traver, Entomologist, Virginia Tech

The poisoning of honey bees and other beneficial insects by pesticides can be a serious problem. Honey bees provide a valuable service to agriculture because they are the most important pollinators of cultivated crops. They also produce honey and beeswax. Efforts should be made to protect honey bees whenever pesticides are used. The protection of honeybees has become even more critical in recent years because of increased colony losses and the uncertain role that pesticides play in colony losses.

Causes of Bee Poisoning

1. Most bee poisoning occurs when insecticides are applied to crops in bloom. This includes crop plants such as sweet corn, which is routinely sprayed when in tassel. While honey bees do not pollinate corn, they will collect pollen from corn tassels.
2. The application of insecticides to fields with weeds that are in bloom. The spring application of insecticides to alfalfa fields with flowering weeds is a particular problem in Virginia.
3. Drift of toxic sprays or dusts onto adjoining crops or weeds that are in bloom.
4. The contamination of flowering ground-cover crops in orchards when spray applications are made.
5. The contamination of water. This includes water collected by bees for drinking and cooling the hive as well as contact with contaminated water or dew on foliage or flowers.
6. The use of systemic insecticides and the possible contamination of nectar and pollen. This is a concern with the use of neonicotinoid insecticides, such as clothianidin, imidacloprid, and thiamethoxam, although more research is needed.

The most serious problems occur when bees collect contaminated pollen or nectar and carry these materials back to the hive. Insecticidal dusts (particularly Sevin) and encapsulated insecticides are especially dangerous because they adhere to foraging bees and may be collected and stored in the hive with pollen. Such materials can cause serious bee kills within the hive for many months.

Ways to Reduce Bee Poisoning

1. When using pesticides that are hazardous to bees, notify the beekeeper so that colonies may be moved or protected.
2. Do not apply insecticides that are toxic to bees on crops in bloom.
3. Use insecticides that are less toxic to bees when such choices are consistent with pest control recommendations (see the table of relative toxicities).
4. Choose the least hazardous formulations when possible. Dusts and encapsulated insecticides are more toxic than sprays of the same material. Wettable powder sprays tend to have a longer residual effect (and are more toxic) than emulsifiable concentrate sprays. Granular applications are usually the safest method of treatment around bees.
5. Avoid drift of toxic sprays onto ground-cover plants, weeds, and crops in nearby fields.
6. Control weeds in fields and avoid direct insecticide applications to flowering weeds whenever possible.
7. If ground-cover plants in orchards are in bloom, mow before spraying.
8. Apply insecticides when bees are not actively foraging, either in the late evening or early morning. This is particularly important with crops such as corn where evening applications avoid many problems since pollen release occurs in the morning. In general, evening applications are least hazardous.
9. Do not apply insecticides when temperatures are expected to be unusually low following treatment. Residues remain toxic to bees for a longer time under such conditions.
10. Avoid direct treatment over colonies.
11. Contact beekeepers with nearby colonies before treatment so that they can move the hives or confine the bees if potential bee losses might occur.

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 bees are present at treatment time or within a day **thereafter**.

Abamectin	Baytex (fenthion)	Denim (emamectin benzoate)	(zeta-cypermethrin)	Titan, Clutch, Acceleron, Arena, Belay, Celero (clothianidin)	Supracide (methidathion)
Acetamiprid, Assail, Tristar	Baythroid (cyfluthrin)	Dibrom (naled)	Guard Star (permethrin) ¹		Swat (bonyl)
Acramite (bifenazate)	Bidrin (dicrotophos)	De-fend, Dimate (dimethoate)	Guthion (azinphos-methyl)	Pounce (permethrin)	Synthrin (resmethrin)
Actara, Centric, Platinum, Helix, Cruiser, Adage (thiamethoxam)	Capture, Annex, Brigade (bifenthrin)	Diazinon (spectracide)	Imidan (phosmet)	Prallethrin	Talstar
Acephate	Carzol	Dimecron (phosphamidon)	Karate	Proaxis (gamma-cyhalo- thrin)	Tameron (methamidophos)
Admire, Advantage, Gaucho, Merit, Premise, Touchstone (imidacloprid)	Cidial (phenthoate)	Dinotefuran	Lannate D (methomyl)	Proclaim (emamectin)	Tefluthrin (Force)
Advantage	Clutch (clothianidin)	Dursban, Eradex (chlorpyrifos)	Lindane	Provado (imidacloprid)	Temik (aldicarb)
Ambush (permethrin)	Comply (fenoxycarb)	Ectrin (fenvalerate)	Lorsban (chlorpyrifos)	Pydrin (fenvalerate 0.1 lb/A) ²	TEPP
Ammo (Fury) (>.025 lb/acre) (cypermethrin)	Curacron (profenofos)	Endigo	Malathion	Pylon, Phantom (chlorfenapyr)	Tralomethrin (Saga)
Apollo, Ovation (clofentezine)	Cygon (dimethoate)	Envidor (spiroadiclofen)	Matacil (aminocarb)	Pyramite	Trimax
Asana (esfenvalerate)	Cymbush	EPN	Mesuroil (methiocarb)		Vapona (dichlorvos)
Avaunt (Advion) (indoxacarb)	Danitol (fenoprothathin)	Ethyl guthion (azinphos-ethyl)	Monitor (methamidophos)	Rebelate (dimethoate)	Venom (dinotefuran)
Avid (avermectin)	Dasanit (fensulfothion)	Famphos (famphur)	Nexter (pyridaben)	Resmethrin	Warrior (lambda-cyhalo- thrin)
Azodrin (monocrotophos)	DDVP (dichlorvos)	Ficam (bendiocarb)	Nudrin (methomyl)	Scout (tralomethrin)	Zectran (mexacarbate)
Baygon (propoxur)	Decis (decamethrin)	Flagship (thiamethoxam)	Orthene (acephate)	Sevin (carbaryl) ³	Zephyr (Agri-Mek) (abamectin)
	Delegate, Radiant (spinetoram)	Folimat	Parathion	Sniper	Zeta-cypermethrin
		Fipronil	Pay Off (flucythrinate)	Spectracide	
		Furadan F (carbofuran)	Phosphamidon	Steward (indoxacarb)	
		Fury	Pirimiphos-methyl (Execute, Actellic)	Sumithion (fenitrothion)	
			Poncho,		

¹Can be applied to ground in front of beehives for the control of small hive beetles.

²Can be applied in the late evening at rate of 0.1 lb/A or less.

³Some formulations of Sevin XLR are rated as moderately toxic.

Group II. Moderately Toxic

These can be used around bees if dosage, timing, and method of application are correct, but should not be applied directly on bees in the field or at the colonies. Safest if applied during late evening, night, or very early morning.

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

¹Checkmite (coumaphos) strip can be used in beehives to treat for varroa mites and small hive beetles.

²Thimet EC should only be applied during late evening.

Group III. Relatively Nontoxic

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

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

¹Fluvalinate is used in Apistan strips to treat beehives for varroa mites. It is illegal to use Mavrik in hives.

1-48 Regulations and Basic Information: *Protecting Honey Bees*

Fungicides

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

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

¹ May increase the toxicity of neonicotinoid insecticides to honeybees if used together.

² May cause loss of honeybee larvae. Use with caution where bees are foraging.

Herbicides, Defoliants and Dessicants

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

¹ Slightly toxic to honey bees

Diseases and Insects

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Effective control of pests that occur in commercial small fruit crops is obtained only through the judicious use of pesticides combined with sound management practices, nutrition, and sanitation. Close observation should be used to determine which pests are present and when treatments should be applied to be most effective. Pesticides are used most frequently by the grower for pest control, and they usually are applied as sprays or occasionally as dusts. The problem of selecting the correct pesticide to do a specific job continues to be challenging to commercial growers. The success or failure of any spray program is not due entirely to the specific pesticide or amount placed in the sprayer tank, but is also influenced by proper timing, thorough application, and weather conditions at the time of application.

The pesticides recommended here have proven to be effective and useful in the control of various common diseases and insects. Differences may exist among them in their effectiveness against specific pest organisms. It has become increasingly evident that no spray program can provide equally satisfactory results in all plantings for all pests. Use extreme caution and read label thoroughly when using highly toxic pesticides.

Integrated Pest Management (IPM) is the use of all suitable tactics to maintain a pest population below an economically damaging level. One such tactic is that of chemical control. Growers may use insecticides to quickly reduce a pest population that is not controlled by other means. Contrary to a commonly held belief, organic growers utilize chemical control as well as other, "conventional" growers. The difference lies in the nature of the insecticides selected – organic growers are restricted to naturally derived materials, generally botanical or mineral products, while conventional growers usually use synthetic materials. Many naturally derived insecticides are substantially less toxic and more environmentally selective than older materials.

Other IPM tactics are appropriately used by both types of growers, namely biological control (use of predators, parasites and pathogens), cultural control (modifying crop production procedures to suppress problems), physical control (exclusion and hand-picking), and resistant varieties.

Organically approved tools listed in this guide for small fruit insect pests include:

Strawberry: Mites – Stylet oil, Trilogy, predatory mites. Leafrollers – Entrust. Thrips – Aza-Direct and Entrust. Aphids – virus-free plants. Sap beetles – sanitation.

Caneberries: Rednecked cane borer – remove galled canes. Raspberry cane borer – remove infested canes. Blackberry psyllid – Surround. Mites – Stylet oil. Japanese beetle – Aza-Direct, Neemix/Trilogy, Surround.

Blueberries: Blueberry tip borer – remove infested tissue when pruning. Plum curculio – Surround. Cranberry/cherry fruitworms – Entrust. Mites – Stylet oil. Japanese beetle – Neemix/Trilogy.

In selecting a pesticide for control of small fruit pests, there are several factors that must be considered. Degree of control desired, type of fruit finish required by the market, type of spray used, compatibility with other pesticides, and effectiveness against other pests are some of the important factors that must be weighed. There are a large number of pesticides available for grower use which vary somewhat in their spectrum of activity and effectiveness on an individual pest.

Generally, pesticides may be used alone for a specific pest or in combination for various pests occurring at any one time.

The recommended concentration of pesticides for control of small fruit pests is based on a regular dilute (1X) spray. The application rate for strawberries is based on 100 to 150 gal per acre. The application rate on caneberries is based on 150 to 250 gal per acre.

For information on small fruit pests and their control, request Virginia Cooperative Extension (VCE) Publications 444-567, 456-232, and 456-018, as well as those listed elsewhere in this volume. Also, additional information on strawberry diseases and their control is available in VCE Publication 456-038. Information on pest and beneficial species identification and monitoring is also available on-line at <http://www.virginiafruit.ento.vt.edu/>. For additional information regarding pest management and small fruit production, consult the Mid-Atlantic Berry Guide, Virginia Cooperative Extension publication 423-020, <http://pubs.cas.psu.edu/freepubs/MABerryGuide.htm>; and the Southern Region Small Fruit Consortium, <http://www.smallfruits.org/SmallFruitsRegGuide/index.htm>.

Be alert for pesticide label changes, particularly with regard to post-application re-entry and pre-harvest interval restrictions.

Fungicide Resistance Guidelines: Based on 2012-2013 strawberry research, the gray mold fungus is resistant to multiple fungicides in many to most fields in Virginia and nearby states. Resistance to Topsin-M was found in every survey sample

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from Virginia, and resistance to many other fungicides was also commonly found. Strawberry growers should, therefore, focus fruit rot fungicide spray programs on broad-spectrum, “multi-site” products such as Captan and Thiram and use other products, when necessary, to increase efficacy and/or to control other diseases like anthracnose. Remember that fungicide-resistant pathogens react similarly to products with the same mode of action, i.e., those within the same “FRAC Group”. In addition to Topsin-M, loss of effectiveness is a concern particularly for FRAC Group 11, which includes Abound and Quadris, Cabrio and Pristine, and Flint. Pristine also contains boscalid, a FRAC Group 7 fungicide, while Quadris Top also contains difenoconazole, a FRAC Group 3 fungicide. However, resistance is showing up to these partner fungicides as well. For these reasons, fungicides containing ingredients in Groups 7, 11, and 17 should not be applied in more than two consecutive sprays and no more than a total of 4-5 times per season. Group 11 fungicide sprays should be targeted on anthracnose control as much as possible. Fruit rot fungicides should be tank-mixed with Captan or Thiram whenever possible to avoid development of fungicide resistance. Interested growers can have the “fungicide resistance spectrum” in their strawberry fields tested by working through their county extension agent to submit blossom or fruit-swab samples to Clemson University for analysis.

Strawberries

Table 2.1a - Strawberry Diseases, At Planting

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
Anthracnose Crown Rot (<i>Colletotrichum gloeosporioides</i> ; <i>C. fragariae</i>)	Abound 2.08F	5.0-8.0 fl oz (dip)	—	Wash roots of bare-root plants to remove excess soil, then dip entire plants for 2 to 5 minutes, planting as quickly as possible. For continued control, follow up with foliar applications 2 to 3 weeks after transplant.
<i>Rhizoctonia</i> sp. (seedling root & basal stem rot)	—	—	0.4-0.8 fl oz /1,000 row feet	Spray prior to infection in narrow band (7 inches or less) centered over rows.

Table 2.1b – Strawberry Diseases, Post-Planting

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
Anthracnose	Pristine 38 WDG	—	18.5-23.0 oz	Crown Rot: Begin sprays when disease is suspected or as soon as observed.
Crown Rot: (<i>Colletotrichum gloeosporioides</i> ; <i>C. fragariae</i>)	Cabrio 20EG	—	12.0-14.0 oz	
Fruit Rot: (<i>C. acutatum</i> ; <i>C. fragariae</i>)	Captan 80WDG or Thiram 65WSB mixed with	—	1.9-3.7 lb	Fruit Rot: Begin sprays before anthracnose develops.
	Topsin-M 70WP	0.7 lb	4.0-5.0 lb	
Or	QuiltXcel	—	1 lb	Captan or Thiram alone usually adequate for fall control. Tank-mix with Topsin-M for early spring sprays.
	Quadris Top	—	14.0 fl oz	
	Abound 2.08F	—	11.0-14.0 oz	Flint suppresses anthracnose versus control.
	Switch 62.5WG	—	12.0-14.0 fl oz	
	Captevate 68WDG	—	6.2-15.4 oz	
	Inspire Super	—	11.0-14.0 oz	
	Flint	—	3.5-5.25 lb	
—	—	—	2.0-3.2 oz	Both diseases: Sprays should continue on a 7- to 10-day schedule. Make no more than 2 sequential applications of fungicides other than Captan or Thiram before alternating to another product with a different fungicidal mode of action (FRAC Group number).

Table 2.1b - Strawberry Diseases, Post-Planting (cont.)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks	
Gray Mold Fruit Rot (<i>Botrytis cinerea</i>)	Rovral 4L or 50W	-	1.5-2.0 pt or lb	Do not apply Rovral after first flower or more than once/season.	
	Captan 80WDG or Thiram 65WSB mixed with	-	1.9-3.7 lb	For early spring sprays; Scala rates lower when tank-mixed with Captan or Thiram.	
	Topsin-M 70W	-	4.0-5.0 lb		
	or Scala 600SC	0.7 lb	1.0 lb		
				9.0 fl oz	
	Switch 62.5WSB	-	11.0-14.0 oz	Preventative fungicide sprays should begin at first bloom and continue on a 7- to 14-day interval, making no more than 2 sequential applications of any fungicide (other than Captan or Thiram) before alternating to another product with a different fungicidal mode of action (FRAC Group number).	
	Captevate 68WDG	-	3.5-5.25 lb		
	Fontelis	-	10-24 fl oz		
		-			
		Elevate 50WDG	-	1.5 lb	Rates of Elevate may be lowered to 1.0-1.5 lb/A when tank-mixed with Captan or Thiram.
		Pristine 38WSB	-	18.5-23.0 oz	
		Captec 4L	-	2.5 qt	
		Inspire Super	-	16-20 fl oz	
		Scala 600SC	-	18.0 fl oz	
	Flint	-	2.0-3.2 oz		
				Suppression only versus control.	
Phytophthora	Ridomil Gold EC	-	1.0 pt		
Crown Rot (<i>P. cactorum</i>)	MetaStar 2E AG	-	1 qt (2.0 pt)		
Red Stele (<i>P. fragariae</i>)	Ultra Flourish	-	1 qt (2.0 pt)		
Leather Rot (<i>P. cactorum</i>)	<u>Phosphite products</u>	-		Phosphite products may be applied as drip treatments just prior to (same day as) planting or as foliar sprays after planting. Foliar sprays after planting avoid possible spread of angular leaf spot.	
	Aliette 80WDG	-	2.5-5.0 lb (spray)		
		2.5 lb (dip)	-		
	Agri-Fos	-	2.5 pt (spray)		
		2.5 pt (dip)	-		
	Phostrol	-	2.5-5.0 pt (spray)		
	2.5 pt (dip)	-			
	ProPhyt	-	2.0-4.0 pt (spray)		
		2.0 pt (dip)	-		

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Table 2.1b - Strawberry Diseases, Post-Planting (cont.)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks	
Powdery Mildew (<i>Sphaerotheca</i> spp.)	Rally 40W or WSP	1.6-3.2 oz	2.5-5.0 oz	Initiate applications at the first sign of infection. Repeat applications every 7-14 days, making no more than 2 sequential applications before alternating to another fungicide with a different mode of action (FAC Group number). Only 2 Torino sprays per year, 14 days apart	
	Procure 50WS or 480SC	-	4.0-8.0 oz or 4.0-8.0 fl oz		
	Quintec	-	-		
	Torino	-	4.0-6.0 fl oz		
	Inspire Super	-	3.4 oz		
	Fontelis	-	16-20 fl oz		
	Flint	-	10-24 fl oz		
	Quadris Top	-	2.0-3.2 fl oz		
	Luna Privilege	-	6.8 fl oz		Apply as preventative treatment via drip irrigation. No more than 2 applications, 5-7 days apart
	Mettle	-	12.0-14.0 fl oz		Repeat Mettle sprays should be applied on a 14- to 21-day schedule.
Sulfur	-	3.0-5.0 fl oz 5.0-10.0 lb			
Angular Leaf Spot (<i>Xanthomonas fragariae</i>)	Various formulations of:	-	See labels	Scout fields regularly for first sign of disease after plant establishment. Avoid overhead irrigation/frost protection. Begin sprays at first sign of disease and continue on 7- to 10-day interval until conditions improve or first sign of crop injury from sprays.	
	Basic copper sulfate	2.0-3.0 lb	-		
	Copper hydroxide		0.35-0.58 lb a.i.		
	Copper salts of fatty & rosin acids		3.0-4.0 pt		
	Cuprous Oxide	-	1.05-4.2 lb a.i.		
	Actigard 50W		0.5-0.75 oz	Do not apply Actigard within 5 days of transplanting, or to plants stressed by drought or excessive moisture, cold, etc.	

Table 2.1b - Strawberry Diseases, Post-Planting (cont.)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
Leaf Spot (Mycosphaerella fragariae)	Captan 80WDG	-	1.9-3.7 lb	Begin applications as symptoms first appear and continue on a 7- to 14-day schedule as conditions warrant.
	Rally 40W or WSP	-	2.5-5.0 oz	
Leaf Scorch (Marssonina fragariae)	Topsin-M 70W	0.7 lb	1.0 lb 2.0	
	Rovral 4L or 50W	-	1.5-2.0 pt or lb	
Leaf Blight (Phomopsis obscurans)	Thiram 65WSB	-	4.0-5.0 lb	
	Pristine 38WG	-	18.5-23.0 oz	
Leaf Blotch (Gnomonia spp.)	Cabrio 20EG	-	12.0-14.0 oz	
	Orbit 3.6E	-	3.0 fl oz	
	Quadris Top	-	12.0-14.0 fl oz	
	Inspire Super	-	16-20 fl oz	
	Flint	-	2.0-3.2 oz	
	Mettle	-	3.0-5.0 fl oz	

Phytophthora diseases (crown rot, red stele, leather rot)

Phosphite-based products are less effective than Ridomil Gold, but should be considered when the pathogen is Ridomil-resistant or if root systems are significantly damaged but plants possess adequate foliage to absorb the product. For crown rot control, phosphite products may be applied by dipping transplants into a fungicide solution for 30 minutes just before (the same day as) planting. Foliar sprays with phosphites should begin 2-3 weeks after planting and be repeated on 30-60 day intervals. Begin spraying perennial plantings when plants start active growth in the spring. For leather rot control, begin phosphite sprays at 10% bloom and early fruit set and continue on a 7-14 day interval as long as conditions favor disease. Aliette may be applied the day of harvest (REI = 12 hr). Although Agri-Fos, Phostrol, and ProPhyt are labeled similarly to Aliette, check their labels for specific use instructions.

Ridomil Gold, MetaStar, and Ultra Flourish may each be applied up to 3 times/cropping season. For control of crown rot or red stele in annual plantings, applications can be made after transplanting, 30 days prior to harvest or fruit set, and during harvest. In established plantings, the first application should occur in the spring after the ground thaws and before first bloom, and the second in the fall after harvest. A supplemental application can be made at fruit set for leather rot control. Apply Ridomil Gold or MetaStar in sufficient water to move the product into the root zone. In drip-treatments, reduce the rate applied according to the ratio of bed-width to row spacing (example: 32 inch-wide bed/60 inch [5 ft] row spacing = 0.53; 0.53*1.0 pt/acre = 0.53 pt/acre for Ridomil Gold; 0.53 gal/acre for MetaStar).

Caution: Abound is extremely phytotoxic to some apple cultivars, including ‘Gala’ and ‘McIntosh’. Contact with apples should be prevented between spray drift and leftover residue in spray tanks.

Pre-Harvest Spray Intervals: Abound, Actigard, Cabrio, Captevate, Elevate, Flint, Fontelis, Inspire Super, Luna Privilege (drip application only), Mettle, MetaStar, Orbit, the phosphite products, Pristine, Quadris Top, QuiltXcel, Rally, Ridomil Gold, Switch, Torino, and Ultra Flourish may be applied the day of harvest. Procure, Quintec, Scala and Topsin-M may be applied the day before harvest. Although the preharvest interval for Captan and Captec is 0 days, protective clothing must be worn if entering the planting within 1 day after Captan application. Preharvest intervals for most copper products are 2 days, and 3 days for Thiram.

Maximum Fungicide Uses per year: Abound – 1.9 qt; Actigard – 6.0 oz; Aliette – 30.0 lb; Cabrio – 70.0 oz; Captan 80WDG – 30.0 lb; Captevate – 21.0 lb; Elevate – 6.0 lb; Flint – 19.2 oz; Fontelis – 72.0 fl oz; Luna Privilege – 13.7 fl oz; Mettle – 20 fl oz; MetaStar – 6.0 qt; Orbit – 16.0 fl oz; Pristine – 115.0 oz; Procure – 32.0 oz; Quadris Top – 56 fl oz; QuiltXcel – 56 fl oz;

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Quintec – 24.0 fl oz; Rally – 30.0 oz; Ridomil Gold – 3.0 pt; Scala – 54.0 fl oz; Switch – 56.0 oz; Topsin-M – 4.0 lb; Torino – 6.8 oz; Ultra Flourish – 6.0 pt.

Table 2.2 - Strawberry Insects

Crop and Pest	Chemical and Formulation	Rate per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
<i>Preplant</i>				
White grubs	diazinon AG500	1.0 pt	—	Apply diazinon in 100 gal/A with boom sprayer. Do not plant strawberries immediately following sod. Fumigant may be also used. Apply Admire Pro at or just before transplanting, or in drip irrigation just before bud opening. Incorporate Admire Pro into soil with at least 0.25 inches of irrigation or rainfall within 2 hrs of application.
	Admire Pro	—	7.0-10.5 fl oz	
Aphids	Admire Pro	—	10.5-14.0 fl oz	
<i>First Cover</i>				
Spittlebug	Sevin XLR	—	2.0 qt	First cover: When blossom buds emerge 1/2 inch from crown. Apply with ground equipment with adequate water for uniform coverage (100-300 gal/A). See Table 2.7 on REI and PHI. It is advisable to delay use of Danitol if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Danitol 2.4EC	10.6 fl oz	—	
	Admire Pro	—	1.3 fl oz	
Strawberry clipper	Lorsban 4E	1.0 pt	1.0 qt	Clipper: First cover, repeat 10 to 14 days later. Early control is important. Prebloom use only, no closer than 21 days before harvest. Treat when an average of 0.6 clipped buds/foot of row are found. Do not apply when berries are present. See Table 2.7 on REI and PHI
	Brigade WSB	3.2-16.0 oz	6.4-32.0 oz	
Spider mites	Savey 50DF or 50WP	—	3.0-4.0 oz	Do not spray for mites on a preventive basis. Rotate acaricides to delay resistance. Do not apply an acaricide more than twice/season. Savey may be applied at the rate of 6.0 oz/A under intense population pressure. See table on PHI and REI (Table 2.7). Acramite may be applied once per season. Use an organosilicone adjuvant. (See label.) ¹ Consult distributors. Avoid use of Sevin, Brigade, or Danitol if predatory mites are used. Brigade and Danitol provide short-term control of mites; later flare-ups may still occur. Their use should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Zeal 72WDG	—	2.0-3.0 oz	
	Oberon 2SC	—	12.0-16.0 oz	
	Acramite 50WS	0.4-0.5 lb	0.75-1.0 lb	
	Agri-Mek 0.15EC	8.0 fl oz	16.0 fl oz	
	Vendex 50WP	8.0 oz	2.0 lb	
	Stylet Oil	3.0 qt	—	
	Danitol 2.4EC	16.0-21.3 fl oz	—	
	Brigade WSB	8.0-16.0 oz	16.0-32.0 oz	
	Predatory mites ¹	—	—	
	Aza-Direct	—	11.5-42.0 fl oz	
	Kanemite 15SC	—	21.0-31.0 fl oz	
Trilogy	—	2% solution		
<i>Second Cover</i>				
Tarnished plant bug	Rimon 0.83EC	9.0-12.0 fl oz	6.4-32.0 oz	When blossoms separate in flower cluster. Treatment threshold is 1 nymph in every 1 to 2 flower clusters. See Table 2.7 on days to harvest and REI. Actara provides suppression only. Use of Danitol or Brigade should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications..
	Brigade WSB	3.2-16.0 oz	—	
	Danitol 2.4EC	10.7 fl oz	11.5-42.0 fl oz	
	Aza-Direct	—	4.0-6.9 oz	
	Assail 30SG	—	2.0-3.0 oz	
	Zeal 72WDG	—	—	
	Actara 25 WDG	—	4.0 oz	
¹ Predatory mites (<i>Amblyseius fallacis</i>) are available commercially; these have been used effectively. Avoid use of Sevin, Brigade, and Danitol if predatory mites are used.				

Table 2.2 - Strawberry Insects (cont.)

Crop and Pest	Chemical and Formulation	Rate per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
Strawberry leafroller	Sevin XLR	—	2.0 qt	Strawberry leafroller is seldom a problem. Entrust is for organic management. Use of Radiant should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Dipel DF	—	0.5-1.0 lb	
	Entrust 80WP	—	1.25-1.5 oz	
	Radiant 1SC	—	6.0-10.0 fl oz	
	Assail 30SG	—	4.0-6.9 oz	
Thrips	Aza-Direct	—	12.5-42.0 fl oz	
	Entrust 80WP	—	1.25-1.5 oz	
	Radiant 1SC	—	6.0-10.0 fl oz	
	Assail 30SG	—	4.0-6.9 oz	
Strawberry clipper	See First Cover	—	—	—
<i>Third Cover</i>				
No insecticides at this time	—	—	—	At 10% bloom.
<i>Fourth Cover</i>				
No insecticides at this time	—	—	—	At 50% bloom.
<i>Fifth Cover</i>				
Tarnished plant bug	See Second Cover	—	—	Berries half-grown, 7 to 10 days after fourth cover. This second TPB spray may be needed. See note in Second Cover. Do not apply Thionex within 15 days of first spray or more than twice within 35 days after fruit are formed.
Spittlebugs	See First Cover	—	—	—
Leafroller	See Second Cover	—	—	—
Spider mites	See First Cover	—	—	—
Strawberry aphid	Actara 25WG	—	1.5-3.0 oz	Use virus-free plants. Admire Pro will not knock down heavy aphid populations.
	Assail 30SG	—	1.9-4.0 oz	
	M-Pede	—	2% solution	
	Aza-Direct	—	11.5-42.0 fl oz	
	Admire Pro	—	1.3 fl oz	
<i>Preharvest</i>				
Sap beetles	Assail 30SG	—	4.0-6.9 oz	Harvest ripe fruit promptly and completely and remove from field. Pesticides not as effective as cultural methods. See Table 2.7 on REI and PHI.
	malathion 8F	1.0 pt	2.0 pt	
	Danitol 2.4EC	16.0-21.3 fl oz	—	
	Rimon 0.83EC	12.0 fl oz	—	
Spotted wing Drosophila	Entrust 80 WP	—	1.25-1.5 oz	Harvest fruit promptly and completely. Rotate among available modes of action to slow development of pesticide resistance. Use of malathion or Brigade should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Brigade WSB	—	16.0 oz	
	PyGanic 1.4 EC	—	64.0 fl oz	
	Azera	—	2.0-3.0 pt	
	Malathion 8F	1.0 pt	2.0 pt	
<i>Post-Harvest</i>				
Strawberry root weevil	Brigade WSB	8.0-16.0 oz	16.0-32.0 oz	Where root weevil has been a problem, spray when leaf feeding appears.
	malathion 8EC	1.0 pt	2.0 pt	

¹Predatory mites (*Amblyseius fallacis*) are available commercially; these have been used effectively. Avoid use of Sevin, Brigade, and Danitol if predatory mites are used.

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Table 2.2 - Strawberry Insects (cont.)

Crop and Pest	Chemical and Formulation	Rate per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
Strawberry leafrollers	See Second Cover	—	—	Leafrollers and aphids may need to be controlled to ensure continued growth, especially in young plantings.
Strawberry aphid	See Fifth Cover			
White grubs	Admire Pro	—	7.0-10.5 fl oz	Apply at renovation; incorporate into soil and furrow with 0.25 inches of water (irrigation or rain).

Caneberries

Table 2.3 - Blackberry and Raspberry Diseases

Crop and Pest	Chemical and Formulation	Rate per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
Anthracnose (<i>Elsinoe veneta</i>)	Dormant or late dormant sprays		See specific product label	Dormant or late dormant sprays: Spray in late winter or early spring when new growth is less than ¾ inch long. Lime-sulfur will likely burn any exposed green tissue, and will burn applicators as well as plants. At least 200 gallons of dilute spray per acre is recommended.
Cane Blight (<i>Leptosphaeria coniothyrium</i>)	Liquid lime sulfur (24-31% solution) Or	-	See specific product label	
Spur Blight (<i>Didymella applanata</i>)	Copper-based products	-		Apply copper products before shoots are 3-4 inches long to avoid leaf burn. Copper can cause phytotoxicity on black raspberry, and occasionally on red raspberry, if used with formulated phosphorus acid products (Alette, for example). Be sure to thoroughly clean equipment after using a copper product or liquid lime sulfur.
	Shoots 6" long to After-Harvest			Shoots 6" long to After-Harvest See fungicide use comments and Table 2.7 for specifics on fungicide use and for REI's, PHI's & maximum use rates for each fungicide.
	Captan	-	See specific product label	
	or		14 oz	
	Cabrio	-	6.2-15.4 fl oz	
	or			
	Abound	-	18.5-23 oz	
	or			
	Pristine	-	14-21 fl oz	
	or			
	QuiltXcel	-		

Table 2.3 - Blackberry and Raspberry Diseases (cont.)

Crop and Pest	Chemical and Formulation	Rate per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks		
Gray mold (<i>Botrytis cinerea</i>)	Rovral 4F, Nevado 4F, Iprodione 4L AG	0.5-1.0 pt	1.0-2.0 pt	See fungicide use comments and Table 2.7 for specifics on fungicide use and for REI's, PHI's & maximum use rates for each fungicide. Resistance to the active ingredients in Elevate and Pristine is an issue in many southeastern States. Caution: Abound is extremely phytotoxic to some apple cultivars. Prevent spray drift and leftover residue in the spray tank which may come in contact with apples.		
	or Pristine 38WDG	-	18.5-23.0 oz			
	or Elevate 50WDG	-	1.5 lb			
	or Captan	-	See label			
	or Switch 62.5WG	-	11.0-14.0 oz			
	or Abound 2.08F	-	6.2-15.4 fl oz			
	Cane and Leaf Rust (<i>Kuehneola uredines</i>) Orange Rust (<i>Arthuriomyces peckianus</i> , <i>Gymnoconia nitens</i>) Yellow Rust (<i>Phragmidium rubi-idaei</i>)	Rally 40WSP	-		1.25-2.5 oz	Applications should be initiated as early as bud break and repeated at 10- to 14-day intervals, depending on the diseases to be controlled. Orange rust: April-June; cane and leaf rust: green tip and just before bloom; yellow leaf rust: April-May; late leaf rust: June-Sept.; powdery mildew: early white bud to full bloom; leaf spot: June-Aug. See fungicide use comments and Table 2.7 for specifics on fungicide use and for REI's, PHI's & maximum use rates for each fungicide.
		or Orbit 3.6EC	-		6.0 fl oz	
		or Tilt 3.6EC	-		6.0 fl oz	
or PropiMax 3.6E		-	6.0 fl oz			
or Cabrio		-	14 oz			
or Abound FL		-	6.2-15.4 fl oz			
or Pristine WG		-	18.5-23 oz			
or Quilt Xcel		-	14-21 fl oz			

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Table 2.3 - Blackberry and Raspberry Diseases (cont.)

Crop and Pest	Chemical and Formulation	Rate per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
Rosette or Double Blossom (<i>Cercospora rubi</i>)	Bordeaux mixture	8 lb Copper sulfate + 8 lb Calcium hydroxide	-	See fungicide use comments for directions on preparing Bordeaux mixture and other fungicide use information. See Table 2.7 for REI's, PHI's & maximum use rates for each fungicide
	or	-	-	
	Abound FL	-	6.2-15.4 fl oz	
	or	-	-	
	Pristine W	-	18.5-23 oz	
	or	-	-	
Powdery mildew (<i>Sphaerotheca macularis</i>)	Sulfur-based products	-	See product label	Use sulfur products only as dormant or late dormant sprays in late winter or early spring when new growth is less than ¼ inch long. Lime-sulfur will likely burn any exposed green tissue, and will burn applicators as well as plants. At least 200 gallons of dilute spray per acre is recommended.
	Rally 40WSP	-	1.25-2.5 oz	
	or	-	-	
	Orbit 3.6EC	-	6.0 fl oz	
	or	-	-	See fungicide use comments and Table 2.7 for specifics on fungicide use and for REI's, PHI's & maximum use rates for each fungicide.
	Tilt 3.6EC	-	6.0 fl oz	
	or	-	-	
	PropiMax 3.6E	-	6.0 fl oz	
	or	-	-	
	Cabrio	-	14 oz	
	or	-	-	
Abound FL	-	6.2-15.4 fl oz		
or	-	-		
Pristine WG	-	18.5-23 oz		
or	-	-		
Quilt Xcel	-	14-21 fl oz		
Leaf spots (<i>Sphaerulina rubi</i> .)	Captan	-	See specific product label	Sprays for anthracnose, Botrytis gray mold, double blossom, and fruit rots should prevent Septoria infections.
	or	-	-	
	Orbit 3.6EC	-	6 fl oz	See fungicide use comments and Table 2.7 for specifics on fungicide use and for REI's, PHI's & maximum use rates for each fungicide.
	or	-	-	
	Tilt 3.6EC	-	6 fl oz	
	or	-	-	
	Cabrio	-	14 oz	
	or	-	-	
	Abound FL	-	6.2-15.4 fl oz	
	or	-	-	
Pristine WG	-	18.5-23 oz		
or	-	-		
QuiltXcel	-	14-21 fl oz		

Fungicide Use for Caneberry Diseases

“Bordeaux mixture” can be prepared using the following procedure: 1-Fill spray tank to ½ the desired water volume; 2-Turn-on agitator; 3-dissolve powdered bluestone (copper sulfate) in spray tank at a rate of 4 lb bluestone/50 gallons of water; 4-make a “milk of lime” suspension by dissolving 4 lb of hydrated lime (calcium hydroxide) in 5 gallons of water in a container, for a rate of 4 lb hydrated lime/50 gallons water; 5-Slowly add “milk of lime” suspension into spray tank; 6-Fill spray tank to desired water volume; 7-maintain constant agitation and apply immediately. Do not mix with Topsin-M or Sevin. Bordeaux mixture will severely burn leaves if applied on very hot days or if combined with insecticides. Slight phytotoxicity will have relatively minor impact.

Captevate, MetaStar, and Ultra Flourish are labeled for raspberry but not blackberry.

If used, QuiltXcel sprays should begin before disease develops. In order to slow development of fungicide resistance, Cabrio, Abound, Pristine, and QuiltXcel should be applied in no more than 2 sequential sprays before alternating with fungicides with a different mode of action. Cabrio, Abound, and Pristine should also be applied in no more than a total of 4 applications per season, while no more than 3 total applications of QuiltXcel and Abound, Cabrio, and Pristine are allowed per season. Do not make more than 4 applications of Rovral or Elevate per season. Resistance to the active ingredients in Elevate and Pristine is an issue in many southeastern States. **Caution: Abound is extremely phytotoxic to some apple cultivars. Prevent spray drift and leftover residue in the spray tank which may come in contact with apples.**

Pre-Harvest Spray Intervals: Abound, Agri-Fos, Cabrio, Elevate, Lime Sulfur, Phostrol, Pristine, ProPhyt, Rally, Rovral, and Switch may be applied the day of harvest. The preharvest interval for Captan, Captec and Captevate is 3 days. Preharvest intervals for most copper products are 2 days, but check the product label to be sure. Orbit, PropiMax, Tilt, and QuiltXcel must be applied at least 30 days before harvest, while MetaStar, Ridomil Gold, and Ultra Flourish have a preharvest interval of 45 days. Aliette can be applied no closer than 60 days before harvest.

Maximum Fungicide Uses per year: Abound – 92.3 fl oz; Aliette – 4 applications; Cabrio – 56.0 oz; Captan 80WDG – 12.5 lb; Captevate – 21.0 lb; Elevate – 6.0 lb; MetaStar – 2 applications; Orbit – 30.0 fl oz; Pristine – 92.0 oz; PropiMax – 30.0 fl oz; QuiltXcel – 105 fl oz; Rally – 10.0 oz; Ridomil Gold – 3.6 pt; Switch – 56.0 oz; Tilt – 30.0 fl oz; Ultra Flourish – 2 applications.

Cane Blights

Spray from Delayed Dormant to After Harvest

Cane blights can cause significant losses to brambles, but in Virginia are often associated with winter injury. Cane blights can also be associated with pruning canes when they are over 3-4 feet in height (resulting in larger pruning wounds) and/or under wet, humid conditions. Cultural practices that promote quick drying of foliage, such as a weed-free strip under the canopy, will help reduce infection. If fungicides are applied, applications should be made as soon as possible after each pruning in order to maximize effectiveness. Applications made after pruning wounds have healed may not be effective. See <http://www.smallfruits.org/bramble/pestinformation/caneblightfactsheetii.pdf> for additional information.

Anthracnose

Nearby (500-1,000 ft) wild blackberries can be a source of infection and should be destroyed. Floricanes should be removed as soon as possible after harvest; new canes with signs of disease or insect injury should also be removed and burned or buried prior to budbreak. Good weed control below the canopy and proper thinning and sucker control will help reduce infection by allowing faster drying of canes and foliage. Erect blackberry varieties are more susceptible than procumbent cultivars. Fungicide sprays should start before $\frac{3}{4}$ " green tissue has formed. Additional sprays may be applied when primocanes are 6" tall and thereafter at 14-day intervals through harvest.

Orange Rust

Orange rust systemically infects black raspberry, blackberry, and wild dewberry. Blackberry varieties Cherokee, Cheyenne, Comanche, Choctaw (erect, thornless), Arapaho (erect, thornless), and Shawnee are considered resistant, although some disease has been observed on all varieties. Wild blackberries within 0.25 mile of planting should be eradicated. Preventative fungicide (Rally, etc.) applications can be effective, but new canes 12-18 inches tall should be inspected thoroughly, early in the season. Note spindly emerging canes with fluorescent orange rust lesions on the underside of leaves. Uproot the entire plant, place it in a plastic bag, and remove it from the planting as soon as possible to reduce spread to healthy plants.

Leaf and Cane Rust

Nearby (500-1,000 ft) wild blackberries can be a source of infection and should be destroyed. Floricanes should be removed as soon as possible after harvest; new canes with signs of disease or insect injury should also be removed and burned or buried prior to budbreak. Good weed control below the canopy and proper thinning and sucker control will help reduce infection by allowing faster drying of canes and foliage. Fungicide sprays should be applied at green tip and prior to bloom, and then resumed after harvest until floricanes have been removed. Further sprays after primocane removal should be delayed until new infections are observed on primocanes.

Phytophthora Root Rot

Aliette 80WDG is registered for control of Phytophthora root rot on all caneberries. Apply as a foliar spray at the rate of 5 lb/A in new plantings. Applications should begin when plants produce 1-3 inches of new growth. Applications in established plantings should begin when conditions favor disease development. Begin foliar sprays in the spring after bud break (1-3 inches of new growth) and continue spraying on a 45-60 day schedule, up to a maximum of 4 sprays during the growing season. The last fall application should be applied at least 30 days prior to leaf drop. Do not mix Aliette with surfactants

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or foliar fertilizers. Do not apply Aliette within 60 days of harvest. Several other phosphorous acid products are labeled as foliar sprays for Phytophthora root rot control, including Agri-Fos, Phostrol, and ProPhyt. See specific product labels for use instructions and application rates.

Ridomil Gold GR, MetaStar 2E AB, and Ultra Flourish are labeled for control of Phytophthora root rot on raspberries only. Apply 4 fl oz of Ridomil Gold EC, 5.0 lb of Ridomil Gold GR, 1.0 pt (16.0 fl oz) of MetaStar 2E AG, or 0.5 pt (8 fl oz) of Ultra Flourish/1,000 linear feet of row to the soil surface in a three-foot band over the row. Make one application in the spring before new growth starts and another in the fall after harvest. Use the formula in the general information section of the appropriate label to calculate the amount of fungicide needed per acre. On a broadcast basis, Ridomil Gold GR is applied at 72.0 lb/A. Do not apply any of these fungicides within 45 days before harvest or possibly illegal residues may result.

Botrytis Gray Mold

Blossom blight and disease spread to ripening fruit can be controlled by sprays starting at early bloom and continuing through full bloom to near harvest. However, the pathogen has developed resistance to multiple fungicides. Growers should follow fungicide resistance management recommendations closely to avoid crop losses. Pre-harvest sprays are usually not necessary for blackberry unless weather is cool and wet.

Rosette (double blossom)

Sprays should start when rosettes are blooming and primocanes begin to grow. Witches-brooms should be clipped-out as they develop and before they flower. Prompt removal and destruction of floricanes after final harvest will help prevent or limit this disease. If disease pressure is high, cut all canes after harvest to 12-18 inches tall, fertilize heavily, and irrigate regularly to increase cane production for the following year.

Powdery mildew

Powdery mildew is usually not a problem, but some western cultivars are very susceptible. Fungicide treatments should begin at the first sign of disease and continue at 10-14 day intervals.

Viruses

A number of viruses are common and can be significant problems in bramble production. However, apparent symptoms don't always reliably indicate their presence. Specific tissue tests must be conducted to verify a virus diagnosis. No control measures are available for bramble viruses, other than rapid removal of symptomatic plants in order to slow plant-to-plant spread. Since viruses can be introduced through propagation, clean planting stock is essential. Although tissue-cultured plants can't be guaranteed to be virus-free, they are more likely to be free of viruses and crown gall, and are highly recommended. Destruction of wild blackberries within 100-200 yards of a commercial planting may help reduce possible spread. Avoiding or minimizing dagger nematodes in the soil can also be important, as these nematodes can be virus vectors.

Comments about the use of copper fungicides on caneberries

Previously, when there was a shortage of other effective fungicides registered for caneberry disease control, information about the use of copper fungicides to address concerns such as the rust diseases was presented here. Many different copper formulations have had a federal registration for use on one or more caneberry crops. Recent developments affect the usage outlook of copper fungicides. Growers should be advised that, as of September 2007, agricultural uses of copper fungicides are undergoing re-registration, and some changes in product labeling should be expected in the next year or two. In the past five years there have been registrations of several new products of different chemical classes that are highly effective on targeted diseases. For example, myclobutanil Rally (Nova), registered about ten years ago, and recently Orbit and PropiMax, should be effective for management of the rusts. These new products do not have the broad phytotoxicity concerns of the copper materials, but they do have potential fungicide-resistance concerns. If copper usage is still permitted after re-registration, you may want to consider using them according to their labels for economic and/or resistance management reasons. Always use a product only in accordance with the label for that particular formulation. Application timing and target diseases may vary with the formulation. Again, caution is advised in using any copper product.

Table 2.4 - Caneberry Insects

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
<i>Dormant</i>				
Raspberry crown borer and rednecked cane borer	—	—	—	Removal of infested canes during winter pruning is an effective cultural control for these borers.
<i>Prebloom</i>				
Leafrollers	Confirm 2F	—	16.0 fl oz	When buds are breaking or new canes are 6 to 8 inches long. See label for timing. Confirm sprays. See Table 2.7 on REI and PHI. Use of Delegate, Brigade or Sniper 2 should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Delegate 25WG	—	3.0-6.0 oz	
	Dipel ES	—	1.0-4.0 pt	
	M-Pede	2.0 gal	2% solution	
	Brigade 10WSB	—	8.0-16.0 oz	
	Entrust 80WP	—	1.25-2.0 oz	
Raspberry sawfly	M-Pede	2.0 gal	2% solution	Use of Delegate should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Delegate 25WG	—	3.0-6.0 oz	
	Entrust 80WP	—	1.25-2.0 oz	
Blackberry psyllid	malathion 8F	1.0 pt	2.0 pt	Spray for psyllid when adults appear on plants. Surround provides suppression. Use of malathion should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Surround 95WP	—	12.5-50.0 lb	
Raspberry cane borer	malathion 8F	1.0 pt	2.0 pt	For cane borer remove all infested canes; prune within a few days after wilted tips appear to minimize tissue removed. Spray just before blossoms open.
	M-Pede	2.0 gal	2% solution	
Raspberry fruitworm	Delegate 25WG	—	3.0-6.0 oz	Use of Delegate should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Entrust 80WP	—	1.25-2.0 oz	
Stink bug (inc. Brown marmorated stink bug) and Tarnished plant bug	Sevin XLR Plus 44EC	—	2.0 qt	Apply when one TPB (Tarnished plant bug) in every two flower clusters. Do not apply more than 6.0 oz/A of Actara per session. After an Actara application, wait at least five days before placing beehives in treated fields. No more than five applications of Assail per season. Sevin not effective for BMSB. Use of Delegate or malathions should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Brigade 10WSB	—	8.0-16.0 oz	
	Assail 30SG	—	4.5-5.3 oz	
	Actara 25WDG	—	3.0 oz	
	Sniper 2	—	3.2-6.4 fl oz	
	Azera	—	2.0-3.0 pt	
Thrips	Aza-Direct	—	12.5-42.0 fl oz	Just before blossoms open. Admire Pro soil-applied.
	Assail 30SG	—	4.5-5.3 oz	
	malathion 8F	—	1.0-4.0 pt	
	Admire Pro	—	2.8 fl oz	
	Entrust 80WP	—	1.25-2.0 oz	
	Delegate 25WG	—	3.0-6.0 oz	
Clipper	Brigade 10WSB	—	16.0 oz	Use of Brigade or Danitol should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Danitol	—	10.66-16.0 fl oz	

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Table 2.4 - Caneberry Insects (cont.)				
Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
Raspberry crown borer	Brigade 10WSB Sniper 2	— —	16.0 oz 6.4 fl oz	Apply as a drench in at least 200 gal of water/A, either prebloom or post harvest but not both. Use of Brigade or Sniper 2 should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
<i>First Cover: at petal fall</i>				
Aphids	malathion 8F Asana XL Sevin XLR Plus 44EC M-Pede Assail 30SG Actara 25WG Admire Pro	1.0 pt — — 2.0 gal — — —	2.0 pt 4.8-9.6 fl oz 2.0 qt 2% solution 2.5-5.3 oz 2.0-3.0 oz 2.8 fl oz	Admire Pro soil-applied. Use of malathion should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
Red-necked cane borer	malathion 8F Brigade 10WSB	1.0 pt —	2.0 pt 8.0-16.0 oz	Spray every 7 to 12 days from early May to early June if this pest has been a problem. Remove galled canes in early spring. Use of malathions or Bridage should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
Thrips	See Prebloom Spray Admire Pro		2.8 fl oz	
Leafrollers	See Prebloom Spray			
Blackberry psyllid	See Prebloom Spray			
Leafhoppers	malathion 8F M-Pede Assail 30SG Admire Pro	1.0 pt 2.0 gal — —	1.5-2.0 pt 2% solution 2.5-5.3 oz 2.8 fl oz	Use of malathion should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
Rose scale	Admire Pro Assail 30SG Brigade 2EC Tri-Tek	— — — —	2.8 fl oz 4.0 - 5.3 oz 3.2-6.4 fl oz 2% solution	Use of Brigade should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
<i>Second Cover: ten days after petal fall</i>				
Aphids	See First Cover			
Brown marmorated stink bug	Actara 25WDG Assail 30SG Brigade 10WSB malathion 8F Sniper 2	— — — — —	3 oz 4.5-5.3 oz 8-16 oz 2 pt 3.2-6.4 fl oz	Do not apply more than 6 oz/A of Actara per season. After an Actara application, wait at least 5 days before moving bee hives into treated fields. No more than 5 applications of Assail per season. Use of malathion, Brigade or Sniper 2 should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications. Assail
Mites	Savey 50DF Stylet Oil Brigade 10WSB Acramite 50W	— 3.0-6.0 qt — —	6.0 oz — 8.0-16.0 oz 0.5-1.0 lb	Savey is highly effective against mite eggs. If many active mites are present, an adulticide should be applied. PHI is 3 days. Use of Brigade should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.

Table 2.4 - Caneberry Insects (cont.)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
<i>Third Cover</i>				
Japanese beetle	Sevin 80S	1.0 lb	2.0 lb	Twenty days after petal fall.
	Sevin XLR Plus 44EC	—	2.0 qt	
	Admire Pro	—	7.0 - 14.0 fl oz (soil) 2.8 fl oz (foliar)	
	Aza-Direct	—	12.5-42.0 fl oz	Neemix/Trilogy mix every 7-10 days. See label for Trilogy mixing instructions. Neemix and Trilogy are OMRI-certified.
	Assail 30SG	—	4.5-5.3 oz	
	Actara 25WG	—	3.0 oz	
	Neemix 4.5 plus	—	7.0-16.0 fl oz +	
	Trilogy 70	—	2% solution	
Surround 95WP	—	12.5-50 lb	Surround provides suppression. Recommended only for 1st three weeks following fruit set in fresh market berries because of visible residues.	
Spotted Wing Drosophila	Entrust 80WP	—	1.25-2.0 oz	Harvest promptly and completely. Spray timing must be at least every 7 days in many cases. Rotate modes of action in order to delay the development of pesticide resistance. Observe seasonal maximum number of applications: Danitol 2 applications, malathion 4 applications, bifenthrin 2 applications, Entrust and Delegate 6 applications. Season limits to product applied may also apply; check the label.
	Delegate 25WDG	—	3.0-6.0 oz	
	Malathion 8F	1.0 pt	2.0 pt	
	Mustang Max	—	4.0 oz	
	Asana	—	4.8-9.6 fl oz	
	Brigade 10WSB	—	16.0 oz	
	PyGanic 1.4EC	—	64.0 fl oz	
	Azera	—	2.0-3.0 pt	
Brown marmorated stink bug	Actara 25WDG	—	3.0 oz	
	Assail 30SG	—	4.5-5.3 oz	
	Azera	—	2.0-3.0 pt	
	Brigade 10WSB	—	8.0-16.0 oz	
	Malathion 8F	1.0 pt	2.0 pt	
	PyGanic 1.4EC	—	64.0 fl oz	
Click beetles	malathion 8F	1.0 pt	2.0 pt	Spray for pests as needed. Do not apply within 1 day of harvest.
Aphids	See First Cover			
Mites	See Second Cover			
<i>Post Harvest</i>				
Raspberry crown borer	Sevin XLR Plus 44EC	—	2.0 qt	Sevin may be applied as foliar spray. Apply Brigade as drench in at least 50 gal of water either postharvest or prebloom but not both.
	Brigade 10WSB	—	16.0 oz	
	Altacor 3USG	—	4.0 - 5.3 oz	
Aphids	See First Cover			
Mites	See Second Cover			
Leafhoppers	See First Cover			
	Spray			
Rose Scale	Admire Pro	—	2.8 fl oz	
	Brigade 2EC	—	3.2-6.4 fl oz	
	Tri-Tek	—	2% solution	

Blueberries

Table 2.5 - Blueberry Diseases

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
Mummy Berry Cups (<i>Monilinia vaccinii-corymbosi</i>)	50% urea mix	—	200.0 lb	Apply when cups appear (usually). Delayed Dormant Urea mix is 50% Urea sprills plus 50% inert materials. It supplies 45 lbs/A nitrogen. Cups may also be covered with 1 to 2 inches soil by discing or raking.
Phomopsis Twig Blight (<i>Phomopsis</i> spp.)	lime sulfur	2.5 gal	5.0 gal	Lime sulfur : Make One Delayed Dormant application. Do not use lime sulfur within 14 days of an oil spray or when temperature is above 75°. Leaf burn may occur when used during periods of warm temperature. Apply Ziram at loose bud scale stage and 7 days later. Do not apply more than two sequential applications of Abound or Pristine before alternating with a fungicide that has a different mode of action. Begin applications before disease development and continue on a 7- to 14-day schedule, following resistance management guidelines. Do not make more than 4 applications of Indar. Do not apply more than 1.44 qt of Abound or 92 oz of Pristine or 56 oz of Switch, 43.7 lb of Captan, or 24 fl oz of Indar/A/year. Do not apply Indar within 30 days of harvest. Abound, Pristine, and Switch may be applied the day of harvest. Caution: Abound is extremely phytotoxic to some apple cultivars including 'Gala.' Prevent spray drift and leftover residue in the spray tank which may come in contact with apples.
	or Ziram 76DF	1.5 lb	3.0 lb	
	or Abound 2.08F	—	6.2-15.4 fl oz	
	or Pristine 38WG	—	18.5-23.0 oz	
	or Switch 62.5WG	—	11.0-14.0 oz	
	or Indar 2F	—	6.0 fl oz	
	or Captan 80WG	—	3.1 lb	

Table 2.5 - Blueberry Diseases (cont.)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
Mummy Berry Twig/fruit infection	Captan 80WDG	—	3.1 lb	Apply Ziram at loose bud scale stage and 7 days later. Begin Bravo applications at budbreak and repeat through early bloom at 10-day intervals. Read the Bravo label for cautions regarding tank mixing and phytotoxicity. Do not apply Bravo after full bloom or within 42 days of harvest. Do not apply more than 12.0 pt of Bravo/A/year. Do not apply more than two sequential applications of Abound, Pristine, or Captevate before alternating with a fungicide that has a different mode of action. Begin applications before disease development and continue on a 7- to 14-day schedule, following resistance management guidelines. For control of mummy berry with Indar or Orbit, make the first application at early greentip and make subsequent applications at 8- to 10-day intervals. Do not make more than 4 applications of Indar. Do not apply more than 24.0 fl oz of Indar, 30.0 oz of Orbit, 43.7 lb of Captan, 92.0 oz of Pristine, 21.0 lb of Captevate, 1.44 qt of Abound, or 56.0 oz of Switch/A/year. Do not apply Indar or Orbit within 30 days of harvest. Pristine, Abound, and Switch may be applied the day of harvest. Caution: Abound is extremely phytotoxic to some apple cultivars including 'Gala.' Prevent spray drift and keep leftover residue in the spray tank from contact with apples.
	or Ziram 76DF	1.5 lb	3.0 lb	
	or Bravo Weather Stik 6F	—	3.0-4.0 pt	
	or Abound 2.08F	—	6.2-15.4 fl oz	
	or Pristine 38WG	—	18.5-23.0 oz	
	or Captevate 68WDG	—	4.7 lb	
	or Switch 62.5WG	—	11.0-14.0 oz	
	or Indar 2F	—	6.0 fl oz	
	or Orbit 3.6E	—	6.0 fl oz	
	or PropiMax 3.6E	—	6.0 fl oz	
	Fruit Rots (Anthracnose, Alternaria rot, <i>Glomerella cingulata</i>)	Captan 80WDG	—	
or Ziram 76DF		1.5 lb	3.0 lb	
or Bravo Weather Stik 6F		—	3.0-4.0 pt	
or Abound 2.08F		—	6.2-15.4 fl oz	
or Pristine 38WG		—	18.5-23.0 oz	
or Switch 62.5WG		—	11.0-14.0 oz	
or Orbit 3.6E		—	6.0 fl oz	
or Captevate 68WDG		—	4.7 lb	

Table 2.5 - Blueberry Diseases (cont.)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Acre Concentration	Spray Timing and Remarks
Leaf Spots (<i>Gloeosporium minus</i> , <i>Gloeocercospora inconspicua</i> , <i>Septoria albopunctata</i> , <i>Dothichiza caroliniana</i> , <i>Alternaria tenissima</i> and <i>Glomerella cingulata</i>)	Captan 80WDG or Pristine 38WG or Indar 2F	— — —	3.1 lb 18.5-23.0 oz 6.0 fl oz	Post Bloom to August at 7- to 10-day intervals. Observe pre-harvest and re-entry regulations. For leaf spot control after harvest, resume spray schedule 1 to 2 times. Arrange season-long schedule to include not more than two sequential sprays of Pristine or the related material, Abound. Do not make more than 4 applications of Indar. If the maximum for Pristine and Abound has been used through harvest, select Captan for post-harvest sprays. Do not apply more than 24.0 fl oz of Indar/A/year. Do not apply Indar within 30 days of harvest or more than 30.0 fl oz/A/year.

Phytophthora root rot control

Ridomil Gold EC, MetaStar 2E AG, and Ultra Flourish are labeled for control of Phytophthora root rot of blueberries. **Established plantings:** Apply 4 fl oz of Ridomil Gold EC, 1 pt of MetaStar 2E AG, or 0.5 pt (8.0 fl oz) of Ultra Flourish per 1000 linear feet of rot (3.6 pt per acre of Ridomil Gold EC, 14.5 pt of MetaStar 2E AG, or 7.2 pt of Ultra Flourish on a broadcast basis) in a three-foot band over the row before the plants start growth in the spring. One additional application may be made to coincide with periods most favorable for root rot development. **New plantings:** Broadcast apply 3.6 pt per acre of Ridomil Gold, 2 gal per acre of MetaStar 2E AG, or 7.2 pt of Ultra Flourish to the soil at or after planting. Supplemental applications of Ridomil Gold or MetaStar should be made at 2- to 3-month intervals or to coincide with periods most favorable for root rot development. An 18-inch width is recommended for banded applications. Use the formula in the general sections of the labels to calculate the amount of fungicide needed per acre. On new plantings, do not broadcast apply more than 0.9 gal per acre of Ridomil Gold EC, 3.6 gal per acre of MetaStar 2E AG, or 7.2 pt per acre of Ultra Flourish broadcast during the 12 months before bearing harvestable fruit or illegal residues may result.

Aliette 80WDG is registered on blueberries at 5.0 lb per acre for control of Phytophthora root rot and suppression of some fruit rots. Begin foliar sprays at approximately the pink bud stage and continue on a 14- to 21-day interval. Do not exceed four applications or 20 lbs per acre per year. Do not apply in less than 10 gal per acre of water or closer than 12 hours to harvest. Several other phosphorous acid products are labeled as foliar sprays for Phytophthora root rot control, including Agri-Fos, Phostrol, and ProPhyt. See labels for specific use instructions and rates.

Table 2.6 - Blueberry Insects

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Acre Conc.	Spray Timing and Remarks
<i>First Cover: at petal fall. (Petal fall spray is the single most important spray for blueberry insects)</i>				
Blueberry tip borer	Sevin XLR Plus	—	2.0 qt	Removing dead canes at pruning aids in control of tip borer. Use of malathion should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	malathion 8F	—	1.25 pt	
Plum curculio	Sevin XLR Plus	—	2.0 qts	Two applications may be required for plum curculio. Surround provides suppression.
	Surround 95WP	—	12.5-50.0 lb	
	Imidan 70W	—	1.5 lb	Recommended only for 1st three weeks following fruit set for fresh berries because of visible residues. Use of malathion should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	malathion 8F	—	1.25 pt	
Cranberry fruit-worm and cherry fruitworm	Intrepid 2F	—	10.0-16.0 fl oz	A maximum of three applications of Azinphos-methyl may be made/season. Do not apply more than 64.0 fl oz of Confirm/A/season. Use of Delegate, malathion or Mustang Max should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Entrust 80W	—	1.25-2.0 oz	
	diazinon 50W	—	1.0 lb	
	Sevin XLR Plus	—	1.0-2.0 qt	
	Dipel ES	—	1.0-4.0 pt	
	Esteem 35WP	—	5.0 oz	
	Delegate 25WG	—	3.0-6.0 oz	
	malathion 8F	—	1.25 pt	
	Assail 30SG	—	4.5-5.3 oz	
	Asana XL	—	4.8-9.6 fl oz	
	Rimon 0.83EC	—	20.0-30.0 fl oz	
	Confirm 2F	—	16.0 fl oz	
	Mustang Max 1.5EC	—	4.3 fl oz	
Avaunt	—	3.5 - 6.0 oz		
Gall Midge	diazinon AG500	—	1 pt	
	Delegate 25WG	—	3.0 - 6.0 oz	
	Entrust 80W	—	1.25 - 2.0 fl oz	
	Malathion 8F	—	1.25 fl oz	
<i>Second Cover: ten days after first cover</i>				
Cranberry fruit-worm and cherry fruitworm	See First Cover			
Brown marmorated stink bug	Actara 25WDG	—	4.0 oz	After an Actara application, wait at least 5 days before placing beehives in treated fields. If flowering plants are present in the ground cover, mow before applying Actara. No more than 5 applications per season of Assail. Residual activity of Azera will be short. Use of malathion should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Assail 30SG	—	4.5-5.3 oz	
	Azera	—	2.0-3.0 pt	
	Lannate SP	—	1.0 lb	
	Rimon 0.83EC	—	20.0-30.0 fl oz	
	malathion 8F	—	1.25 pt	
Leafrollers	Confirm 2F	—	16.0 fl oz	See label for timing Confirm sprays. Use of Delegate should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Delegate 25WG	—	3.0-6.0 oz	
Aphids	M-Pede	2.0 gal	—	Repeated sprays of M-Pede may be needed. Do not apply M-Pede within 3 days of sulfur.
	Admire Pro	—	1.0-1.4 fl oz	
	Actara 25WG	—	3.0-4.0 oz	
	Assail 30SG	—	4.5-5.3 oz	

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Table 2.6 - Blueberry Insects (cont.)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Acre Conc.	Spray Timing and Remarks
Blueberry tip borer	See First Cover			
Plum curculio	See First Cover			
<i>Preharvest</i>				
Blueberry maggot	Entrust 80W	—	1.25-2.07 oz	Spray if flies trapped for two consecutive weeks, or three flies/week. Delegate provides suppression. See Table 2.7 on PHI. See footnote petal fall spray. GF-120 NF Naturalyte fruit fly bait. Spot or strip spray several areas of inner canopy (1.0-3.0 fl oz/tree). OMRI-approved
	Imidan 70W	—	1.5 lb	
	Surround 95WP	—	12.5-50.0 lb	
	Danitol 2.4EC	—	10.7-18.0 fl oz	
	Delegate 25WG	—	3.0-6.0 oz	
	malathion 8F	—	1.25 pt	
	Admire Pro	—	2.1 - 2.8 fl oz	
	Assail 30SG	—	4.5-5.3 oz	
	Asana XL	—	9.6 fl oz	
	Sevin XLR	—	1.0-2.0 q	
Rimon 0.83EC	—	20.0-30.0 fl oz		
GF-120	—	10.0-20.0 fl oz		
Brown marmorated stink bug	Actara 25WDG	—	4.0 oz	After an Actara application, wait at least 5 days before placing beehives in treated fields. If flowering plants are present in the ground cover, mow before applying Actara. No more than 5 applications per season of Assail. Residual activity of Azera will be short.
	Assail 30SG	—	4.5-5.3 oz	
	Azera	—	2.0-3.0 pt	
	Lannate SP	—	1.0 lb	
	Rimon 0.83EC	—	20.0-30.0 fl oz	
Spotted Wing Drosophila	malathion 8F	—	1.25-2.0 oz	Harvest promptly and completely. Spray timing must be at least every 7 days in many cases. Rotate modes of action in order to delay the development of pesticide resistance. There is a 24(c) label for malathion 8F allowing 2.5 pt for SWD.
	Imidan 70W	—	2.5 pt	
	Lannate SP	—	1.5 lb	
	Delegate 25WG	—	0.25-0.5 lb	
	Mustang Max	—	3.0-6.0 oz	
	Danitol 2.4EC	—	4.0 oz	
	Asana XL	—	10.7-18.0 fl oz	
	Brigade 10WSB	—	9.6 fl oz	
	PyGanic 1.4EC	—	16.0 oz	
	Azera	—	64.0 fl oz	
Mites	Stylet oil	3.0-6.0 qt	—	Acramite non-bearing only. Spray Stylet oil every 7 to 10 days while mite eggs persist.
	Acramite 50WS	—	0.75-1.0 lb	
Japanese beetle	Admire Pro	—	1.0 - 1.4 fl oz	Apply Neemix/Trilogy over 7-10 days. See Trilogy label for mixing instructions. Neemix and Trilogy are OMRI-certified.
	Danitol 2.4EC	—	10.7-18.0 fl oz	
	malathion 8F	—	1.25 pt	
	Assail 30SG	—	4.5-5.3 oz	
	Asana XL	—	4.8-9.6 fl oz	
	Sevin XLR	—	1.0-2.0 qt	
	Actara 25WG	—	4.0 oz	
	Neemix 4.5 plus	—	7.0-16.0 fl oz +	
Trilogy 70	—	2% solution		
<i>Special Soil Treatment</i>				
Japanese beetle	Admire Pro	—	7.0 - 14.0 fl oz	Apply as chemigation or in band followed by irrigation.

Small Fruit Pesticides

Table 2.7 - Chemical Names, Re-entry Intervals (REI) and Preharvest Intervals (PHI)

Chemical	Manufacturer	Re-entry Interval	Preharvest Interval		
			Strawberry	Caneberries	Blueberry
Fungicides					
Abound (Azoxystrobin)	Syngenta	4 hours	0 days	0 days	0 days
Actigard	Syngenta	12 hours	0 days	—	0 days
Agri-Fos	Monterey	4 hours	0 days	0 days	0 days
Aliette (fosetyl Al)	Bayer CropScience	12 hours	12 hours	60 days	12 hours
Bordeaux mixture (coppers)	various	24 hours	—	(see label)	—
Bravo Weather Stik (Chlorothalonil)	Syngenta	12 hours (See label caution about eye protection of 6.5 days)	—	—	42 days
Cabrio (pyraclostrobin)	BASF	24 hours 12 hours (strawberries)	0 days	0 days	0 days
Captan (Captan, Captec)	Micro Flo, etc.	see label	0 days (see label)	3 days (Captan 80WDG)	0 days (see label)
Captevate (Captan & fenhexamid)	Arysta	24 hours (strawberries) 48 hours (blueberries & raspberries)	0 days	3 days (raspberries)	0 days
Elevate (fenhexamid)	Arysta	12 hours	0 days	0 days	0 days
Flint (trifloxystrobin)	Syngenta	12 hours	0 days	—	—
Fontelis (penthiopyrad)	DuPont	12 hours	0 days	—	0 days
Indar (fenbuconazole)	Dow AgroSciences	12 hours	—	30 days	30 days
Inspire Super (difenoconazole)	Syngenta	12 hours	0 Days	—	—
Lime sulfur	various	48 hours	—	0 days	—
Luna Privilege	Bayer CropScience	12 hours	0 days (drip)	—	—
MetaStar (metalaxyl)	LG life Science	48 hours	0 days	45 days	—
Mettle (tetraconazole)	Isagro USA	12 hours	0 days	—	0 days
Orbit (propiconazole)	Syngenta	24 hours	0 days	30 days	30 days
Phostrol	Nufarm Americas	4 hours	0 days	0 days	0 days
Pristine (pyraclostrobin & boscalid)	BASF	24 hours 12 hours (strawberries)	0 days	0 days	0 days
ProPhyt	Helena	4 hours	0 days	0 days	0 days

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Table 2.7 - Chemical Names, Re-entry Intervals (REI) and Preharvest Intervals (PHI) (cont.)

Chemical	Manufacturer	Re-entry Interval	Preharvest Interval		
			Strawberry	Caneberries	Blueberry
Fungicides (cont.)					
PropiMax (propiconazole)	Dow AgroSciences	24 hours	—	30 days	30 days
Quadris Top (azoxystrobin & difenoconazole)	Syngenta	12 hours	0 days	—	—
QuiltXcel	Syngenta	12 hours	0 days	30 days	30 days
Rally (myclobutanil)	Dow AgroSciences	24 hours	0 days	0 days	—
Ridomil Gold	Syngenta	0 hours (soil-injected or incorporated applications) 48 hours (soil- directed or foliar sprays)	0 days 0 days	— 45 days	— 45 days
Rovral (iprodione)	Bayer CropScience	24 hours	prebloom	0 days	—
Scala	Bayer CropScience	12 hours	1 day	—	—
Switch (cyprodinil & fludioxonil)	Syngenta	12 hours	0 days	0 days	0 days
Thiram	Taminco	24 hours	3 days	—	—
Tilt	Syngenta	12 hours	0 days	30 days	30 days
Topsin-M	United Phosphorus	12 hours	1 day	—	—
Torino (cyflufenamid)	Gowan	4 hours	0 days	—	0 days
Ultra FLourish	New Farm Americas	48 hours	0 days	45 days	0 days
Ziram	United Phosphorus, Taminco	48 hours	—	(see label)	(see label)
Insecticides					
Actara (thiamethoxam)	Syngenta	12 hours	3 days	3 days	3 days
Admire Pro (imidacloprid)	Bayer CropScience	12 hours	14 days (soil) 7 days (foliar)	3 days	7 days (soil) 3 days (foliar)
Agri-Mek (ivermectin)	Syngenta	12 hours	3 days	—	—
Asana (esfenvalerate)	DuPont	12 hours	—	7 days	14 days
Assail (acetamiprid)	United Phosphorus	12 hours	1 day	1 day	1 day
Aza-Direct (azadirachtin)	Gowan	4 hours	0 days	0 days	0 days
Azera (azadirachtin and pyrethrins)	MGK	12 hours	0 days	0 days	0 days

Table 2.7 - Chemical Names, Re-entry Intervals (REI) and Preharvest Intervals (PHI) (cont.)

Chemical	Manufacturer	Re-entry Interval	Preharvest Interval		
			Strawberry	Caneberries	Blueberry
Brigade (bifenthrin)	FMC	12 hours	0 days	3 days	1 day
Confirm (tebufenozide)	Dow AgroSciences	4 hours	—	14 days	14 days
Danitol (fenpropathrin)	Valent	24 hours	2 days	—	21 days
Delegate (spinetoram)	Dow AgroSciences	4 hours	—	1 day	3 days
diazinon	Makhteshim-Agan	3 days strawberries 5 days blueberries	5 days	—	7 days
Dipel	Valent	4 hours	0 days	0 days	0 days
Entrust (spinosad)	Dow AgroSciences	4 hours	1 day	1 day	3 days
Esteem (pyriproxyfen)	Valent	12 hours	—	—	7 days
Imidan (phosmet)	Gowan	3 days	—	—	3 days
Intrepid (methoxyfenozide)	Dow AgroSciences	4 hours	—	—	7 days
Kanemite (acequinocyl)	Arysta LifeScience	12 hours	1 day	—	—
Lannate (methomyl)	DuPont	48 hours	—	—	3 days
Lorsban (chlorpyrifos)	Dow AgroSciences	24 hours	21 days	—	—
malathion	Gowan, UAP	12 hours	3 days	1 day	1 day
M-Pede (insecticidal soap)	Dow AgroSciences	12 hours	0 days	0 days	0 days
Mustang Max (zeta cypermethrin)	FMC	12 hours	—	1 day	1 day
Neemix (azadirachtin)	Certis	12 hours	0 days	0 days	0 days
PyGanic (pyrethrin)	MGK	12 hours	0 days	0 days	0 days
Radiant (spinetoram)	Dow AgroSciences	4 hours	1 day	—	—
Rimon (novaluron)	Chemtura	12 hours	1 day	—	8 days
Sevin (carbaryl)	Bayer CropScience	12 hours	7 days	7 days	7 days
Sniper (bifenthrin)	Loveland Products	12 hours	—	3 days	—
Surround (kaolin)	Engelhard	4 hours	—	0 days	0 days
Trilogy (clarified neem extract)	Certis	4 hours	0 days	0 days	0 days

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Table 2.7 - Chemical Names, Re-entry Intervals (REI) and Preharvest Intervals (PHI) (cont.)

Chemical	Manufacturer	Re-entry Interval	Preharvest Interval		
			Strawberry	Caneberries	Blueberry
Tri-Tek (oil)	Brandt	4 hours	0 days	0 days	0 days
Zeal (etoxazole)	Valent	12 hours	1 day	—	—
Acaricides					
Acramite (bifenazate)	Uniroyal	12 hours	1 day	1 day	non-bearing only
Brigade (bifenthrin)	FMC	12 hours	0 days	3 days	1 day
Kanemite (acequinocyl)	Arysta LifeScience	12 hours	1 day	—	—
Oberon (spiromesifen)	Bayer CropScience	12 hours	3 days	—	—
Savey (hexythiazox)	Gowan	12 hours	3 days	3 days	—
Stylet Oil	JMS Flower Farms	4 hours	0 days	0 days	0 days
Vendex (fenbutatin oxide)	Griffin	48 hours	1 day	—	—

Nematodes

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Table 2.8 - Preplant Fumigation: Blackberries, Blueberries, Raspberries, and Strawberries

Pests/Pathogens Controlled	Soil Fumigant Product	Broadcast Equivalent Rate/Acre	Remarks
Plant parasitic nematodes only	1,3-dichloropropene 94% (Telone II)	27.0-35.0 gal	Follow detailed label instructions carefully.
Certain soil fungi only	Chloropicrin	150-500 lb	Follow detailed label instructions carefully.
Plant parasitic nematodes and certain soil fungi	Methyl Bromide: chloropicrin 50:50	350-400 lb	Methyl bromide will probably not be available in 2014.
	1,3-dichloropropene, 65% + chloropicrin, 35% (Telone C-35)	39.0-50.0 gal	Also moderate nutsedge control when Telone C-35 is tarped with VIF.
	1,3-dichloropropene, 40% + chloropicrin, 60% (PicClor 60)	44.1-48.6 gal	Good control of most annual weeds; but not nutsedge.
	Metam sodium 42% (Vapam HL, Sectagon, Metam CLR, etc.)	45.0 gal	Application methods for metam sodium and metam potassium products vary significantly depending on target pests and other factors. See labels for extensive, detailed instructions.
	Metam potassium (K-Pam HL)	37.2 gal	
	Paladin (dimethyl disulfide); should be formulated with 21% chloropicrin.	35.0-51.3 gal	Paladin can provide good nutsedge control, but poor control of certain small-seeded broadleaf weeds and grasses.
	Dazomet 99% (Basamid G)		Dazomet is registered for "non-bearing food crops". Use only for crops due to be harvested no sooner than 1 year after planting. Follow detailed label instructions for each product carefully.

CAUTION: Vapors from fumigants are toxic. **Read the label completely and follow directions strictly.**

Methyl bromide and the soil fumigant "Midas" are no longer available for purchase, although growers may apply product already in hand. Small fruit growers should select a soil fumigant product based on the types of soil pathogens and pests present in their field(s). Soil assays for plant-parasitic nematode populations should indicate the need for a nematode control product. Products containing 1,3-dichloropropene do so in order to control nematodes, while the chloropicrin, metam or potassium sodium, etc., are included to control fungal pathogens and weed seeds. All soil fumigants are restricted use pesticides, with all the associated requirements, including respirator fit-testing, mandated use of full-face respirators for many soil fumigants, written "fumigant management plans" (FMPs), restrictions on cutting and removal of tarps, air monitoring in special circumstances, posting of treated fields and buffer zones surrounding treated fields, and 3-day "entry restricted periods (ERPs)". FMPs must be completed *before* application, and include documenting the site(s) to be fumigated, handler information, compliance with mandatory good agricultural practices (GAPs), as well as weather conditions surrounding soil fumigation. A "post-application summary" must also be completed for each fumigation. FMPs and post-application summaries must be maintained for 2 years. Most soil fumigant labels also now include minimum distances between treated fields and sites that would be difficult to evacuate (schools, etc.) and official notification requirements.

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Growers who fumigate soil or contract with others to fumigate their fields need to familiarize themselves with all new requirements.

The mandatory GAPs included in the new soil fumigant labels document practices long recommended for soil fumigant application. Prior to fumigation, soil should be cultivated deeply and thoroughly, breaking up all clods and crop debris so that the area to be gassed is in good “seed bed” condition and free of excessive un-decayed organic matter. *Adequate soil moisture and soil temperatures at the depth of injection between 50° and 80°F are critical to effective soil fumigation.* Fumigation characteristics vary significantly among soil fumigants, so check product labels for specific directions regarding shank spacing and outlet depth for specific products and target pests. For example, shank spacing is often narrower and outlet depth shallower for application of metam sodium products. Soil should be smoothed and compacted and/or covered with plastic mulch immediately after use of all soil fumigants in order to minimize gas escape.

Broadcast fumigation may provide more lengthy nematode control when the crop to be planted will be maintained for multiple years, but the “in-row” fumigation common in annual strawberry plasticulture typically provides excellent control over a single growing season using less total fumigant, because less soil is actually treated. The amount of product needed for in-row fumigation is calculated based upon the area treated relative to the total area of land devoted to the crop. *Important note: the area to be fumigated is based on the width of the “bed” at the bottom versus the top.* VIF (virtually impermeable film) and TIF (totally impermeable film) plastic mulches are available that increase fumigant activity and reduce fumigant emissions into the atmosphere. Use of VIF or TIF mulches may enable applicators to reduce the fumigant rates, sometimes reducing the size of buffer zones. Formulations of soil fumigants are also now available that enable application of these products through drip-lines, similar to in-row fumigation. Be sure to read, understand, and follow instructions in these labels carefully.

Because fumigant residues can severely damage new plantings, a waiting period is required for all soil fumigants, but broadcast soil fumigation for perennial crops is typically timed in the fall to allow at least a 4 to 8 week “waiting period” to allow the fumigant to dissipate from treated soil. Waiting periods vary for different fumigants and are also highly influenced by environmental conditions. Check fumigant labels for recommended procedures to ensure fumigant residues have dissipated sufficiently to avoid crop injury.

Weeds

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Table 2.9 - Herbicides

Crop	Weeds Controlled	Chemical Rate/A (Product/A)	Remarks
<i>Preemergence directed</i>			
Blueberries, Blackberries, and Raspberries	Most annuals, fescue, quackgrass, dandelions, dock, and other herbaceous perennials	dichlobenil 4.0-6.0 lb (Casoron 4G 100.0-150.0 lb or 2.3-3.4 lb/1000 sq ft)	Apply dry granules in late winter or early spring. Shallow incorporation may improve weed control. Do not apply within 4 weeks after transplanting. Short residual activity; regrowth usually occurs in late summer. Do not graze livestock in treated areas. Do not make application within one month of harvest. Do not apply over 4.0 lb of dichlobenil to blackberries or raspberries and do not apply during new shoot emergence.
	Annual grasses and broadleaf weeds	flumioxazin 0.19-0.375 lb (Chateau 51WDG 6.0-12.0 oz)	For blueberries only. Do not apply to blueberries established less than 2 years unless stems are protected by grow tubes, wraps, or waxed containers. Do not apply after budbreak through final harvest. Avoid contact with foliage and green bark.
	Annual broadleaf and certain annual grassy weeds	mesotrione 0.09-0.18 lb (Callisto 3.0-6.0 fl oz)	Blueberries only. Apply preemergence or early postemergence. For improved postemergence control, apply 3.0 fl oz Callisto followed 3 weeks later by a second application at that rate. Apply prior to bloom. Include a crop oil concentrate tolerated by blueberries if applied postemergence to weeds.
	Annual grasses and certain broadleaf weeds	napropamide 4.0 lb (Devrinol 50DF 8.0 lb)	Apply to a weed-free surface or include an appropriate postemergence herbicide. May be applied to newly planted and established crop. Must be incorporated by rainfall or irrigation within 24 hours of application for optimum results. May be tank-mixed with other herbicides for broader-spectrum weed control.
	Annual grasses, certain broadleaf weeds, and suppression of perennial grasses and nutsedge	norflurazon 2.0-4.0 lb (Solicam DF 2.5-5.0 lb)	Apply only to blueberries established at least 6 months and to raspberries and blackberries established at least 12 months. Apply when crop is dormant. Apply to weed-free soil or include an appropriate postemergence herbicide. Combine with simazine for improved broadleaf control.
	Annual grasses and certain broadleaf weeds	oryzalin 2.0-6.0 lb (Surflan 4AS 2.0-6.0 qt, Oryzalin 4AS 2.0-6.0 qt, Surflan DF 2.4-7.1 lb)	May be used immediately after planting or in established plantings. Apply to weed-free soil or include an appropriate postemergence herbicide. Use lowest rate for short-term control, 4.0 lb for full-season control, and the highest rate for long-term (8-12 months) control. May be tank-mixed with such herbicides as simazine or terbacil to control a broader spectrum of weeds in established plantings.
	Annual grasses and broadleaf weeds	simazine 2.0-4.0 lb (Princep 4L 2.0-4.0 qt)	Apply to weed-free soil or include an appropriate postemergence herbicide. Split application possible with 1/2 rate in fall and 1/2 rate in spring. On plantings less than 6 months old use 1/2 the total rate of application.
	Annual grasses and broadleaf weeds plus some perennial broadleaf weeds	terbacil 0.8-1.6 lb (Sinbar 80W 1.0-2.0 lb)	Only treat plantings established for one year or more. Use higher rate on heavy (clay) soils with high organic matter (3%+). May be applied in early spring or late fall.

Table 2.9 - Herbicides (cont.)

Crop	Weeds Controlled	Chemical Rate/A (Product/A)	Remarks
<i>Postemergence directed</i>			
Blueberries, Blackberries, and Raspberries	Annual broadleaf weeds	carfentrazone-ethyl 0.016-0.031 lb (Aim 2EC, 1.9 EW 1.0-2.0 fl oz/A)	Apply post-directed using a hooded sprayer for control of small annual broadleaf weeds less than 4 inches tall. Add a crop-oil concentrate or nonionic surfactant. Can be tank mixed with other herbicides for broader-spectrum weed control. Can also be used for control of primocanes – see label rates and directions for this use.
	Annual and perennial grasses	clethodim 0.09-0.12 lb Select 2EC 6.0-8.0 fl oz or Select Max 9.0-16.0 fl oz + 0.25% v/v nonionic surfactant)	Apply to actively growing grasses. Will control annual bluegrass. For spot treatment, use 0.33-0.65 fl oz Select 2EC or 0.44-0.88 fl oz Select Max per gallon plus 0.33 fl oz nonionic surfactant. A repeat application may be required for perennial grass control. Can only be used on nonbearing plants. Allow at least one year between application and harvest.
	Annual and perennial grasses	fluazifop-P-butyl 0.25- 0.375 lb (Fusilade DX 16.0-24.0 fl oz + 2 pt crop oil concen- trate or 1/2 pt nonionic surfactant/25.0 gal)	Use a directed spray on actively growing grasses. Treat annual grasses before tillering for optimum results. Perennial grasses may need repeat treatment for total control. Do not treat canes to be harvested within one year of application. For spot treatment use 0.75 oz Fusilade DX plus 1.5 fl oz crop-oil concentrate or 0.5 fl oz nonionic surfactant/gal.
	Annual and perennial weeds	glufosinate 0.88-1.5 lb (Rely 280 48.0-82.0 fl oz)	Blueberries only. Apply as a directed spray, keeping droplets off blueberry foliage and stems. Repeat application may be needed for perennial weed control. Do not apply within 14 days of harvest. For spot application apply 1.7 fl oz Rely 280/gal.
	Annual and perennial grasses and broad- leaf weeds	glyphosate 0.75-3.75 lb ae (Roundup UltraMax 26.0 fl oz-4 qt, Touchdown 1.0-5.0 qt, or other labeled formula- tion. For wiper application use 1 part Roundup to 4 parts water)	Can be applied prior to planting or to control emerged weeds after planting. Avoid contacting leaves or stems of crop plants or systemic injury could occur. For spot treatment use 2.0 fl oz Roundup UltraMax or Touchdown/gal and spray to wet. Other glyphosate formulations are available. Check the label for appropriate rates.
	Annual weeds, con- tact activity only, will not control estab- lished perennial weeds	paraquat 0.5-1.0 lb (Gramoxone Inteon 2.0-4.0 pt/A + 1.0-2.0 pt nonionic surfactant/100 gal water)	Apply as coarse directed spray to thoroughly wet emerged weeds. Apply before emergence of new crop shoots. Do not allow spray to contact new shoots or green stems, otherwise injury is likely. RESTRICTED USE PESTICIDE
	Annual and perennial grasses	sethoxydim 0.28-0.47 lb ai (Poast 1.5-2.5 pt + 1.0 qt crop-oil concentrate)	Do not apply within 45 days of harvest in raspberries and blackberries or within 30 days of harvesting blueberries. Apply in a minimum of 10 gal/A of water. Apply the lower rate to annual grasses up to 6 inches tall and apply higher rate to annual grasses up to 12 inches tall and to perennial grasses. For spot treatment, use 1.25 fl oz Poast plus 1.25 fl oz crop-oil concentrate/gal.
	Yellow nutsedge and certain broadleaf weeds	halosulfuron 0.036-0.047 lb (Sanda 0.75-1.0 oz non- ionic surfactant 0.25% V/V)	Apply only to highbush blueberry. 14-day preharvest interval. Plants need to be established at least one year and keep the spray off the blueberry foliage. Treat when yellow nutsedge is actively growing under good soil moisture.

Table 2.9 - Herbicides (cont.)

Crop	Weeds Controlled	Chemical Rate/A (Product/A)	Remarks
Strawberries	Annual and perennial grasses	clethodim 0.09-0.125 lb (Select 2EC 6.0-8.0 fl oz + 1% crop-oil concentrate or Select Max 9.0-16.0 fl oz + 0.25% nonionic surfactant)	Apply to actively growing grasses. Will control annual bluegrass. For spot treatment, use 0.33-0.65 fl oz Select 2EC or 0.44-0.88 fl oz Select Max per gallon plus 0.33 fl oz nonionic surfactant. A repeat application may be required for perennial grass control. Allow at least 4 days between application and harvest.
	Certain annual and perennial broadleaves	clopyralid 0.12-0.25 lb (Stinger 0.33-0.67 pt/A)	Apply to actively-growing broadleaf weeds. Primarily controls weeds in the legume and composite families. Stinger can be applied to strawberries at 0.33 pt/A in spring. Do not apply within 30 days of harvest. Up to 0.67 pt/A can be used after harvest. Growers who intend to use the product in strawberries must sign a waiver of liability.
	Annual broadleaf weeds	carfentrazone-ethyl 0.006-0.025 lb (Aim 40DF 0.33-1.0 oz, Aim 1.9EW or 2EC 0.5-1.6 fl oz)	Apply post-directed using a hooded sprayer for control of small annual broadleaf weeds less than 4 inches tall. Add a crop-oil concentrate or nonionic surfactant. Can be tank mixed with other herbicides for broader-spectrum weed control.
	Annual grasses and broadleaf weeds	flumioxazin 0.09 lb (Chateau WDG 3.0 oz/A)	Apply to dormant strawberries for preemergence weed control. Addition of a crop-oil concentrate or nonionic surfactant may improve postemergence weed control. Can be applied using a hooded or shielded spray to row middles prior to fruit set. Do not apply overtop of strawberries.
	Annual grasses and certain broadleaf weeds	DCPA 6.0-9.0 lb (Dacthal W-75 8.0-12.0 lbs/A)	Can be used in new and established plantings. Apply prior to weed germination. Do not apply after first bloom through harvest.
	Annual grasses and certain broadleaf weeds	napropamide 4.0 lb (Devrinol 50 DF 8.0 lb)	Use on established strawberries. Delay application until daughter plants in the desired number have become established. Do not apply from bloom to harvest. Make only one application/season. Does not control established weeds. Apply in fall through early winter. Early spring applications may also be made, but rainfall or irrigation will be needed for optimum weed control.
	Annual broadleaf weeds	oxyfluorfen 0.25-0.5 lb (Goal 2XL 1.0-2.0 pt)	Apply to the surface of preformed fallow beds at least 30 days prior to transplanting strawberries. Incorporation prior to planting reduces the potential for crop injury. Plastic mulch can be applied anytime after application but, ideally, soon after the Goal was applied.

Table 2.9 - Herbicides (cont.)

Crop	Weeds Controlled	Chemical Rate/A (Product/A)	Remarks
Strawberries (cont.)	Annual weeds	acifluorfen 0.25-0.375 lb (UltraBlazer 1.0-1.5 pt)	Preemergence and postemergence weed control. Can be applied after the last harvest or following bed renovation. Can also be applied during winter to dormant strawberries. DO NOT APPLY within 120 days of harvest.
	Annual weeds and suppression of perennials	paraquat 0.5 lbs (Gramoxone Inteon 2.0 pt)	Directed spray to row middles using a shielded spray. Do not allow spray to contact strawberry plants. Do not apply within 21 days of harvest.
	Annual and perennial grasses	sethoxydim 0.28-0.47 lb ai (Poast 1.5-2.5 pt + 1.0 qt crop-oil concentrate)	Do not apply within 7 days of harvest. Apply the lower rate to annual grasses up to 6 inches tall. Apply higher rate to taller annual grasses and perennial grasses. For spot treatment use 1.25 fl oz Poast plus 1.25 fl oz crop-oil concentrate/gal. Do not tank mix with other pesticides.
	Annual broadleaf weeds	2,4-D amine 1.0-1.5 lb (Formula 40 1.0-1.5 qt)	Apply to established beds in late winter when the strawberries are dormant or immediately after last picking 7 to 10 days before renovation. Do not apply during bud, flower, or fruit stage, or during runner formation. Do not apply unless some injury is acceptable.
	Annual grasses and broadleaf weeds	terbacil 0.1-0.3 lb (Sinbar 80W 2-6 ounces/A)	Use only on plants established at least 6 months. Apply after postharvest renovation before new growth begins or in late fall to control winter annuals. Do not apply more than 8.0 oz of Sinbar/A/ growing season. Do not use on soils less than 2% organic matter.

Table 2.10 - Relative Effectiveness of Preemergence Herbicides in Small Fruit

	Dichlobenil	DCPA	Flumioxazin	Mesotrione	Napropamide	Norflurazon	Oryzalin	Oxyfluorfen	Simazine	Terbacil
<i>Annual Grasses</i>										
Barnyardgrass	G	G	F	P	G	E	G	F	F-G	G
Cheat	G	-	-	-	G	G	G	-	G	G
Crabgrass	G	G	F-G	F	E	E	E	F	F-G	F-G
Fall panicum	F	G	F	P	G	E	G	-	F-G	G
Foxtails	G	G	F-G	P	E	E	E	F	G	G
Goosegrass	F	G	F-G	P-F	E	G	E	F	E	-
Johnsongrass (seedling)	F	-	P-F	N	P	G	F-G	-	N	-
<i>Annual Broadleaf Weeds</i>										
Annual fleabane	E	-	-	-	G	F	G	G	G	E
Annual morningglory	G	N	F-G	F	N	F	P-F	F	E	G
Black nightshade	G	N	G	P	N	F-G	P-F	G	E	-
Carpetweed	G	F	-	-	G	G	G	G	E	E
Common chickweed	G	G	-	-	G	G	G	G	E	G
Common lambsquarter	G	G	G	G	F-G	G-E	G	G	E	G
Common ragweed	G	N	-	P	F	F	P	F	E	G
Hairy galinsoga	G	N	-	G	G	-	P	G	E	E
Henbit	G	-	-	G	F	-	G	G	E	G
Horseweed	G	-	G	-	P	G	F	F	E	G
Knotweed	G	-	-	-	G	F	G	G	E	G
Mustards	G	P	-	-	P	F	P-F	G	G	E
Pennsylvania smartweed	G	N	-	-	P	-	P-F	G	E	G
Pigweeds	G	F	G	F-G	G	F	G	G	E	G
Prickly lettuce	G	-	-	-	G	-	F	G	E	G
Prickly sida	F-G	-	G	-	N	P	P-F	G	G	-
Purslane	G	G	-	-	G	G	G	G	E	E
Shepherds' purse	G	P	-	-	F	G	G	G	E	G
Speedwells	-	G	-	G	-	-	-	-	-	-
Velvetleaf	-	N	G	-	N	F	P-F	F	G	G
Virginia pepperweed	G	-	-	-	F	G	G	-	E	-
<i>Perennial Grasses And Sedges</i>										
Bermudagrass	N	N	-	P	N	P	N	N	N	F
Dallisgrass	-	N	N	P	N	P	N	N	N	F-G
Fescues	G	N	N	N	N	F	N	N	P	F
Johnsongrass (rhizome)	-	N	N	N	N	P	N	N	N	P
Nimblewill	-	N	N	F-G	N	F	N	N	P	P
Orchardgrass	G	N	N	-	N	F	N	N	P-F	G-E

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

Table 2.10 - Relative Effectiveness of Preemergence Herbicides in Small Fruit (cont.)

	Dichlobenil	DCPA	Flumioxazin	Mesotrione	Napropamide	Norflurazon	Oryzalin	Oxyfluorfen	Simazine	Terbacil
<i>Perennial Grasses And Sedges (cont.)</i>										
Purpletop, Redtop	-	N	N	-	N	F-G	N	N	N	F-G
Quackgrass	G	N	N	-	N	P	N	N	P-F	G
Yellow nutsedge	P-F	N	N	F	P	P-F	N	N	N	F-G
<i>Perennial Broadleaf Weeds</i>										
Broadleaf plantain	G	N	-	-	N	P	N	N	G	F
Buckhorn plantain	G	N	-	-	N	P	N	N	G	F
Canada thistle	P-F	N	-	-	N	N	N	N	N	N
Chicory	G	N	-	-	N	N	N	N	P-F	G
Common dandelion	E	N	-	-	N	N	N	N	P-F	G-E
Common mallow	G	N	-	-	N	N	N	N	N	-
Common milkweed	-	N	-	-	N	N	N	N	N	N
Common yarrow	-	N	-	-	N	N	N	N	-	N
Docks (broadleaf, curly)	G	N	-	-	N	N	N	N	N	F
Goldenrod	F-G	N	-	-	N	N	N	N	N	P-F
Ground ivy	E	N	-	-	N	N	N	N	N	N
Hemp dogbane	N	N	-	-	N	N	N	N	N	N
Horsenettle	N	N	-	-	N	N	N	N	P	F-G
Mugwort	G-E	N	-	-	N	N	N	N	N	P
Red sorrel	G	N	-	-	N	N	N	N	N	P
Thistles (bull, musk, curly)	F	N	-	-	N	N	-	N	-	-
White flowered aster	G	N	-	-	N	N	N	N	N	N
Wild carrot	G	N	-	-	N	F	N	N	N	F
Wild strawberry	G	N	-	-	N	P	N	N	N	N
Yellow rocket	G	N	—	—	N	F	N	N	P	G
Yellow woodsorrel (from seed)	G	G	—	—	P	F	F	N	F	G
<i>Special Perennial Weed Problems</i>										
Bigroot morningglory	N	N	—	—	N	N	N	N	N	N
Brambles (Rubus spp.)	N	N	—	—	N	N	N	N	N	N
Common greenbriar	N	N	—	—	N	N	N	N	N	N
Japanese honeysuckle	N	N	—	—	N	N	N	N	N	N
Poison ivy	N	N	—	—	N	N	N	N	N	N
Virginia creeper	N	N	—	—	N	N	N	N	N	N
Wild garlic	F	N	—	—	N	N	N	N	N	N

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

Table 2.11 - Relative Effectiveness of Postemergence Herbicides in Small Fruit

	Acifluorfen	Carfentrazone	Fluazifopbutyl	Glyphosate	Sethoxydim	2,4-D	Clopyralid	Paraquat	Clethodim
<i>Annual Grasses</i>									
Barnyardgrass	N	N	E	E	E	N	N	G	E
Cheat	—	—	G	E	G	N	N	G	-
Crabgrass	N	N	E	E	E	N	N	G	E
Fall panicum	P	N	E	E	E	N	N	G	E
Foxtails	P	N	E	E	E	N	N	G	E
Goosegrass	N	N	E	E	E	N	N	G	E
Johnsongrass (seedling)	P	N	E	E	E	N	N	G	E
<i>Annual Broadleaf Weeds</i>									
Annual fleabane	—	—	N	E	N	G	—	E	N
Annual morningglory	G-E	F	N	E	N	E	N	G	N
Black nightshade	F-G	G	N	E	N	F-G	F	G	N
Carpetweed	—	G	N	E	N	E	—	E	N
Common chickweed	—	F	N	E	N	P	—	E	N
Common lambsquarter	P-F	G	N	E	N	G	P	E	N
Common ragweed	E	P	N	E	N	G	E	E	N
Hairy galinsoga	—	—	N	E	N	G	—	E	N
Henbit	—	G	N	E	N	G	—	E	N
Horseweed	—	—	N	E	N	G	G	G	N
Knotweed	—	—	N	E	N	F	—	F	N
Mustards	—	—	N	E	N	G	—	F	N
Pennsylvania smartweed	G	—	N	E	N	P	F	G	N
Pigweeds	G-E	G	N	E	N	G	P	G	N
Prickly lettuce	—	—	N	E	N	P	—	G	N
Prickly sida	N	—	N	E	N	G	—	E	N
Purslane	—	—	N	E	N	F	—	G	N
Shepherds' purse	—	—	N	E	N	G	—	G	N
Speedwells	—	G	N	E	N	P	—	P	N
Velvetleaf	P	E	N	E	N	G	P	E	N
Virginia pepperweed	—	—	N	E	N	G	—	G	N
<i>Perennial Grasses And Sedges</i>									
Bermudagrass	—	N	G	G	G	N	N	P	G
Dallisgrass	—	N	G	E	G	N	N	P	—
Fescues	—	N	P-F	E	P-F	N	N	F	F
Johnsongrass (rhizome)	—	N	G	E	G	N	N	P	G
Nimblewill	—	N	G	G-E	F-G	N	N	P	—
<i>Perennial Grasses And Sedges (cont.)</i>									

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

Table 2.11 - Relative Effectiveness of Postemergence Herbicides in Small Fruit (cont.)

	Acifluorfen	Carfentrazone	Fluazifopbutyl	Glyphosate	Sethoxydim	2,4-D	Clopyralid	Paraquat	Clethodim
Orchardgrass	—	N	F	E	F	N	N	F	F
Purpletop, Redtop	—	N	G	E	G	N	N	P	—
Quackgrass	—	N	G	G	G	N	N	P	G
Yellow nutsedge	—	N	N	G	N	N	N	P	N
<i>Perennial Broadleaf Weeds</i>									
Broadleaf plantain	—	—	N	E	N	G	—	P	N
Buckhorn plantain	—	P	N	E	N	G	P	P	N
Canada thistle	—	—	N	F-G	N	F-G	G	P	N
Chicory	—	—	N	E	N	G	—	P	N
Common dandelion	—	P	N	E	N	G	F	P	N
Common mallow	—	—	N	E	N	—	—	P	N
Common milkweed	—	—	N	G	N	P-F	—	P	N
Common yarrow	—	—	N	G	N	F	—	P	N
Docks (broadleaf, curly)	—	P	N	G	N	G	—	P	N
Goldenrod	—	—	N	E	N	P-F	—	P	N
Ground ivy	—	—	N	G	N	P-F	—	P	N
Hemp dogbane	—	—	N	F	N	P-F	—	P	N
Horsenettle	—	—	N	F-G	N	P	—	P	N
Mugwort	—	—	N	F	N	P	P-F	P	N
Red sorrel	—	—	N	G	N	P	—	P	N
Thistles (bull, musk, curly)	—	—	N	G	N	F-G	G	P	N
White flowered aster	—	—	N	E	N	N	—	P	N
Wild carrot	—	—	N	E	N	P-F	—	P	N
Wild strawberry	—	—	N	E	N	P-F	—	P	N
Yellow rocket	—	—	N	E	N	P-F	—	P	N
Yellow woodsorrel	—	—	N	E	N	F	N	P	N
<i>Special Perennial Weed Problems</i>									
Bigroot morningglory	—	—	N	F-G	N	F-G	—	P	N
Brambles (<i>Rubus</i> spp.)	—	—	N	G	N	P	—	P	N
Common greenbriar	—	—	N	P	N	N	—	P	N
Japanese honeysuckle	—	—	N	F-G	N	P-F	—	P	N
Poison ivy	—	—	N	G	N	F	—	P	N
Virginia creeper	—	—	N	F-G	N	F	—	P	N
Wild garlic	—	—	N	F	N	F	—	P	N

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

Diseases and Insects in Vineyards

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Additional information on pest and beneficial species identification is available online at <http://www.virginiafruit.ento.vt.edu/>.

Application rates: The rate per acre column gives rates for low-volume or concentrate applications. Sprays may be applied as semi-concentrate (40-100 gal/A) or concentrate (10-40 gal/A) sprays. Use caution with more concentrated sprays; the smaller droplet sizes associated with low-volume application are more prone to drift. Amount of pesticide to be applied for dilute applications (usually 100 gal/A early in early season, 200 gal/A in mid season, and 300 gal/acre in late season) is usually given on the label.

Table 3.1 - Disease and Insect Control

Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
<i>Dormant</i>			
Anthracnose (Bird's eye rot) Powdery Mildew Phomopsis	lime sulfur solution	10.0 gal	Only necessary where anthracnose, Phomopsis, or powdery mildew have been a serious problem. Lime sulfur can reduce overwintering inoculum of these diseases.
Mealybugs	Applaud 70DF Belay 50WDG Venom 70 Scorpion 35SL Assail 30SG Admire Pro Baythroid XL 1EC Movento 2SC Actara 25WDG	9.0-12.0 oz 6.0 fl oz 1.0-3.0 oz (foliar) 5.0-6.0 oz (soil) 2.0-5.0 fl oz (foliar) 9.0-10.5 fl oz (soil) 2.5 oz 1.0-1.4 fl oz (foliar) 7.0-14.0 fl oz (soil) 2.4-3.2 fl oz 6.0-8.0 fl oz 1.5-3.5 oz	If a problem at harvest in the previous year. If a delayed dormant spray does not provide adequate control, a summer application may be made. Baythroid targets only crawlers. Movento prebloom only in table grapes. The use of Baythroid should be delayed until fourth cover in blocks where spotted wing drosophila must be controlled, in order to observe maximum applications per season.
Grape scale	Dormant oil	2% solution	Apply in high volume (dilute) application. Loose bark on vines makes coverage of scale difficult.
<i>Bud Swell</i>			
Grape flea beetle	Danitol 2.4EC Sevin XLR Plus Imidan 70WP Baythroid XL 1EC	8.0 fl oz 2.0 qt 2.0 lb 2.4-3.2 fl oz	If adult beetles are present in damaging numbers. See Table 3.4 for Restricted Entry Intervals. The REI for Imidan may render it impractical for most growers. The use of Baythroid and Tombstone should be delayed until fourth cover in blocks where spotted wing drosophila must be controlled, in order to observe maximum applications per season.
European red mite (ERM)	superior oil (70 sec)	2.0 gal	Only where ERM is a problem. Apply as a dilute spray.

3-2 Grapes: Diseases and Insects in Vineyards

Table 3.1 - Disease and Insect Control (cont.)			
Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
Climbing cutworms	<i>Bacillus thuringiensis</i> (Bt)	Rates vary	Spray in evening if possible. Various preparations of Bt available. Check label for rates. See Table 3.4 for Restricted Entry Intervals. The use of Delegate, Baythroid, Brigade and Sniper 2 should be delayed until fourth cover in blocks where spotted wing drosophila must be controlled, in order to observe maximum applications per season.
	Sevin XLR Plus	2.0 qt	
	Danitol 2.4EC	15.0 fl oz.	
	Intrepid 2F	12.0-16.0 fl oz	
	Tourismo	10.0-14.0 fl oz	
	Entrust 2SC	4.0-8.0 fl oz	
	Delegate 25WG	3.0-5.0 oz	
	Baythroid XL 1EC	2.4-3.2 fl oz	
	Brigade 10WSB	8.0-16.0 oz	
	Altacor 35WDG	3.0-4.5 oz	
	Belt 4SC	3.0-4.0 fl oz	
Sniper 2	3.2-6.4 fl oz		
<i>New Shoots: at weekly intervals or according to label until pre-bloom</i>			
Black rot, Phomopsis cane and leaf spot, Downy mildew	captan 50WP or equivalent	2.0-4.0 lb	Important to maintain protection starting at 1/2 inch to 1 inch shoot length where black rot or Phomopsis has been a problem. Add a surfactant to improve wetting of pubescent young growth. Captan has only fair efficacy against black rot. At high disease pressure, it should be tank-mixed with a more efficacious material. Do not make captan applications within two weeks of an oil spray.
	mancozeb 75DF	2.0-4.0 lb	
	Ziram	2.0-4.0 lb	
	See Table 3.2		
Powdery mildew	wettable sulfur (81.25% or 92%) See Table 3.2	2.0-5.0 lb (See label)	Where powdery mildew is a severe problem. Do not make sulfur applications within two weeks of an oil spray. Do not use sulfur prior to or during periods of excessively high temperatures. Do not apply sulfur to Concord, red-fruited French-American hybrids, and other sulfur sensitive varieties.
Anthracnose	copper fungicides with lime See Table 3.2	see label	Apply at 4- to 10-inch shoot length. Repeat at 10- to 14-day intervals. Only necessary where anthracnose has been a problem.
Grape cane girdler	Danitol 2.4EC	10.6 fl oz	When shoots are 4- to 6-inches long, where infesting more than 10% of shoots. Mainly a problem when training young vines. See Table 3.4 for Restricted Entry Intervals.
	Imidan 70WP	2.0 lb	
	Baythroid 2EC	2.4-3.2 fl oz	
Redbanded leafroller	Altacor 35WDG	3.0-4.5 oz	Where pest has been a problem in past. Various preparations of Bt available. Check rates. See Table 3.4 for Restricted Entry Intervals.
	Entrust 2SC	4.0-8.0 fl oz	
	Delegate 25WG	3.0-5.0 oz	
	Intrepid 2F	12.0-16.0 fl oz	
	Imidan 70WP	2.0 lb	
	Sevin XLR Plus	2.0 qt	
<i>Bacillus thuringiensis</i> (Bt)	See label		

Table 3.1 - Disease and Insect Control (cont.)

Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
Climbing cutworms	<i>Bacillus thuringiensis</i> (Bt)	See label	Spray in evening if possible. Various preparations of Bt available. Check rates. See Table 3.4 for Restricted Entry Intervals. The use of Delegate, Baythroid, Brigade and Sniper 2 should be delayed until fourth cover in blocks where spotted wing drosophila must be controlled, in order to observe maximum applications per season.
	Sevin XLR Plus	2.0 qt	
	Danitol 2.4EC	15.0 fl oz	
	Intrepid 2F	12.0-16.0 fl oz	
	Tourismo	10.0-14.0 fl oz	
	Entrust 2SC	4.0-8.0 fl oz	
	Delegate 25WG	3.0-5.0 oz	
	Baythroid XL 1EC	2.4-3.2 fl oz	
	Brigade 10WSB	3.2-6.4 oz	
	Altacor 35WDG	3.0-4.5 oz	
	Belt 4SC	3.0-4.0 fl oz	
	Sniper 2	3.2-6.4 fl oz	
<i>Pre-Bloom - Just before blossoms open, critical spray for black rot, powdery, and downy mildew</i>			
Black rot	Ziram	2.0-4.0 lb	Infection occurs at 7 or more hours of leaf wetness (dew, fog, and/or rain), depending on temperature. Apply all fungicides before or between these wet periods. Spray every 10-14 days throughout the growing season according to label. Do not use sterol inhibitors (group 3, Rally, Elite, Orius, Procure, Inspire Super, Mettle, Revus Top) or strobilurins (group 11, Abound, Sovran, Flint, or Pristine) continuously; rotate with other groups of fungicides.
	mancozeb 75DF	2.0-4.0 lb	
	Rally 40WSP	3.0-5.0 oz	
	tebuconazole 45% (Orius 45DF, formerly Elite)	4.0 oz	
	Abound	10.0-15.5 fl oz	
	Sovran	3.2-5.6 oz	
	Flint	2.0 oz	
	Pristine	8.0-12.5 oz	
	Adament	4.0-7.2 oz	
	Inspire super	16.0-20.0 oz	
	Revus Top	7.0 oz	
	Luna Experience	5.0-8.6 oz	

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Table 3.1 - Disease and Insect Control (cont.)			
Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
<i>Pre-Bloom - Just before blossoms open, critical spray for black rot, powdery, and downy mildew (cont.)</i>			
Downy mildew	captan 50WP	2.0-4.0 lb	Apply 2 weeks before blossom caps begin to drop on very susceptible varieties. Downy mildew strains with resistance to Abound, Pristine, and other Group II fungicides are present in many Virginia locations. Rotating or tank mixing with a different anti-downy-mildew material is recommended. Presidio should be tank-mixed with another fungicide active against downy mildew.
	mancozeb 75DF	2.0-4.0 lb	
	Ridomil Gold MZ	1.5-2.0 lb	
	phosphorous acid	See label	
	Gavel	2.0-2.5 lb	
	Revus	8.0 oz	
	Revus Top	7.0 oz	
	Forum	6.0 oz	
	Ranman	2.1-2.75 oz	
	Presidio	3.0-4.0 oz	
Powdery mildew	tebuconazole 45% (Orius, formerly Elite)	2.0-6.0 oz	Do not use sterol inhibitors (see above under black rot) or strobilurins continuously; rotate with other groups of fungicides. Powdery mildew strains with resistance to the strobilurins (Abound, Sovran, and Flint) are very common in Virginia and can cause control failure! It is recommended that strobilurins be tank mixed with sulfur or another anti-mildew material. Pristine contains a strobilurin, but also a different active chemical (group 7) and does not need to be tank mixed. Rates for sulfur can be increased to as high as 5.0 lb/100 gallons. Severe disease pressure may warrant this, but beware of possible plant injury at higher rates.
	wettable sulfur (81.25% or 92%)	2.0-4.0 lb	
	Rally 40WSP	3.0-5.0 oz	
	Procure	4.0-8.0 oz	
	Pristine	8.0-12.5 oz	
	Endura	4.5 oz	
	Quintec	4.0 oz	
	Adament	7.2 oz	
	Inspire Super	16.0-20.0 oz	
	Revus Top	7.0 oz	
	Vivando	10.3-15.4 oz	
	Luna Experience	5.0-8.6 oz	

Table 3.1 - Disease and Insect Control (cont.)

Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
<i>Pre-Bloom - Just before blossoms open, critical spray for black rot, powdery, and downy mildew (cont.)</i>			
Grape berry moth	Intrepid 2F	12.0-16.0 fl oz	Use higher rate of Entrust for more intensive infestations and larger larvae, where pest has been a problem in past. Mating disruption: SPLAT-GBM is registered for GBM. Spray edge rows with insecticides. For SPLAT-GBM mating disruption, apply when temperatures are between 60-80°F and no rain is expected within 1 to 2 hours. For high population densities, apply 1.0 kg/A as 1,000 point sources of 1.0 g (1/4 tsp.) throughout an acre. For low-moderate populations, apply 1.0 kg as 250 point sources of 2.5 g (1/2 tsp.). See application information on label. See Table 3.4 for Restricted Entry Intervals. The use of Delegate should be delayed until fourth cover in blocks where spotted wing drosophila must be controlled, in order to observe maximum applications per season.
	Tourismo	10.0-14.0 fl oz	
	Entrust 2SC	4.0-8.0 fl oz	
	Delegate 25WG	3.0-5.0 oz	
	Altacor 35WDG	2.0-4.5 oz	
	Imidan 70WP	2.0 lb	
	Belay 50WDG	6.0 fl oz	
	SPLAT-GBM	1.0 kg	
	Avaunt 30DG	5.0-6.0 oz	
	Sevin XLR	2.0 qt	
	<i>Bacillus thuringiensis</i> (BT)	Rates vary	
Grape leafhopper	Assail 70WP	1.1 oz	Use a treatment threshold of 5 nymphs/leaf before July 15, 10/leaf thereafter. Apply Surround at least 2 or 3 times at 7- to 14-day intervals throughout infestation; not recommended for table grapes because of visible residues. Nexter may be applied up to twice per season. Use 8.8-10.67 oz/A in vineyards with dense foliage. See Table 3.4 for Restricted Entry Intervals. The use of malathion should be delayed until fourth cover in blocks where spotted wing drosophila must be controlled, in order to observe maximum applications per season.
	Assail 30SG	2.5 oz	
	Actara 25WDG	1.5-3.5 oz	
	Admire Pro	1.0-1.4 fl oz	
	Imidan 70WP	2.0 lb	
	malathion 8F	2.7 pt	
	Surround 95WP	12.5-50.0 lb	
	Sevin XLR Plus	2.0 qt	
	Nexter 75WP	4.4-5.2 oz	
Grape Scale	Applaud 70DF	9.0-12.0 oz	Apply when crawlers are active, or at 493 and 990 degree-days above 50°F starting at April 1 (early and peak activity of first generation).
	Movento 2SC	6.0-8.0 fl oz	
	Admire Pro	1.0-1.4 fl oz	
	Assail 30SG	2.5 oz	
Grape tumid gallmaker	Movento 2SC	6.0-8.0 fl oz	Apply when galls first appear in blocks with a history of high populations of grape tumid gallmaker

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Table 3.1 - Disease and Insect Control (cont.)			
Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
<i>Bloom</i>			
Botrytis	Rovral 4F or Meteor	0.67-1.33 lb or 1.5-2.0 pt	Materials may be applied at early mid-bloom and again before bunch closing, if needed. Botrytis strains with resistance to strobilurins, Endura, Pristine, and Topsin M, and with reduced sensitivity to Rovral/Meteor are widespread in Virginia. Isolates with reduced sensitivity to Vanguard and Scala have also been observed in some locations.
	Vanguard	5.0-10.0 oz	
	Scala	9.0-18.0 oz	
	Elevate	1.0 lb	
	Switch	11.0-14.0 oz	
<i>Post-Bloom: Immediately after bloom</i>			
Black rot	mancozeb 75DF	4.0 lb	This is a very important spray . Do not delay more than 12-14 days after last pre-bloom spray. Note: Rally, Elite, Inspire Super, or Revus Top at the higher rates using 200 gal/A dilute sprays in combination with black rot predictor models provide excellent curative control.
	Ziram	4.0 lb	
	Rally 40WSP	3.0-5.0 oz	
	Elite 45DF	4.0 oz	
	Orius	10.0-15.5 fl oz	
	Abound	3.2-5.6 oz	
	Sovran	2.0 oz	
	Flint	8.0-12.5 oz	
	Pristine	16.0-20.0 oz	
	Inspire Super	7.0 oz	
	Revus Top	5.0-8.6 oz	
Luna Experience		Note 5-day REI for cane work.	
Downy mildew	captan 50WP	4.0 lb	Do not apply mancozeb or Gavel within 66 days of harvest. Copper fungicides may be mixed with hydrated lime to reduce risk of phytotoxicity, especially in cool, wet conditions, when copper fungicides may cause injury on certain varieties.
	mancozeb 75DF	4.0 lb	
	Ridomil Gold Copper	1.0-2.0 lb	
	copper fungicides	See label	
	phosphorous acid	See label	
	Gavel	2.0-2.5 lb	
	Revus	8.0 oz	
	Presidio	3.0-4.0 oz	
	Forum	6.0 oz	
	Revus Top	7.0 oz	
	Ranman	2.1-2.75 oz	

Table 3.1 - Disease and Insect Control (cont.)

Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
<i>Post-Bloom: Immediately after bloom (cont.)</i>			
Powdery mildew	Elite 45DF	4.0 oz	Very important spray. Use at 14- to 18-day intervals as needed. Use higher rates and/or shorter intervals (see label) under severe disease pressure. See notes for prebloom.
	Orius	3.0-5.0 oz	
	Rally (Nova) 40WSP	4.0 lb	
	wettable sulfur (81.25% or 92%)	4.0-8.0 oz	
	Procure	8.0-12.5 oz	
	Pristine	4.0 oz	
	Quintec	4.5 oz	
	Endura	16.0-20.0 oz	
	Inspire Super	7.0 oz	
	Revus Top	3.0-5.0 oz	
	Mettle	10.3-15.4 oz	
	Vivando	5.0-8.6 oz	
	Luna Experience		
Grape berry moth	Intrepid 2F	12.0-16.0 fl oz	Mating disruption is registered for GBM. Use full labeled rate and consult a grape entomologist before use for specific instructions. See prebloom spray. See Table 3.4 for Restricted Entry Intervals. The REI for Imidan may render it impractical for most growers.
	Tourismo	10.0-14.0 fl oz	
	Entrust 2SC	4.0-8.0 fl oz	
	Delegate 25WG	3.0-5.0 oz	
	Altacor 35WDG	2.0-4.5 oz	
	<i>Bacillus thuringiensis</i> (Bt)	Rates vary	
	Imidan 70WP	2.0 lb	
	Sevin 50WP	4.0 lb	
	Avaunt 30DG	5.0-6.0 oz	
Grape rootworm	Sevin XLR PLUS	2.0 qt	Apply when beetles appear, usually in late June or early July. Second application may be necessary 10 days later.
Grape leafhopper	Admire Pro	1.0-1.4 fl oz	Apply if more than 5 leafhopper nymphs/leaf before August 1, and 10/leaf thereafter. Portal on nonbearing vines only. See Table 3.4 for Restricted Entry Intervals. The use of malathion should be delayed until fourth cover in blocks where spotted wing drosophila must be controlled, in order to observe maximum applications per season.
	Nexter 75WP	4.4-5.2 oz	
	Assail 70WP	1.1 oz	
	Assail 30SG	2.5 oz	
	Actara 25WDG	1.5-3.5 oz	
	Belay 50WDG	2.0-4.0 fl oz	
	Imidan 70WP	2.0 lb	
	malathion 8F	1.88 pt	
	Sevin 50WP	4.0 lb	
	Sevin XLR PLUS	2.0 qt	
	Applaud 70DF	9.0-12.0 oz	
	Portal 5EC	1.0-2.0 pt	

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Table 3.1 - Disease and Insect Control (cont.)

Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
Phylloxera	Assail 70WP	1.1 oz	Spray when yellow crawlers first detected with hand lens or when galls first appear. Repeat 10-12 days after first spray if foliar form was a problem the previous year. Movento for pre-bloom use only on table grapes. Movento provides control of root infestations.
	Assail 30SG	2.5 oz	
	Movento 2SC	6.0-8.0 fl oz	
European red mite	Vendex 50WP	2.0 lb	Only if mites exceed 10/leaf (20/leaf on <i>labrusca</i> types), and more than minor bronzing occurs. Rotate acaricides. Use 8.8-10.67 oz of Nexter if twospotted spider mite is the predominant mite, or in vineyards with dense foliage. Vendex is available in water-soluble bags (1-2.5 bags/A). Acramite may only be applied once per year. Use 8.0 oz of Agri-Mek for low populations, 16.0 oz for severe. Stylet Oil should be applied at 1.0-2.0 gal/A, every 10 to 14 days against mite eggs.
	Vendex 4L	1.0 qt	
	Nexter 75WP	4.4-5.2 oz	
	Acramite 50WS	0.75-1.0 lb	
	Agri-Mek 0.15EC	8.0-16.0 fl oz	
	JMS Stylet Oil	1.0-2.0 gal	
	Envidor 2SC	16.0-18.0 fl oz	
	Zeal WP	2.0-3.0 oz	
	Onager 11.8EC	12.0-24.0 fl oz	
	Portal 5EC	1.0-2.0 pt	
Tri-Tek	1.0-2.0% solution		
<i>First Cover: 7 to 10 days after post-bloom spray</i>			
Black rot, downy mildew, powdery mildew	Same fungicides and rates as post-bloom spray.		Do not apply ferbam more than twice after pre-bloom spray. Copper fungicides with hydrated lime may be used for control of downy mildew. Observe per-season limits on pesticide amounts.
Grape berry moth, grape leafhopper, phylloxera, European red mite, grape rootworm	Same insecticides and rates as post-bloom spray.		Do not apply imidan within 14 days of harvest.
<i>Second Cover: 7-10 days after first cover spray (when berries are about pea size, but before they touch in cluster)</i>			
Black rot, downy mildew, powdery mildew, grape berry moth, grape leafhopper, phylloxera, European red mite	Same fungicides and rates as Post-bloom spray. Same insecticides and rates as Post-bloom spray		Observe per-season limits on pesticide amounts. (See label.)
Japanese beetle, June beetle, wasps	Sevin 50WP	4.0 lb	Apply when beetles are common. Sevin may not be applied within 7 days of harvest. See Table 3.4 for Restricted Entry Intervals. Neemix and Trilogy are to be combined.
	Sevin XLR PLUS	2.0 qt	
	Surround 95WP	12.5-50.0 lb	
	Imidan 70WP	2.0 lb	
	Belay 50 WDG	2.0-4.0 fl oz	
	Actara 25WDG	1.5-3.5 oz	
	Assail 70WP	1.1 oz	
	Avaunt 30DG	3.5-6.0 oz	
	Neemix 4.5	7.0-16.0 fl oz	
	+ Trilogy	+ 2% solution	

Table 3.1 - Disease and Insect Control (cont.)

Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
<i>Third Cover: before bunch closing</i>			
Botrytis	Rovral 4F or Meteor	1.0-1.33 lb	
	Vanguard	or 1.5-2.0 pt	
	Scala	5.0-10.0 oz	
	Elevate	9.0-18.0 oz	
	Switch	1.0 lb	
		11.0-14.0 oz	
<i>Veraison: berry ripening, sugar building up</i>			
Botrytis	Rovral 4F or Meteor	1.0-1.33 lb	Anti-Botrytis materials can be applied at beginning of ripening and again prior to harvest if needed. Fruit rot can be caused by a variety of organisms. Many anti-Botrytis fungicides have little effect on organisms other than Botrytis. Botrytis strains with resistance to strobilurins, Endura, Pristine, and Topsin M, and with reduced sensitivity to Rovral/Meteor are widespread in Virginia. Isolates with reduced sensitivity to Vanguard and Scala have also been observed in some locations. Rotating Vanguard or Scala (same group), Elevate, Rovral or Meteor, Switch, Elevate, and/ or Luna Experience is recommended. Carefully observe per season limits on number of sprays.
	Vanguard	or 1.5-2.0 pt	
	Scala	5.0-10.0 fl oz	
	Elevate	9.0-18.0 oz	
	Switch	1.0 lb	
		11.0-14.0 oz	
<i>Veraison: berry ripening, sugar building up (cont.)</i>			
Spotted wing drosophila	Entrust 2SC	4.0-8.0 fl oz	Spotted wing drosophila is more important in red varieties beginning at veraison. It is critical to rotate among differing modes of action in order to delay the development of resistance. PyGanic has a short residual life which limits its efficacy. Entrust and PyGanic are organic alternatives. Be watchful for flare-ups of secondary pests (mealybugs, spider mites) following application of pyrethroids. For more information on SWD, visit www.virginiafruit.ento.vt.edu/SWD.html .
	Delegate 25WG	3.0-5.0 oz	
	malathion 8F	1.88 pt	
	Mustang Max 0.8EC	4.0 fl oz	
	Tombstone 2EC	2.4-3.2 fl oz	
	PyGanic 1.4EC	64.0 fl oz	
	Surround WP	25.0-50.0 lb	
Grape Scale	Applaud 70DF	9.0-12.0 oz	Second generation crawlers can be targeted at first and peak activity (1100 and 2000 degree-days above 50°F after April 1) (mid-July and mid-August).
	Movento 2SC	6.0-8.0 fl oz	
	Admire Pro	1.0-1.4 fl oz	
	Assail 30SG	2.5 oz	
<i>Fourth Cover: mid-August or 10 days after third cover spray</i>			
Same diseases and insects as above plus:	Same fungicides and insecticides as Post-bloom spray, except ferbam, plus the following:		DO NOT APPLY copper within 30 days of harvest or sulfur within 10- to 14-days of harvest to minimize enological problems if berries are to be used for wine.
Drosophila flies (vinegar flies)	malathion 8EC or 8F	2.0-2.5 pt	Apply if drosophila are abundant. See separate comments below on spotted wing drosophila

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Table 3.1 - Disease and Insect Control (cont.)			
Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
Brown Marmorated Stink Bug	Scorpion 35SL	2.0-5.0 fl oz (foliar)	
		9.0-10.5 fl oz (soil)	
	Assail 70WP	1.1 oz	
	malathion 8EC	3.0 pt	
	Actara 25WDG	1.5-3.5 oz	
	Azera	2.0-3.0 pt	
	Venom	3.0 oz	
Spotted Wing Drosophila	Azera	1.0-2.0 p	Spotted wing drosophila is more important in red varieties beginning at veraison. It is critical to rotate among differing modes of action in order to delay the development of resistance. PyGanic has a short residual life which limits its efficacy. Entrust and PyGanic are organic alternatives. Be watchful for flare-ups of secondary pests (mealybugs, spider mites) following application of pyrethroids. For more information on SWD, visit www.virginiafruit.ento.vt.edu/SWD.html .
	Entrust 2SC	4.0-8.0 fl oz	
	Baythroid XL 1EC	2.4-3.2 fl oz	
	Delegate 25WG	3.0-5.0 oz	
	malathion 8F	1.88 pt	
	PyGanic 1.4EC	64.0 fl oz	
	Tombstone 25EC	2.4-3.2 fl oz	
	Surround WP	25.0-50.0 lb	
Yellow jackets	Sevin 80WSP	1.5 lb	Chemical control is not very effective because short PHI materials provide limited control and only current workers are killed. Try to find the nest and spot treat, especially if located in vineyard. Yellow jacket traps placed early in spring to trap overwintered queens may be helpful.
	Sevin XLR Plus	2.0 qt	
<i>Harvest: Day before or day of harvest</i>			
Brown Marmorated Stink Bug	Belay 50WDG	6.0 fl oz	This spray is aimed at knock down of stink bugs in the clusters at harvest. Not intended for residual control.
	PyGanic 1.4EC	64.0 fl oz	
<i>Postharvest: vines only</i>			
Mealybugs	Applaud 70DF	9.0-12.0 oz	Apply if control is not achieved by delayed dormant spray.
	Venom 70	1.0-3.0 oz	
	Assail 70WP	1.1 oz	
	Assail 30SG	2.5 oz	
	Actara 25WDG	1.5-3.5 oz	
	Admire Pro	1.0-1.4 fl oz	
	Belay 50WDG	6.0 fl oz	
	Movento 2SC	6.0-8.0 fl oz	
Leaves of vines should be protected up until frost to maintain healthy plants. This is especially important for control of powdery and downy mildew. Maintain green functioning leaves as long as possible. Follow sprays for powdery and downy mildew under post-bloom.			

Table 3.1 - Disease and Insect Control (cont.)

Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
<i>Special Borer Treatment</i>			
Grape root borer	Lorsban 4E Isomate GRB	— 100 dispensers	Good weed control usually prevents GRB populations from reaching high levels. In problem infestations, consider soil mounding, 8-12 inches high, around July 1. Pull down mound before following season. Also consider soil treatment with Lorsban. If GRB is a problem, apply just before adult emergence, but not within 35 days before harvest. Apply 2.0 qt of diluted spray mixture (4.5 pt/100gal) to soil surface on a 15 ft sq area around base of each vine. No more than once/season. Do not allow to contact fruit or foliage. Apply pheromone dispenser at 100/A, at the beginning of flight, around the first of July.

Special Sharpshooter Sprays

In some vineyards in the eastern part of the state, sharpshooter leafhoppers, the vectors of Pierce's disease are of concern. While research is needed on the vector relationships and timing in Virginia, the neonicotinoids Admire Pro (1.0-1.4 fl oz), Assail 70WSP (1.1 oz/A), Assail 30SG (2.5 oz/A), Belay 50WDG (4.0-6.0 fl oz), Scorpion 35SL (2.0-5.0 fl oz), Venom 70SG (1.0-3.0 oz/A), and Venom 20SG (0.44-0.66 lb/A) are registered for control of sharpshooters. Use the higher rates for higher pressure. In addition, Scorpion and Venom are registered for soil application (9.0-10.5 fl oz; 5.0-6.0 oz/A respectively), as is Admire Pro (7.0-14.0 fl oz/A). Soil applications should be applied between bud-break and pea-berry stage and should be considered when there are three or fewer nights below 15°F during the preceding winter. The neonicotinoids share a common mode of action; avoid overuse to avoid resistance.

Besides neonicotinoids, the following pyrethroids are registered for sharpshooter control: Danitol 2.4EC (10.67-21.33 fl oz/A), Brigade 2EC (6.4 fl oz/A), and Baythroid 2EC (1.6-3.2 fl oz/A). Danitol is limited to two applications, Baythroid to four applications, and Brigade to two applications at the low rate, one at the high.

In blocks where spotted wing drosophila will need to be controlled, early use of pyrethroids will decrease the number of applications available in late season.

Consult <http://www.virginiafruit.ento.vt.edu/PDsharpshooters.html> for updated information.

Effectiveness of Grape Pesticides

Effectiveness ratings of grape pesticides for disease, insect, mite, and weed control are based on research from Virginia and surrounding states. Although the ratings are compiled from the results of 5-10 years of research, they may not hold true for all vineyard conditions within Virginia. Results can vary from location to location depending on the weather conditions, how well the vines were sprayed the previous year, inoculum density, pest populations, canopy size, age of vines, formulation of a given pesticide, and how the pesticide was applied (low or high volume). Under certain environmental conditions and cultural practices, the effectiveness ratings could change from good to fair or vice versa. The ratings given are intended as general guides to assist the grower in pesticide selection for disease, insect, mite, and weed control.

Table 3.2 - Relative Effectiveness of Selected Fungicides in Grapes

(E=excellent; G=good; F=fair; P=poor; N=none; – =information lacking or not registered; Var=variable depending on presence of resistance)

Fungicides Trade Name	Fungicides Common Name	Resistance Risk	Mode of Action Group	Anthraco-nose	Black rot	Botrytis bunch rot	Downy Mildew	Phomopsis cane/leaf spot	Powdery Mildew
Abound ¹	azoxystrobin ¹	H	11	G	E	Var	Var	F-G	Var
Adament	tebuconazole + trifloxystrobin	H	3+11	–	E	Var	P-F	–	F-G ¹⁰
Aliette	fosetyl-AI	L	33	–	–	–	E	–	–
Armicarb, Kaligreen, Agricure	potassium bicarbonate	L	M	–	–	–	–	–	F-G
Captan, Captec, etc	captan	L	M4	G	F	F	G-E	G-E	N
Coppers ³	Bordeaux ³ , fixed coppers ⁸	L	M1	F-G	F	P-F	G-E	F	F-G
Elevate	fenhexamid	M	17	–	–	G-E	–	–	P-F
Elite, Orius, Tebuzol	tebuconazole	M	3	–	E	–	–	–	G ¹⁰
Endura	boscalid	M	7	G	–	Var	–	–	G-E
Ferbam	ferbam	L	M3	–	G	N	F	F	N
Flint ¹	trifloxystrobin ¹	H	11	–	E	Var	Var	F-G	Var
Forum	dimethomorph	L-M	40	–	–	–	G-E	–	–
Gavel	zoxamide + mancozeb	M for zoxamide	22+M3	F	F	–	G	G	–
Inspire Super	difenoconazole + cyprodinil	M	3+9	–	E	G-E	–	–	E
Luna Experience	Fluopyram + tebuconazole	M	7+3	–	E	E	–	–	E
Manzate, various ⁴	mancozeb ⁴	L	M3	G	G	N	E	G-E	N
Mettle	tetraconazole	M	3	–	E	–	–	–	G-E
Nutrol	mono potassium phosphate	L	M	–	–	–	–	–	F
Oils: Sun Ultra-Fine Oil JMS Stylet-Oil, Pure Spray Green, Safe-T-Side, etc.		L	M	–	–	–	–	–	G
Oxidate	hydrogen peroxide	L	M	–	–	–	–	–	F
Presidio	fluopicolide	M	43	–	–	–	labeled	–	–
Ph-D	polyoxin D	M	19	–	–	labeled	–	–	labeled
Pristine ¹	boscalid plus pyraclostrobin ¹	H+M	11+7	G	G-E	Var	Var	labeled	E
Procure, Viticure	triflumizole	M	3	–	–	–	–	–	G
ProPhyt, Phostrol, Agri-Fos, Fosphite, Fungi-Phite	phosphorous acid (phosphite)	L	33	–	–	–	G-E	–	–

Table 3.2 - Relative Effectiveness of Selected Fungicides in Grapes (cont.)

(E=excellent; G=good; F=fair; P=poor; N=none; – =information lacking or not registered; Var=variable depending on presence of resistance)

Fungicides Trade Name	Fungicides Common Name	Resistance Risk	Mode of Action Group	Anthraco-nose	Black rot	Botrytis bunch rot	Downy Mildew	Phomopsis cane/leaf spot	Powdery Mildew
Quadris Top	azoxystrobin + difenoconazole	M-H	–	G	E	Var	Var	F-G	G-E
Quintec	quinoxifen	M	13	–	P	–	–	–	G-E
Rally ²	myclobutanil ²	M	3	G	E	–	N	P	G ¹⁰
Ranman	cyazofamid	M-H	21	–	–	–	G-E	–	–
Reason	fenamidone	H	11	–	–	–	P-E	–	–
Revus	mandipropamid	M	40	–	–	–	G-E	–	–
Revus Top	difenoconazole + mandipropamid	M	3+40	–	E	–	G-E	–	E
Ridomil Gold MZ ⁶	mefenoxam + mancozeb ⁶	H for mefenoxam	4+M3	F	F	–	E	F	–
Ridomil Gold/Copper ⁶	mefenoxam + copper ⁶	H for mefenoxam	4+M3	–	F	P	E	F	F
Rovral ⁵ , Meteor ⁵	iprodione ⁵	M	2	–	P	G-Var	–	N	N
Rubigan, Vintage ²	fenarimol ²	M	3	F	F	–	–	–	G-E ¹⁰
Scala	pyrimethanil	M	9	–	–	G-E	–	–	P?
Sovran ¹	kresoxim methyl ¹	H	11	G	E	Var	F-Var	F-G	Var
Sulfur, Various ⁷	sulfur ⁷	L	M2	–	N	N	N	–	G
Switch	cyprodinil + fludioxonil	–	–	–	–	E	–	–	–
Tanos	cymoxanil + famoxadone	M	11+27	–	–	–	Var	–	–
Topsin M	thiophanate methyl	H	1	F-G	F	P-G ⁹	N	F	P-G ⁹
Torino	cyflufenamid	M	U6	–	–	–	–	–	E
Vanguard	cyprodinil	M	9	–	–	G-E	–	–	–
Vivando	metrafenone	M	V8	–	–	–	–	–	E
Ziram Granuflo, Ziram 76	ziram	L	M3	G	G	–	F	G	–

¹ Do not use Abound (azoxystrobin), Sovran (kresoxim methyl), Flint (trifloxystrobin), or Pristine (pyraclostrobin plus boscalid) continuously. Rotate with other fungicide groups as per label. Powdery and downy mildew as well as Botrytis strains with resistance to these strobilurins have been found in **many** locations in Virginia, and can cause control failure! It is recommended that strobilurins be tank mixed with sulfur or another anti-powdery mildew material, and also with another anti-downy-mildew material. Pristine contains a strobilurin and also boscalid (group 7), which has separate activity against powdery mildew but **not** against downy mildew. Botrytis strains with resistance to both ingredients in Pristine are common in Virginia. Abound can cause serious injury to some **apple** cultivars. Avoid drift to apples and do not spray apples with equipment containing Abound residues. Pristine or Flint should **not** be used on **Concord grapes**. Sovran can injure some cherry cultivars.

² Rally and Elite can control black rot after infection has occurred. For effective control, infection periods must be monitored and fungicide applied within 3 days after the start of an infection period. Application of these materials and Mettle, Inspire Super, Revus Top, and Procure to sporulating lesions of powdery mildew is best avoided to prevent selection of resistant strains of the pathogen. Continuous heavy use of this group of fungicides may entail the risk of selecting resistant strains of disease-causing fungi.

³ Bordeaux mixture is a mixture of copper sulfate and hydrated lime; it may be purchased prepacked or mixed fresh by the grower. See also note⁹ for fixed copper fungicides.

⁴ Trade names for mancozeb include Manzate 200, Manzate 200 DF (DuPont), Dithane M45, Dithane F45, Dithane DF (Dow), and Penncozeb (United Phosphorus). Gavel is mancozeb + zoxamide.

⁵ Continuous use of Rovral or Meteor, and Vanguard or Scala entails the risk of selecting strains of Botrytis with resistance to these fungicides. Strains of Botrytis with reduced sensitivity to all these products have been found in some Virginia vineyards. Do not routinely apply more than two sprays of either of these two groups per season.

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- ⁶ Ridomil Gold MZ contains 10% metalaxyl plus 48% mancozeb; Ridomil Gold/Copper contains 10% metalaxyl plus 60% copper hydroxide (see also note⁸).
- ⁷ Sulfur is very phytotoxic on the foliage of Concord, red-fruited French-American hybrids and several other, mainly American (*Labrusca*-type), varieties. Even tolerant varieties may be injured when temperatures over 85°F occur during or immediately following an application.
- ⁸ Fixed copper compounds that are registered for use on grapes include Kocide 101, BCS-Copper Fungicide, Ten-Cop 5E, copper oxychloride sulfate (C-O-C-S), and many other compounds and formulations. The main drawback of copper fungicides is the potential for severe injury to grape foliage, depending on variety and weather conditions, and for reduced vine vigor and yields even in the absence of visible foliar injury. Cool wet weather generally makes copper toxicity worse. Phytotoxicity can be lessened by adding spray lime. One should be very careful mixing other pesticides with preparations containing lime: many of these combinations are incompatible. Excessive use of copper within 30 days of harvest may interfere with wine making. On the plus side, copper fungicides are usually cheap and may provide longer-lasting activity than others such as ferbam and captan. If growers wish to use copper materials, they should try them first on a limited acreage of each variety before treating the entire planting.
- ⁹ Continuous use of Topsin M entails the risk of selecting Topsin M-resistant strains of disease-causing fungi. Topsin M-resistant Botrytis and powdery mildew have been found in many Virginia vineyards.
- ¹⁰ In some areas of the eastern U.S., including Virginia, Rally (Nova), Orius, Adament, and Elite, and to a lesser extent Procure, have lost some of their efficacy against grape powdery mildew.

Table 3.3 - Relative Effectiveness of Selected Insecticides/Acaricides in Grapes

Insects and mites	Insecticides/Acaricides and Ratings																																					
	Acramite	Actara	Agri-Mek	Altacor	Appaud	Assail	Avant	Azera	Baythroid	Bt	Belay	Brigade	Dantol	Delegate	Diazinon	Entrust	Envidor	Imidan	Intrepid	Lannate	Lorsban	Malathion	Movento	Nemix/Trilogy	Nexter	Onger	Provado	Pyganic	Sevin	SPLAT-GBM	Sylect Oil	Surround	Vendex	Venom	Zeal			
Brown Marmorated Stink bug	-	G	-	-	G	-	F	-	G	G	G	G	-	-	-	-	-	P	-	F	G	-	-	-	-	-	-	G	P	-	-	-	-	-	G	-		
Cutworms	-	-	G	-	-	-	-	G	G	G	G	G	G	-	-	-	-	-	-	G	-	-	-	-	-	-	-	-	G	-	-	-	-	-	-	-	-	
Drosophila flies	-	-	-	-	-	-	G	-	-	-	-	-	-	E	E	-	-	-	-	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Grape berry moth	-	-	E	-	G	-	E	F	G	E	G	G	G	E	G	G	-	-	-	G	E	G	-	-	-	-	-	-	G	G	-	-	-	-	-	-	-	
Grape cane girdler	-	-	-	-	-	-	E	-	-	-	-	-	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Grape flea beetle	-	-	-	-	-	-	E	-	-	-	-	-	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	-	-	-	-	-	-	-	-	
Grape leafhopper	-	G	-	E	E	-	E	-	E	G	E	E	G	-	G	-	-	-	-	G	G	G	-	-	-	-	-	E	E	-	-	-	-	-	-	-	-	
Grape rootworm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G	-	-	-	-	-	-	-	-	
Grape root borer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Grape scale	-	-	-	E	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G	-	-	-	-	-	-	-	-	
Japanese beetle	-	G	-	-	G	G	-	G	-	G	-	E	-	-	-	-	-	-	-	-	G	-	G	-	-	-	-	-	G	-	-	-	-	-	-	-	-	
June beetle	-	G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G	-	-	-	-	-	-	-	-	
Mealybugs	-	G	-	E	G	-	G	-	G	-	G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G	-	-	-	-	-	-	-	-	-	
Phylloxera (Leaf form)	-	-	-	-	-	-	-	-	-	-	-	-	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Redbanded leafroller	-	-	E	-	-	-	-	-	G	-	-	-	F	E	-	G	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rose chafer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sharpshooter	-	-	-	-	G	-	-	-	G	G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spider mites	G	-	G	-	-	-	-	-	-	-	-	E	-	F	-	E	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spotted wing drosophila	-	-	-	-	-	-	F	E	-	-	-	E	-	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wasp	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(E=excellent; G=good; F=fair; P=poor; N=none; - = information lacking or not registered)

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Table 3.4 - Chemical Names, Re-entry Times, and Days to Harvest¹

Chemical (Other name)	Manufacturers	Restricted Entry Interval	Days to Harvest
Abound (azoxystrobin)	Syngenta	4 hours	14
Acramite (bifenazate)	Uniroyal	5 days (cane turning, tying, girdling) 12 hours (other activities)	14
Actara (thiamethoxam)	Syngenta	12 hours	5
Adament (tebuconazole + trifloxystrobin)	Bayer CropScience	12 hours	14
Admire (imidacloprid)	Bayer CropScience	12 hours	30 (soil) 0 (foliar)
Agri-Mek (abamectin)	Syngenta	12 hours	28
Aliette (fosetyl AI)	Bayer CropScience	12 hours	15
Altacor (chlorantraniliprole)	DuPont	4 hours	14
Applaud (buprofezin)	Nichino America	12 hours	30
Assail (acetamiprid)	United Phosphorus	12 hours	7
Avaunt (indoxacarb)	DuPont	12 hours	7
Azera (azadirachtin, pyrethrins)	MGK	12 hours	0
Baythroid (cyfluthrin)	Bayer CropScience	12 hours	3
Belay (clothianidin)	Valent	12 hours	0
Belt (flubendiamide)	Bayer CropScience	12 hours	7
Brigade (bifenthrin)	FMC	12 hours	30
Bordeaux mixture (copper sulfate & hydrated lime)	Instructions for making Bordeaux mix available at www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7481.html		0
Captan (Captan, Captec)	Arysta, Drexel	2-4 days (see label)	0
copper, fixed	Various	24-48 hours	0
Danitol (fenpropathrin)	Valent	24 hours	21
Delegate (spinetoram)	Dow AgroSciences	4 hours	7
Diazinon	Makhteshim-Agan	24 hours	28
Dipel (<i>B.t.</i>)	Abbott	4 hours	0
Elevate (fenhexamid)	Arysta	12 hours	0
Elite (tebuconazole)	Bayer CropScience	12 hours	14
Endura (boscalid)	BASF	12 hours	14
Entrust (spinosad)	Dow AgroSciences	4 hours	7
Envidor (spiroticlofen)	Bayer CropScience	12 hour (6 days for high contact activities in table grapes)	14
Flint (trifloxystrobin)	Bayer CropScience	12 hours	14
Forum (dimethomorph)	BASF	12 hours	28
Gavel (zoxamide + mancozeb)	Gowan	48 hours	66
Imidan (phosmet)	Gowan	14 days	14
Inspire Super (difenoconazole + cyprodinil)	Syngenta	12 hours	14
Intrepid (methoxyfenozide)	Dow AgroSciences	4 hours	30
Lorsban 4E (chlorpyrifos)	Dow AgroSciences	24 hours	35

¹This information is given as a guideline only. Always read the label because there have been many changes in re-entry times and preharvest intervals in recent years, and more changes are expected in the future.

²See label cautions regarding potential effects on harvest parameters.

Table 3.4 - Chemical Names, Re-entry Times, and Days to Harvest¹ (cont.)

Chemical (Other name)	Manufacturers	Restricted Entry Interval	Days to Harvest
Luna Experience (fluopyram & tetraconazole)	Bayer	12 hours (5 days for cane work)	14
malathion (Malathion)	Gowan	24 hours	3
mancozeb (Dithane M45, Manzate 200, Penncozeb)	Dow AgroSciences, DuPont, United Phosphorus, etc.	24 hours	66
Meteor (iprodione)	United Phosphorus	48 hours	7
Mettle (tetraconazole)	Isagro	12 hours	14
Movento (spirotetramat)	Bayer CropScience	24 hours	7
Neemix (azadirachtin)	Certis	12 hours	0 days
Nexter (pyridaben)	Gowan	12 hours	7
Onager (hexythiazox)	Gowan	12 hours	28
Orius 20AQ (tebuconazole)	Mahkteshim Agan	12 hours	14
Ph-D (polyoxin D)	Arysta	4 hours	0
Portal (fenproximate)	Nichino America	12 hours	nonbearing
Presidio (fluopicolide)	Valent	12 hours	21
Pristine (boscalid+pyraclostrobin)	BASF	12 hours (5 days for cane work)	14
Procure, Viticure (triflumizole)	Chemtura	12 hours	7
ProPhyt (phosphorous acid)	Helena	4 hours	0
Provado (imidacloprid)	Bayer CropScience	12 hours	0
Purespray Green (oil)	Petro-Canada	4 hours	0
PyGanic (pyrethrins)	MGK	12 hours	0
Quadris Top (azoxystrobin+difenoconazole)	Syngenta	12 hours	14
Quintec (quinoxifen)	Dow Agrosociences	12 hours	14
Rally (myclobutanil)	Dow AgroSciences	24 hours	14
Ranman (cyazofamid)	FMC	12 hours	30
Reason (fenamidone)	Bayer	12 hours	30
Revus (mandipropamid)	Syngenta	4 hours	14
Revus Top (difenoconazole + cyprodinil)	Syngenta	12 hours	14
Ridomil Gold Copper (mefenoxam & copper)	Syngenta	48 hours	42
Ridomil Gold MZ (mefenoxam + mancozeb)	Syngenta	48 hours	66
Rovral (iprodione)	FMC	48 hours	7
Scala (pyrimethanil)	Bayer CropScience	12 hours	7
Scorpion (dinotefuran)	Gowan	12 hours	1 (foliar) 28 (soil)
Sevin (carbaryl)	Aventis	12 hours	7
Sniper (bifenthrin)	Loveland Products	12 hours	30

¹This information is given as a guideline only. Always read the label because there have been many changes in re-entry times and preharvest intervals in recent years, and more changes are expected in the future.

²See label cautions regarding potential effects on harvest parameters.

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Table 3.4 - Chemical Names, Re-entry Times, and Days to Harvest¹ (cont.)

Chemical (Other name)	Manufacturers	Restricted Entry Interval	Days to Harvest
SPLAT-GBM (pheromone)	ISCA Technologies	4 hours	–
Sovran (kresoxim methyl)	Cheminova	12 hours	14
Stylet Oil	JMS Flower Farms	4 hours	0
Sulfur (Kumulus, sulfur, Microthiol, liquid sulfur, wettable sulfur, etc.)	various	24 hours	0
Surround (Kaolin)	BASF	4 hours	0 ²
Switch (cyprodinil + fludioxonil)	Syngenta	12 hours	7
Tanos (cymoxanil + famoxadone)	DuPont	12 hours	30
Topsin M (thiophanate methyl)	United Phosphorus	2-7 days (see label)	14
Torino (cyflufenamid)	Gowan	4 hours	3
Tourismo (flubendiamide + buprofezin)	Nichino America	12 hours	7
Trilogy (classified hydrophobic extract of neem oil)	Certis	4 hours	0
Tri-Tek	Brandt	4 hours	0
Vangard (cyprodinil)	Syngenta	12 hours	7
Vendex (fenbutatin oxide)	DuPont	48 hours	28
Venom (dinotefuran)	Valent	12 hours	1 (foliar) 28 (soil)
Vivando (metrafenone)	BASF	12 hours	14
Zeal (etoxazole)	Valent	12 hours	14
Ziram	United Phosphorus, Taminco	48 hours	21

¹This information is given as a guideline only. Always read the label because there have been many changes in re-entry times and preharvest intervals in recent years, and more changes are expected in the future.

²See label cautions regarding potential effects on harvest parameters.

Weed Control in Vineyards

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Table 3.5 - Herbicides Labeled for Use in Grapes

For preemergence herbicides, use lower rates on sandy soils and higher rates on clay soils. Do not disturb soil after a preemergence herbicide application. Tank mixes of certain preemergence and postemergence herbicides can be made to control existing vegetation and control weeds germinating from seed. Check compatibility of tank mixes prior to application.

Pest	Chemical and Formulation Rate per Acre	Timing and Remarks
<i>Preemergence directed under vines</i>		
Many annual weeds	indaziflam 0.065 lb (Alion 5.0 fl oz)	Vines must be established at least 5 years. Do not use in soils high in sand or gravel. Apply only once per year. Do not apply within 14 days of harvest.
Most annuals, fescue, quackgrass, dandelions, dock, and other herbaceous perennials	dichlobenil 4.0-6.0 lb (Casoron 4G 100.0-150.0 lb or 2.3-3.4 lb/1000 sq ft)	Apply dry granules in late winter or early spring. Shallow incorporation may improve weed control. Do not apply within 4 weeks after transplanting. Short residual activity, regrowth usually occurs in late summer. Do not graze livestock in treated areas. Do not make an application within 1 month of harvest.
Most annuals and some perennials	diuron 1.6-2.4 lb (Karmex 80DF 2.0-3.0 lb)	Apply a single application/year in early spring to a weed free surface or include an appropriate postemergence herbicide. Use in vineyards established at least 3 years. Do not replant to any crop within 2 years after application.
Annual grasses and broad-leaf weeds	flumioxazin 0.19-0.375 lb (Chateau 6.0-12.0 oz/A)	Preemergence and early postemergence action. Apply as a directed spray to dormant vines or use shields if applications are made after flowering to prevent spray contact with grape foliage or fruit. Do not apply to vines established less than 2 years unless protected from spray contact using nonporous wraps, grow tubes, or waxed containers. Apply prior to weed germination or to small emerged weed seedlings. Combine with a labeled postemergence herbicide such as glufosinate for control of larger annual weeds or perennials.
Annual broadleaf weeds	isoxaben 0.5-1.0 lb (Trellis 0.67-1.33 lb)	Do not apply within 165 days of harvest. Apply after soil has settled following transplanting. Combine with a preemergence herbicide for annual grass control, such as oryzalin. Add a postemergence herbicide to control emerged weeds.
Many annual weeds	simazine 2.0-4.0 lb (Princep Caliber 90 2.2-4.4 lb or 4L 2.0-4.0 qt)	Apply a single application per year in the fall or spring to a weed free surface or include an appropriate postemergence herbicide. Vineyards must be established at least 3 years.
Annual grasses and certain annual broadleaf weeds	oryzalin 2.0-6.0 lb (Orzalin 4AS, Surflan 4AS 2.0-6.0 qt, Surflan DF 2.4-7.1 lb)	May be used in non-bearing and bearing vineyards. Areas to be treated should be free of weeds or include an appropriate postemergence herbicide. 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. May be tank-mixed with diuron or simazine to control many broadleaf weeds. Observe precautions and time limitations for diuron or simazine.
Annual broadleaf weeds and certain annual grasses	oxyfluorfen 0.5-2.0 lb (Goal 2XL 2.0-8.0 pt, GoalTender 1.0-4.0 pt)	Dormant application only. Will control certain small seedling weeds plus provide soil residual control of annual broadleaf weeds and certain annual grasses.

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Table 3.5 - Herbicides Labeled for Use in Grapes (cont.)

Pest	Chemical and Formulation Rate per Acre	Timing and Remarks
Annual broadleaf weeds and certain annual grasses	rimsulfuron 0.063 lb (Matrix FNV 4 oz/A)	Preemergence and postemergence control of certain annual weeds. Combine with other preemergence herbicides such as oryzalin or pendimethalin and with other postemergence herbicides (including glyphosate and glufosinate) for broader spectrum control. Grapevines need to be in the ground at least one year.
Annual and perennial grasses and certain broadleaf weeds	pronamide 1.0-4.0 lb (Kerb 50W 2.0-8.0 lb)	Apply in the fall after fruit harvest but prior to leaf drop and soil freeze-up. Do not apply to vines less than one year old. RESTRICTED USE PESTICIDE.
Annual grasses and certain annual broadleaf weeds	pendimethalin 2.0-4.0 lb (Prowl 3.3EC 2.4-4.8 qt, Prowl H ₂ O 2.0-4.0 qt)	Prowl EC - use on nonbearing plantings only. Prowl H ₂ O - do not apply within 90 days of harvest. Allow soil to settle around vines before application. Apply only to dormant plants. Do not apply after buds have started to swell. Do not apply ovetop vines.
Annual grasses, certain annual broadleaf weeds and suppression of yellow nutsedge	norflurazon 1.0-4.0 lb (Solicam 1.25-5.0 lb)	Apply prior to budbreak. Vines must be established at least 2 years. Combine with simazine or diuron for improved broadleaf weed control in vineyards over 3 years old. Apply to weed-free areas or combine with an appropriate postemergence herbicide.
<i>Postemergence directed under vines</i>		
Annual and perennial grasses	fluazifop-butyl 0.25-0.375 lb ai (Fusilade DX 16.0-24.0 fl oz + 2.0 pt crop oil concentrate or 1/2 pt nonionic surfactant/25 gal)	Do not apply within 50 days of harvest. Use on non-bearing plantings only. Apply as directed spray to actively growing grasses. Treat annual grasses before tillering for optimum results. Perennial grasses may need repeat treatment for total control. Do not treat canes to be harvested within one year of application. For spot treatment use 0.75 fl oz Fusilade DX plus 1.5 oz crop oil concentrate or 0.5 fl oz nonionic substance/gal. Ensure thorough coverage of weed foliage.
	clethodim 0.09-0.12 lb ai (Select 2EC 6.0-8.0 fl oz or Select Max 9.0-16.0 fl oz + nonionic surfactant at 0.25% by volume)	Use on nonbearing plantings only (at least 1 yr before harvest). Postemergence control of actively-growing grasses. For spot treatment, apply 0.33-0.65 fl oz/gal Select 2EC solution or 0.44-0.88 fl oz Select Max with 0.33 fl oz nonionic surfactant.
	sethoxydim 0.28-0.47 lb ai (Poast 1.5E 1.5-2.5 pt + 1.0 qt crop oil concentrate)	Do not apply within 50 days of harvest. Apply in a minimum of 10 GPA of water. Apply the lower rate to annual grasses up to 6 inches tall and apply higher rate to annual grasses up to 12 inches tall and to perennial grasses. For spot treatment use 1.25-1.9 fl oz Poast plus 1.25 fl oz crop oil concentrate/gal. Provides postemergence grass control only.
Annual weeds and certain perennials	glufosinate 0.88-1.5 lb (Rely 280 48.0-82.0 fl oz)	Apply as a directed spray to emerged weeds. Do not allow spray to contact desired foliage or green bark. Do not apply within 14 days of harvest. For spot treatment, mix 1.7 fl oz Rely 280/gal of water. Rely can also be used for sucker control. See label for directions.
Annual and perennial grasses and broadleaf weeds	glyphosate 0.75-3.75 lb ae (acid equivalent) (Roundup UltraMax 26 fl oz-4 qt, Touchdown 1.0-5.0 qt, or other labeled formulation) Spot treatment 1.3-2.6 fl oz Roundup UltraMax or Touchdown/gallon. For wiper application use 1 part Roundup Ultra Max or Touchdown to 2 parts water	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 foilage, green bark, suckers, or vines and renewals less than 3 years of age. Spray contact, other than with mature bark on the main trunk, can result in serious localized or systemic injury. If repeat treatments are necessary, do not exceed a total of 10.6 qt/A/year. Do not treat within 14 days of harvest. Apply prior to the end of the bloom stage or apply with shielded equipment to avoid crop damage.

Table 3.5 - Herbicides Labeled for Use in Grapes (cont.)

Pest	Chemical and Formulation Rate per Acre	Timing and Remarks
All weeds, general contact	paraquat 0.63-1.0 lb (Gramoxone Inteon 2.5-4.0 pt/A plus a nonionic surfac- tant at 1.0-2.0 pt/gal)	Apply as a directed spray in at least 30 gal of water/A. Most effective on small, actively growing weeds. Repeat applications will be needed to control perennial weeds. Do not allow spray to contact foliage, fruit, or stems. Corrosive to aluminum. Do not mix or store in aluminum tanks or in systems with aluminum fittings. Paraquat is toxic and a restricted use pesticide - handle with caution. RESTRICTED USE PESTICIDE.
Annual grasses and certain annual broadleaf weeds	napropamide 4.0 lb (Devrinol 50DF 8.0 lb)	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, but may be used with an appropriate post-emergence herbicide to kill existing vegetation or with simazine to broaden the spectrum of weeds controlled. 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. Must be incorporated within 24 hours by rainfall, irrigation, or mechanical means for optimum results.

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Table 3.5 - Herbicides Labeled for Use in Grapes (cont.)

Pest	Chemical and Formulation Rate per Acre	Timing and Remarks
Annual broadleaf weeds	carfentrazone-ethyl 0.016-0.031 lb (Aim 2EC, 1.9EW 1.0-2.0 fl oz/A)	Apply post-directed using a hooded sprayer for control of small annual broadleaf weeds less than 4 inches tall. Add a crop-oil concentrate or nonionic surfactant. Can be tank mixed with other herbicides for broader-spectrum weed control. Can also be used for control of suckers—see label for rates and directions for this use.

Table 3.6 - Relative Effectiveness of Selected Preemergence Herbicides and Ratings in Grapes

Weeds	Alion (indaziflam)	Dichlobenil (Casoron)	Diuron (Karmex)	Flumioxazin (Chateau)	Isoxaben (Trellis)	Napropamide (Devrinol)	Oryzalin (Surflan)	Oxyfluorfen (Goal)	Pronamide ¹ (Kerb)	Rimsulfuron (Matrix)	Simazine (Princep)	Pendimethalin (Prowl)	Norflurazon (Solicam)
<i>Annual Grasses</i>													
Barnyardgrass	-	G	G	-	-	G	G	F	F	G	F-G	G	E
Cheat	-	G	G	-	-	G	G	-	G	-	G	-	G
Crabgrasses	E	G	G	F-G	P	E	E	F	G	F	F-G	E	E
Fall panicum	-	F	F	-	-	G	G	-	F	F	F-G	G	E
Foxtails	G	G	G	F-G	-	E	E	F	G	G	G	G	F
Goosegrass	G	F	G	F-G	-	E	E	F	G	P	E	G	G
Johnsongrass (seedling)	-	F	G	P-F	-	P	F-G	-	-	-	N	G	G
<i>Annual Broadleaf Weeds</i>													
Annual fleabane	-	E	G	-	-	G	G	G	F	-	G	-	F
Annual morningglory	P	G	G	G	p	N	P-F	F	F	F	E	P	F
Black nightshade	-	G	G	G	-	N	P-F	G	F	P	E	P	F
Carpetweed	E	G	E	-	-	G	G	G	G	-	E	G	G
Common chickweed	G	G	E	F-G	E	-	G	G	G	-	E	G	G
Common lambsquarters	F-G	G	E	E	F	F-G	G	G	F	F	E	F	G
Common ragweed	F-G	G	E	E	G	P	F	F	E	P	N	F	-
Hairy galinsoga	-	G	E	G	G	G	G	G	-	-	E	N	-
Henbit	E	G	E	-	G	F	P	G	G	-	E	G	-
Horseweed	-	G	G	-	F	P	F	F	P	-	E	P	G
Knotweed	-	G	G	-	-	G	G	G	E	-	E	-	F
Mustards	-	G	G	-	-	P	P-F	G	G	-	G	-	F
Pennsylvania smartweed	-	G	G	-	G	P	P-F	G	-	P	E	-	-
Pigweeds	-	G	E	E	G	G	G	G	N	G	E	F	F
Prickly lettuce	-	G	G	G	-	G	F	G	-	-	E	-	-
Prickly sida	-	F-G	G	E	-	N	P-F	G	N	-	G	-	P
Purslane	-	G	E	-	G	G	G	G	-	F	E	F	G
Shepherds' purse	-	G	G	-	-	F	G	G	G	-	E	N	G
Speedwells	-	-	-	-	-	-	-	-	P	-	-	-	-

(E=excellent; G=good; F=fair; P=poor; N=none; - = not registered or information lacking)

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Table 3.6 - Relative Effectiveness of Selected Preemergence Herbicides and Ratings in Grapes (cont.)

Weeds	Allion (indaziflam)	Dichlobenil (Casoron)	Diuron (Karmex)	Flumioxazin (Chateau)	Isoxaben (Trellis)	Napropamide (Devrinol)	Oryzalin (Surflan)	Oxyfluorfen (Goal)	Pronamide* (Kerb)	Rimsulfuron (Matrix)	Simazine (Princep)	Pendimethalin (Prowl)	Norflurazon (Solicam)
Velvetleaf	-	-	F	G	F	N	P-F	G	P	F	G	G	-
Virginia pepperweed	-	G	G	-	-	F	G	-	P	-	E	-	G
Yellow rocket	-	G	P	-	-	N	N	-	P-F	-	P	N	F
<i>Perennial Grasses And Sedges</i>													
Fescues	-	G	F	-	N	N	N	N	G	-	P	N	F
Johnsongrass (rhizome)	-	-	P	N	N	N	N	N	P	-	N	N	P
Nimblewill	-	-	P	-	N	N	N	N	P	-	P	N	F
Orchardgrass	-	G	P-F	-	N	N	N	N	G	-	P	N	F
Quackgrass	-	G	G	-	N	N	N	N	G	-	P-F	N	P
Yellow nutsedge	N	P-F	P	N	N	N	N	N	N	F	N	N	P
Purpletop, redtop	-	-	P	-	N	N	N	N	-	-	N	N	F
Dallisgrass	-	-	F	-	N	N	N	N	-	-	N	N	P
Bermudagrass	N	N	N	N	N	N	N	N	P	N	N	N	P
<i>Perennial Broadleaf Weeds</i>													
Broadleaf plantain	-	G	P-F	-	N	N	N	N	F	-	G	N	P
Buckhorn plantain	-	G	P-F	-	N	N	N	N	F	-	G	N	P
Canada thistle	-	P-F	N	-	N	N	N	N	-	-	N	N	N
Chicory	-	G	G	-	N	N	N	N	-	-	P-F	N	N
Common dandelion	-	E	P-F	-	N	N	N	N	P	-	P-F	N	N
Common mallow	-	G	F	-	N	N	N	N	-	-	N	N	N
Common milkweed	-	-	N	-	N	N	N	N	-	-	N	N	N
Common yarrow	-	-	N	-	N	N	N	N	-	-	-	N	N
Docks (broadleaf, curly)	-	G	F	-	N	N	N	N	F	-	N	N	N
Goldenrod	-	F-G	-	-	N	N	N	N	-	-	N	N	N
Ground ivy	-	E	N	-	N	N	N	N	-	-	N	N	N
Hemp dogbane	-	N	N	-	N	N	N	N	-	-	N	N	N
Horsenettle	-	N	P-F	-	N	N	N	N	-	-	P	N	N
Mugwort	-	G-E	P	-	N	N	N	N	-	-	N	N	N
Red sorrel	-	G	N	-	N	N	-	N	F-G	-	N	N	N
Thistles (bull, musk, curl)	-	F	N	-	N	N	N	-	P	-	N	N	N
White flowered aster	-	G	N	-	N	N	N	N	-	-	N	N	N
Wild carrot	-	G	P	-	N	N	N	-	-	-	N	N	F
Wild strawberry	-	G	G	-	N	N	N	-	-	-	N	N	P
Yellow woodsorrel (from seed)	-	G	F	-	G	N	N	G	-	-	F	N	F
<i>Special Perennial Weed Problems</i>													
Bigroot morning-glory	-	N	N	-	N	N	N	N	N	-	N	N	N

(E=excellent; G=good; F=fair; P=poor; N=none; - = not registered or information lacking)

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3-24 Grapes: Weed Control in Vineyards

Table 3.6 - Relative Effectiveness of Selected Preemergence Herbicides and Ratings in Grapes (cont.)

Weeds	Allion (indaziflam)	Dichlobenil (Casoron)	Diuron (Karmex)	Flumioxazin (Chateau)	Isoxaben (Trellis)	Napropamide (Devrinol)	Oryzalin (Surflan)	Oxyfluorfen (Goal)	Pronamide* (Kerb)	Rimsulfuron (Matrix)	Simazine (Princep)	Pendimethalin (Prowl)	Norflurazon (Solicam)
Brambles (<i>Rubus</i> spp.)	-	N	N	-	N	N	N	N	N	-	N	N	N
Common greenbriar	-	N	N	-	N	N	N	N	N	-	N	N	N
Japanese honeysuckle	-	N	N	-	N	N	N	N	N	-	N	N	N
Poison ivy	-	N	N	-	N	N	N	N	N	-	N	N	N
Virginia creeper	-	N	N	-	N	N	N	N	N	-	N	N	N
Wild garlic	-	F	N	-	N	N	N	N	N	-	N	N	N

(E=excellent; G=good; F=fair; P=poor; N=none; - = not registered or information lacking)

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Table 3.7 - Relative Effectiveness of Selected Postemergence Herbicides and Ratings in Grapes

Weeds	Carfentrazone (Aim)	Clethodim (Select)	Fluazifopbutyl (Fusilade)	Glufosinate (Rely)	Glyphosate (Various)	Paraquat ¹ (Gramoxone)	Sethoxydim (Poast)
<i>Annual Grasses</i>							
Barnyardgrass	N	E	E	G	E	E	E
Cheat	-	-	G	G	E	E	G
Crabgrasses	N	E	E	G	E	E	E
Fall panicum	N	E	E	G	E	E	E
Foxtails	N	E	E	G	E	E	E
Goosegrass	N	E	E	G	E	E	E
Johnsongrass (seedling)	N	E	E	G	E	E	E
<i>Annual Broadleaf Weeds</i>							
Annual fleabane	-	N	N	-	E	E	N
Annual morningglory	F	N	N	G	E	G	N
Black nightshade	G	N	N	G	E	G	N
Carpetweed	G	N	N	-	E	E	N
Common chickweed	F	N	N	G	E	E	N
Common lambsquarters	G	N	N	G	E	E	N
Common ragweed	P	N	N	G	E	E	N
Hairy galinsoga	-	N	N	-	E	E	N
Henbit	G	N	N	G	E	E	N
Horseweed	-	N	N	G	E	F	N
Knotweed	-	N	N	-	E	F-G	N

(E=excellent; G=good; F=fair; P=poor; N=none; - = not registered or information lacking)

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Table 3.7 - Relative Effectiveness of Selected Postemergence Herbicides and Ratings in Grapes (cont.)

Weeds	Carfentrazone (Aim)	Clethodim (Select)	Fluazifopbutyl (Fusilade)	Glufosinate (Rely)	Glyphosate (Various)	Paraquat ¹ (Gramoxone)	Sethoxydim (Poast)
<i>Annual Broadleaf Weeds (cont.)</i>							
Mustards	-	N	N	G	F	G	N
Pennsylvania smartweed	-	N	N	G	E	G	N
Pigweeds	G	N	N	G	F	G	N
Prickly lettuce	-	N	N	G	E	G	N
Prickly sida	-	N	N	G	E	E	N
Purslane	-	N	N	G	E	G	N
Shepherds' purse	-	N	N	G	E	F-G	N
Speedwells	G	N	N	-	E	P	N
Velvetleaf	E	N	N	G	E	E	N
Virginia pepperweed	-	N	N	-	E	G	N
<i>Perennial Grasses And Sedges</i>							
Fescues	N	-	P	F	E	F	P-F
Johnsongrass (rhizome)	N	G	G	P	E	P	G
Nimblewill	N	-	F-G	-	G-E	P	F-G
Orchardgrass	N	-	F	P	E	F	F
Quackgrass	N	-	G	P	G	P	G
Yellow nutsedge	N	N	N	F-G	G	P	N
Purpletop, redtop	N	-	G	-	E	P	G
Dallisgrass	N	-	G	-	E	P	G
Bermudagrass	N	G	G	F	G	P	G
<i>Perennial Broadleaf Weeds</i>							
Broadleaf plantain	-	N	N	F	E	P	N
Buckhorn plantain	P	N	N	F	E	P	N
Canada thistle	-	N	N	-	F-G	P	N
Chicory	-	N	N	-	E	P	N
Common dandelion	P	N	N	G	E	P	N
Common mallow	-	N	N	-	E	P	N
Common milkweed	-	N	N	-	G	P	N
Common yarrow	-	N	N	-	G	P	N
Docks (broadleaf, curly)	P	N	N	-	G	P	N
Goldenrod	-	N	N	-	E	P-F	N
Ground Ivy	-	N	N	G	G	P-F	N
Hemp dogbane	-	N	N	P	F	P	N
Horsenettle	-	N	N	F-G	F-G	P	N

(E=excellent; G=good; F=fair; P=poor; N=none; - = not registered or information lacking)

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3-26 Grapes: Weed Control in Vineyards

Table 3.7 - Relative Effectiveness of Selected Postemergence Herbicides and Ratings in Grapes (cont.)

Weeds	Carfentrazone (Aim)	Clethodim (Select)	Fluazifopbutyl (Fusilade)	Glufosinate (Rely)	Glyphosate (Various)	Paraquat ¹ (Gramoxone)	Sethoxydim (Poast)
Mugwort	-	N	N	-	F	P	N
Red sorrel	-	N	N	G	G	P	N
Thistles (bull, musk, curl)	-	N	N	-	G	P	N
White flowered aster	-	N	N	-	E	P-F	N
Wild carrot	-	N	N	-	E	P	N
Wild strawberry	-	N	N	-	E	P-F	N
Yellow rocket	-	N	N	-	E	F	N
Yellow woodsorrel	-	N	N	G	E	P	N
<i>Special Perennial Weed Problems</i>							
Bigroot morningglory	-	N	N	-	F-G	P	N
Brambles	-	N	N	F-G	G	P	N
Common greenbriar	-	N	N	-	P	P	N
Japanese honeysuckle	-	N	N	-	F-G	P	N
Poison ivy	-	N	N	-	G	P	N
Virginia creeper	-	N	N	-	F-G	P	N
Wild garlic	-	N	N	G	F	P	N

(E=excellent; G=good; F=fair; P=poor; N=none; - = not registered or information lacking)

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Table 3.8 - Chemical Names, Re-entry Times, and Days to Harvest¹

Chemical (Other name)	Manufacturers	Re-entry time	Days to Harvest
Alion (indaziflam)	Bayer	12 hours	14
Aim (carfentrazone)	FMC	12 hours	3
Casoron (dichlobenil)	Chemtura	12 hours	30
Chateau (flumioxazin)	Valent	12 hours	60
Devrinol (napropamide)	United Phosphorus	12 hours	35
Fusilade (fluazifop-butyl)	Syngenta	12 hours	50
Trellis (isoxaben)	Dow AgroSciences	12 hours	50
Goal (oxyfluorfen)	Dow AgroSciences	24 hours	NA ²
Gramoxone (paraquat)	Syngenta	12 hours	NA ⁵
Karmex (diuron)	DuPont	12 hours	NA ³
Kerb (pronamide)	Dow AgroSciences	24 hours	NA ⁴
Matrix (rimsulfuron)	DuPont	4 hours	14
Poast (sethoxydim)	BASF	12 hours	50
Princep (simazine)	Syngenta	12 hours	NA ⁶
Prowl (pendimethalin)	BASF	24 hours	365

Rely (glufosinate)	Bayer	12 hours	14
Roundup (glyphosate)	Monsanto	4 hours	14
Select (clethodim)	Valent	24 hours	365
Solicam (norflurazon)	Syngenta	12 hours	60
Surflan (oryzalin)	United Phosphorus	24 hours	NA ⁶
Touchdown (glyphosate)	Syngenta	12 hours	14

¹This information is given as a guideline only. Always read the label because there have been many changes in re-entry times and pre-harvest intervals in recent years, and more changes are expected in the future.

²Apply when crop is dormant.

³Apply between March and May.

⁴Apply in the fall after harvest.

⁵Do not allow paraquat to contact fruit.

⁶Apply between harvest and spring.

Diseases

Chuan Hong, Extension Plant Pathologist, Hampton Roads AREC

Fungicides and bactericides play an important part in the prevention of container and field-grown ornamental and flower diseases. They do not take the place of cultural control methods, but should be used to complement them. In some disease situations there are no effective chemicals available. Only chemicals registered by the Environmental Protection Agency (EPA) are recommended.

Most fungicides on the market protect woody shrubs, ground cover plants, and flowers against diseases. This protection is accomplished by preventing plant pathogens from becoming established. Systemic fungicides are therapeutic and may eradicate pathogens that are already established. Because chemicals are subject to weathering and degradation, they must be reapplied to the soil or container or susceptible parts at regular intervals as long as the danger of plant disease exists. In general, protectants must **not** be reapplied more frequently than recommended treatment intervals, or applied in excess of recommended rates.

In every instance, the manufacturer's label should be read carefully and attention should be directed particularly to the safety measures listed on the label regarding mixing, handling, compatibility with other chemicals, and application methods and rate. It is always essential that the user familiarize himself with the antidote given on the label. In many instances, the addition of a surfactant will improve retention of the chemical.

Table 4.1 - Common Diseases and Chemical Control Options

Plant Disease	Fungicide Rate/100 Gal	Remarks
Ajuga Sclerotium rot	Terraclor (75% WP) 2.0 lb/1,000 sq ft or 2.5 lb/300.0 gal water; quintozone	Dust or drench on soil surface before planting and thoroughly work into the top 2 inches of soil.
	Heritage (50%); 1.0-4.0 oz (spray) 0.2-0.9 oz (drench) azoxystrobin	Apply every 1 to 4 weeks.
Andromeda (Japanese) (<i>Pieris</i> spp.)	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
<i>Phytophthora</i> dieback	Alliette (80% WDG) 1.3-4.0 lb fosetyl-Al	Spray at new leaf emergence or at first sign of diseases and at 7- to 14-day intervals.
	FenStop 7.0-14.0 fl oz fenamidone	Spray plants at a 28-day interval.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Phytophthora root rot	Alliette (80% WDG) 1.0-2.0 lb/1,000 sq ft; fosetyl-Al	Drench Alliette monthly (2.0 pt/sq ft) over the surface of the potting medium.
	Subdue MAXX 1.0-2.0 fl oz mefenoxam	Repeat at 3-month intervals. Provide good drainage. After application, irrigate to thoroughly wet soil.
	Terrazole (35% WP) 3.5-10.0 oz etridiazole	Treat soil at 4- to 12-week intervals.

4-2 Nursery Crops: Diseases

Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks
Andromeda Phytophthora root rot (cont.)	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Arborvitae Phomopsis needle twig blight	Cleary 3336-WP (50% WP) 1.5 lb thiophanate methyl	Begin application at bud break and repeat at 7- to 10-day intervals throughout the growing season.
	Heritage (50%) 1.0-4.0 oz azoxystrobin	Apply at 1- to 4-week intervals.
Cercospora blight	Cleary 3336-WP (50% WP) 1.5 lb thiophanate methyl	Cleary 3336 should be applied when disease first appears and repeat on 10- to 14-day intervals. Shorten interval during humid, rainy weather.
	Fore (80% WP) or Dithane T/O Rainshield or Dithane WF or Fore Flowable Rainshield NT or Fore WSP Rainshield 1.5 lb or 1.2 qt mancozeb	Mancozeb should be applied at 7- to 10-day intervals.
Aucuba Phytophthora root rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Spray every 7 days.
	Subdue MAXX 1.0-2.0 fl oz mefenoxam	See Andromeda.
	Terrazole (35% WP) 3.5-10.0 oz etridiazole	Treat soil at 4- to 12-week intervals.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.

Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks
Azalea Cylindrocladium root rot	Fore Rainshield NT Dithane T/O Rainshield Dithane WF or Fore WSP Rainshield 1.5 lb or 1.2 qt mancozeb	See Arborvitae.
	Cleary 3336-WP (50% WP) 0.8 lb thiophanate methyl	Drench Cleary 3336 on the surface of growing medium to prevent disease development. Repeat at 2- to 4-week intervals during disease pressure period.
	Terraguard 50W triflumizole	Soil drenched for propagation beds, 6.0-8.0 oz or established root systems 6.0-12.0 oz.
	OHP 26 GT-O 1.0 qt; iprodione	Dip cuttings for 5 minutes prior to planting.
Exobasidium leaf and flower gall	Fore Rainshield NT Fore WSP Rainshield Dithane T/O Rainshield NT or Dithane WF 1.5 lb or 1.2 qt mancozeb	Hand pick infected leaves and remove from plant. Apply mancozeb just before leaves unroll in spring and 10 days later.
Rust	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray to run-off when rust first appears.
Botrytis blight (Gray mold)	Compass 2.0-4.0 oz; trifloxystrobin	Spray at 7- to 14-day intervals.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply to petals to protect from disease. Continue at 10- to 14-day intervals as long as disease conditions are favorable.
	Cleary 3336-WP (50% WP) 0.8 lb thiophanate methyl	Repeat every 7 to 10 days as needed during disease periods.
	Decree (50 WDG) 0.7-1.5 lb fenhexamide	Repeat at 7- to 10-day intervals.
Ovulinia petal blight	Strike (25% WDG) 8.0-16.0 oz triadimefon	Apply Strike to all flower buds to point of run-off. Application should be made during the expanded bud stage (color showing). A second application may be needed.
	Cleary 3336-WP (50% WP) 0.5 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply Cleary 3336 as flowers open. Repeat every 4 to 6 days as needed during disease periods.
	Systhane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt chlorothalonil	Spray Daconil every 7 days during wet weather.
	Fore (80% WP) or Dithane T/O (75% DF) or Dithane WF (4F) or Fore Flowable (4F) 1.5 lb or 1.2 qt mancozeb	Spray mancozeb or ziram at 7- to 10-day intervals when flowers start to show color.
	Ziram (F-4) 3.0-4.0 pt ziram	Spray mancozeb or ziram at 7- to 10-day intervals when flowers start to show color.
	Phomopsis dieback	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz thiophanate methyl
Phytophthora root and crown rot	Alude 1.0-2.0 qt Vital 2.0-4.0; phosphite	Spray every 7 days.
	Subdue MAXX 0.6-1.2 fl oz mefenoxam	Thoroughly wet soil after application of Subdue and repeat at 3-month intervals.
	Terrazole (35% WP) 3.5-10.0 oz etridiazole	Treat soil at 4- to 12-week intervals.

4-4 Nursery Crops: Diseases

Table 4.1 - Common Diseases and Chemical Control Options (cont.)		
Plant Disease	Fungicide Rate/100 Gal	Remarks
Azalea Phytophthora root and crown rot (cont.)	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Phytophthora shoot blight	Alliette (80% WDG) 2.5-5.0 lb; fosetyl-Al	One application every 30 days.
	Alude 1.0-2.0 qt Vital 2.0-4.0; phosphite	Spray every 7 days.
	FenStop 7.0-14.0 fl oz; fenamidone	Spray plants at a 28-day interval.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Powdery mildew	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray to run-off when mildew first appears.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
	Systhane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Cygnus (50%) 1.6-3.2 oz; kresoxim-methyl	Apply at 10- to 14-day intervals.
	Banner Maxx 2.0-4.0 fl oz propiconazole	Apply at 2- to 3-week intervals.
Rhizoctonia web blight	Medallion (50% WP) 1-2 packets fludioxonil	Only in greenhouses and closed structures at 7- to 14-day intervals.
	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Avoid crowding the plants. Use a drench spray treatment. Repeat at 2- to 4-week intervals.
	OHP 26 GT-O 1.0-2.5 qt; iprodione	Spray plants every 7 to 14 days.
Septoria leaf spot	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Repeat at 10- to 14-day intervals throughout the growing season.

Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks
Boxwood (English, American, Korean, Japanese) Phytophthora root rot	Alude 1.0-2.0 qt Vital 2.0-4.0 phosphite	Spray every 7 days.
	Alliette (80% WDG) 6.4-12.8 oz (drench) sq ft fosetyl-Al	See Azalea.
	Subdue MAXX 1.0-2.0 fl oz mefenoxam	See Azalea.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0- 2.0 pints per square foot at a 28-day interval.
	Terrazole (35% WP) 3.5-10.0 oz etridiazole	See Azalea.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.	
boxwood blight	Daconil weather Stik 2.0 pt Concord (54% SST) 1.4 pt chlorothalonil Cleary 3336-WP 1.5 lb thiophanate methyl Dithane 75 DF Rainshield 1.5 lb mancozeb Pageant 12.0-18.0 oz boscalid + pyraclostrobin	Apply and repeat at 7- to 14-day intervals during prolonged wet periods in spring and fall.
Camellia Leaf gall	See Azalea.	Hand pick infected leaves.
Sclerotinia flower blight	Terraclor (75% WP) 1 cup in enough water to give thorough coverage of 100 sq ft quintozone	Drench soil surface in late December or early January.
Phytophthora root rot	See Azalea.	
Cedar Phomopsis needle and twig blight	Heritage (50%) 1.0-4.0 oz azoxystrobin	Apply every 1 to 4weeks.
	Cleary 3336-WP (50% WP) 1.5 lb thiophanate methyl	Begin application at bud break and repeat at 7- to 10-day intervals throughout the growing season.
Cercospora blight	Fore (80% WP) or Dithane T/O (75% DF) or Dithane WF (4F) or Fore Flowable (4F) 1.5 lb or 1.2 qt mancozeb	Spray at 7- to 10-day intervals, starting when plants are well leafed out or at first sign of disease.
	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Spray at 7- to 10-day intervals, starting when plants are well leafed out or at first sign of disease.

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Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks
Chrysanthemum Rhizoctonia root rot	Medallion (50% WP) 1 packet fludioxonil	Apply after transplant (1.0-2.0 pt/sq ft). Repeat every 14 days.
	Chipco 26019 (50% WP) 0.4 lb iprodione	Apply after transplant (1.0-2.0 pt/sq ft). Repeat every 14 days.
	Cleary 3336-F 12.0-16.0 fl oz or Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply Cleary 3336-F as a heavy drench or spray.
Chrysanthemum Mycosphaerella ray blight	Banner Maxx 2.0-4.0 fl oz propiconazole	Apply on a 14-day schedule.
	Chipco 26019 (50% WP) 1.0-2.0 lb iprodione	Apply at 7- to 10-day intervals.
	Daconil Weather Stik 1.4 pt chlorothalonil	Apply first spray of Daconil just before flower color shows and at 7-day intervals.
	Fore (80% WP) or Dithane T/O (75% DF) or Dithane WF (4F) or Fore Flowable (4F) 1.5 lb or 1.2 qt mancozeb	Apply mancozeb at 7- to 10-day intervals. Apply at transplant of cuttings.
	Maneb 80 (80% WP) or Maneb Plus Zinc F4 Fungicide (37% F) 1.0-1.5 lb of 80 or 1.2 qt of F4; maneb Fore WSP Rainshield or Fore Rainshield NT 1.5 lb mancozeb	Apply maneb at 7- to 10-day intervals. Apply at transplant of cuttings.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply at first sign of disease and repeat at 10- to 14- day intervals.
	Cleary 3336-WP (50% WP) 0.8 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply Cleary 3336 at 7- to 10-day intervals as needed.
Botrytis gray mold and <i>Septoria</i> leafspot	Fore WSP Rainshield or Fore Rainshield NT 1.5 lb Junction (15% DF) 1.5 lb mancozeb	Apply at 7- to 10-day intervals.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.4 pt chlorothalonil	Apply at prebloom and repeat at 7- to 14-day intervals.
	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply at prebloom and repeat at 7- to 14-day intervals.
Leaf rust	Strike (25% WDG) 2.0-4.0 oz triadimefon	Apply at first sign of disease and repeat at 7- to 14-day intervals.
	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Cygnus (50%) 3.2-6.4 oz Kresoxim-methyl	Apply at 10- to 14-day intervals.
	Fore (80% WP) or Dithane T/O (75% DF) or Dithane WF (4F) or Fore Flowable (4F) 1.5 lb or 1.2 qt mancozeb	Spray at 7- to 10-day intervals.

Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks
Chrysanthemum Pythium root rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Subdue MAXX 0.05-1.0 fl oz mefenoxam	See Azaleas
	Terrazole (35% WP) 4.0-6.0 oz etridiazole	Repeat bedding plants at 4- to 8-week intervals. Repeat container plants at 4- to 12-week intervals.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoastrobilin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Powdery mildew	Rubigan 3.0-5.0 fl oz; fenarimol	Spray every 10 to 14 days.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	See manufacturer's directions. Spray to run-off when mildew first appears.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
Southern blight (<i>Sclerotium</i>)	Terraclor (25% WP) 8.0 oz quintozene	See manufacturer's directions.
Crabapple Cedar-apple rust	Banner Maxx 2.0-4.0 fl oz propiconazole	Three applications every 14 days starting at green tip.
	Systhane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt chlorothalonil	Start as flower buds open and spray 3 times at 10-day intervals.
	Fore (80% WP) or Dithane T/O (75% DF) or Dithane WF (4F) or Fore Flowable (4F) or 1.5 lb or 1.2 qt; mancozeb	Begin application at 1/4 inch to 1/2 inch green tip and continue on a 7- to 10-day schedule.
	Maneb 80 (80% WP) 1.5 lb maneb	Begin application at 1/4 inch to 1/2 inch green tip and continue on a 7- to 10-day schedule.
	Cleary 3336-WP (50% WP) 1.0 lb thiophanate methyl	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
Fire blight	Alliette (80% WP) 2.5 lb fosetyl-Al	Apply every 7 days.
	Agri-Strep 0.5 lb streptomycin sulfate	Apply at early, mid, and late flowering.

4-8 Nursery Crops: Diseases

Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks
Crabapple Powdery mildew	Banner Maxx, 2.0-4.0 fl oz propiconazole	Apply Banner every 14 to 21 days.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray to run-off when mildew first appears.
	Terraguard 50W 4.0-8.0 oz triflumizole	Apply as foliar spray as needed.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
Scab	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Banner Maxx, 2.0-4.0 fl oz propiconazole	Banner applied on a 14-day schedule. Begin at green tip.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.4 pt chlorothalonil	Apply at bud break and at 7-day intervals during wet weather.
	Cleary 3336-WP (50% WP) 0.75 lb thiophanate methyl	Apply at 7- to 10-day intervals from bud break until two weeks after petal fall.
	Fore (80% WP) or Dithane T/O (75% DF) or Dithane WF (4F) or Fore Flowable (4F) or 1.5 lb or 1.2 qt Junction (15% DF) 1.5 lb mancozeb	Apply at 7- to 10-day intervals from bud break until two weeks after petal fall.
Manzate 80 (80 % WP) 1.5 lb; maneb	Apply at 7- to 10-day intervals from bud break until two weeks after petal fall.	
Crape Myrtle Powdery mildew	Banner Maxx 2.0-4.0 fl oz propiconazole	Apply Banner every 21 days.
	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray Strike to run-off when mildew first appears.
	Terraguard 50W 4.0-8.0 oz triflumizole	Use higher rates under severe conditions.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
Daffodil Botrytis blight	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply every 10-14 days.
	Decree (50 WDG) 0.7-1.5 lb fenhexamid	Repeat at 7- to 10-day intervals.
Fusarium and Penicillium bulb rots	Cleary 3336-WP (50% WP) 0.8 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Soak bulbs for 15 to 30 minutes in a warm dip (80° to 85°F.)
Dahlia Powdery mildew	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray to run-off when mildew first appears.
Botrytis blight (Gray mold)	Fore Rainshield NT or Fore WSP Rainshield 1.5 lb mancozeb	
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply to protect against disease. Repeat at 10- to 14- day intervals.

Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks
Dahlia Botrytis blight (Gray mold) (cont.)	Cleary 3336-WP (50% WP) 0.75 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply to protect against disease. Repeat at 10- to 14- day intervals.
	Decree (50 WDG) 0.7-1.5 lb fenhexamid	Repeat at 7- to 10-day intervals.
Dogwood Rhizoctonia root rot Botrytis petal blight	Chipco 26019 (50% WP) 6.5 lb iprodione	Use as a drench and apply 1.0-2.0 pts of solution/sq ft.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply Chipco 26019 at 7- to 14-day intervals.
	Cleary 3336-WP (50% WP) 0.8 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply Cleary 3336 at 10- to 14-day intervals.
Phytophthora root rot	Decree (50 WDG) 0.7-1.5 lb fenhexamid	Repeat at 7- to 10-day intervals.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Spray every 7 days.
	Subdue MAXX 1.0-2.0 fl oz mefenoxam	See Azalea.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
Septoria leaf spot	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Fore Rainshield NT Dithane T/O Rainshield NT Dithane WF or Fore WSP Rainshield 1.5 lb or 1.2 qt Junction (15% DF) 1.5 lb; mancozeb	Begin at first sign of disease and spray at intervals of 7 to 10 days.
	Daconil Weather Stik 1.4 pt Concorde (54% SST) 1.4 pt chlorothalonil	Apply at early bloom. Apply at 7- to 14-day intervals.
Spot anthracnose, Leaf and flower blight Anthracnose (<i>Discula</i> sp.)	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Spray when disease first appears and repeat at 10- to 14-day intervals.
	Fore Rainshield NT or Fore WSP Rainshield or Dithane T/O Rainshield NT or Dithane WF 1.5 lb or 1.2 qt mancozeb	Apply when buds begin to open, when bracts have fallen, 4 weeks later, and again in late summer after flower buds for next season have formed.
	Banner Maxx, 2.0-4.0 fl oz propiconazole	Apply Banner at 14-day intervals.

4-10 Nursery Crops: Diseases

Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks
Dogwood Spot anthracnose, Leaf and flower blight Anthracnose (<i>Discula</i> sp.) (cont.)	Daconil Weather Stik 2.0 pts. chlorothalonil	For spot anthracnose and leaf and flower blight apply when buds begin to open. Repeat when bracts have fallen, 4 weeks later and in the late summer after flower buds have formed. For anthracnose (<i>Discula</i> sp.) apply 3 to 4 sprays during leaf expansion in the spring, at 10- to 14-day intervals.
	Maneb 80 (80% WP) or Maneb Plus Zinc F4 Fungicide (37% F) 1.0-1.5 lb or 0.8-1.2 qt maneb Junction (15% DF) 1.5 lb mancozeb	For spot anthracnose, leaf and flower blight apply when buds begin to open. Repeat when bracts have fallen, 4 weeks later and in the late summer after flower buds have formed. For anthracnose (<i>Discula</i> sp.) apply 3 to 4 sprays during leaf expansion in the spring, at 10- to 14-day intervals.
Powdery mildew	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray to run-off when mildew first appears.
	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
	Cygnus (50%) 1.6-3.2 oz kresoxim-methyl	
Euonymus Powdery mildew	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray to run-off when mildew first appears.
	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
	Cygnus (50%) 1.6-3.2 oz kresoxim-methyl	
Crown gall	Galltrol-A	See manufacturer's directions. Purchase healthy plants. Do not replant in beds where infected plants have been removed.
Anthracnose (<i>Colletotrichum</i>)	Fore Rainshield NT Dithane T/O Rainshield NT Dithane WF, or Fore WSP Rainshield 1.5 lb or 1.2 qt Junction (15% DF) 1.5 lb mancozeb	Spray at bud break, then repeat at 14-day intervals.
	Daconil Weather Stik 1.375 pt Concorde (54% SST) 1.37 pt chlorothalonil	Spray at bud break, then repeat at 14-day intervals.
Botrytis blight (Gray mold)	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Repeat at 10- to 14-day intervals.
	Decree (50 WDG) 0.7-1.5 lb fenhexamid	Repeat at 7- to 10-day intervals.
Forsythia Rhizoctonia	Chipco 26019 (50% WP) 0.4 lb iprodione	Apply after transplanting (1.0-2.0 pt/sq ft). Repeat after 14 days.
	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Apply as a drench or heavy spray.
Phytophthora shoot blight	See Azalea shoot blight	
Gladiolus Botrytis leaf blight	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Chipco 26019 at 10- to 14-day intervals.

Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks
Gladiolus Botrytis leaf blight (cont.)	Daconil Weather Stik 1.4 pt chlorothalonil	Apply Daconil every 7 to 10 days during normal weather, every 2 to 3 days during wet periods.
	Decree (50 WDG) 0.7-1.5 lb fenhexamid	Apply at 7- to 10-day intervals.
Penicillium and Fusarium corm rots (pre-planting)	Cleary 3336-WP (50% WP) 0.8 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Submerge clean corms for 15-30 minutes in warm water (80° to 85°F). Stir solution constantly to be sure chemical remains in suspension.
Curvularia and Leaf spots <i>Stemphylium</i>	Maneb 80 (80% WP) or Maneb Plus Zinc F4 Fungicide (37% F) 1.5 lb or 1.2 qt; maneb	Begin when flower spikes are developing. Repeat 2 to 3 times at weekly intervals.
Hawthorn Rust and <i>Fabraea</i> leaf spot	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt chlorothalonil	Spray at prebloom with cover sprays at 7- to 10-day intervals as needed.
	Fore Rainshield NT Dithane T/O Rainshield NT Dithane WF or Fore WSP Rainshield 1.5 lb; mancozeb	
Holly (Japanese) Root rot (<i>Thielaviopsis basi-</i> <i>cola</i> , <i>Rhizoctonia</i>)	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Sanitation in propagation. Apply as heavy drench or spray to 800 sq ft of bench area (1.0-2.0 pts/sq ft). Repeat at 2- to 4-week intervals.
	OHP 26 GT-0 13.0 fl oz	Drench 1.0 to 2.0 pints of solution per square foot every 14 days.
Rhizoctonia web blight (<i>Rhizoctonia solani</i>)	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply as a heavy drench or spray to 800 sq ft of bench or bed area, (1.0-2.0 pts/sq ft). Repeat at 2- to 4-week intervals.
Phytophthora and Pythium root rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Subdue MAXX 1.0-2.0 fl oz mefenoxam	See Azalea.
	Alliette (80% WDG) 1.0-2.0 lbs/1000 sq ft fosetyl-Al	
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoastrobilin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.

4-12 Nursery Crops: Diseases

Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks
Hydrangea Botrytis leaf blight	Fore Rainshield NT Fore WSP Rainshield Dithane T/O Rainshield NT or Dithane WF 1.5 lb; mancozeb	Apply at 7- to 14-day intervals.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Spray every 10 to 14 days.
	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply when disease first appears, repeat at 10- to 14-day intervals.
	Decree (50 WDG) 0.7-1.5 lb fenhexamid	Repeat at 7- to 10-day intervals.
Juniper Phomopsis needle and twig blight	Cleary 3336-WP (50% WP) 1.5 lb thiophanate methyl	Begin application at bud break and repeat at 7-day intervals through the growing season.
	Fore Rainshield NT Fore WSP Rainshield Dithane T/O Rainshield NT or Dithane WF 1.5 lb mancozeb	Begin application at bud break and repeat at 7-day intervals through the growing season.
Rhizoctonia web blight (<i>Rhizoctonia solani</i>)	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply as a heavy drench or spray to 800 sq ft of bench or bed area, (1.0-2.0 pts/sq ft). Repeat at 2- to 4-week intervals. Avoid crowding plants.
	OHP 26 GT 1.0-2.5 qt; iprodione	Spray plants every 7 to 14 days.
Phytophthora and Pythium root rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Subdue Maxx 1.0-2.0 fl oz; mefenoxam	See Azalea.
	Alliette (80% WP) 1.0-2.0 lbs/1000 sq ft; fosetyl-AI	See Azalea.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.	
Lilac Powdery mildew	Systhane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray to run-off when mildew first appears.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
Mountain Laurel (<i>Kalmia latifolia</i>)	Daconil Weather Stik 2.0 pt chlorothalonil	Spray at 7-day intervals during wet weather. Spray when buds break in the spring and twice more at 2-week intervals.

Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks
Mountain Laurel Cercospora leaf spot (cont.)	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
Pachysandra Volutella leaf and stem blight	Fore Rainshield NT Dithane T/O Rainshield NT Dithane WF or Fore WSP Rainshield 1.5 lb mancozeb	Apply first spray in the spring. Make 5 applications at 10- to 14-day intervals.
	Fixed Copper (WP) 1.0 lb; copper	Apply Fixed Copper at 7- to 10-day intervals.
Peony Botrytis blight (Gray mold)	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Begin when disease first appears and repeat at 10- to 14-day intervals.
	Decree (50 WDG) 0.7-1.5 lb fenhexamid	Repeat at 7- to 10-day intervals.
Alternaria leaf spot and Phytophthora blight	Maneb 80 (80% WP) or Maneb Plus Zinc F4 Fungicide (37% F) 1.5 lb or 1.2 qt; maneb	Begin when disease first appears and repeat at 10- to 14-day intervals.
Periwinkle (Vinca minor) Phomopsis stem rot	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Begin when disease first appears and repeat at 10- to 14-day intervals.
Photinia Powdery mildew	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
Entomosporium leaf spot (<i>Entomosporium maculatum</i>)	Banner MAXX 2.0-4.0 fl oz propiconazole	Apply in early spring as growth starts and reapply on 14-day schedule until new growth is fully expanded.
	Strike (25% WDG) 16.0 oz; triadimefon	
	Daconil Weather Stik 1.4 pt Concorde (54% SST) 1.4 pt chlorothalonil	Spray at 2- to 4-week intervals. Avoid overhead irrigation. Avoid crowding containers.
	Fore Rainshield NT Dithane T/O Rainshield NT Dithane WF or Fore WSP Rainshield 1.5 lb mancozeb	Spray at 7- to 14-day intervals.
	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Spray at 7- to 14-day intervals.
Pine (White, Japanese, Black) Phytophthora root rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Subdue Maxx 1.0-2.0 fl oz mefenoxam	See Azalea.
	Alliette (80% WP) 1.0-2.0 lbs/100 sq ft fosetyl-Al	See Azalea.
	Stature (43.55% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14 day intervals. Constant agitation required.

4-14 Nursery Crops: Diseases

Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks	
Pine (White, Japanese, Black) Phytophthora root rot (cont.)	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.	
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.	
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.	
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.	
Pyracantha (Firethorn) Fire blight	Alliette (80% WP) 2.5 lb fosetyl-AI	Begin spray at pre-bloom. Repeat as necessary but do not exceed one application every 7 days until blooming period ends.	
	Streptomycin agric. compd. 100 ppm streptomycin sulfate	Spray when 20% of the blossoms are open and repeat 5 to 7 days during bloom period. COMMERCIAL ORNAMENTAL USE ONLY.	
	Fixed copper 1.0 lb copper	Apply the first spray at bud break, 10 to 14 days later and at petal fall.	
Pyracantha Scab	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.	
	Daconil Weather Stik 1.4 pt Concorde (54% SST) 1.4 pt chlorothalonil	Spray at bud break and repeat twice at 10-day intervals.	
	Fore Rainshield NT Dithane T/O Rainshield NT Dithane WF or Fore Flowable WSP Rainshield 1.5 lb or 1.2 qt Junction (15% DF) 1.5 lb mancozeb	Spray at 7- to 14-day intervals.	
	Fixed Copper 1.0 lb; copper	Spray at 7- to 14-day intervals.	
	Cleary 3336-WP (50% WP) 0.8 lb thiophanate methyl	Begin when disease appears and repeat at 10- to 14-day intervals.	
	Rhododendron Ovulinia petal blight	Same as for Azalea.	Same as for Azalea.
	Phytophthora root rot and wilt	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
Subdue Maxx 1.0-2.0 fl oz mefenoxam		See Azalea.	
Alliette (80% WDG) 2.5-5.0 lb fosetyl-AI		Spray to run-off at monthly intervals.	
Terrazole (35% WP) 4.0-10.0 oz etridiazole		See Azalea.	
Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride		Repeat every 3 weeks to 3 months.	
Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph		Apply at 10- to 14-day intervals. Constant agitation required.	

Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks
Rhododendron Phytophthora root rot and wilt (cont.)	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Rust	Same as for Azalea.	Same as for Azalea.
Botrytis gray mold	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	See Azalea.
	Cleary 3336-WP (50% WP) 0.8 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	See Azalea.
	Decree (50 WDG) 0.7-1.5 lb fenhexamid	Apply at 7- to 10-day intervals.
Rose Crown gall	Galltrol-A	See manufacturer's directions. Purchase healthy rose bushes. Do not injure the roots or crowns of roses.
Black spot	Banner EC Maxx, 2.0-4.0 fl oz propiconazole	Tank mix with a registered contact fungicide labeled for black spot control.
	Systhane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Daconil Weather Stik 1.375 pt chlorothalonil	Start applications in the spring as leaves expand. During dry weather, treat at 7- to 10-day intervals for Daconil.
	Cleary 3336-WP (50% WP) 0.8 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Start applications in the spring as leaves expand. During dry weather, treat at 7- to 10-day intervals for Daconil.
	Fore Rainshield NT Dithane T/O Rainshield NT Dithane WF or Fore WSP Rainshield 1.5 lb Junction (15% DF) 1.5 lb mancozeb	Apply at 7- to 14-day intervals.
	Maneb 80 (80% WP) or Maneb Plus Zinc F4 Fungicide (37% F) 1.5 lb or 1.2 qt; maneb	Apply at 7- to 14-day intervals.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
Botrytis blight (Gray mold)	Decree 0.7-1.5 lb; fenhexamid	Spray every 7 to 14 days.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply to buds to protect against disease. Repeat at 10- to 14-day intervals.
	Cleary 3336-WP (50% WP) 0.8 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply to buds to protect against disease. Repeat at 10- to 14-day intervals.
Downy mildew	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Alliette (80% WDG) 2.5 lb fosetyl-AI	Apply every 7 to 14 days.

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Table 4.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide Rate/100 Gal	Remarks
Rose Downy mildew (cont.)	Heritage (50%) 2.0-4.0 oz azoxystrobin	Apply every 1 to 3 weeks.
	Cygnus (50%) 3.2-6.4 oz kresoxim-methyl	
	FenStop 7.0-14.0 fl oz fenamidone	Spray plants at a 28-day interval.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Powdery mildew	Banner Maxx, 2.0-4.0 fl oz propiconazole	Thorough coverage is needed for best results.
	Systhane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Start applications in the spring as leaves expand. Treat at 10- to 14-day intervals to protect. Spray at 7-day intervals if mildew is present.
	Cygnus (50%) 1.6-3.2 oz kresoxim-methyl	Start applications in the spring as leaves expand. Treat at 10- to 14-day intervals to protect. Spray at 7-day intervals if mildew is present.
	Terraguard 50W 4.0-16.0oz triflumizole	Apply on a 7- to 14-day interval as needed. Use the high rate on an existing infection.
Willow Crown gall	Galltrol-A	See manufacturer's directions.
Yew (Taxus) Phytophthora root rot and crown rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Terrazole (35% WP) 4.0-10.0 oz etridiazole	Repeat every 4 to 12 weeks.
	Alliette (80% WDG) 1.0-2.0 lbs/1000 sq ft; fosetyl-Al	See Azalea.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.

Organic Controls for Insect Pests of Nursery Crops

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Table 4.2 - Organic Controls for Predators and Pathogens

Products	Insects Controlled	Remarks
d-limonene	Imported fire ants	Provides quick kill of workers.
Insecticidal soap	Works well on soft bodied insects in particular aphids, mites, lacebugs, mealybugs	This product is sold under many trade names and is a fatty acid soap.
Spinosad	Many insect pests, including thrips, lepidopterous larvae, and leaf beetles	Entrust is for certified organic production.
Rotenone	Many insect pests, including aphids, leafhoppers, weevils Japanese beetles, flea beetles	Usually sold as a dust, but some formulations can be mixed in water.
Pyrethrum	Broad spectrum, works on a wide variety of insects	Usually sold mixed with other botanical insecticides.
Predators	Insects Controlled	Remarks
Lady beetles	Feed on aphids and other soft bodied insects	Lady beetles may leave to find other prey after release. <i>Cryptolaemus</i> is used for mealybug, <i>Delphastus</i> is used for whitefly. <i>Chilocorus</i> is used for scales.
Lacewings	Aphids, scales, mealybugs, other soft bodied insects	Immature <i>Chrysoperla carnea</i> are called aphid lions.
Predatory mites	Mostly for control of spider mites	Release approximately 2/square foot. <i>Phytoseiulus persimilis</i> will work in some situations.
Parasitic wasps	Many insect pests on the foliage including caterpillars, whiteflies	<i>Trichogramma</i> wasps work well on many Lepidoptera eggs; <i>Encarsia formosa</i> for whiteflies; <i>Diglyphus</i> for leaf miners; <i>Aphytis</i> for armored scale.
Pathogens	Insects Controlled	Remarks
<i>Bacillus thuringiensis</i>	Leaf-feeding caterpillars, elm and willow leaf beetle	Known as "Bt;" sold under many trade names. A strain of <i>Bt</i> is sold as M-One for beetle control
<i>Beauveria bassiana</i>	Aphids, leafhoppers, thrips, mites, beetles, caterpillars	Trade names include Naturalis-O, Mycotrol, BotaniGard. Multiple applications may be needed.
Entomopathogenic nematodes	Root-feeders, borers, black vine weevil	For grubs or weevil larvae, apply to ground at base of plants. Rates are on product label; soil temperature should exceed 60° F. Apply late in the day, irrigate immediately. For borers, inject directly into galleries using syringe or turkey baster. Aqueous sprays to trunk are effective. Rates are on label. Not effective against foliar feeding pests as desiccation and exposure to ultraviolet light on the leaf surface kills the nematodes within hours.

Insects

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These recommendations are for use by nursery producers, commercial and municipal arborists, and other Certified Applicators, Category 3, who are responsible for the production, care, and protection of shade trees, shrubs, and other woody ornamental plants. Pest control is a highly complex and technical implementation of cultural and pest management practices.

There is no simple magic formula for pest control on trees and shrubs. More than 250 species of insects and mites are commonly found which damage or are potentially injurious to over 100 genera of woody ornamentals. Great diversity by insects in host preferences, seasonal development, periods of activity, habits, and susceptibility to insecticides requires careful planning and critical timing of control measures. It is a simple fact that insects and mites will occur, multiply, and cause serious losses if ignored or inadequately controlled. The most frequent cause of insect problems is the failure of nurserymen and arborists to carry out necessary control procedures properly at the right time due to pressures from other phases of production and maintenance.

The best way to control insects and mites is a preventive program. First, do not introduce pest problems. In nursery production, propagate or buy **ONLY** clean, uninfested stock plants. In municipal tree plantings or private landscaping, set out **ONLY** insect-free plant materials. The presence of a few hardly noticeable insects or mites at planting time is a sure source of extra work and costly effort later on. Second, draw up a seasonal pest monitoring schedule to prevent the establishment and buildup of insects and mites. Third, maintain regular surveillance of established plant materials and be prepared to schedule control measures for difficult or complex pest problems which arise. Take advantage of assistance from your local Extension faculty and the Extension specialists at Virginia Tech.

How to Use These Recommendations

Prepare a seasonal monitoring and management schedule for your specific plant types and pest problems. Each nursery, municipality, or local area tends to have its own unique pest situation depending on routine cultural and control practices. If the pest situation is not known, conduct a thorough survey to determine which problems exist and what the control needs are. Select those treatments which most conveniently fit the work plan in your own operation. For example, the use of dormant sprays on many plants will minimize or eliminate the need for spraying operations during the busier periods of the season. Another example is controlling spruce and southern red mite in the fall rather than the spring, or controlling pine needle scale in late July rather than in May. With careful study and planning these recommendations can be adapted to an effective, seasonal, preventive control program. There are numerous built-in options and alternatives. It is essential to carry out the program precisely. Thoroughness and proper timing are critical in obtaining effective results. Degree day (DD) accumulations to the susceptible life stage are included (50°F base temperature) in the timing section. Beware that using this information without scouting can lead to unnecessary applications.

Precautions

Be absolutely sure to read and follow **ALL** of the directions and precautions on the labels and accompanying brochures of the pesticides used. Every statement included is important and can prevent serious injuries or losses. Be sure that those involved in the application of pesticides are fully informed of all precautions for use and are certified applicators. Formulations and amounts to mix in preparing sprays are given; however, consult the labels for precise directions. It is illegal to use pesticides inconsistent with uses specified on the label. Be sure the host plants and pests to be controlled are stated on the label of the product you use.

Toxicity and Hazard to Humans and Animals

As a guide to general hazards of chemicals, know the relative toxicities of common insecticides. Also study the precautionary statements on pesticide labels. Certain chemicals may be more readily absorbed through the skin than if ingested, or vice versa. Some may be relatively non-toxic to bees and birds, but highly toxic to fish. In using pesticides, avoid application where undesirable side effects may result. When spraying, it is essential to stay out of drift and direct spray. Wear protective equipment as directed by the label.

Plant Injury

Insecticides vary greatly in their phytotoxicity. Be sure to avoid treating sensitive or stressed plants. Cautions on the label usually indicate plants which should not be sprayed. **Read the entire label carefully.** Petroleum oils for dormant or summer spraying are much safer, but may injure 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 never be applied to plants.

Table 4.3 - Control Measures for Major Pests and Pest Groups

Pest	Control	Timing of Treatment	Remarks
Adelgids spruce gall adelgid	bifenthrin carbaryl chlorpyrifos diazinon endosulfan imidacloprid lindane malathion	Treat just before buds break in the spring, and/or in September and early October after galls have opened.	Spring treatments should be applied before cottony egg masses are evident on buds in the spring. 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. Lindane is being phased out.
pine bark adelgid	bifenthrin chlorpyrifos deltamethrin diazinon horticultural oil imidacloprid insecticidal soap lindane malathion	Treat in late April or early May and repeat 2-3 weeks later.	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. Deltamethrin labeled for adelgids. Lindane is being phased out.
hemlock woolly adelgid	bifenthrin diazinon dinotefuran horticultural oil insecticidal soap imidacloprid thiamethoxam	Treat in late June and/or in September or October.	When spraying, thoroughly wet entire plant including the bark of branches and the trunk. Use a forceful spray; be sure the new growth is thoroughly wet. Use care when treating soil to avoid runoff from site.
hickory leafstem gall aphid	malathion	Treat just as new buds are beginning to open. Timing is critical.	Because aphids begin feeding immediately as leaf buds begin to open, control is very difficult and often ineffective.
Ambrosia Beetles	bifenthrin permethrin	Treat trunk and larger branches in April when the daytime temperature exceeds 70°F for the first time.	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.
Ants see "imported fire ant"			

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Aphids (general)	abamectin	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 migrate to hosts throughout the season and in the fall. Look for honeydew or sooty mold.	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, aphid lions, syrphid larvae, and other populations. Do not apply when plants are flowering and honeybees are active.
	acephate		
	acetaprimid		
	azadirachtin		
	<i>Beauveria bassiana</i>		
	bifenthrin		
	chlorpyrifos		
	cyfluthrin		
	deltamethrin		
	diazinon		
	dimethoate		
	dinotefuran		
	endosulfan		
	flonicamid		
	fluvalinate		
	imidacloprid		
	insecticidal soap		
	lambda-cyhalothrin		
	malathion		
methiocarb			
permethrin			
pymetrozine			
rotenone			
spirotetramat			
thiamethoxam			
Bagworm	acephate	Apply treatments when bags are less than 1/2 inch. Late May in coastal Virginia, early to mid-June elsewhere. DD-600 controls less effective in mid-late summer.	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 and permethrin may lead to mite increases. Light infestations can be handpicked and destroyed. Indoxacarb is for landscape use only.
	azadirachtin		
	bifenthrin		
	carbaryl		
	chlorpyrifos		
	cyfluthrin		
	deltamethrin		
	diazinon		
	dimethoate		
	fluvalinate		
	indoxacarb		
	gamma-cyhalothrin		
	lambda-cyhalothrin		
permethrin			
spinosad			
tebufenozide			
	<i>Bacillus thuringiensis</i> (Bt)	Treat when larvae are young in mid to late June.	Lightly misting the foliage is sufficient. Mist blower treatments are effective.
	remove and burn bags	August to May for light infestation of a few infested trees.	Overwintering eggs remain inside the bags until hatching in late May. Destroy the bags; eggs will hatch from bags thrown on the ground.
Bark Beetles Deciduous trees	bifenthrin	Treatments should be applied to prevent infestation of and breeding in the bark. Treat weakened or injured trees in late April and repeat 2 or 3 times at monthly intervals.	Thoroughly soak the bark of the trunk and branches. Sprays are more concentrated than usual foliar treatments. Lindane is being phased out. Cypermethrin, landscapes only.
	chlorpyrifos		
	cypermethrin		
	lindane		
	permethrin		

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Bark Beetles (cont.) elm bark beetle	sanitation	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.	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.
	bifenthrin chlorpyrifos methoxychlor permethrin	As late in the spring as possible before LEAF BUDS open. This treatment can be supplemented with a second spray in early June.	Complete coverage of all bark is absolutely essential, especially the one year-old twigs in the tops and outer reaches of the trees. The trunk and larger branches should be soaked thoroughly. Spraying is supplementary to sanitation.
Conifers	bifenthrin chlorpyrifos lindane permethrin	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.	Thoroughly wet 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. Lindane is being phased out.
	sanitation	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 burning, burying where feasible. Beetles will not reinfest or attack wood or trees dead longer than one year.
shot-hole borer, fruit tree bark beetles, ash bark beetle (<i>Scolytus</i>)	bifenthrin lindane permethrin	Spray the bark of healthy trees in late April and early June.	Lindane is being phased out.
Borers banded ash borer	bifenthrin chlorpyrifos permethrin	Treat trunk and main stems in late July and again in early September	Control measures are aimed at newly hatched larvae prior to tunneling into the tree.
lilac borer ash borer	bifenthrin chlorpyrifos endosulfan permethrin	Treat trunk and branches in early May and again 6 weeks later. DD-148	Treatments kill emerging as well as entering borers. Thorough wetting and soaking of the bark is necessary. Foliage need not be treated.
dogwood borer	bifenthrin chlorpyrifos endosulfan permethrin	Treat trunk and larger branches in mid-May and repeat after 6 weeks. DD-250	Brown frass around bark cracks and wounds indicate an infestation.
peach tree borer	acelepryn bifenthrin chlorpyrifos chlorantraniliprole permethrin	Treat trunks and soil around the base in July and repeat in 6 weeks.	Cracked bark, frass, and gummosis at the root crown are signs of infestation.
rhododendron borer	bifenthrin chlorpyrifos permethrin	Treat the trunks and larger branches in late June. DD-192	Wilting foliage and dieback are symptoms.
bronze birch borer	bifenthrin chlorpyrifos permethrin	Treat all bark surfaces, especially in the uppermost part of the tree in mid-May, early, mid-, and late June. DD-440	Bifenthrin and permethrin are labeled for landscapes.

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Borers (cont.) emerald ash borer	bifenthrin carbaryl cyfluthrin dinotefuran emamectin benzoate permethrin	Branch and trunk applications in early May and early June.	Additional insecticides are labeled as soil drenches and tree injections. See PMG 456-018 <i>Insects of trees and shrubs</i> . Do not move firewood.
two-lined chestnut borer	chlorpyrifos	Treat trunk and branches during mid- late May and mid-late June.	
round-headed and flat-headed tree borer	bifenthrin permethrin lindane	Treat bark of trunk and branches in early May, early June, and early July.	Bifenthrin is labeled for flatheaded appletree borer in landscapes. Lindane is being phased out.
oak borer	bifenthrin chlorpyrifos permethrin	Treat trunk to ground level early June.	Populations are larger in even-numbered years.
locust borer	chlorpyrifos lindane	Treat the trunk and larger branches in late August to mid-September or in spring.	Sprays applied in early spring are directed at small larvae. Lindane is being phased out.
Cicada (periodical cicada)	bifenthrin carbaryl chlorpyrifos	Treat bark of twigs on susceptible hosts soon after adult male singing becomes evident, usually around early May.	Cicada damage is caused by adult females inserting eggs in deep slits in twigs. Control is necessary only for young trees.
Defoliators general	acephate azadirachtin <i>Bacillus thuringiensis</i> (<i>Bt</i>) bifenthrin carbaryl chlorantraniliprole chlorpyrifos clothianidin cryolite deltamethrin diazinon malathion methoxychlor novaluron permethrin phosmet	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.	Insecticide combinations marketed by formulators and distributors are available. Consult the labels for specific uses and precautions. Mist blowers are effective. (Use <i>Bt</i> only for caterpillars). Novaluron is labeled for armyworms. Chlorantraniliprole for landscapes; deltamethrin for many defoliators; clothianidin for landscapes; cryolite for caterpillars.
cankerworms	acephate azadirachtin <i>Bacillus thuringiensis</i> (<i>Bt</i>) carbaryl chlorpyrifos cyfluthrin deltamethrin diazinon fluvalinate lambda-cyhalothrin methoxychlor permethrin phosmet spinosad tebufenozide	In May when the leaves are half to two-thirds full size, treatments must be applied when larvae are small. DD-148	Do not use methoxychlor on Chinese elm, Japanese or red maple, or redbud. See Intro., Plant Injury. Mist blowers are very effective.

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Defoliators (cont.) elm leaf beetle	bifenthrin carbaryl chlorpyrifos cyfluthrin cypermethrin deltamethrin endosulfan fluvalinate imidacloprid lambda-cyhalothrin methoxychlor spinosad	Treat in mid-to-late May, when eggs have hatched but larvae are small. Second generation may need treatment in mid-to-late July.	Do not use methoxychlor on Chinese elm. Carbaryl may injure tender foliage if plants are wet or humidity is high.
fall webworm	<i>Bacillus thuringiensis</i> (Bt) bifenthrin carbaryl chlorpyrifos cyfluthrin deltamethrin diazinon lambda-cyhalothrin methoxychlor permethrin spinosad tebufenozide	When larvae first begin to feed in late June. Repeat in late July. DD-1266	Do not use methoxychlor on Chinese elm, Japanese red maple, or redbud.
flea beetles	bifenthrin carbaryl cryolite cyfluthrin deltamethrin diazinon fluvalinate lambda-cyhalothrin spinosad	When insects are found feeding on host plants as adults or as larvae.	Flea beetles can appear suddenly and cause serious injury to foliage. Monitoring of susceptible plants is critical.
grasshoppers	bifenthrin carbaryl chlorpyrifos deltamethrin lambda-cyhalothrin	When grasshoppers are found feeding.	Grasshoppers are infrequent pests but can be destructive when abundant.
gypsy moth	acephate <i>Bacillus thuringiensis</i> (Bt) bifenthrin carbaryl chlorpyrifos cryolite cypermethrin deltamethrin diflubenzuron fluvalinate indoxacarb gamma-cyhalothrin lambda-cyhalothrin methoxychlor permethrin phosmet spinosad tebufenozide	When leaves have expanded but caterpillars are small, usually in mid-May. DD-90	Mist blowers and aerial applications are effective. Indoxacarb and cypermethrin are for landscape use only.

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Defoliators (cont.) Japanese beetle	azadirachtin bifenthrin carbaryl clothianidin cyfluthrin deltamethrin diazinon dinotefuran gamma-cyhalothrin imidacloprid lambda-cyhalothrin malathion methoxychlor permethrin	In late June or early July after adults have begun to congregate on selected hosts. Repeat as necessary into August. DD-1029	Since adults actively fly and move continuously, they seem to be present constantly even where treatments have been applied. Clothianidin for landscapes only.
rose chafer	azadirachtin chlorpyrifos endosulfan malathion methoxychlor	During June and mid-summer when insects are found.	Adults are active flyers and move continually onto susceptible hosts.
rose slugs	malathion methoxychlor	Throughout the growing season when young larvae are seen on plants, especially in May, June.	Time treatments to when larvae are young and damage is not yet severe.
sawflies	azadirachtin carbaryl chlorpyrifos cyfluthrin deltamethrin gamma-cyhalothrin lambda-cyhalothrin malathion methoxychlor spinosad	Timing varies depending on the host plant and the sawfly species.	Labeled uses are limited to pines, larch, ash, and spruce.
tussock moth	azadirachtin bifenthrin chlorpyrifos cyfluthrin fluvalinate gamma-cyhalothrin indoxacarb lambda-cyhalothrin methoxychlor tebufenozide spinosad	In mid-May or late August.	Treat when larvae are small. Indoxacarb is for landscape use only.
willow leaf beetle	carbaryl methoxychlor spinosad	In May, June, and later if infestations persist. There may be several generations in a season.	Be sure to treat the undersides of the leaves.
Gall Insects	carbaryl spinosad fenoxycarb thiamethoxam	Treatments are effective when insects are active, before galls appear in spring.	Spinosad is labeled for dipterous gall midges (e.g. honeylocust pod gall midge). Fenoxycarb is labeled for honeylocust pod gall midge. Thiamethoxam is labeled for honeylocust pod-gall, nipple gall, and blister gall.

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Imported Fire Ant	abamectin (bait) acephate bifenthrin chlorpyrifos deltamethrin fenoxycarb (bait) hydramethylnon (bait) indoxacarb (bait) lambda-cyhalothrin methoprene (bait) pyriproxyfen (bait)	When ants or mounds are observed.	Nurseries and landscapers shipping out of the quarantine area must contact VDACS. 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. Combinations of chemicals are also available. Many products are sold under multiple trade names.
Lacebugs	acephate bifenthrin carbaryl chlorantraniliprole chlorpyrifos cyfluthrin deltamethrin diazinon dimethoate dinotefuran fenpropathrin imidacloprid lambda-cyhalothrin lindane malathion methoxychlor permethrin spirotetramat	On evergreens, overwintering eggs hatch in mid-late May. Treat in late May or early June. On deciduous hosts, adults emerge in May. Treat in late May.	Consult the label for host plants and specific pests listed under directions for use. Nonsystemic treatments must cover the undersides of the leaves thoroughly. Control of the first generations is most important to slow populations buildup. Examine foliage for lacebugs. Lindane is being phased out. Chlorantraniliprole for landscapes only. Repeat at 3-week intervals if using a low residual product.
Leafhoppers	acetaprimid azadirachtin bifenthrin buprofezin carbaryl chlorpyrifos clothianidin cyfluthrin deltamethrin dinotefuran flonicamid fluvalinate gamma-cyhalothrin imidacloprid lambda-cyhalothrin permethrin spirotetramat thiamethoxam	When leafhoppers are first seen and before stippling on leaves becomes extensive.	Thorough coverage of the undersides of the leaves improves control when using nonsystemics. Clothianidin for landscapes only.

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Leafminers azalea leafminer	abamectin acephate azadirachtin bifenthrin clothianidin deltamethrin diazinon dimethoate fenoxycarb lambda-cyhalothrin permethrin	Treat in mid-late May or when mines are first seen on the plants.	Be cautious with dimethoate on azaleas; some varieties may be susceptible to plant injury. Fenoxycarb will not control adult stages. Clothianidin for landscapes only.
boxwood leafminer adults	cyromazine deltamethrin diazinon lambda-cyhalothrin malathion permethrin spinosad	Treat in late April or early May when adults are active. DD-448	Numerous adults can be eliminated before eggs are laid.
boxwood leafminer larvae	cyromazine dimethoate dinotefuran imidacloprid	Treat in May-June after eggs have hatched.	Systemic treatment are most effective in eliminating miners. They are also effective later in the season, and into the following year.
holly leafminer adults	cyromazine diazinon lambda-cyhalothrin permethrin spinosad	Treat in mid-May when new leaves are unfolding and adults are active on the foliage. (DD-192)	Helps reduce feeding punctures on undersides of leaves but may not prevent all mines in the foliage.
holly leafminer larvae	acephate cyromazine dimethoate dinotefuran imidacloprid	Treat in mid-late June after eggs have hatched.	Systemics are effective in eliminating miners. Do not treat chinese or burford hollies with dimethoate.
oak leafminer	acephate permethrin lambda-cyhalothrin fenoxycarb	Treat when mines are first seen - less than 1/4 inch. Several generations occur each summer.	Rake and destroy leaves in fall.
Leaf-rollers, Leaf Tiers	azadirachtin <i>Bacillus thuringiensis</i> (Bt) bifenthrin carbaryl chlorpyrifos cryolite cyfluthrin deltamethrin diazinon gamma-cyhalothrin lambda-cyhalothrin permethrin phosmet	Treat when insects are first seen. On some hosts, injury occurs in early spring when new buds are opening.	Consult the label for specific host plants listed. Phosmet is currently labeled for fruit trees and can be used on flowering fruit trees only.

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)			
Pest	Control	Timing of Treatment	Remarks
Mealybugs	horticultural oil	Treat in late spring, before new growth begins.	Spray on warm days when the temperature remains above 40°F (5°C) for 12-24 hours. Do not spray sensitive plants listed on the label.
	acephate	Treat whenever mealybugs are first noticed. Repeat 2-3 applications if necessary until infestation is eliminated.	Forceful spray streams help penetrate cracks and crevices in the bark and waxy secretions that protect the mealybugs. Destroying infested plants is another option. Fenpyroximate for suppression only.
	acetaprimid		
	azadirachtin		
	<i>Beauveria bassiana</i>		
	bifenthrin		
	buprofezin		
	carbaryl		
	chlorpyrifos		
	cyfluthrin		
	deltamethrin		
	dimethoate		
	dinotefuran		
	fenpyroximate		
	flonicamid		
	imidacloprid		
lambda-cyhalothrin			
malathion			
permethrin			
pyridaben			
spirotetramat			
thiamethoxam			
Mites hemlock rust mite eriophyid mites	horticultural oil	Treat in early spring before new growth develops.	Do not use on sensitive plants indicated on the label.
	abamectin azadirachtin carbaryl fenazaquin fenpyroximate	Treat when mites are found in very early spring, in late fall, or during the growing season.	Thoroughly wet the undersides of leaves with a full coverage spray.
spruce mite, southern red mite, boxwood mite	abamectin acequinocyl azadirachtin bifenazate chlorpyrifos clofentazine dimethoate etoxazole fenazaquin fenbutatin-oxide fenpropathrin fenpyroximate fluvalinate hexythiazox methiocarb milbectin pyridaben spinosad spiromesifen	Treat in late April or early May and/or in September and October.	Thoroughly wet all of the foliage and stems with a full coverage spray. Fenpropathrin is labeled for shade and lath house use only. Acequinocyl is labeled for spruce spider mite and two-spotted spider mite. See spiromesifen label for list of mite species. Etoxazole for shade and lath house use only.
honeylocust mite	abamectin fenazaquin	Treat when mites occur, repeat after 10 days.	Thoroughly wet the undersides of leaves with a full coverage spray.

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Mites two spotted spider mite	abamectin acequinocyl bifenthrin dimethoate etoxazole fenazaquin fenbutatin-oxide fenpyroximate fluvalinate hexythiazox methiocarb milbectin pyridaben spiromesifen	Treat whenever mites first appear. Infestations may occur from spring to fall. Mite infestations are directly proportionate to increasingly warmer temperatures.	Thoroughly wet the foliage and stems with a full coverage spray. Do not use acequinocyl on miniature roses. Etoxazole for shade and lath house use only. See bifenthrin label for special instructions.
Oriental Beetle	bifenthrin chlorpyrifos imidacloprid	Treat when small larvae are present.	Most effective against early instars. Beneficial nematodes may be effective. Apply bifenthrin as granules, other materials as soil drenches.
Plant Bugs, Planthoppers	bifenthrin buprofezin carbaryl chlorpyrifos cyfluthrin flonicamid fluvalinate lambda-cyhalothrin malathion permethrin thiamethoxam	Treat when insects or signs of damage first appear. Treat honeylocust as soon as new growth begins.	Control is difficult because plant bugs are active flyers and move around continuously. Fluvalinate is labeled for plant bugs. Permethrin is labeled for Lygus bugs.
Psyllids (Boxwood psyllid, hackberry psyllid)	azadirachtin <i>Beauveria bassiana</i> bifenthrin carbaryl chlorpyrifos deltamethrin dinotefuran lambda-cyhalothrin lindane spirotetramat	Treat in late April or early May as new growth begins to develop.	Addition of a wetting agent or spreader-sticker is advised. Lindane is being phased out.
Sawflies	acetaprimid azadirachtin bifenthrin carbaryl chlorpyrifos cyfluthrin deltamethrin dinotefuran gamma-cyhalothrin imidacloprid lambda-cyhalothrin malathion methoxychlor thiamethoxam	Treat when insects are first seen. Treat in April for Virginia pine sawfly. Larvae are gregarious and broods often cluster on one branch.	See label for which species are registered for each chemical.

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Scale Insects (All scales)	deltamethrin dinotefuran flonicamid horticultural oil imidacloprid lambda-cyhalothrin pyriproxyfen spirotetramat thiamethoxam	Treat with horticultural oil 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 to 24 hours. Oils can also be used as summer sprays when indicated on the label.	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. Thiamethoxam is labeled for soft scales. Pyriproxyfen, Deltamethrin and spirotetramat are labeled for scale crawlers.
Azalea bark scale	carbaryl diazinon insecticidal soap lambda-cyhalothrin malathion	Crawlers: June 5-25. Treat June 10-30.	Scale is often mistaken for mealybugs.
brown soft scale	bifenthrin buprofezin carbaryl diazinon fenoxycarb insecticidal soap lambda-cyhalothrin	Treat when scale insects appear. Treat 2-3 times at 10-day intervals.	This scale insect does not winter outside in colder plant zones of Virginia.
calico scale	carbaryl insecticidal soap lambda-cyhalothrin	Crawlers: June 1-20. Treat June 15-30.	Often seen on Zelcova and honeylocust trees.
camellia scale	dimethoate insecticidal soap lambda-cyhalothrin	Crawlers first appear in May. Treat at 2-week intervals as needed.	Dimethoate is being phased out.
cottony camellia scale	carbaryl insecticidal soap lambda-cyhalothrin malathion	Crawlers: June 1-10. Treat June 15-30.	
cottony maple leaf scale	acephate carbaryl diazinon insecticidal soap lambda-cyhalothrin	Crawlers: June 1-10. Treat June 15-30.	Ovisacs are found on foliage.
cottony maple scale	carbaryl insecticidal soap lambda-cyhalothrin	Crawlers: June 5-25. Treat June 10-30.	Be sure to thoroughly cover stems and branches near the ground.
euonymus scale	carbaryl dimethoate fenoxycarb insecticidal soap malathion lambda-cyhalothrin	Crawlers: first generation May 1-10; second July 5-15. Treat May 10-20, and July 15-25.	Do not spray when beneficial lady beetles are present.
euonymus alatus scale	carbaryl diazinon dimethoate lambda-cyhalothrin	Crawlers: in June and July. Treat: June to late July.	
European elm scale	carbaryl diazinon insecticidal soap lambda-cyhalothrin	Crawlers: June 5-25. Treat June 10-30.	

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Scale Insects (cont.) fern scale	buprofezin carbaryl dimethoate insecticidal soap lambda-cyhalothrin	Crawlers: first appear in mid-May. Treat at 2-week intervals as needed.	Often on lirioppe, near the base of the plant.
fletcher scale	carbaryl dimethoate insecticidal soap lambda-cyhalothrin malathion	Crawlers: in early to mid-June. Treat June 15-20.	On Taxus and Arborvitae.
Florida red scale	acephate buprofezin carbaryl diazinon insecticidal soap lambda-cyhalothrin	Crawlers: May 5-15. Treat May 15-30.	Found on burford holly.
forbes scale	carbaryl insecticidal soap lambda-cyhalothrin malathion	Crawlers: June 1-15. Treat June 5-20.	
gloomy scale	carbaryl diazinon insecticidal soap lambda-cyhalothrin	Crawlers: peak June 10-20. Treat June 20-30.	Serious pest of maples that is difficult to control.
golden oak scale	dimethoate insecticidal soap lambda-cyhalothrin	Crawlers: June 1-30. Treat June 10 - July 10.	
hemlock scale	dimethoate insecticidal soap lambda-cyhalothrin	Crawlers: peak May 15-June 20, some produced throughout the season. Treat May 20-25 and June 5-20.	Also called fiorinia hemlock scale.
Japanese maple scale	carbaryl diazinon lambda-cyhalothrin malathion	Crawlers: June 1-September 1. Treat at 2-week intervals June-September.	Serious pest that is difficult to control. Thorough coverage is needed.
juniper scale	carbaryl insecticidal soap lambda-cyhalothrin malathion	Crawlers: April 5-20 and June 5-20. Treat April 10-25 and/or June 10-25.	Crawler dates vary based on temperature.
latania scale	diazinon insecticidal soap lambda-cyhalothrin	Crawlers: continuous from June through season. Treat 2-3 times at 10 day intervals.	
lecanium scale	chlorpyrifos diazinon lambda-cyhalothrin	Crawlers: May 25-June 25. Treat June 15-30.	Treat crawlers for oak lecanium June 1-10 in coastal areas. Avoid harming beneficials by using soaps or oils in March-April.
oak kermes	carbaryl lambda-cyhalothrin malathion	Crawlers: June 1-20. Treat June 10-30.	
obscure scale	carbaryl diazinon lambda-cyhalothrin malathion	Crawlers: on red oak during July. Treat white oaks in mid-August.	Also treat with oil as a dormant spray. Can be a serious pest.

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Scale Insects (cont.) oystershell scale	buprofezin carbaryl insecticidal soap lambda-cyhalothrin	Crawlers: May 1-20 and July 15-25. Treat May 10-25 and/or July 20-30.	
peony scale	carbaryl diazinon insecticidal soap lambda-cyhalothrin malathion	Crawlers: mid-May. Treat in late May.	Often found on azaleas.
pine needle scale	bifenthrin carbaryl chlorpyrifos diazinon gamma-cyhalothrin insecticidal soap lambda-cyhalothrin malathion	Crawlers: April 20-May 30 and July 10-20. Treat May 5-30 and/or July 15-20.	Sporadic outbreaks can occur.
pine tortoise scale	carbaryl insecticidal soap gamma-cyhalothrin lambda-cyhalothrin	Crawlers: June 10-July 5. Treat June 20-July 15.	
rose scale	carbaryl insecticidal soap lambda-cyhalothrin	Crawlers: late May-June 30, possible second generation in August. Treat June 5-10 and 20-30 and in mid-August.	
San Jose scale	bifenthrin buprofezin carbaryl diazinon insecticidal soap lambda-cyhalothrin lime sulfur pyriproxyfen	Crawlers: at least 3 generations June, July, and September. Treat June, July, and September.	Lime sulfur as dormant spray only.
tea scale	chlorpyrifos dimethoate insecticidal soap lambda-cyhalothrin	Crawlers: throughout season in overlapping generations. Treat 2-3 times at 10-day intervals when infested.	Do not use dimethoate on Chinese or burford hollies.
wax scale	buprofezin carbaryl fenoxycarb lambda-cyhalothrin	Crawlers: June 1-25. Treat June 5-30.	Thoroughly wet foliage and bark with a full-coverage spray.
white peach scale	buprofezin chlorpyrifos diazinon fenoxycarb insecticidal soap lambda-cyhalothrin malathion	Crawlers: April 25-May 15, July 1-15, August 20-September 15. Treat May 1-15, July 5-15, September 1-15.	
Spittle Bug	bifenthrin carbaryl chlorpyrifos cyfluthrin deltamethrin gamma-cyhalothrin lambda-cyhalothrin spirotetramat	Treat in early June if yellowing or damage occurs.	Often noticed on pines, but rarely causes any injury.

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Slugs and Snails	Iron phosphate metaldehyde methiocarb orthoboric acid	Apply when pests are observed.	Iron phosphate is available in homeowner packaging.
Stink Bug	flonicamid	Apply when pests are observed.	Some pansy cultivars may be sensitive.
Tent Caterpillars	azadirachtin <i>Bacillus thuringiensis</i> (<i>Bt</i>) bifenthrin carbaryl chlorpyrifos cyfluthrin deltamethrin diazinon gamma-cyhalothrin indoxacarb lambda-cyhalothrin methoxychlor permethrin spinosad tebufenozide	Treat in early spring as new growth is developing and when caterpillars are small.	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. Spinosad and lambda-cyhalothrin are labeled for eastern tent caterpillar only. Indoxacarb is for landscape use only.
Thrips	abamectin acephate acetaprimid azadirachtin <i>Beauveria bassiana</i> bifenthrin chlorpyrifos cyfluthrin dinotefuran flonicamid fluvalinate imidacloprid lambda-cyhalothrin methiocarb novaluron permethrin spinosad spirotetramat	Treat in May-June when thrips are active on new foliage.	Methiocarb is labeled for western flower thrips. Spirotetramat provides suppression at low levels. Dinotefuran is for suppression.
Tip Moths	acephate azadirachtin bifenthrin chlorpyrifos cyfluthrin diflubenzuron dimethoate disulfoton gamma-cyhalothrin lambda-cyhalothrin permethrin tebufenozide	Treat with liquid formulation in mid March, April, June and July when moths are flying. Treat with dimethoate when larval activity begins in late April and in late May or early June. Treat with disulfoton soil application 2-3 weeks prior to adult activity in late March.	Spray entire tree to runoff. Two and three-needle pines are susceptible to tip moth. Soil systemic treatment requires only one application annually; for nursery use and professional applicators only. Disulfoton must be incorporated and watered into the soil. Younger trees are preferred.
Treeshoppers	bifenthrin carbaryl chlorpyrifos	Treat when nymphs are seen on twigs (usually in clusters) before adults are present to begin egg-laying, usually in late summer and fall.	Apply sprays to cover the small twigs thoroughly.

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Webworms cotoneaster webworm	cyfluthrin deltamethrin diazinon gamma-cyhalothrin lambda-cyhalothrin permethrin	Treat when larvae are first found.	Apply a full-coverage spray, wetting foliage to the point of runoff.
juniper webworm	bifenthrin chlorpyrifos cyfluthrin deltamethrin diazinon gamma-cyhalothrin lambda-cyhalothrin permethrin	Treat in late July or in August when larvae are small. Spring treatments may be applied when plants are found to be infested.	Apply a forceful spray to penetrate severely webbed foliage. Thoroughly wet the foliage to runoff.
fall webworm	<i>Bacillus thuringiensis (Bt)</i> bifenthrin chlorpyrifos cyfluthrin deltamethrin diazinon indoxacarb gamma-cyhalothrin lambda-cyhalothrin methoxychlor permethrin tebufenozide	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.	Caterpillars are gregarious and infest individual branches. Apply full-coverage foliar spray to infested area, or entire tree in years of high populations. Indoxacarb is for landscape use only.
mimosa webworm	carbaryl chlorpyrifos cyfluthrin deltamethrin diazinon gamma-cyhalothrin lambda-cyhalothrin permethrin	Apply foliage sprays at 4-5 day intervals until the infestation is controlled.	
pine webworm	bifenthrin chlorpyrifos cyfluthrin deltamethrin diazinon gamma-cyhalothrin lambda-cyhalothrin permethrin	Treat in early June.	
Weevils Two banded Japanese weevil, black vine weevil	acephate <i>Beauveria bassiana</i> bifenthrin chlorpyrifos dinotefuran lambda-cyhalothrin	Apply in June or July as a full-coverage spray when foliar feeding is first observed.	Lambda-cyhalothrin is for black vine weevil adults.
white pine weevil	bifenthrin gamma-cyhalothrin lindane	Apply sprays in the late spring before adults lay eggs, normally prior to April 1-10	Treat only the main terminal leaders of the tree down to the first whorl of branches. Thoroughly wet the bark. Lindane is being phased out.
white pine weevil (cont.)	Cut out and burn infested leaders.	Prune out infested leaders during June.	Adults begin emerging from infested leaders in July.

Table 4.3 - Control Measures for Major Pests and Pest Groups (cont.)

Pest	Control	Timing of Treatment	Remarks
Whiteflies	abamectin	When whiteflies are found. Treat every three weeks until infestation is controlled.	See labels for whitefly species. Clothianidin for landscapes.
	acetaprimid		
	azadirachtin		
	<i>Beauvaria bassiana</i>		
	bifenthrin		
	chlorpyrifos		
	clothianidin		
	cyfluthrin		
	dinotefuran		
	fenoxycarb		
	flonicamid		
	fluvalinate		
	imidacloprid		
	lambda-cyhalothrin		
	novaluron		
	permethrin		
	pymetrozine		
pyridaben			
spiromesifen			
spirotetramat			
thiamethoxam			
Zimmerman Pine Moth	bifenthrin	Treat in early- to mid-April and in early September. (DD-121)	Apply as full coverage spray to the point of runoff. Lindane is being phased out.
	dimethoate		
	endosulfan		
	lindane		

Table 4.4 - Directions for Pesticide Usage

Chemical	Formulation	Pests Controlled	Amount to Use		Phototoxicity and Remarks
			per 100 gal	per 3 gal	
abamectin (Avid) (Sirocco)	0.15EC	aphids, mites leafminers, thrips, white- flies, imported fire ants	4.0-8.0 fl oz	0.75-1.5 tsp	See label for rate and volume directions. Sirocco also contains bifentazate. Do not use on ferns or Shasta Daisy. Generic products exist. 12-hr REI. Bait for imported fire ants. SIGNAL WORD - WARNING
	0.011B				
acephate (Orthene)	75S	All labeled uses.	See label for rates		Rates differ as to pests. See label for phytotoxicity list. 24-hr REI. Bait for imported fire ants. SIGNAL WORD - CAUTION
	97				
acequinocyl (Shuttle)	15SC	two-spotted spider mite, spruce spider mite	6.4-12.8 fl oz	1.0-2.0 tsp	Do not use on miniature roses or impatiens. Use low rate on standard roses. See label for resistance management. 12-hr REI. SIGNAL WORD - CAUTION
acetaprimid (Tristar)	70WSP	aphids, European pine sawfly, tentiform leaf miner, mealybug, leafhopper, whiteflies, thrips	See label for rates		See label for resistance management, restrictions, and precautions. 70WSP in water soluble packets. 12-hr REI. SIGNAL WORD - CAUTION
	30SG				

Table 4.4 - Directions for Pesticide Usage (cont.)

Chemical	Formulation	Pests Controlled	Amount to Use		Phototoxicity and Remarks
			per 100 gal	per 3 gal	
azadirachtin (Azatin, Triact, Ormazin)	various	All labeled uses.	See label for rates	See label for rates	Product is sold by several companies, and in many formulations. 4-hr REI. SIGNAL WORD - CAUTION
<i>Bacillus thur-</i> <i>ingiensis</i> (Bt)	various	defoliating caterpillars (see label)	See label for rates	See label for rates	Product is sold by many companies, and in many formulations. 4-hr REI. SIGNAL WORD - CAUTION
<i>Beauveria</i> <i>bassiana</i> (BotaniGard)	22WP ES	aphids, mealy- bugs, thrips, whiteflies	0.5-2.0 lb 0.5-2.0 qt	1.5-6.0 tbsp 1.0-4.0 tbsp	12-hr REI. SIGNAL WORD - CAUTION
bifenazate (Floramite) (Sirocco)	50WP	mites	See label for rates	—	See label for species controlled. Sirocco also contains abamectin. 12-hr REI. SIGNAL WORD - CAUTION
bifenthrin (Talstar, Onyx Pro)	F	All labeled uses	See label for rates	—	Onyx Pro is labeled for nurseries. Generic products exist. 12-hr REI. SIGNAL WORD - WARNING.
	0.2G	All labeled uses.	See label for rates	—	SIGNAL WORD - CAUTION
buprofezin (Talus)	70WSP	leafhoppers, mealybugs, planthop- pers, scales, whiteflies	6.0-14.0 oz	—	Sold in water soluble bags. Consult label for rate. 12-hr REI. SIGNAL WORD - CAUTION
carbaryl (Sevin)	50W	All labeled uses.	2.0 lbs	6.0 tbsp	Do not apply to wet foliage or in high humidity; injury may result. 12-hr REI. SIGNAL WORD - WARNING
	SL		1.0 qt	3.0 tbsp	
	23.4% EC		2.0 qt	4.0 tbsp	
chlorant- raniliprole (Acelepryn)	1.67SC	Leaf-feeding caterpillars, lacebugs, birch leaf miner, clear- wing borers	See label for rates	See label for rates	No signal word required. 4-hr REI. For landscape use.
chlorpyrifos (Dursban)	2E	See label for pests.	1.0 pt	1.0 tbsp	See label for sensitive plants. SIGNAL WORD - WARNING
	4E		8.0 oz	1.5 tsp	
	50W		0.5 lb-6.0 lb	—	
(DuraGuard)	ME		1.5-3.0 pt	1.5-3.0 tbsp	Rates vary with formulation. Read label carefully. 50W in water-solu- ble packets. See label for special rates for borers, bark beetles, and weevils. 12-hr REI.
clofentezine (Ovation)	5SC	mites	2.0 fl oz	1.0 tbsp	Not for landscape use. 12-hr REI. SIGNAL WORD - CAUTION
clothianidin (Arena, Aloft)	50WDG .25G	See label	See label	See label	Landscape use only. Aloft also contains bifenthrin. 12-hr REI. SIGNAL WORD - CAUTION
cryolite (Kryocide)	D	See label	See remarks	See remarks	Rate is 8.0-24.0 lbs/A. 12-hr REI. SIGNAL WORD - CAUTION
cyfluthrin (Discus, Decathlon)	20WP F	See label.	1.3-1.9 oz	0.75-1.0 tsp	Discus also contains imidacloprid. 12-hr REI. SIGNAL WORD - WARNING

Table 4.4 - Directions for Pesticide Usage (cont.)

Chemical	Formulation	Pests Controlled	Amount to Use		Phototoxicity and Remarks
			per 100 gal	per 3 gal	
cypermethrin (Cynoff)	EC, WP	box elder bug, elm leaf beetle	See label for rates	See label for rates	Only in landscapes. 12-hr.- REI. SIGNAL WORD - WARNING (WP) CAUTION (EC).
cyromazine (Citation)	75WP	leaf miners, shoreflies, fungus gnats	2.66 oz	—	Sold in water-soluble pouches. Not to exceed 6 applications/crop. Shoreflies on greenhouse crops only. 12-hr REI. SIGNAL WORD - CAUTION
deltamethrin (Deltagard)	5SC	See label	4.0-8.0 fl oz	0.75-1.5 tsp	Registered for landscape and nursery ornamentals. 12-hr REI. SIGNAL WORD - CAUTION
diazinon	AG500, 4F 50W	See label for pests.	1.0-3.0 pt 1.0-3.0 lb	1.0-3.0 tbsp 3.0-9.0 tbsp	Not all formulations have the same pests on the label. Read the label carefully. 12-hr REI. SIGNAL WORD - WARNING
	Knox-out	See label.	3.0-6.0 pt	1.0-2.0 tbsp	See label. 12-hr REI. SIGNAL WORD - CAUTION
diflubenzuron (Dimilin)	25W	Pine tip moth, gypsy moth	4.0 oz	2.0 tsp	12-hr REI. SIGNAL WORD - CAUTION
dimethoate (Cygon, Dimate)	4E	See label for pests controlled	1.0-4.0 pt	1.5-11.6 tsp or 0.5-4.0 tbsp	Do not use on Burford "China Girl", or "Bluemaids" hollies. See label for restrictions. Rates vary with formulations and pests. 48-hr REI. SIGNAL WORD - WARNING
	2.67E	See label Soil drench	0.75-3.1 pt	0.75-3.0 tbsp	Increase rate proportionately for larger plants. See label for specific directions.
dinotefuran (Safari, Zylam)	20SG	All labeled uses.	See label for rates.	—	See label for proper rate for target pest. See label for scale species. Apply as foliar spray or drench. 12-hr REI. SIGNAL WORD - CAUTION Make applications post-bloom when bees are present. Zylam is labeled for landscape ornamentals as a soil drench or soil injection.
emamectin benzoate (Tree-age)	F	All labeled uses	—	—	Applied by injection to base of tree. SIGNAL WORD - WARNING
endosulfan (Thionex)	50WP	All labeled uses.	1.0-1.5 lb	—	Sold in water-soluble bags. Do not exceed 6 lbs/A/year. 24-hr REI. SIGNAL WORD - WARNING
	3EC	All labeled uses.	0.66-1.33 qt	1.33-2.66 tbsp	Rate varies depending on pest. See label. Do not exceed 4 qts/acre/year.
etoxazole (TetraSan)	5WDG 5WSP	spider mites	See label for rates	See label for rates	Shade and lath house use only. 12-hr REI. SIGNAL WORD - CAUTION
fenazaquin (Magus)	200SC	mites, whiteflies	12.0-24.0 fl oz	2.0 tsp-1.5 tbsp	Do not exceed 24 oz per acre per year. Do not use on roses. 12-hr REI. SIGNAL WORD - WARNING
fenbutatin oxide (Promite)	50WP	mites	8.0-16.0 oz	—	Sold in soluble pouches. 48-hr REI. SIGNAL WORD - DANGER
fenoxycarb (Precision)	25WP	All labeled uses.	2.0-8.0 oz	—	See label for proper rate for target pest. Sold in 1-oz pouches. 12-hr REI. SIGNAL WORD - CAUTION

Table 4.4 - Directions for Pesticide Usage (cont.)

Chemical	Formulation	Pests Controlled	Amount to Use		Phototoxicity and Remarks
			per 100 gal	per 3 gal	
fenpropathrin (Tame)	2.4EC	All labeled uses.	5.33-16.0 oz	1.0-3.0 tsp	24-hr REI. SIGNAL WORD - DANGER
fenpyroximate (Akari)	5SC	mites, mealybugs	16.0-24.0 fl oz	1.0-1.5 tbsp	Good coverage is essential. 12-hr REI. SIGNAL WORD - WARNING
flonicamid (Aria)	WSP	All labeled uses	0.7-2.1 oz	—	See label for proper rate for target pest. Sold in 20.0 g packets 12-hr REI. SIGNAL WORD - CAUTION.
flucyvalinate (Mavrik)	2F	All labeled uses.	4.0-10.0 fl oz	0.75-2.0 tsp	See label for precautions and rates for root weevils. For outdoor plantings and containerized nursery stock. 12-hr REI. SIGNAL WORD - CAUTION
gamma-cyhalothrin (Proaxis)	(0.5F)	All labeled uses	2.56-5.12 fl oz	—	SIGNAL WORD - CAUTION
hexythiazox (Hexygon)	50WP	mites	1.0-2.0 oz or 4.0-6.0 oz/A	0.5-1.0 tsp	Use only once/crop cycle. 12-hr REI. SIGNAL WORD - CAUTION.
horticultural oils	various	All labeled uses.	See label for rates.		Numerous companies sell this product. See label for phytotoxicity. 4- to 12-hr REI. SIGNAL WORD - CAUTION
hydramethylnon (Amdro, Max Force)	various	imported fire ant	See label for rates		Apply when ants are foraging. 12-hr REI. SIGNAL WORD - CAUTION
imidacloprid (Marathon, Discus)	1G 60WP II F	aphids, mealybugs, thrips, whiteflies	See label for rates		See label for application directions. Labeled for soil and foliar application. Discus also contains cyfluthrin. Generic products exist. 12-hr REI. SIGNAL WORD - CAUTION
indoxacarb (Provaunt, Advion)	30WDG 0.45G	caterpillars, sawfly, leafhoppers, imported fire ant	1.25-5.0 oz	—	Provaunt is labeled for landscape use only. Granular form for imported fire ants. SIGNAL WORD - CAUTION.
insecticidal soap	various	All labeled uses.	See label for rates.		Several companies sell this product. 12-hr REI. SIGNAL WORD - WARNING
iron phosphate	1% bait	snails, slugs	—	—	Rate is 1.0 lb per 1000 sq ft. SIGNAL WORD - CAUTION.
lamba-cyhalothrin					Labeled for commercial and residential turf and landscape ornamental plants. Generic products are sold by many companies. 12-hr REI. SIGNAL WORD - CAUTION
(Scimitar)	10WP 9.7CS	All labeled uses.	1.2-4.8 oz 1.5-5.0 oz	— 0.33-1.0 tsp	Scimitar is labeled for commercial landscapes; WP is sold in soluble packs. 24-hr REI. SIGNAL WORD - WARNING
lime sulfur	26-30% L	armored scales	10.0-12.0 gal	39.0-45.0 fl oz	Apply when plants are fully dormant. Will cause yellow staining of paint, masonry. SIGNAL WORD - DANGER
lindane	25%WP	All labeled uses.	1.0 lb	3.0 tbsp	Read label carefully! 12-hr REI. Product is being phased out. SIGNAL WORD - WARNING

Table 4.4 - Directions for Pesticide Usage (cont.)

Chemical	Formulation	Pests Controlled	Amount to Use		Phototoxicity and Remarks
			per 100 gal	per 3 gal	
lindane (cont.)	20% L	All labeled uses.	1.0-18.0 pt	1.0-18.0 tbsp	See label for application directions and rate for target pest. Product is being phased out.
malathion	Various	All labeled uses.	See label	—	See label for rates and directions for target pests. Product is sold by several firms. 12-hr REI. SIGNAL WORD - CAUTION
metaldehyde (Deadline, Metarex)	Bait	slugs, snails	Ready-to-use.		12-hr REI. SIGNAL WORD - CAUTION
methiocarb (Grandslam, Mesuro)	75W	aphids, mites, slugs, snails, thrips	1.0-4.0 lb	3.0-12.0 tbsp	Do not apply with foliar fertilizer. Apply up to 4 applications/season. 24-hr REI. SIGNAL WORD - WARNING
methoprene s-methoprene (Extinguish)	various	imported fire ant	See label for rates		Also sold in combination with hydramethylnon. 4-hr REI. SIGNAL WORD - CAUTION
methoxychlor (Marlate)	50WP	All labeled uses.	2.0-3.0 lb	6.0 tbsp	Do not use on Chinese elm, Japanese and red maple, redbud, privet and viburnum, repeated uses on evergreens. 12-hr REI. SIGNAL WORD - CAUTION
milbemectin (Ultiflora)	1% EC	spider mites	8.0-16.0 fl oz	1.5-3.0 tsp	See label for application directions. See label for sensitive species. 12-hr REI. SIGNAL WORD - CAUTION.
novaluron (Pedestal)	10SC	white-flies, thrips, leafminers, armyworms	6.0-8.0 oz	1.0-1.5 tsp	Registered for container-grown ornamentals. 12-hr REI. SIGNAL WORD - CAUTION
orthoboric acid (Niban)	5G	snails and slugs	See remarks for rates	—	4-hr REI. Apply evenly at 6.0 oz per 100 sq ft.
permethrin	2E	All labeled uses.	6.4-12.8 oz	1.0-2.0 tsp	Permethrin is sold under several trade names. Do not apply to salvia or snapdragon. 12-hr REI. SIGNAL WORD - CAUTION
	3.2EC	All labeled uses.	4.0-8.0 oz	0.75-1.5 tsp	
phosmet (Imidan)	70W	Elm spanworm, gypsy moth, birch leafminer, spring cankerworm,	0.75-1.0 lb	2.25-3.0 tbsp	See label for rates and pests on evergreens. 24-hr REI. SIGNAL WORD - WARNING
pymetrozine (Endeavor)	50WG	aphids, whiteflies	2.5-5.0 oz	—	Sold in WSP. 12-hr REI. SIGNAL WORD - CAUTION
pyriproxyfen (Distance)	0.86EC	scale crawlers, imported fire ant	See label for rates	See label for rates	See label for sensitive species. Granular formulation for imported fire ants. 12-hr REI. SIGNAL WORD - CAUTION
	0.5G				
pyridaben (Sanmite)	75SP	All labeled uses.	2.0-6.0 oz	—	Sold in 1.0 oz soluble bags only. 12-hr REI. SIGNAL WORD - WARNING
spinosad (Conserve, Entrust)	SC	All labeled uses.	6.0-22.0 fl oz	1.0-4.0 tbsp	See label for resistance management strategies and rates for specific pests. Compatible with IPM programs. 4-hr REI. SIGNAL WORD - CAUTION

Table 4.4 - Directions for Pesticide Usage (cont.)

Chemical	Formulation	Pests Controlled	Amount to Use		Phototoxicity and Remarks
			per 100 gal	per 3 gal	
spiromesifen (Forbid, Judo)	4F	mites, whiteflies	2.0-4.0 fl oz	0.38-0.75 tsp	Forbid registered for outdoor landscapes only; Judo registered for nursery and greenhouse sites. 12-hr REI. SIGNAL WORD - CAUTION
spirotetramat (Kontos)	240SC	See label.	1.7-3.4 fl oz	0.07-0.1 fl oz	See label for additional pests. 24-hr REI. as foliar spray; no REI. for drench. SIGNAL WORD - CAUTION
tebufenozide (Confirm)	2E	See label.	4.0-16.0 fl oz	0.75-3.0 tsp	See label for rates for specific pests. 4-hr REI. SIGNAL WORD - CAUTION
thiamethoxam (Flagship)	25WG .22G	aphids, lace bugs, soft scales, mealy- bugs, blister gall, white- flies, sawflies, leafhoppers, plantbug, nip- ple gall, hon- eylocust pod- gall, hemlock wooly adelgid	2.0-4.0 oz See label	— See label	See label for application direction and specific rate. Granular is labeled for aphids, mealybugs, whiteflies, and beetle larvae (grubs). 12-hr REI. SIGNAL WORD - CAUTION

Abbreviations

W, WP = wettable, wettable powder; WSP = water-soluble packets; S, SP = sprayable powder; L, LS = liquid, liquid spray; E, EC = emulsifiable, emulsifiable concentrate; SC = spray concentrate.

Precautions:

Do not apply liquid concentrate when the temperature is above 85°F (29-30°C.) or any spray when the temperature is above 90°F (32°C).

Do not apply oil sprays if the temperature is below 40°F (4-5°C) or is likely to approach or go below freezing within 24 hours. Never use a sprayer or a tank that has been used previously to apply herbicides.

Use only the recommended dosage rates. The label directions are the final authority. Wettable powders and other suspensions (flowable) require continuous agitation in the tank to avoid settling. Do not allow spray suspensions to remain in the tank without agitation, or any spray mixture to remain in a non-operating sprayer for more than 1 hour.

Clean all spraying equipment thoroughly after each use.

Use spreader-stickers only for hard-to-wet foliage and special uses. Unnecessary wetting agents and spreaders cause excess run-off.

Equivalents:

1 pt liquid in 100 gal = 1 tsp in 1 gal

1 lb powder in 100 gal = 1 tbsp in 1 gal

1 gal = 4 qt = 8 pts = 128 fl oz

1 cup = 1/2 pt = 8 fl oz = 16 tbsp

1 fl oz = 1/8 cup = 2 tbsp = 29.57 milliliter

1 lb = 16 oz = 454 grams

1 tbsp = 1/2 fl oz = 3 tsp = 14.78 milliliter

1 oz = 28.3 grams

Weeds

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Nonchemical Weed Control

Use a 2- to 4-inch depth of mulch. Avoid overmulching. Suitable mulch materials include pine bark, hardwood bark, pine straw, leaves, or similar organic materials. Rock mulches can also be used in certain landscape situations for weed management and tend to provide greater weed control than an organic mulch. Consider placing a landscape fabric under a rock mulch to act as a soil separator. Do not spread mulch that has an off-odor (rotten egg/sulfur smell or an ammonia odor) or plant injury can occur. Mulches will suppress annual weeds but generally will not control perennial weeds.

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. Use landscape fabrics only in woody landscape beds. Fabrics will inhibit emergence of herbaceous perennials and will inhibit rooting in of groundcovers. Certain weeds, such as yellow nutsedge, can penetrate through landscape fabrics. Biobarrier with slow release trifluralin provides greater weed control than do landscape fabrics that do not contain an herbicide.

Chemical Weed 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. 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 (diquat, glufosinate, paraquat, or glyphosate) or cultivation is usually necessary to give control of all species.

One application of a preemergent herbicide will not give adequate weed control for an entire year. Late fall or winter applications of isoxaben, simazine, dichlobenil, or pronamide will provide weed control well into the growing season. When control begins to decrease, the area can be cultivated or a postemergence herbicide could be applied and application of one of the other preemergent herbicides can be made.

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 increases chances of injury. Irrigate after a granular herbicide application to wash the granules off the leaf surfaces. Certain granular herbicides can cause spotting of foliage if granules are not washed off leaves.

Tables 4.6, 4.7, 4.8, and 4.9 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 or planted in containers which are maintained outdoors. Consult herbicide labels to determine which compounds can be used in propagation, be it seedbeds or vegetative propagation. See the section on weed control in the greenhouse for plants maintained indoors.

It is wise to keep a separate sprayer for herbicides since certain ones are difficult to clean from the spray tank.

Table 4.5 - Herbicides

Time of Application	Weed Problem	Chemical Rate/Acre	Remarks
Preplant soil fumigation	Most annual and perennial weeds	dazomet (Basamid 350 lb or 8.0 lb/1000 sq ft)	Incorporate after application. Irrigate or cover with plastic after application. Do not use below soil temperature of 43° F. Waiting period for transplants ranges from 10 to over 25 days.
Postplant but preemergence to weeds	Annual grasses and certain broad-leaf weeds	napropamide 4.0-6.0 lb (Devrinol 50DF 8.0-12.0 lb, Devrinol 2G 200.0-300.0 lb)	Use on container or field grown nursery stock. Apply to weed-free soil or include an appropriate postemergence herbicide. Safe on a wide variety of plant material. May be used on newly transplanted stock after soil has settled from first watering. Needs incorporation (mechanical or irrigation). For small areas, apply 2.9-4.4 oz Devrinol 50DF or 4.6-6.9 lb Devrinol 2G/1000 sq ft.
		oryzalin 2.0-4.0 lb (Surflan 4AS 2.0-4.0 qt, Oryzalin 4PRO 2.0-4.0 qt, Surflan WDG 2.4-4.7 lb)	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. For small areas, apply 1.5-2.9 fl oz Surflan 4AS or 0.9-1.7 oz Surflan WDG/1000 sq ft. For those desiring a granular formulation of Surflan, XL contains 1% oryzalin and 1% benefin (Balan). The list of registered species and weeds controlled is very similar to that of Surflan.
		prodiamine 0.65-1.5 lb (Barricade 65WG 1.0-2.3 lb, Barricade 4FL 21.0-48.0 oz)	Apply prior to weed germination. Do not apply more than 2.3 lb Barricade 65WG or 48 fl oz Barricade 4FL/year. For small areas apply 0.4-0.8 oz Barricade 65WG or 0.5-1.1 fl oz Barricade 4FL/1000 sq ft.
		pendimethalin 2.0-4.0 lb (Corral 2.7G 76.0-113.0 lb, Pendulum 2G 100.0-200.0 lb, Pendulum AquaCap 2.1-4.2 qt, Pendulum 3.3EC 2.4-4.8 qt)	Can be applied to container and field grown ornamentals. Do not apply to moist foliage. Will not control established weeds. For small areas apply 1.7-2.6 lbs Corral 2.7G, 2.3-4.6 lbs Pendulum 2G, or 1.6-3.2 fl oz Pendulum AquaCap, Pendulum 3.3EC 1.8-3.6 fl oz/1000 sq ft. DO NOT APPLY PENDULUM 3.3EC OVERTOP ACTIVELY GROWING NURSERY PLANTS.
		trifluralin 0.5-4.0 lb (Treflan 5G 10.0-80.0 lb Preen Garden Weed Preventer 270 lb)	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. For small areas, apply 0.3-1.8 lb Treflan 5G/1000 sq ft or 6.2 lb Preen Garden Weed Preventer.
		DCPA 10.5-12.0 lb (Dacthal W-75 14.0-16.0 lb/A)	Apply after transplanting or to established ornamentals. For small areas, apply 0.3 lb/1000 sq ft.
	Annual grasses and broadleaf weeds	flumioxazin 0.375 lb (BroadStar 150.0 lb/A)	Apply granules to dry foliage prior to weed germination and follow with irrigation. For use in woody ornamental production and in landscape maintenance. For small areas, apply 3.4 lb/1000 sq ft. DO NOT APPLY TO NEWLY PLANTED LINERS.

Table 4.5 - Herbicides (cont.)

Time of Application	Weed Problem	Chemical Rate/Acre	Remarks
Postplant but preemergence to weeds (cont.)	Annual grasses and broadleaf weeds (cont.)	flumioxazin 0.25-0.375 lb (SureGuard 8.0-12.0 oz/A)	Preemergence and early postemergence action. Apply as a directed spray to dormant nursery trees or to established woody landscape ornamentals prior to weed germination or to small emerged weed seedlings. Combine with a labeled postemergence herbicide for control of larger annual weeds or perennials. Can be applied ovetop dormant conifers. For small areas, apply 0.18-0.275 oz/1000 sq ft.
		indaziflam 0.029-0.058 lb (Specticle FLO 6-12 fl oz)	Use Marengo in nursery production and Specticle FLO in landscape beds. Apply to established trees and shrubs as a direct spray, ideally when the plants are dormant. Do not exceed 18.5 fl oz/acre/year. Long residual herbicide for preemergence control of many annual weeds. Include a postemergence herbicide for control of emerged weeds as indaziflam has limited postemergence activity. Do not apply to herbaceous ornamentals.
		Indaziflam 0.036-0.075 lb (Marengo 7.5-15.5 fl oz)	
		isoxaben 0.5-1.0 lb (Gallery 75DF 0.6-1.3 lb)	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. For small areas, apply 0.25-0.5 oz Gallery 75DF/1000 sq ft.
		isoxaben 0.5-1.0 lb + trifluralin 2.0-4.0 lb (Snapshot 2.5TG 100-200 lb)	A prepackaged mix of the active ingredients in Gallery and Treflan. For small areas apply 2.3- 4.6 lb Snapshot 2.5TG/1000 sq ft. Apply prior to weed germination.
		isoxaben 0.25-0.5 lb + trifluralin 2.0-4.0 lb + oxyfluorfen 0.25-0.5 lb (Showcase 100.0-200.0 lb)	Similar to Snapshot in activity. For small areas apply 2.3-4.6 lb Showcase/1000 sq ft. Apply prior to weed germination.
		oxadiazon 2.0-4.0 lb (Chipco Ronstar 2G 100.0-200.0 lb, Ronstar 50WP 4.0-8.0 lb)	Use on container or field grown nursery stock. The granular formulation is safe on a wide variety of plant material. Apply prior to weed germination. Disturbing soil after application may result in reduced weed control. Do not apply when foliage is wet. For continued weed control, an additional application to certain ornamentals can be made 60-120 days later. Toxic to fish. Do not contaminate water by washing equipment or disposal of waste. For small areas, apply 2.3-4.5 lb Ronstar 2G/1000 sq ft. Ronstar WP can cause foliar injury to certain species that are not injured by Ronstar G. Check WP label to determine which species can be treated.
		oxyfluorfen 1.0-2.0 lb - conifers (Goal 2XL 4.0-8.0 pt, GoalTender 2.0-4.0 pt)	Apply to seedbeds, containers, or transplants of many conifer species and to certain field-grown trees. Apply before bud-break or after new growth has hardened-off. Goal has preemergence and postemergence activity if applied to weeds less than 3-4 inches in height.
		oxyfluorfen 0.5-1.5 lb Shadetrees (Goal 2XL 2.0-6.0 pt, GoalTender 1.0-3.0 pt)	

Table 4.5 - Herbicides (cont.)

Time of Application	Weed Problem	Chemical Rate/Acre	Remarks
Postplant but preemergence to weeds (cont.)	Annual grasses and broadleaf weeds (cont.)	oxyfluorfen 2.0 lb + pendimethalin 1.0 lb (Ornamental Herbicide 2, 100.0 lb)	Apply to weed-free soil immediately after transplanting or to established ornamentals grown in containers or in the field. Do not apply to ornamentals when foliage is moist or foliar injury can result. Apply overhead irrigation to wash granules off leaf surfaces. For small areas, apply 2.3 lb OH2/1000 sq ft.
		oxyfluorfen 2.0 lb + oryzalin 1.0 lb (Rout Ornamental Herbicide 100 lb)	Apply to a weed-free soil surface when foliage is dry and plants are not making a flush of growth. Use on container and field grown stock. Apply overhead irrigation to wash granules off leaf surface. Do not apply to ornamentals when foliage is moist or foliar injury can result. For small areas, apply 2.3 lb Rout/1000 sq ft.
		simazine 1.0-3.0 lb (Princep Liquid 1.0-3.0 qt, or other labeled formulation)	Apply to weed-free soil in the fall or spring before new weed growth appears. Apply no more than once per year. Apply at least one year after transplanting. For small areas, apply 0.8-2.2 fl oz Princep Liquid/1000 sq ft.
	Annual and certain perennial weeds	dichlobenil 4.0-6.0 lb (Barrier, Casoron 100.0-150.0 lb)	Apply in the late fall, winter, or early spring. 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. For small areas, apply 2.3-3.4 lb Barrier or Casoron/1000 sq ft.
	Primarily annual grasses and yellow nutsedge	metolachlor 1.2-2.4 lb (Pennant Magnum 1.3-2.6 pt)	Apply to weed-free soil. Direct toward base of ornamentals established for at least 2 weeks. For additional broadleaf weed control, tank-mix with Princep where labeled. For small areas, apply 0.5-0.9 fl oz Pennant Magnum/1,000 sq ft.
	Annual grasses, yellow nutsedge, and certain annual broadleaf weeds	pendimethalin + dimethenamid 1.75-3.5 lb ai (FreeHand 1.75G 100-200lbs or 2.3 - 4.6 lbs/1000 sq ft)	Apply to established plantings prior to weed emergence. Delay application for 2-4 weeks after transplanting bare-root liners. Irrigate after transplanting to settle the soil prior to application.
		dimethenamid 0.98-1.5 lb (Tower 6EC 21.0-32.0 fl oz or 0.48-0.73 fl oz/1000 sq ft)	Apply to established plantings prior to weed emergence or include a postemergence herbicide to control emerged weeds. Apply as directed spray either prior to bud break or after new growth has hardened. Combine with a preemergence broadleaf herbicide for broader-spectrum control. Use a shielded spray if ornamentals have been in the ground less than one year.
	Annual weeds and certain perennial grasses	pronamide 1.0-2.0 lb (Kerb 50W 2.0-4.0 lb)	Fall application when temperatures are below 60° F. High rate has given quackgrass control as well as control of other cool season grasses. Do not use on fine-textured soils of high organic content. Kerb should not be applied to transplants less than 1 year old. For small areas, apply 0.7-1.4 oz Kerb 50W/1,000 sq ft. RESTRICTED USE.

Table 4.5 - Herbicides (cont.)

Time of Application	Weed Problem	Chemical Rate/Acre	Remarks
Postemergence to weeds	All weeds contact kill	diquat 0.5 lb (Reward 2.0 pt + nonionic surfactant)	Avoid contact with desired foliage. For spot treatment, mix 3/4 fl oz Reward plus a nonionic surfactant per gallon. Thorough coverage of weed foliage is needed for best results.
		paraquat 0.63-1.0 lb (Gramoxone Inteon 2.5-4.0 pt + nonionic surfactant 1.0-2.0 pt/100.0 gal)	Paraquat must be applied as a directed spray to immature and succulent weeds. Application to perennial weeds usually requires retreatment. Do not contact desirable foliage or green bark. Will not injure woody bark. May be combined with other herbicides such as simazine or oryzalin to give residual activity. For small area application, mix 2/3 oz of formulation plus 0.5 fl oz spreader sticker/gal water and lightly wet weed foliage. RESTRICTED USE.
		glufosinate 0.75-1.5 lb (Finale 3-6 qts)	Apply as a directed spray. Do not contact bark or foliage of desired plants. For spot application use 2.0-4.0 fl oz/gal on a spray to wet basis, prior to runoff. Ensure complete coverage of weed foliage.
	All weeds controlled	glyphosate 0.75-3.75 lb ae (Roundup Pro 1.0-5.0 qt, Roundup Pro Max 1.0-3.3 qt, Roundup Pro Dry 1.2-6.25 lb or Touchdown Pro 1.0-5.0 qt. For wiper application, use 1 part herbicide to 2 parts water; for cut stump treatments, use a 50% to 100% solution)	Apply as a directed spray in established plantings. Adjust rate of application to weed species according to label instructions. Do not contact bark or foliage of desired plants or serious systemic injury may occur. For small area application with a hand sprayer, use 2.0 fl oz/gal water and lightly wet the foliage. Also cleared for site preparation prior to planting nursery stock. Other glyphosate formulations are available. See label for application rates.
	Annual and perennial grasses including bermudagrass, quackgrass, and johnsongrass	clethodim 0.09-0.25 lb (Envoy Plus 9.0-32.0 fl oz + 0.25% nonionic surfactant)	Apply to actively growing grasses. For spot treatment use a 0.44-0.88 fl oz/gal solution plus 0.25% nonionic surfactant (0.33 fl oz/gal). A repeat application may be required for perennial grass control.
		fenoxaprop-ethyl 0.06-0.17 lb (Acclaim Extra 13.0-39.0 fl oz)	Primarily useful in landscape maintenance. Controls annual grasses and suppresses bermudagrass and johnsongrass. Apply when grasses are small and actively growing. Do not apply under drought stress. For spot treatment, mix 0.3-0.46 fl oz Acclaim Extra/gal.
Postemergence to selected weeds	Annual and perennial grasses including bermudagrass, quackgrass, and johnsongrass	fluazifop-P-butyl 0.25-0.375 lb (Ornamec 64.0-96.0 fl oz, Fusilade II 16.0-24.0 fl oz, or other labeled formulation + 0.5 pt nonionic surfactant/25.0 gal)	May be applied overtop to ornamentals and as a directed spray to others. Treat bermudagrass when runners are 4-8" long, quackgrass when 6-10" tall and johnsongrass when 8-10" tall. Treat annual grasses prior to tillering. Apply only to actively growing grasses not under moisture stress. For spot treatment, use 2.5 fl oz Ornamec or 0.75 fl oz Fusilade II plus 0.5 fl oz nonionic surfactant/gal and lightly wet grass.

Table 4.5 - Herbicides (cont.)

Time of Application	Weed Problem	Chemical Rate/Acre	Remarks
Postemergence to selected weeds (cont.)	Annual and perennial grasses including bermudagrass, quackgrass, and johnsongrass	sethoxydim 0.28-0.46 lb (Segment 36.0-60.0 fl oz)	Apply overtop of ornamentals to actively growing grasses. Use lower rate on annual grasses less than 6 inches tall and higher rate on grasses up to 12 inches in height. Treat perennial grasses with higher rate as follows: bermudagrass, 6 inch runners; johnsongrass, 15-20 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. For spot treatment, use or 2.0-3.0 fl oz Segment/gal.
	Yellow nutsedge and certain broadleaf weeds	bentazon 0.75-1.0 (Basagran T/O 1.5-2.0 pt + 1 qt crop oil concentrate)	Apply as a directed spray to small, actively growing weeds. A second application 7-10 days later may be needed for acceptable yellow nutsedge control. Minimize contact with foliage of desired trees and shrubs. For small areas, mix 3/4 to 1 1/2 fluid ounces Basagran T/O plus 3/4 fl oz crop oil concentrate/gal.
	Yellow and purple nutsedge	halosulfuron 0.0321-0.062 lb (SedgeHammer 0.66-1.33 oz plus 0.25-0.5% nonionic surfactant)	Apply as a directed spray around woody ornamentals that have been established at least 3 months after transplanting in landscapes. Do not contact leaves of desired woody plants. Do not apply to herbaceous perennials or bedding plants. For small areas, mix 0.9 g SedgeHammer plus 2 tsp (0.33 fl oz) nonionic surfactant/gal and wet entire foliage of sedges.
	Certain broadleaf weeds	clopyralid 0.09-0.5 lb (Lontrel 0.25-1.33 pt)	Provides postemergence control of primarily legume and composite weeds such as clover, vetch, thistles, ragweed, and horseweed. Do not apply to container-grown ornamentals. Avoid drift to sensitive ornamentals such as daisy, redbud, locust, or linden. Apply as a directed spray.
	Poison ivy	glyphosate (Roundup Pro 2.67 fl oz/gal, Roundup Pro Max 2.0 fl oz/gal or other labeled formulation)	Apply as a foliar spray when poison ivy is actively growing. Do not allow herbicide to contact leaves or green bark of desired plants. Use shielded sprays or other techniques. For wiper applications, use a 33% to 70% solution. For cut stump treatments, apply a 50% to 100% solution immediately after cutting stems.
	Phragmites (common reed)	glyphosate (various)	Apply to foliage during active growth. Repeat applications will be needed for control. Use a formulation registered for aquatic sites if treating near water, such as AquaMaster or Glyphomate 41.

Table 4.6 - Guide for Herbicide Selection - Annual and Perennial Flowers, Vines, and Groundcovers¹

	Acclaim	Barricade	Dacthal	Devrinol	Envoy	FreeHand	Gallery	Ornamec	Pendulum G	Pennant	Segment	Ronstar G	Snapshot	Surflan	Treflan
Annual And Perennial Flowers															
Alyssum	-	-	F	-	C,F	-	-	-	C,F	F	C,F	-	-	-	F
Aster	-	C,F	F	C	-	-	-	-	C,F	F	-	-	C,F	-	F
Begonia	F	-	-	-	-	-	-	-	C,F	-	C,F	-	-	-	-
Chrysanthemum	F	-	F	C	C,F	-	-	-	C,F	F	C,F	-	C,F	F	F
Coleus	F	-	F	-	C,F	-	-	-	-	-	C,F	-	-	-	-
Daffodil	-	C,F	-	C	-	C,F	-	-	C,F	F	-	-	-	F	F
Dahlia	-	-	F	C	C,F	-	-	-	C,F	-	-	-	-	-	F
Daylily	F	C,F	-	-	C,F	C,F	C,F	C,F	C,F	F	F	-	C,F	-	-
Delphinium	-	-	F	-	-	-	-	-	-	F	-	-	-	-	-
Ferns	-	-	-	-	-	-	-	-	C,F	-	-	-	-	-	-
Forget-me-not	F	-	F	-	-	-	-	-	-	-	-	-	-	-	F
Four-o'clock	-	-	F	-	-	-	-	-	-	-	-	-	-	-	F
Geranium	F	-	F	C	C,F	-	-	-	C,F	F	C,F	-	-	F	-
Gladiolus	-	F	F	C	-	C,F	-	-	C,F	F	C,F	-	-	F	F
Hosta	F	C,F	-	C	C,F	C,F	C,F	C,F	C,F	C,F	C,F	-	C,F	-	-
Impatiens	-	-	-	-	-	-	-	-	C,F	-	C,F	-	-	F	F
Iris	F	C,F	F	-	C,F	C,F	-	-	C,F	F	C,F	-	C,F	F	F
Lily	-	C,F	F	-	-	-	-	-	C,F	F	-	-	-	-	-
Marigold	-	-	-	-	C,F	C,F	-	C,F	C,F	F	C,F	-	-	F	F
Nasturtium	-	-	F	-	-	-	-	-	-	-	-	-	-	-	F
Pansy	-	-	-	-	-	-	-	-	C,F	-	C,F	-	-	F	-
Peony	F	-	F	-	-	-	-	-	C,F	-	-	-	-	-	-
Periwinkle	F	-	-	-	-	C,F	-	-	C,F	-	C,F	-	-	-	-
Petunia	F	-	F	C	C,F	C,F	-	-	C,F	F	C,F	-	-	-	F
Phlox	F	-	-	-	C,F	C,F	-	-	C,F	F	-	-	-	-	F
Salvia	-	-	-	-	C,F	C,F	-	-	C,F	-	C,F	-	-	-	F
Shasta daisy	F	-	-	C	-	C,F	-	C,F	C,F	-	C,F	-	-	-	F
Snapdragon	F	-	-	-	C,F	-	-	-	C,F	F	C,F	-	-	-	F
Sunflower	-	-	F	-	-	C,F	-	-	C,F	-	-	-	-	-	F
Sweetpea	-	-	F	-	-	-	-	-	-	-	-	-	-	-	F
Sweet William	F	-	-	-	-	-	-	C,F	C,F	F	C,F	-	-	-	F
Tulip	-	C,F	-	-	-	-	-	-	C,F	F	-	-	-	F	F
Zinnia	F	-	F	C	C,F	C,F	-	C,F	C,F	F	C,F	-	-	F	F

¹This table should be used only as a guide. A 'C' indicates the herbicide is registered for use on that species when container-grown. 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 4.6 - Guide for Herbicide Selection - Annual and Perennial Flowers, Vines, and Groundcovers¹

	Acclaim	Barricade	Dacthal	Devrinol	Envoy	FreeHand	Gallery	Ornamec	Pendulum G	Pennant	Segment	Ronstar G	Snapshot	Surflan	Treflan
Vines And Groundcovers															
Ajuga	F	-	-	F	C,F	-	-	-	C,F	C,F	-	F	-	-	-
Bamboo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clematis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
English ivy	F	C,F	-	F	C,F	-	C,F	C,F	C,F	C,F	C,F	F	C,F	F	F
Euonymus	-	C,F	F	-	-	-	-	C,F	C,F	C,F	-	F	C,F	C,F	-
Honeysuckle	-	C,F	F	-	C,F	-	-	-	-	F	-	F	F	-	-
Jasmine	-	C,F	-	-	C,F	-	-	-	C,F	-	-	-	-	-	-
Liriope	F	C,F	-	F	C,F	-	C,F	C,F	C,F	C,F	C,F	-	C,F	C,F	F
Vines And Groundcovers (cont.)															
Pachysandra	-	-	F	F	C,F	-	C,F	C,F	C,F	C,F	C,F	F	C,F	-	F
Pampasgrass	-	C,F	-	-	-	-	C,F	-	C,F	F	-	-	C,F	-	-
Santolina	-	C,F	-	-	-	-	-	-	-	-	-	-	-	-	-
Sedum	-	C,F	-	F	C,F	C,F	-	-	C,F	F	-	F	C,F	-	F
Vinca (Periwinkle)	F	C,F	-	F	C,F	-	-	C,F	C,F	F	C,F	F	F	F	F
Yucca	-	C,F	-	-	-	-	-	C,F	C,F	C,F	-	-	-	C,F	-

¹This table should be used only as a guide. A 'C' indicates the herbicide is registered for use on that species when container-grown. 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 4.7 - Guide for Herbicide Selection - Narrowleaf and Broadleaf Evergreens

Tolerant Species	Acclaim	Barricade	BroadStar	Casoron	Dacthal	Devrinol	Envoy	Pennant	Ornamec	Gallery	Goal	Kerb	Lontrel	Specticle
Narrowleaf Evergreens														
Arborvitae	-	C,F	C,F	F	F	C	C,F	C,F	C,F	C,F	C,F	F	F	F
Cedar (<i>Cedrus</i>)	-	-	C,F	-	-	C,F	C,F	-	-	F	-	F	-	-
Chamaecyparis	-	F	C,F	-	-	-	-	-	-	C,F	-	-	-	-
Cryptomeria	-	-	-	-	-	-	-	-	-	C,F	-	-	-	-
Fir	-	F	C,F	-	F	C,F	C,F	F	C,F	C,F	C,F	F	F	-
Hemlock	-	C,F	C,F	-	-	F	C,F	F	C,F	-	C,F	F	-	-
Juniper	F	C,F	C,F	F	F	C,F	C,F	C,F	C,F	C,F	C,F	F	F	F
Leyland cypress	-	-	-	-	-	C,F	-	-	C,F	-	-	-	-	-
Pine	F	C,F	C,F	F	F	C,F	C,F	C,F	C,F	F	C,F	F	F	-
Spruce	-	F	C,F	-	F	F	C,F	F	C,F	C,F	C,F	F	F	-
Yew	F	C,F	C,F	F	F	F	C,F	C,F	C,F	C,F	C,F	F	F	-

¹This table should be used only as a guide. A 'C' indicates the herbicide is registered for use on that species when container-grown. 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 4.7 - Guide for Herbicide Selection - Narrowleaf and Broadleaf Evergreens (cont.)

Tolerant Species	Acclaim	Barricade	BroadStar	Casoron	Dacthal	Devrinol	Envoy	Pennant	Ornamec	Gallery	Goal	Kerb	Lontrel	Specticle
Broadleaf Evergreens														
Aucuba	-	C,F	-	-	-	F	C,F	C,F	C,F	-	-	-	-	-
Azalea	F	C,F	C,F	F	F	C,F	C,F	C,F	C,F	F	-	F	F	F
Barberry	F	C,F	C,F	F	F	-	C,F	F	C,F	C,F	-	F	-	-
Bayberry	-	-	C,F	-	-	-	C,F	F	-	-	-	-	-	-
Boxwood	F	C,F	C,F	F	F	C,F	C,F	C,F	C,F	F	-	F	F	F
Camellia	-	-	C,F	F	-	C,F	C,F	F	C,F	-	-	-	-	F
Euonymus	F	C,F	C,F	F	F	C,F	-	F	C,F	-	-	F	-	-
Holly	F	C,F	C,F	-	F	C,F	C,F	C,F	C,F	C,F	-	F	-	F
Leucothoe	-	-	-	F	-	C,F	-	C,F	-	-	-	-	-	-
Magnolia (Southern)	F	F	C,F	F	F	-	-	F	C,F	-	-	F	-	-
Mahonia	-	-	C,F	-	-	-	-	-	C,F	-	-	-	-	-
Mountain laurel	-	-	-	-	F	-	-	C,F	-	C,F	-	F	-	-
Osmanthus	-	C,F	-	F	-	F	-	F	-	-	-	-	-	-
Pittosporum	-	C,F	C,F	F	F	C,F	C,F	C,F	-	C,F	-	-	-	-
Pyracantha	F	C,F	C,F	F	-	C,F	C,F	F	C,F	C,F	-	F	-	-
Rhododendron	F	C,F	C,F	F	F	C,F	C,F	C,F	C,F	-	-	F	F	-
	OH 2	Segment	Pendulum G	Princep	Ronstar G	Rout	Showcase	Snapshot	SureGuard	Surflan	Treflan	Tower	FreeHand	
Narrowleaf Evergreens														
Arborvitae	-	C,F	C,F	F	-	C,F	-	-	C,F	F	F	F	C,F	
Cedar (<i>Cedrus</i>)	-	-	-	-	C,F	-	-	-	-	-	-	-	-	
Cryptomeria	-	-	C,F	-	-	-	-	-	-	C,F	-	-	-	
Chamaecyparis	C,F	-	C,F	-	C,F	C,F	F	F	-	-	-	-	-	
Fir	-	C,F	C,F	-	-	-	-	F	C,F	F	F	F	C,F	
Hemlock	-	C,F	C,F	F	F	-	-	-	C,F	-	F	F	C,F	
Juniper	C,F	C,F	C,F	F	C,F	C,F	C,F	C,F	C,F	C,F	F	F	C,F	
Leyland cypress	-	C,F	C,F	-	-	-	-	-	-	-	-	-	C,F	
Pine	C,F	C,F	C,F	F	C,F	C,F	C,F	F	C,F	F	F	-	-	
Spruce	C,F	C,F	C,F	F	F	C,F	C,F	F	C,F	F	F	F	C,F	
Yew	C,F	C,F	C,F	F	F	-	F	F	C,F	F	F	F	C,F	-

¹This table should be used only as a guide. A 'C' indicates the herbicide is registered for use on that species when container-grown. 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 4.7 - Guide for Herbicide Selection - Narrowleaf and Broadleaf Evergreens (cont.)

Tolerant Species	OH 2	Segment	Pendulum G	Princep	Ronstar G	Rout	Showcase	Snapshot	SureGuard	Surflan	Treflan	Tower	FreeHand
Broadleaf Evergreens													
Aucuba	-	-	C,F	-	-	-	-	-	-	-	-	-	-
Azalea	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	F	F	F	C,F
Barberry	C,F	C,F	C,F	F	C,F	C,F	C,F	C,F	-	C,F	F	F	C,F
Bayberry	-	-	-	-	-	-	-	-	-	-	-	-	-
Boxwood	C,F	C,F	C,F	-	C	C,F	C,F	C,F	-	C,F	F	F	C,F
Camellia	C,F	C,F	C,F	-	C,F	-	C,F	C,F	-	-	F	-	C,F
Euonymus	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	C,F	F	-	-
Holly	C,F	C,F	C,F	F	C,F	C,F	C,F	C,F	-	C,F	F	F	C,F
Leucothoe	-	-	C,F	F	C	-	-	-	-	F	-	-	-
Magnolia (Southern)	-	C,F	C,F	-	C	-	C,F	C,F	-	F	-	F	-
Mahonia	C,F	-	-	F	C,F	C,F	C,F	C,F	-	F	-	-	C,F
Mountain laurel	-	-	C,F	-	-	-	-	-	-	F	F	-	-
Osmanthus	-	C,F	C,F	F	C	C,F	-	-	-	F	-	-	-
Pittosporum	C,F	C,F	-	-	C,F	C,F	C,F	C,F	-	-	F	-	-
Pyracantha	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	C,F	F	-	-
Rhododendron	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	C,F	F	-	-

¹This table should be used only as a guide. A 'C' indicates the herbicide is registered for use on that species when container-grown. 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 4.8 - Guide for Herbicide Selection - Deciduous Trees and Shrubs¹

Tolerant Species	Acclaim	Barricade	BroadStar	Casoron	Dacthal	Devrinol	Envoy	Pennant	Ornamec	Gallery	Goal	Kerb	Lontrel	Specticle
Deciduous Trees														
Amelanchier	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ash	-	-	C,F	F	F	F	C,F	F	C,F	F	F	F	-	F
Beech	-	-	-	-	-	-	-	F	-	-	-	F	-	-
Birch	-	-	C,F	F	F	F	C,F	C,F	C,F	F	F	F	-	-
Cherry	-	-	-	-	-	F	-	F	-	F	F	F	-	-
Deciduous Trees (cont.)														
Crabapple	-	C,F	C,F	F	F	F	C,F	F	-	F	F	F	-	-
Dawn redwood	-	-	-	-	-	-	-	-	-	-	-	-	-	-

¹This table should be used only as a guide. A 'C' indicates the herbicide is registered for use on that species when container-grown. 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 4.8 - Guide for Herbicide Selection - Deciduous Trees and Shrubs¹ (cont.)

Tolerant Species	Acclaim	Barricade	BroadStar	Casoron	Dacthal	Devrinol	Envoy	Pennant	Ornamec	Gallery	Goal	Kerb	Lontrel	Specticle
Dogwood	-	C,F	C,F	F	F	C,F	C,F	C,F	C,F	-	F	F	F	-
Elm	-	-	C,F	F	F	-	-	-	-	F	-	F	-	F
Ginkgo	-	-	C,F	-	-	-	-	F	-	-	-	F	-	-
Goldenchain tree	-	-	-	F	-	F	C,F	-	-	-	-	-	-	-
Goldenrain tree	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hawthorn	F	C,F	-	F	F	F	-	-	-	-	-	F	-	-
Honeylocust	-	-	-	F	-	F	-	F	C,F	-	-	F	-	-
Linden	-	-	-	F	-	-	-	-	-	F	-	F	-	-
Magnolia	F	F	C,F	F	F	-	-	F	C,F	-	-	F	-	-
Maple	F	C,F	C,F	F	F	F	C,F	C,F	C,F	F	F	F	F	F
Oak	-	C,F	C,F	F	F	F	C,F	C,F	C,F	F	F	F	F	-
Pear	-	C,F	-	F	-	F	-	F	-	F	F	-	-	-
Poplar	-	-	C,F	F	F	-	-	F	-	-	F	F	-	-
Redbud	-	-	C,F	-	F	-	C,F	-	C,F	-	F	-	-	-
Russian Olive	-	-	-	F	-	-	C,F	F	C,F	-	F	-	-	-
Sourgum (<i>Nyssa</i>)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sourwood (<i>Oxydendron</i>)	-	C,F	-	-	-	-	-	-	-	-	-	-	-	-
Sweetgum	-	-	C,F	-	-	-	C,F	F	C,F	F	F	F	-	-
Sycamore	-	-	C,F	-	F	-	-	-	-	F	F	F	F	-
Tulip tree	-	-	-	-	F	-	-	F	-	-	F	-	-	-
Walnut	F	-	C,F	-	F	F	-	-	-	-	F	F	-	-
Willow	F	-	-	F	F	-	-	F	C,F	F	-	F	-	-
Zelkova	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deciduous Shrubs														
Abelia	-	C,F	C,F	-	F	C,F	C,F	C,F	-	-	-	-	-	F
Cotoneaster	-	C,F	C,F	F	F	C,F	-	C,F	C,F	C,F	-	F	-	F
Crape myrtle	-	C,F	C,F	-	-	C,F	-	F	C,F	-	F	-	-	-
Deutzia	-	-	-	F	-	-	-	-	-	-	-	-	-	-
Euonymus	-	C,F	C,F	F	F	C,F	-	C,F	-	-	-	F	-	-
Flowering quince	-	-	-	F	-	-	-	-	C,F	-	-	F	-	-
Forsythia	-	C,F	C,F	F	F	C,F	-	C,F	-	-	-	F	-	F
Hibiscus	-	C,F	-	-	-	C,F	-	F	-	C,F	-	-	-	F
Deciduous Shrubs (cont.)														
Honeysuckle	-	C,F	C,F	F	F	F	C,F	F	-	-	-	-	-	-
Hydrangea	F	C,F	-	-	F	-	-	F	-	-	-	-	-	-

¹This table should be used only as a guide. A 'C' indicates the herbicide is registered for use on that species when container-grown. 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 4.8 - Guide for Herbicide Selection - Deciduous Trees and Shrubs¹ (cont.)

Tolerant Species	Acclaim	Barricade	BroadStar	Casoron	Dacthal	Devrinol	Envoy	Pennant	Ornamec	Gallery	Goal	Kerb	Lontrel	Specticle
Hypericum	-	-	-	-	-	F	-	F	-	-	-	-	-	-
Lilac	-	-	C,F	F	-	-	-	F	C,F	F	F	F	-	F
Nandina	F	C,F	-	F	-	C,F	C,F	F	-	C,F	-	-	-	-
Photinia	F	C,F	C,F	F	-	C,F	C,F	F	C,F	C,F	-	-	-	-
Privet	F	C,F	-	F	F	C,F	C,F	C,F	C,F	-	-	F	-	-
Rose	F	C,F	C,F	F	F	C,F	C,F	F	C,F	F	-	F	-	-
Spirea	-	C,F	-	F	F	-	C,F	F	C,F	-	-	-	F	-
Viburnum	F	C,F	C,F	-	F	F	C,F	C,F	F	-	-	-	-	-
Vitex	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weigela	F	C,F	C,F	F	F	-	-	F	C,F	-	-	-	-	-
Witchhazel (<i>Hamamelis</i>)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Tolerant Species	OH 2	Segment	Pendulum G	Princep	Ronstar G	Rout	Showcase	Snapshot	SureGuard	Surflan	Treflan	Tower	FreeHand
Deciduous Trees													
Amelanchier (serviceberry)	-	-	-	-	-	-	-	-	-	-	-	-	-
Ash	-	C,F	C,F	-	F	-	-	-	F	-	F	F	-
Beech	-	-	-	-	-	-	-	-	-	-	-	-	-
Birch	C,F	C,F	C,F	-	F	-	C,F	C,F	F	-	F	-	-
Cherry	-	C,F	C,F	-	-	-	F	F	F	F	F	-	-
Crabapple	-	C,F	C,F	F	F	-	-	-	F	-	F	-	-
Dawn redwood	-	C,F	-	-	-	-	-	-	-	-	-	-	-
Dogwood	C,F	C,F	C,F	F	C,F	C,F	C,F	C,F	F	-	F	F	C,F
Elm	-	C,F	C,F	F	-	-	-	F	-	-	-	F	-
Ginkgo	-	C,F	C,F	-	C	-	-	F	F	C,F	-	-	-
Goldenchain tree	-	-	-	-	-	-	-	-	-	-	-	-	-
Goldenrain tree	-	-	-	-	-	-	-	-	-	F	-	-	-
Hawthorn	C,F	C,F	C,F	-	-	-	-	-	-	-	-	F	-
Honeylocust	-	C,F	C,F	F	-	-	-	F	-	-	F	-	C,F
Linden	-	C,F	C,F	-	-	-	-	-	-	-	-	-	-
Magnolia	C,F	C,F	C,F	-	C,F	C,F	-	-	-	F	-	F	C,F
Maple	C,F	C,F	C,F	-	F	C,F	C,F	F	F	F	F	F	C,F
Oak	C,F	C,F	C,F	F	C,F	C,F	C,F	F	F	C,F	F	-	C,F
Pear	-	C,F	C,F	-	-	-	-	F	F	F	-	F	-

¹This table should be used only as a guide. A 'C' indicates the herbicide is registered for use on that species when container-grown. 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 4.8 - Guide for Herbicide Selection - Deciduous Trees and Shrubs¹ (cont.)

Tolerant Species	OH 2	Segment	Pendulum G	Princep	Ronstar G	Rout	Showcase	Snapshot	SureGuard	Surflan	Treflan	Tower	FreeHand
Deciduous Trees (cont.)													
Poplar	-	C,F	C,F	-	-	-	-	-	F	-	-	-	-
Redbud	C,F	-	-	-	-	-	-	C,F	F	-	F	-	C,F
Russian olive	-	-	C,F	F	F	C,F	-	F	-	-	-	-	-
Sourgum (<i>Nyssa</i>)	-	-	C,F	-	-	-	-	-	-	-	-	-	-
Sourwood (<i>Oxydendron</i>)	-	C,F	-	-	-	-	-	C,F	-	-	-	-	C,F
Sweetgum	-	C,F	C,F	-	-	-	-	F	F	C,F	F	-	-
Sycamore	-	C,F	C,F	-	-	-	-	F	F	-	F	-	-
Tulip tree	-	C,F	C,F	-	-	-	-	-	-	-	F	-	-
Walnut	-	C,F	C,F	-	-	-	-	F	F	-	F	F	-
Willow	-	C,F	C,F	-	-	-	-	F	-	-	F	-	-
Zelkova	-	-	-	-	-	-	-	-	-	-	-	-	-
Deciduous Shrubs													
Abelia	C,F	C,F	C,F	-	-	C,F	C,F	C,F	-	F	-	-	C,F
Cotoneaster	C,F	C,F	C,F	F	C,F	C,F	C,F	C,F	-	C,F	F	-	-
Crape myrtle	-	C,F	C,F	-	-	-	-	F	-	C,F	-	F	C,F
Deutzia	-	C,F	C,F	-	-	-	-	F	-	-	F	-	-
Euonymus	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	C,F	F	-	C,F
Flowering quince	-	C,F	-	-	-	-	-	-	-	-	-	-	-
Forsythia	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	F	F	-	C,F
Hibiscus	-	C,F	C,F	-	-	C,F	C,F	C,F	-	F	-	-	-
Honeysuckle	C,F	-	C,F	-	C,F	C,F	C,F	C,F	-	-	F	-	-
Hydrangea	C,F	C,F	C,F	-	-	-	-	-	-	-	-	F	C,F
Hypericum	C,F	-	-	-	-	C,F	-	-	-	-	-	-	-
Lilac	-	C,F	C,F	-	F	-	-	-	F	C,F	F	-	-
Nandina	-	C,F	C,F	-	-	C,F	-	C,F	-	C,F	-	F	C,F
Photinia	C,F	C,F	C,F	-	C	C,F	C,F	C,F	-	C,F	-	-	C,F
Privet	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	C,F	F	-	C,F
Rose	-	C,F	-	-	C,F	-	-	F	-	F	F	F	C,F
Spirea	C,F	C,F	C,F	-	-	C,F	C,F	C,F	-	-	F	F	C,F
Viburnum	-	C,F	C,F	-	C	C,F	C,F	C,F	-	C,F	F	C,F	C,F
Vitex	-	C,F	C,F	-	-	-	-	-	-	-	-	-	-
Weigela	-	C,F	C,F	F	-	C,F	-	F	-	F	F	-	-
Witchhazel (<i>Hamamelis</i>)	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 4.9 - Guide to Weeds Which May Be Controlled by Preemergence Herbicides Approved for Use in Ornamentals

Weed	Barricade	BroadStar, SureGuard	Casoron	Dacthal	Devrinol	FreeHand	Pendulum	Pennant	Gallery	Goal	Kerb	Specticle
Grasses And Sedges												
Annual bluegrass	G	P-F	G	F	G	G	G	F	P	F	G	E
Barnyardgrass	G	-	G	G	G	-	G	G	-	F	F	-
Bermudagrass	N	N	P	N	N	N	N	N	N	N	N	N
Cheat	-	-	-	-	-	-	-	-	-	-	-	-
Crabgrass	G	F-G	G	G	G	G	G	G	P	F	F	E
Doveweed	P	G	-	-	-	G	P	G	N	-	-	-
Fall panicum	-	-	G	G	G	G	G	G	-	-	F	-
Foxtails	G	F-G	G	G	G	G	G	G	-	F	F	-
Goosegrass	G	-	G	G	G	G	G	G	-	F	-	-
Johnsongrass (seedling)	-	F	G	-	G	-	G	G	-	-	F	-
Microstegium	G	-	-	-	-	-	G	-	-	-	-	-
Orchardgrass, fescue	N	N	G	N	N	N	N	N	N	N	G	-
Quackgrass	-	-	G	N	N	N	-	N	-	-	G	-
Small grains (volunteer)	-	-	-	-	G	-	-	-	-	-	G	-
Stinkgrass	-	-	-	-	-	-	-	-	-	-	-	N
Yellow Nutsedge	N	N	G	N	P	F-G	N	F-G	N	-	N	-
Broadleaf Weeds												
Artemisia (wild chrysanthemum)	-	-	G	N	N	-	-	-	-	-	-	E
Bittercress	P-F	G	-	P	F	F-G	P-F	P	G	G	-	-
Canada thistle	-	-	-	N	N	-	-	-	-	-	-	-
Carpetweed	G	-	G	G	G	G	G	F	-	-	-	E
Chamberbitter	P	G	-	-	-	F	F	P	P-F	-	-	G
Chickweed	G	F-G	G	G	G	G	G	F	G	F	G	G
Cutleaf evening primrose	P	-	G	-	G	-	P	P	F	F	-	-
Dandelion	-	-	G	N	-	-	-	-	-	-	-	-
Dock	-	-	G	N	-	-	-	-	-	-	-	-
Dodder	-	-	G	F	-	-	-	-	-	-	-	-
Dogfennel	-	-	G	N	-	G	-	-	G	-	-	-
Eclipta	P	G	-	-	P	F-G	P	P	G	F	-	-
Filaree	-	-	-	-	F	-	-	-	-	-	-	-
Galinsoga (quickweed)	-	-	-	P	F	F	N	G	G	G	P	-

G = good control, F = fair, P = poor, N = no control, and - = no information.

Table 4.9 - Guide to Weeds Which May Be Controlled by Preemergence Herbicides Approved for Use in Ornamentals (cont.)

Weed	Barricade	BroadStar, SureGuard	Casoron	Dacthal	Devrinol	FreeHand	Pendulum	Pennant	Gallery	Goal	Kerb	Specitcic
Broadleaf Weeds (cont.)												
Groundsel, common	-	G	G	-	F	F	P	P	F	G	-	-
Henbit (deadnettle)	-	-	G	-	G	-	-	G	G	G	-	G
Horseweed (marestail)	-	-	G	-	N	-	-	P	F	G	-	G
Knotweed	-	-	-	F	G	-	-	-	-	G	-	P
Lambsquarters	-	E	G	G	F	-	F	P	G	G	F	-
Long-Stalk Phyllanthus	F	G	-	-	-	F	F	P	P-F	-	-	-
Morningglory	-	G	G	P	N	-	P	N	P	G	-	-
Mulberry weed	F-G	G	-	-	-	G	F-G	F-G	G	-	-	-
Mustard	-	-	-	P	N	-	-	-	-	G	-	-
Nightshade	-	-	-	P	N	-	P	G	-	G	-	-
Pigweed	-	G	G	F	F	G	F	G	G	G	F	-
Poison Ivy	N	-	-	N	N	-	N	N	N	N	-	-
Prickly lettuce	-	-	-	-	G	-	-	-	-	G	-	-
Prickly sida	-	E	G	-	P	-	-	P	-	-	-	-
Purslane	-	-	G	G	G	-	F	F	G	G	G	-
Pusley, Florida	-	-	-	-	-	-	-	-	-	-	-	-
Ragweed	P	E	G	N	P	-	N	N	G	F	P	-
Red sorrel	-	-	G	N	-	-	-	-	-	-	-	-
Shepherds' purse	-	-	-	P	P	-	N	-	G	G	-	-
Smartweed	-	-	G	N	P	-	-	P	G	G	F	-
Sowthistle	-	G	-	-	G	F	F	-	-	G	-	G
Spurge, prostrate (spotted)	G	G	-	F	P	G	G	P	F	F	-	-
Tassel flower	N	G	-	-	-	F-G	N	N	F	-	-	-
Velvetleaf	-	G	-	N	N	-	G	P	F	G	P	-
Veronica (speedwell)	-	-	-	G	-	-	-	-	-	G	-	-
Virginia copperleaf	-	P-F	-	-	-	-	-	-	-	-	-	-
Wild aster	-	-	-	N	-	-	-	-	-	-	-	-
Wild carrot	-	-	G	-	-	-	-	-	-	-	-	-
Yellow woodsorrel (<i>Oxalis</i>) from seed	G	G	G	G	N	G	G	P	F	G	-	G

G = good control, F = fair, P = poor, N = no control, and - = no information.

Table 4.9 - Guide to Weeds Which May Be Controlled by Preemergence Herbicides Approved for Use in Ornamentals (cont.)

	OH2	Princep	Ronstar	Rout	Showcase	Snapshot	Surflan	Tower	Treflan
Monocots									
Annual bluegrass	G	G	F	G	G	G	G	-	-
Barnyardgrass	G	G	G	G	-	G	G	G	G
Bermudagrass	N	P	N	N	N	N	N	N	N
Cheat	-	-	-	-	-	-	-	-	-
Crabgrass	G	F	G	G	G	G	G	G	G
Doveweed	P-F	-	P-F	P-F	N	N	N	G	N
Fall panicum	G	F	-	G	-	G	G	G	G
Foxtails	G	F	G	G	-	G	G	G	G
Goosegrass	G	G	G	G	G	G	G	G	G
Johnsongrass (seedling)	G	P	-	G	-	G	G	P	G
Microstegium	-	-	G	-	-	-	G	-	-
Orchardgrass, fescue	N	F	N	N	N	N	N	N	N
Quackgrass	N	F	-	N	N	N	N	N	N
Small grains (volunteer)	G	-	-	G	-	-	-	-	-
Stinkgrass	-	-	-	-	-	-	-	-	-
Yellow Nutsedge	N	N	N	N	N	N	N	F-G	N
Broadleaf Weeds									
Artemisia (wild chrysanthemum)	-	-	-	-	-	-	-	-	-
Bittercress	G	-	G	G	G	G	G	-	F
Canada thistle	N	N	N	N	-	-	N	-	N
Carpetweed	-	-	-	-	-	-	-	-	-
Chamberbitter	G	-	G	G	F	F	G	-	N
Chickweed	F	G	N	F	G	G	F	-	G
Cutleaf evening primrose	G	F	G	G	-	G	F	-	-
Dandelion	G	-	-	G	-	-	-	-	-
Dock	-	-	-	-	-	-	-	-	-
Dodder	-	-	-	-	-	-	-	-	-
Dogfennel	-	F	P	G	-	G	G	-	-
Eclipta	F	-	P	G	P	F-G	F-G	-	-
Filaree	-	-	-	-	-	-	-	-	-
Galinsoga (quickweed)	G	G	G	G	G	G	N	-	N
Groundsel, common	G	G	F	G	F	F-G	P	-	-
Henbit (deadnettle)	G	G	G	G	-	G	G	-	-
Horseweed (marestail)	G	-	G	G	-	G	-	-	-
Knotweed	G	-	-	G	-	-	-	-	-
Lambsquarters	G	G	G	G	-	G	G	P	F
Long-Stalk Phyllanthus	G	-	G	G	F	F	F	-	P

G = good control, F = fair, P = poor, N = no control, and - = no information.

Table 4.9 - Guide to Weeds Which May Be Controlled by Preemergence Herbicides Approved for Use in Ornamentals (cont.)

	OH2	Princep	Ronstar	Rout	Showcase	Snapshot	Surflan	Tower	Treflan
Broadleaf Weeds (cont.)									
Morningglory	G	F	P	G	-	-	N	N	N
Mulberry weed	G	-	F-G	G	G	F-G	G	-	P
Mustard	G	G	-	G	-	-	-	-	-
Nightshade	G	G	-	G	-	G	P	-	P
Pigweed	G	G	G	G	-	-	F	-	F
Poison Ivy	N	N	N	N	N	N	N	N	N
Prickly lettuce	G	G	-	G	G	-	-	-	-
Prickly sida	-	G	-	-	-	-	P	P	P
Purslane	G	G	G	G	-	G	F	-	F
Pusley, Florida	-	-	-	-	-	-	-	-	-
Ragweed	-	G	P	G	-	G	N	P	N
Red sorrel	-	-	-	-	-	-	-	-	-
Shepherds'purse	G	G	G	G	-	-	N	-	N
Smartweed	G	G	-	G	-	-	P	P	P
Sowthistle	G	F	-	G	G	-	-	-	-
Spurge, prostrate (spotted)	G	G	F	G	G	G	G	-	-
Tassel flower	G	-	N	G	P-F	P-F	P-F	-	N
Velvetleaf	-	P	F	G	-	G	P	N	P
Veronica (speedwell)	G	-	-	G	-	-	-	-	-
Virginia copperleaf	P	-	-	P	P-F	F	-	-	-
Wild aster	-	-	-	-	-	-	-	-	-
Wild carrot	-	-	-	-	-	-	-	-	-
Yellow woodsorrel (<i>Oxalis</i>) from seed	G	-	G	G	G	G	F	-	-
Wild aster	N	-	N	-	-	N	-	G	N
Wild carrot	N	-	N	-	-	N	-	G	N
Yellow woodsorrel (<i>Oxalis</i>) from seed	N	N	N	G	N	N	-	G	N

G = good control, F = fair, P = poor, N = no control, and - = no information.

Table 4.10 - Guide to Weeds Which May Be Controlled by Postemergence Herbicides Approved by Use in Ornamentals

Weed	Acclaim	Basagran	Envoy	Finale	Lontrel	Ornamec	Reward	Roundup	Segment
Monocots									
Annual bluegrass	N	N	G	G	N	P	G	G	N
Bamboo	-	-	-	P	N	-	-	F	-
Barnyardgrass	-	N	G	G	N	G	G	G	G
Bermudagrass	F	N	G	F	N	G	P	G	G
Cheat	-	N	-	-	N	-	-	G	-
Crabgrass	G	N	G	G	N	G	G	G	G
Doveweed	N	-	N	-	N	N	-	-	N
Fall panicum	-	N	G	G	N	G	G	G	G
Foxtails	G	N	G	G	N	G	G	G	G
Goosegrass	G	N	G	G	N	G	G	G	G
Johnsongrass (seedling)	-	N	G	-	N	G	-	G	G
Microstegium	G	-	G	G	N	G	-	G	G
Orchardgrass, fescue	N	N	F	P	N	F	F	G	F
Quackgrass	P	N	G	P	N	G	-	G	G
Small grains (volunteer)	-	N	-	-	N	G	-	G	G
Stinkgrass	-	N	-	-	N	-	-	G	-
Yellow Nutsedge	N	F	N	F	N	N	F	G	N
Broadleaf Weeds									
Artemisia (wild chrysanthemum)	N	-	N	-	F	N	-	F	N
Bittercress	N	G	N	-	N	N	G	G	N
Canada thistle	N	-	N	-	G	N	F	G	
Carpetweed	N	-	N	-	-	N	G	G	N
Chickweed	N	-	N	G	-	N	G	G	N
Cutleaf evening primrose	N	N	N	G	-	N	-	F	N
Dandelion	N	-	N	G	F	N	-	G	N
Dock	N	-	N	-	-	N	-	G	N
Dodder	N	-	N	-	-	N	-	G	N
Dogfennel	N	N	N	-	-	N	F	G	N
Eclipta	N	G	N	G	E	N	-	G	N
Filaree	N	-	N	-	-	N	-	G	N
Galinsoga (quickweed)	N	-	N	-	-	N	G	G	N
Groundsel, common	N	F	N	G	G	N	G	G	N
Henbit (deadnettle)	N	-	N	G	-	N	G	G	N
Horseweed (marestail)	N	-	N	G	F	N	F	G	N
Knotweed	N	-	N	-	-	N	-	G	N
Lambsquarters	N	P	N	G	P	N	F	G	N
Morningglory	N	P	N	-	N	N	G	F	N

G = good control, F = fair, P = poor, N = no control, and - = no information.

Table 4.10 - Guide to Weeds Which May Be Controlled by Postemergence Herbicides Approved by Use in Ornamentals (cont.)

Weed	Acclaim	Basagran	Envoy	Finale	Lontrel	Ornamec	Reward	Roundup	Segment
Broadleaf Weeds (cont.)									
Mustard	N	-	N	G	-	N	G	G	N
Nightshade	N	-	N	-	F	N	G	G	N
Pigweed	N	P	N	G	P	N	G	G	N
Poison Ivy	N	-	N	-	-	N	P	G	N
Prickly lettuce	N	-	N	G	-	N	G	G	N
Prickly sida	N	G	N	-	-	N	F	G	N
Purslane	N	-	N	G	-	N	G	G	N
Pusley, Florida	N	-	N	-	-	N	-	G	N
Ragweed	N	G	N	G	E	N	G	G	N
Red sorrel	N	-	N	G	-	N	F	G	N
Shepherds' purse	N	-	N	G	-	N	G	G	N
Smartweed	N	G	N	G	F	N	F	G	N
Sowthistle	N	-	N	-	F	N	-	G	N
Spurge, prostrate (spotted)	N	N	N	G	-	N	G	G	N
Velvetleaf	N	G	N	G	-	N	-	G	N
Veronica (speedwell)	N	-	N	-	-	N	-	G	N

G = good control, F = fair, P = poor, N = no control, and - = no information.

Diseases

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The conditions under which many floral and foliage crops are produced, i.e., high humidity, low light intensity, and frequent watering, are favorable for the development of fungal and bacterial diseases. If insects are uncontrolled in the greenhouse, viruses can become a major problem. Nematodes may be introduced on infected plant material or unsterilized soil.

There are three principles in the management of floral crop health. The first principle is to prevent pathogens from entering production systems. Applications of this principle include use of disease-free propagating materials, noncontaminated or decontaminated containers, soil-less media and irrigation water, etc. The second principle is to create environments that are working against pathogens. Some common practices of this principle are to (i) use of disease-resistant or tolerant plant species and varieties, (ii) remove diseased plants and planting materials from production beds once they are noticed, to reduce disease potential and dissemination risk, (iii) irrigate crops in early morning instead of evening to shorten the wet period on foliage that is essential for many pathogen germination, infection, and growth, and (iv) use of biopesticides such as Actino-Iron. The third principle is to control the disease when it does arise. The keys to successfully implementing this principle include early detection of a disease, correct diagnosis of its cause and selection of the right chemicals. Fungicides should be only used for fungal diseases, so should bactericides for bacterial diseases, oomyceticides for downy mildew, Phytophthora and Pythium diseases. The rest of this section provides general recommendations for control of major floral crop diseases. It is important that growers carefully consult and strictly follow the label when applying a fungicide, bactericide, oomyceticide or nematicide for disease control.

Table 5.1 - Common Diseases and Chemical Control Options

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
African Violet Botrytis blight (Gray mold)	Decree 0.7-1.5 lb fenhexamid	Spray 7- to 14-day intervals.
Phytophthora root rot	Alude 1.0-2.0 qt	Apply every 7 days.
	Vital 2.0-4.0 pt phosphite	
	Subdue Maxx 0.5-1.0 fl oz mefenoxam	Apply in 100 gal of water over 400-800 sq ft (1.0 pt/sq ft). For soil depth greater than 4 inches apply 1.5-2.0 pts solution/sq ft. Repeat at 1- to 2-month intervals. Irrigate to thoroughly wet soil after application. For Subdue 5G do not apply rate of 9 oz more often than once every 6 weeks.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoastrobilin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyra- clostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.	
Powdery mildew	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Apply at 7- to 14-day intervals.
	Sythane (40% WSP) 4 oz myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal neem oil	Apply every 14 days.

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Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Ageratum Botrytis blight (Gray mold)	Decree 0.70-1.5 lb fenhexamid	Spray 7- to 14-day intervals.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply at 7- to 14-day intervals.
	Exotherm (Termil) 3.5 oz/1000 sq ft chlorothalonil	Fumigate every 7 to 14 days.
Powdery mildew	Systhane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
Ageratum Powdery mildew (cont.)	Strike (25% WDG) 2.0-4.0 oz triadimefon	Apply at 7- to 14-day intervals.
	Triact 70 0.5-1.0 gal neem oil	Apply every 14 days.
Root Rot (<i>Pythium</i>)	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Apply every 7 days.
	Subdue Maxx 0.5-1.0 fl oz mefenoxam	Drench at seeding (soil 2-3 inches deep). Mix Subdue with 100 gal of water and apply 1 pt of solution/sq ft. Transplanting mix 0.5-2.0 fl oz with 100 gal of water and apply 1 pt solution/sq ft or 1.5-2.0 pt for soil depth greater than 4 inches. Do not apply rates of 1.5-2.0 fl oz more often than once every six weeks.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Terrazole (35% WP) 3.0-10.0 oz etridiazole	Apply on 400 sq ft or saturate the soil medium, such as 1/2 pt/6-inch container.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	Root rot (<i>Rhizoctonia</i>)	Medallion (50% WP) 1 packet fludioxonil
Chipco 26019 (50% WP) 0.4 lb Sextant (23.3%) 1.0-2.5 lb iprodione		Apply 1.0- to 2.0 pt/sq ft every 14 days.
Annual Vinca (Madagascar periwinkle) Phytophthora blight	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Apply every 7 days.
	Subdue Maxx 0.5-1.0 fl oz mefenoxam	Drench at seeding (soil 2 to 3 inches deep). Mix Subdue with 100 gal of water and apply 1 pt of solution/sq ft. Transplanting mix 0.5-2.0 fl oz with 100 gal of water and apply 1 pt solution/sq ft or 1.5-2.0 pt for soil depth greater than 4 inches. Do not apply rates of 1.5-2.0 fl oz more often than once every six weeks.
	FenStop 7.0-14.0 fl oz fenamidone	Spray plants at a 28-day interval.

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
Annual Vinca Phytophthora blight (cont.)	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Azalea (Rhododendron) Botrytis blight (Gray mold)	Chipco 26019 (50% WP) 1.0-2.0 lb iprodione	Spray every 10 to 14 days.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.3 pt chlorothalonil	Spray every 7 to 10 days during wet weather. Apply at early bloom.
	Exotherm (Termil) 3.5 oz/1000 sq ft chlorothalonil	Fumigate every 7 to 14 days.
Cylindrocladium root rot	Cleary 3336-WP 0.8 lb thiophanate methyl	Drench Cleary 3336 on the surface of growing medium to prevent disease development. Repeat at 2- to 4-week intervals during disease pressure.
	Fore Rainshield NT Fore WSP Rainshield Dithane T/O Rainshield NT Dithane WF Junction (15% DF) 1.5 lb mancozeb	Apply in a full coverage spray every 7 to 10 days while flowers are opening spray ground under bushes and into open flowers.
	Terragard, 50 W triflumizole	Soil drench 6.0-8.0 oz or 1-1 1/3 tps/gal on propagation beds. On established plants apply a drench at 6.0-12.0 oz or 1.0-2.0 tsp/gal.
Ovulinia flower blight	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.1 pt chlorothalonil	Spray every 7 to 10 days. Apply at new leaf emergence.
	Strike (25% WDG) 8.0-16.0 oz triadimefon	Begin applications at the expanded bud stage.
	Cleary 3336-WP 0.5 lb thiophanate methyl	Apply as flowers open. Repeat every 4 to 6 days as needed during disease periods.
	Fore Rainshield NT Fore WSP Rainshield Dithane T/O Rainshield NT Dithane WF Junction (15% DF) 1.5 lb mancozeb	Apply in a full coverage spray every 7 to 10 days while flowers are opening also spray ground under bushes.
Powdery mildew	Banner Maxx 2.0-4.0 fl oz propiconazole	Apply at 2- to 3-week intervals.
	Cygnus (50%) 1.6-3.2 oz Kresoxim-methyl	Apply every 10 to 14 days.

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Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Apply to run-off when mildew first appears.
	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal neem oil	Apply every 14 days.
Phytophthora shoot blight	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Apply every 7 days.
	FenStop 7.0-14.0 fl oz fenamidone	Spray plants at a 28-day interval.
Azalea Phytophthora shoot blight (cont.)	Aliette (80% WDG) 2.5-5.0 lbs fosetyl-AI	Apply as a spray to wet, repeat at monthly intervals.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Phytophthora root and crown rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Apply every 7 days.
	Terrazole (35% WP) 8.0 oz etridiazole	Container & Bed grown Plants: Mix 8 oz with 100 gal of water/400 sq ft or apply in sufficient amount to saturate the soil mixture such as 0.5 pt/6-inch pot. Irrigate immediately with additional water equal to at least half the volume of the fungicidal drench for improved soil penetration of the fungicide. Repeat at 4-week intervals if necessary.
	Subdue Maxx 0.6-1.3 fl oz mefenoxam	Apply 1.0 pt solution/sq ft. For soil depth greater than 4 inches apply 1.5-2.0 pts solution/sq ft.
	Aliette (80% WDG) 0.4-0.8 lb fosetyl-AI	Apply as a drench with 100 gal of water/400 sq ft (2 pt solutions/sq ft) or 0.5-0.8 lb (8.0-12.8 oz)/cubic yard of potting soil at transplanting.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	See African Violet.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Septoria leaf spot	Cleary 3336-F 12.0-16.0 fl oz or 1 tsp/gal thiophanate methyl	Repeat at a 10- to 14-day interval throughout the growing season.
Bedding various flowering plants	Soil Gard (12% G) 1.0-1.5 lb/cubic yd microbial / (biocontrol)	Mix with soilless media before seeding/plants.
Damping-off, <i>Rhizoctonia</i> , <i>Pythium</i>	Captan (50% WP) 2.0-4.0 lb captan	Apply at 7- to 10-day intervals.
	Terrazole (35% WP) 3.5-10.0 oz etridiazole	Apply at 4- to 12-week intervals.
Begonia Botrytis flower spot (Gray mold)	Fore Rainshield NT Fore WSP Rainshield Dithane T/O Rainshield NT Dithane WF Junction (15% DF) 1.5 lb mancozeb	Apply in a full coverage spray every 7 to 10 days while flowers are opening spray ground under bushes and into open flowers.
	Exotherm (Termil) 3.5 oz/1000 cu ft chlorothalonil	Fumigate every 7 to 14 days.
	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Spray every 10 to 14 days.
Powdery mildew	Rubigan 3.0-5.0 fl oz fenarimol	Apply at 10- to 14-day intervals.
	Systhane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Strike (25% WDG) 2.0-4.0 oz	Spray every 7 to 14 days. Follow label instructions. Spray triadimefon to run-off when mildew first appears.
	Triact 70 0.5-1.0 gal neem oil	Apply every 14 days.
Pythium root rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Apply every 7 days.
	Terrazole (35% WP) 3.0-10.0 oz etridiazole	Apply on 400 sq ft or saturate the soil medium, such as 0.5 pt/6-inch container.
	Subdue Maxx 0.6-1.3 fl oz mefenoxam	See African Violet.
	Aliette (80% WDG) 1.25-4.0 lb fosetyl-AI	Apply as a foliar spray. Do not exceed one application every 30 days.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	See African Violet.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.

5-6 Floral Crops: Diseases

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Black-eyed Susan (rudbeckia) Septuria leaf spot	Daconil WeatherStik 2.0 pt Concord (54% SST) 2.0 pt chlorothalonil	Apply at 7- to 10-day intervals.
Downy mildew	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Apply every 7 to 10 days.
Black-eyed Susan Downy mildew (cont.)	FenStop 7.0-14.0 fl oz fenamidone	Spray plants at a 28-day interval if necessary.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Cactus Root rot (<i>Rhizoctonia</i>)	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Apply as drench (1.0-2.0 pt/sq ft).
	Chipco 26019 (50% WP) 0.4 lb iprodione	Apply 1.0-2.0 pt/sq ft every 14 days.
Caladium Various tuber rots	Cleary 3336-F 12.0-16.0 fl oz 2.0 tsp/gal Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Dip tubers in solution prior to planting.
	Chipco 26019 (50% WP) 0.4 lb Sextant (23.3%) 1.0 lb iprodione	Dip tubers in solution prior to planting.
Pythium root rot	Subdue Maxx 0.5-1.0 fl oz; mefenoxam	See African Violet.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil every 3 weeks to 3 months.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Calendula powdery mildew rust	Rubigan 3.0-5.0 fl oz; fenarimol	Apply at 10- to 14-day intervals.
	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Apply as a spray at 14- to 21-day intervals.
	Banner Maxx 2.0-4.0 fl oz propiconazole	Apply every 14 to 21 days.
	Triact 70 0.5-1.0 gal neem oil	Apply every 14 days.
Calibrachoa Phytophthora crown rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Apply every 7 days.
	Subdue Maxx 0.5-1.0 fl oz mefenoxam	Apply in 100 gal of water over 400-800 sq ft (1.0 pt/sq ft). For soil depth greater than 4 inches apply 1.5-2.0 pts solution/sq ft. Repeat at 1- to 2-month intervals. Irrigate to thoroughly wet soil after application. For Subdue 5G do not apply rate of 9 oz more often than once every 6 weeks.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoastrobilin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Black root rot (thielaviopsis)	Cleary 3336 12.0-16.0 fl oz thiophanate methyl	Drench at 1.0-2.0 pts/sq ft.
Carnation (<i>Dianthus</i>) Alternaria blight	Daconil Weather Stik 1.4 pt Concorde (54% SST) 1.4 pt chlorothalonil	Apply every 7 to 14 days.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply as a spray every 10 to 14 days.
	Maneb 80 (80% WP) or Maneb Plus Zinc F4 Fungicide (37% F) 1.0-1.5 lb maneb	Begin when new growth starts. Repeat weekly.
Botrytis flower spot (Gray mold)	Chipco 26019 (50% WP) Sextant (23.3%) 1.0-2.5 lb iprodione	Spray every 10 to 14 days.
	Exotherm (Termil) 3.5 oz/1000 cu ft chlorothalonil	Fumigate every 7 to 14 days.

5-8 Floral Crops: Diseases

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Botrytis flower spot (Gray mold) (cont.)	Cleary 3336-WP 0.8 lb thiophanate methyl	Spray every 7 to 14 days.
Fusarium stem rot	Cleary 3336-WP 0.8 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Heavy spray or drench during cool, moist conditions.
Rhizoctonia stem rot	Chipco 26019 0.4 lb iprodione	Apply 1.0-2.0 pt/sq ft every 14 days.
	Terraclor (75% WP) 0.5 lb quintozone	Apply 1.0 pt of solution/sq ft or 100 gal to 800 to 1000 sq ft.
Chrysanthemum Botrytis blight (Gray mold)	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply every 10 to 14 days.
	Cleary 3336-WP 0.8 lb thiophanate methyl	Spray every 10 to 14 days under normal weather.
	Cleary 3336-F (4.5 F) 10.0 fl oz or 0.75 tsp/gal thiophanate methyl	Apply as foliar spray every 7 to 14 days.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 2.0 pt chlorothalonil	
	Cygnus (50%) 1.6-3.2 oz Kresoxim-methyl	Apply every 10 to 14 days.
Bacterial blight	Camelot 3.0 pt copper salts	Apply every 7 days.
Powdery mildew	Rubigan 3.0-5.0 fl oz fenarimol	Apply at 10- to 14-day intervals.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray to run-off when mildew first appears.
	Triact 70 0.5-1.0 gal neem oil	Apply every 14 days.
Puccinia horiana white rust	Strike (25% WDG) 2.0-4.0 oz triadimefon	Control of this rust consists of avoiding wetting of the foliage when watering and spraying with Bayleton when disease is first observed. If not controlled, cut back plants to the ground, gather all plant material and debris and incinerate. Spray Bayleton to run-off when rust first appears.
	Sythane (40%WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
Mycosphaerella ray blight	Banner Maxx 2.0-4.0 fl oz propiconazole	Apply at 14-day intervals.
	Daconil Weather Stik 1.4 pt Concorde (54% SST) 1.4 pt chlorothalonil	Apply at transplant of cuttings.
	Chipco 26019 (50% WP) 1.0-2.0 lb or 1.0-2.0 tbsp/gal Sextant (23.3%) 1.0-2.5 lb iprodione	Apply as a spray every 10 to 14 days.
Pythium root rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Apply at 7-day intervals.
	Subdue Maxx 0.5-1.0 fl oz; mefenoxam	See African Violet.
	Terrazole (35% WP) 4.0 oz etridiazole	Retreat bedding plants with etridiazole at 4- to 8-week intervals. Retreat container plants at 4- to 12-week intervals.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil every 3 weeks to 3 months.

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Chrysanthemum Pythium root rot (cont.)	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Rhizoctonia root rot	Soil Gard (12% G) 1.0-1.5 lb/cubic yd microbial / (biocontrol)	Mix with soilless media before seeding/plants.
	Captan (50% WP) 2.0-4.0 lb captan	Apply at 7- to 10-day intervals.
	Terrazole (35% WP) 3.5-10.0 oz etradiazole	Apply at 4- to 12-week intervals.
Rhizoctonia	Medallion (50% WP) 1 packet fludioxonil	Drench at 3- to 4-week intervals.
	Chipco 26019 (50% WP) 0.4 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply 1.0-2.0 pt/sq ft every 14 days.
	Cleary 3336-WP 0.8 lb thiophanate methyl	Apply 1.0-2.0 pt/sq ft every 14 days.
Septoria leaf spot	Cleary 3336-WP 0.8 lb thiophanate methyl	Apply at weekly intervals when a new shoot growth begins. Cover lower leaf surfaces completely. Apply thiophanate methyl at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt chlorothalonil	Spray chlorothalonil every 7 to 14 days. Apply at transplanting of cuttings.
Cineraria Powdery mildew (<i>Erysiphe cichoracearum</i>)	Strike (25% WDG) 2.0-4.0 oz or 0.5-1.0 tsp/gal; triadimefon	Spray to run-off when mildew first appears.
	Triact 70 0.5-1.0 gal neem oil	Spray every 14 days.
Cyclamen Botrytis leaf blight (Gray mold)	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb	Spray every 10 to 14 days.
	Cleary 3336-WP 0.8 lb thiophanate methyl	Apply every 10 to 14 days and reduce humidity.
Daylily Leaf streak	Cleary 3336 WP 1.5 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Repeat at 7- to 14-day intervals.
	Systhane (40% WSP) 4.0 oz myclobutanil	
Rust	Synthane (40% WSP) 4.0 oz myclobutanil	Repeat every 7 to 14 days.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.4 pt chlorothalonil	
	Banner Maxx 2.0-4.0 fl oz propiconazole	Apply at 2- to 3-week intervals.
	Heritage 1.0-4.0 oz azoxystrobin	Apply every 1 to 4 weeks.

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Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Foliage Plants Pythium root rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Spray every 7 days.
	Terrazole (35% WP) 12.0 oz etridiazole	Use well-drained growing medium, sanitation, above ground benches. Avoid overhead watering. Drench at 4-week intervals.
	Subdue Maxx 0.5-1.0 fl oz mefenoxam	
	Aliette (80% WDG) 0.4-0.8 lb fosetyl-AI	Apply as a drench with 100 gal of water/400 sq ft (2.0 pt solutions/sq ft) or 0.5-0.8 lb (8.0-12.8 oz)/cu yd of potting soil at transplanting.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil every 3 weeks to 3 months.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Geranium Botrytis leaf blight (Gray mold)	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Spray every 10 to 14 days.
	Decree 0.7-1.5 lb fenhexamid	Spray at 7- to 14-day intervals.
Bacterial blight	Compass 2.0-4.0 oz	Spray every 7- to 14 days.
	Camelot 3.0 pt copper salts	Purchase clean stock plants. Practice good sanitation procedures. Apply every 7 days.
Pythium blackleg or black rot	Terrazole (35% WP) 3.0-10.0 oz etridiazole	Apply 0.5 pt/6-inch container. Sterilize rooting media, pots, and benches with steam-flow sanitation program.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Geranium (cont.) Rhizoctonia root and stem rot	Chipco 26019 (50% WP) 0.4 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply 1.0-2.0 pt/sq ft every 14 days.
	Cleary 3336-WP 0.8 lb thiophanate methyl	Apply as a drench or heavy spray (1.0-2.0 pt/sq ft) after transplanting into containers or propagation beds.
Rust	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt Concorde (54% SST) 1.4 pt chlorothalonil	Apply during cool, moist conditions.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray at first sign of disease.
	Triact 70 0.5-1.0 gal neem oil	Apply every 14 days.
Powdery mildew	Triact 70 0.5-1.0 gal neem oil	Apply every 14 days.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray to run-off when mildew first appears.
	Sythane (40% WP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Cygnus (50%) 1.6-3.2 oz Kresoxim-methyl	
Gerbera Botrytis blight (Gray mold)	Decree 0.7-1.5 lb fenhexamid	Apply at 7- to 14-day intervals.
	Cleary 3336-WP (50% WP) 0.8 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Spray every 10 to 14 days to run-off.
Powdery mildew (<i>Erysiphe cichoracearum</i>)	Strike (25% WDG) 2.0-4.0 oz or 0.5-1.0 tsp/gal; triadimefon	Spray to run-off when mildew first appears.
	Triact 70 0.5-1.0 gal neem oil	Apply every 14 days.
Root/stem rot (non-water molds)	Medallion (50% WP) 1 packet fludioxonil	Drench at 3- to 4-week intervals.
Root/stem rot (<i>Pythium</i> and <i>Phytophthora</i>)	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Apply every 7 days.
	Terrazole (35% WP) 3.0-10.0 oz etridiazole	Apply as a drench at 0.5 pt/6-inch pot at 4- to 12-week intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoastrobilin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.

5-12 Floral Crops: Diseases

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Gerbera Root/stem rot (<i>Pythium</i> and <i>Phytophthora</i>) (cont.)	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Gladiolus Botrytis blight	Fore Rainshield NT Fore WSP Rainshield Dithane T/O Rainshield Dithane WF Junction (15% DF) 1.5 lb mancozeb	Apply at a 7- to 14-day interval.
	Cleary 3336-WP 0.8 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply as a spray plus sticker-spreader just as first flowers show color. Repeat at 10- to 14-day intervals.
	Daconil Weather Stick 2.0 pts Concorde (54% SST) 1.4 pt chlorothalonil	Apply as a spray with a sticker-spreader on a 10-day interval.
Fusarium basal rot (<i>Fusarium oxysporium</i> <i>F. gladioli</i>)	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Soak cleaned corms for 15 to 30 minutes in a warm dip (80° to 85°F.) within 48 hours of digging. Dry corms after treatment.
Leaf and flower spot (<i>Curvularia lunata</i>)	Cleary 3336-WP 0.8 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply as a spray with a sticker-spreader on a 10-day interval.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Spray every 10 to 14 days.
	Maneb 80 (80% WP) 1.5 lb maneb	Begin when flower spikes develop. Repeat 2 to 3 times at weekly intervals.
Impatiens Rhizoctonia stem rot	Chipco 26019 (50% WP) 1.0-2.0 lb iprodione	Do not use iprodione as a drench treatment on Impatiens. Apply as a foliar spray on a 7- to 14-day interval.
	Cleary 3336-F 12.0-16.0 fl oz or 1.0 tsp/2 gal water Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply as a drench or heavy spray at the rate of 1.0-2.0 pts/sq ft.
Impatiens necrotic spot virus	Transmitted by thrips feeding	See insect control section on thrips control.
Downy mildew	Subdue Maxx 1.0 fl oz	Spray or drench with control up to 3 months.
	Fenstop 7.0-14.0 fl oz fenamidone Segway (34.5%SC) 3.5 fl oz cyazoflamid	Spray with protection of plants up to 4 weeks.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt Phosphite Pagent (38.0%WDG) 4.0-18.0 oz Pyraclostrobin + boscalid Stature (43.5% SC) 6.0--13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals
Soft rot		Disinfect tools when cutting rhizomes. Avoid overwatering. Rotate with resistant plants if damage is severe.
Kalanchoe Botrytis blight	Decree 0.7-1.5 lb fenhexamid	Spray at 7- to 14-day intervals.

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Powdery mildew		See African violet.
Leucanthemum Phytophthora root rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Apply every 7 days.
	Subdue Maxx 0.5-1.0 fl oz mefenoxam	Apply in 100 gal of water over 400-800 sq ft (1.0 pt/sq ft). For soil depth greater than 4 inches apply 1.5-2.0 pts solution/sq ft. Repeat at 1- to 2-month intervals. Irrigate to thoroughly wet soil after application. For Subdue 5G do not apply rate of 9 oz more often than once every 6 weeks.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoastrobilin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Rhizoctonia root rot	Medallion (50% WP) 1 packet fludioxonil	Drench at 3- to 4-week intervals.
	Chipco 26019 (50% WP) 0.4 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply 1.0-2.0 pt/sq ft every 14 days.
Lily Botrytis blight	Fore Rainshield NT Fore WSP Rainshield Dithane T/O Rainshield Dithane WF Junction (15% DF) 1.5 lb mancozeb	Spray at a 7- to 14-day interval.
	Chipco 26019 (50% WP) 1.0-2.0 lb iprodione	Spray every 10 to 14 days.
	Decree 0.7-1.5 lb; fenhexamid	Apply at 7- to 14-day intervals.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) chlorothalonil	Spray every 7 to 14 days. Apply at prebloom.
	Exotherm (Termil) 3.5 oz/1000 cu ft chlorothalonil	Fumigate every 7 to 14 days.
	Cleary 3336-WP 0.8 lb thiophanate methyl	Spray every 10 to 14 days.
Penicillium and Fusarium bulb rot	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Soak cleaned bulbs for 15 to 30 minutes in warm dip (80° to 85°F), preferably within 48 hours after digging.
Root rot complex (<i>Pythium</i> spp. and <i>Rhizoctonia solani</i>)	See Chrysanthemum.	

5-14 Floral Crops: Diseases

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Narcissus Bulb rot	See Gladiolus <i>Fusarium</i> basal rot.	
Pansy Botrytis blight	Decree 0.7-1.5 lb fenhexamid	Spray at 7- to 14-day intervals.
	Fore Rainshield NT Fore WSP Rainshield Dithane T/O Rainshield NT Dithane WF Junction (15% DF) 1.5 lb mancozeb	
	Daconil Weather Stik 2.0 pt chlorothalonil	Spray every 7 to 10 days.
	Cleary 3336-F (4.5 F) 10.0 fl oz Cleary 3336-WP (50% WP) 0.8 lb thiophanate methyl	Apply every 10 to 14 days.
Root rot (<i>Rhizoctonia</i>)	Medallion (50% WP) 1 packet fludioxonil	Drench at 3- to 4-week intervals.
<i>Sclerotinia</i> , <i>Fusarium</i> , and <i>Thielaviopsis</i>	Systhane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
<i>Sclerotinia</i> , <i>Fusarium</i> , and <i>Thielaviopsis</i>	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply as a drench at 1.0-2.0 pts/sq ft.
	Hurricane, 1 packet/gallon water fludioxonil and mefenoxam	Drench this solution into one cubic yard of potting mix before seeding or transplanting.
Phytophthora root/crown rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Apply every 7 days.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Subdue Maxx 0.5-1.0 fl oz mefenoxam	Apply in 100 gal of water over 400 to 800 sq ft (1.0 pt/sq ft). For soil depth greater than 4 inches apply 1.5-2.0 pts solution/sq ft. Repeat at 1- to 2-month intervals. Irrigate to thoroughly wet soil after application. For Subdue 5G do not apply rate of 9 oz more often than once every 6 weeks.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Petunia Phytophthora root/crown rot (cont.)	Alude 1.0-2.0 qt	Apply every 7 days.
	Vital 2.0-4.0 pt; phosphite	
	Subdue Maxx 0.5-1.0 fl oz mefenoxam	Apply in 100 gal of water over 400-800 sq ft (1.0 pt/sq ft). For soil depth greater than 4 inches apply 1.5-2.0 pts solution/sq ft. Repeat at 1- to 2-month intervals. Irrigate to thoroughly wet soil after application. For Subdue 5G do not apply rate of 9 oz more often than once every 6 weeks.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	Adorn (39.5%) 1.0-4.0 fl oz fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Fungus root rot (<i>Rhizoctonia</i> and <i>Fusarium</i>)	Terrazole (35% WP) 3.5-10.0 oz etridiazole	Apply every 4 to 12 weeks.
Botrytis blight	Decree 0.7-1.5 lb fenhexamid	Spray at 7- to 14-day intervals.
	Fore Rainshield NT Fore WSP Rainshield Dithane T/O Rainshield NT Dithane WF Junction (15% DF) 1.5 lb mancozeb	
	Daconil Weather Stik 2.0 pt chlorothalonil	Spray every 7 to 10 days.
	Cleary 3336-F (4.5 F) 10.0 fl oz Cleary 3336-WP (50% WP) 0.8 lb thiophanate methyl	Apply every 10 to 14 days.
Poinsettia Botrytis blight	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.4 pt chlorothalonil	
	Chipco 26019 (50% WP) 1.0-2.0 lb iprodione	Spray every 10 to 14 days.
	Cleary 3336-WP 0.8 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Spray every 10 to 14 days.
	Exotherm (Termil) 3.5 oz/1000 cu ft chlorothalonil	Fumigate every 7 to 14 days. Do not apply when foliage is wet or when temperature is above 75°F.
Root rot complex (<i>Rhizoctonia solani</i> , <i>Pythium</i> spp., and <i>Thielaviopsis basicola</i>)	Cleary 3336-WP (50% WP) 1.0 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl + Terrazole (35% WP) 3.0-10.0 oz or 0.5 pt/6-inch pot etridiazole	Cleary 3336 will not control <i>Pythium</i> . However, a mixture of Cleary 3336 and Terrazole applied every 4 weeks will prevent root rot caused by most soil-borne fungi.

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Poinsettia Rhizoctonia leaf blight	Medallion (50% WP) 1-2 packet fludioxonil	Spray only before bract formation and at 7- to 10-day intervals in greenhouses and closed structures.
	Terraguard 50W 4.0-8.0 oz triflumizole	Controls Rhizoctonia as a drench at 3- to 4-week intervals.
	Fungo 50 AGC 12.0-16.0 oz Cleary 3336-WP 0.8 lb thiophanate methyl	Spray every 10 to 14 days.
Rose Botrytis blight, black spot	Decree 0.7-1.5 lb fenhexamid	Apply every 7 to 14 days.
	Cleary 3336-WP (50% WP) 0.8 lb Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply as a spray at 10- to 14-day intervals.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply as a spray at 10- to 14-day intervals.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.3 pt chlorothalonil	Repeat at 7- to 14-day intervals.
	Cygnus (50%) 1.6-3.2 oz Kresoxim-methyl	
Powdery mildew	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray to run-off when mildew first appear.
	Terraguard 50W 4.0-16.0 oz triflumizole	Apply at 7- to 14-day intervals as needed. Use higher rate on existing initial infection.
	Cygnus (50%) 1.6-3.2 oz Kresoxim-methyl	
Snapdragon Botrytis blight	Decree 0.7-1.5 lb; fenhexamid	Apply every 7 to 14 days.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.4 pt chlorothalonil	Repeat on a 7- to 14-day interval.
	Fungo 50 AGC 12.0-16.0 oz Cleary 3336-WP 0.8 lb thiophanate methyl	Spray every 10 to 14 days.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	
	Exotherm (Termil) 3.5 oz/1000 cu ft chlorothalonil	Fumigate every 7 to 14 days.
Downy mildew	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Apply every 7 days.
Rust	Banner Maxx, 2-4 fl oz propiconazole	Apply every 14 to 21 days.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray to run-off when rust first appears.
	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal neem oil	Apply every 14 days.
	Cygnus (50%) 3.2-6.4 oz Kresoxim-methyl	

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Snapdragon Powdery mildew	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal neem oil	Apply every 14 days.
	Cygnus (50%) 1.6-3.2 oz Kresoxim-methyl	
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray to run-off when mildew first appears.
Rhizoctonia root rot	Medallion (50% WP) 1 packet fludioxonil	Drench at 3- to 4-week intervals.
	Chipco 26019 (50% WP) 0.4 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply 1.0-2.0 pt/sq ft every 14 days.
	Cleary 3336-F (4.5 F) 20.0 fl oz thiophanate methyl	
Tulip Botrytis blight (Gray mold)	Fore Rainshield NT Fore WSP Rainshield Dithane T/O Rainshield NT Dithane WF Junction (15% DF) 1.5 lb mancozeb	Spray at a 7- to 14-day interval.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Spray every 10 to 14 days.
Fusarium and Penicillium bulb rot	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Soak cleaned bulbs for 15 to 30 minutes in warm dip (80° to 85°F). Dry bulbs after treatment.
Zinnia Alternaria blight	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Spray every 10 to 14 days.
	Fore Rainshield NT Fore WSP Rainshield Dithane T/O Rainshield NT Dithane WF Junction (15% DF) 1.5 lb mancozeb	Spray every 10 to 14 days.
	Maneb 80 (80% WP) or Maneb Plus Zinc F4 Fungicide (37%) 1.0-1.5 lb maneb	Spray every 10 to 14 days.
Bacterial blight		Purchase clean stock plants. Practice good sanitation procedures.
Powdery mildew	Rubigan 3.0-5.0 fl oz fenarimol	Spray every 10 to 14 days.
	Sythane (40% WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
	Cygnus (50%) 1.6-3.2 oz Kresoxim-methyl	Apply at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt chlorothalonil	Treat at 7- to 10-day intervals at first sign of disease.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Spray every 7- to 10 days.

Table 5.1 - Common Diseases and Chemical Control Options (cont.)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Zinnia Powdery mildew (cont.)	Terraguard 50W 4.0-8.0 oz triflumizole	Foliar spray at weekly intervals.
	Triact 70 0.5-1.0 gal neem oil	Apply every 14 days.

Insects

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Relatively few kinds of insects and related pests occur on greenhouse and floral crops, but they attack a wide range of plants, can be highly destructive, and are difficult to control.

Many insecticide and miticide formulations are available to growers, but specific uses may be quite limited for any one crop, and plant varieties vary greatly in susceptibility to chemical injury. Your local Extension faculty may be able to help you obtain the technical information you need.

Proper Use of Pesticides

Insecticides are poisonous, and their use in the greenhouse can present a serious danger to both the applicator and plant material if handled carelessly or improperly. Restricted pesticides must be applied only by certified pesticide applicators.

Pesticides no longer being sold are listed to insure proper usage of existing material in the user's possession. Products withdrawn for marketing reasons can reappear under new brand names.

In order to use a pesticide safely and effectively, the product label should be read thoroughly before using. By law, pesticides must be used in accordance with label directions.

Effective application of pesticides depends on: proper timing, favorable treatment conditions of temperature, humidity, moisture, and time of day; plant condition; and thorough coverage, especially the undersides of leaves and in dense or low-growing foliage. Thorough wetting is especially important on waxy foliage and waxy insects such as mealybugs and scales. Most insecticides do not act efficiently at temperatures below 50-55°, and may cause plant injury if used when the temperature is above 90°, especially when coupled with high humidity. Overhead irrigation or watering should be avoided for at least 12 hours after applying pesticide treatments. Plants should be well watered, with foliage allowed to dry, before applying chemicals.

Non-chemical control methods should not be overlooked, particularly preventative measures such as making sure not to introduce infested plants into production areas. Weeds and excess plants left around can harbor pests and may be sources of infestation. Parasites (*Encarsia formosa* for whiteflies) and predators (*Cryptolaemus montrouzieri* for mealybugs) can be introduced for biological control. Others are listed in the Organic Controls chapter.

Plant Injury

Phytotoxicity is a term referring to plant injury caused by chemicals, particularly pesticides. Greenhouse plants seem to be especially prone to this problem, in part because of the wide variety of plants often grown or held in one common area. Signs of phytotoxicity include: 1) tip or marginal burn of leaves; 2) chlorosis in spots, at tips, or on margins of the leaves; 3) leaf distortion, including curling, twisting, or cupping; 4) stunting or growth reduction in the size of entire plants or certain parts; and 5) abnormal or excessive growth of certain plant parts. Flower parts and bracts are especially sensitive. Treatments may cause root injury resulting in decline, stunting, and damage to older leaves.

The following suggestions will reduce phytotoxic potential:

- 1) Do not apply pesticides to plants under stress;
- 2) Avoid spraying under extremely hot, sunny, or humid conditions;
- 3) Apply sprays in the mornings between 6:00 a.m. and 10:00 a.m.;
- 4) Avoid treating when temperature extremes or severe fluctuations are likely;
- 5) Apply pesticides when foliage is dry and conditions are conducive to drying;
- 6) Use wettable powders rather than emulsifiable concentrates;
- 7) Do not mix pesticides without prior experience; check compatibility;
- 8) Keep nozzles of aerosols or mist blowers at least 18-24" from plants being treated;
- 9) Never spray insecticides in equipment that has been used for applying herbicides (tanks, pumps, hoses, guns);
- 10) Clean sprayer, tank, pump, hose, and gun after each use;
- 11) Do not let spray mixes stand in the sprayer; do not expose spray concentrates to extreme heat or freezing;
- 12) Read **ALL** of the label directions every time you use each pesticide.

Formulations and Application Methods

Pesticides are available in various formulations: as concentrates for spraying, granular soil treatments, or aerosols. In some cases, only one or a few application methods may be registered for use of a specific pesticide.

Dilute sprays are applied with pressurized tank sprayers or high-pressure powered spraying machines. Formulations to be used may be wettable powders (WP), emulsifiable concentrates (E or EC), soluble powders (SP), liquids or liquid concentrates (L, LC), or flowables (F). Wettable powders are less likely to cause phytotoxicity problems.

Concentrate sprays are applied with motor-driven or electric mist sprayers and deliver droplets 5 to 20 times as concentrated as dilute sprayers.

Rates of application from aerosol bombs, generators, and foggers are based on air volume in closed greenhouses in terms of amount of pesticide/cubic feet. It is important to close the greenhouse tightly for the recommended length of time followed by adequate prescribed ventilation.

Compatibility and Coverage

Care should be taken in mixing different chemicals. Mixing different formulations such as wettable powders and emulsifiable concentrates is not recommended. Never mix herbicides or fungicides, and never use a sprayer that has been used to apply herbicides for insecticide or fungicide application.

For especially waxy foliage, the addition of a wetting agent or spreader-sticker may be desirable when applying sprays. However, it is unnecessary if two or more pesticides are added together, since a greater amount of wetting agent or emulsifier will be present in the tank. The use of two (2) or more emulsifiable concentrates mixed together in the same quantity of water results in twice as much or more solvent applied to the plants and may cause plant injury. **Read the pesticide label carefully for compatibility** statements and mixing **precautions**. Highly alkaline water (pH 8.0 or higher) may cause rapid breakdown of many pesticide chemicals.

Safety and Toxicity

Pesticides are readily absorbed through the skin, as well as being poisonous by ingestion, by inhalation, or by contact in the eyes. Penetration of the skin occurs immediately on contact and is most hazardous when handling undiluted concentrates. It is essential to wear protective clothing, proper gloves, boots, and adequate face shields and respirators or gas masks as directed on the label. Frequent changes to clean clothing and protective devices are essential. With some chemicals, potential eye damage warrants a danger or warning category on the label even though oral and dermal toxicities are in the caution range.

The signal word on the pesticide label (“caution,” “warning,” or “danger - poison”) and the LD₅₀ values are helpful as guides to relative toxicities of pesticides. The LD₅₀'s given below are for technical grade material.

Table 5.2 - Label Categories

Signal Word	Toxicity Category	LD ₅₀ mg/kg	
		Oral	Dermal
DANGER, POISON (skull and crossbones)	Highly toxic	0-50	0-200
WARNING	Moderately toxic	51-500	201-2000
CAUTION	Slightly toxic	501-5000	2001-20,000
CAUTION (optional)	Relatively non-toxic	over 5000	over 20,000

Table 5.3 - Selected Relative Toxicities

Pesticide	Toxicity LD ₅₀ (mg/kg)	
	oral	dermal
Abamectin	650	>2,000
Acephate	866-945	>10,250
Azadirachtin	>5,000	>2,000
<i>Bacillus thuringiensis</i>	none	none
Chlorpyrifos	96-270	2,000
Cyfluthrin	900	>5,000
Endosulfan	100	359
Fenoxycarb	16,800	>2,000
Fluvalinate	261-282	>20,000
Metaldehyde	250-1,000	—
Methiocarb	10-35	>5,000
Permethrin	>430-4,000	>2,000

How to Use These Recommendations

Once the pest problem has been identified, consult Table 5.4. Find the pest or pest group (arranged alphabetically) to determine which control measures are available, the formulations that are registered, and remarks. Then consult Table 5.5 for specific use and precautionary information on the control measure chosen. Be sure to check the potential phytotoxicity statements. If in doubt about a crop, treat a small sample area. Observe sprayed plants for several days for indications of plant injury.

After using the recommendations here, read and follow the directions on the pesticide label prior to mixing and application.

Table 5.4 - Guide to Pesticide and Formulations Recommended by Pest or Pest Group

Pesticide	Signal Word	Foliar Spray	Aerosol	Smoke Fog Vapor	Soil	Remarks ¹
Aphids						
Abamectin	warning	0.15EC	—	—	—	See label
Acephate	caution	75SP, 97	3A	—	—	Aerosol is labeled for most crops. See label for phytotoxicity
Acetamiprid	caution	70WSP, 30SG	—	—	—	See label
Azadirachtin	caution	EC	—	—	—	All crops
<i>Beauveria bassiana</i>	caution	22WF, ES	—	—	—	All crops
Bifenthrin	warning	.667F	A	—	—	Greenhouse-grown ornamentals
Chlorpyrifos	caution	20ME	8A	—	—	See label
Cyfluthrin	warning	20WP	—	—	—	See label
Dinotefuran	caution	20SG	—	—	20SG, 2G	Soil application as drench, granules
Endosulfan	danger	50W	—	—	—	All crops
Fenoxycarb	caution	25WP	0.6A	—	—	All crops
Fenpropathrin	warning	2.4EC	1A	—	—	See label
Flonicamid	caution	SG	—	—	—	See label for rate range
Fluvalinate	caution	2AF	—	—	—	All crops; see label for phytotoxicity
Imidacloprid	caution	II	—	—	1%G, 60WP	See label
Insecticidal soap	warning	—	—	—	—	See label
Kinoprene	warning	II	—	—	—	All crops
Lambda-cyhalothrin	caution	GC	—	—	—	All crops
Methiocarb	warning	75WP	—	—	—	See label
Permethrin	caution	3.2EC	—	—	—	All crops
Pymetrozine	caution	50WG	—	—	—	All crop
Pyrethrin	caution	—	A	—	—	See label
Pyriproxyfen	caution	.86L	—	—	—	See label
Resmethrin	caution	2EC	A	—	—	All crops
Spirotetramat	caution	240SC	—	—	240SC	Soil application as drench
Thiamethoxam	caution	25WG	—	—	25WG	See label
Tolfenpyrad	warning	EC	—	—	—	See label for phytotoxicity
Ultra-fine oil	caution	—	—	—	—	See label
Caterpillars, Cutworms, Loopers, Armyworms						
Acetamiprid	caution	70WSP 30SG	—	—	—	See label for pest species
Azadirachtin	caution	EC	—	—	—	All crops
<i>Bacillus thuringiensis (Bt)</i>	caution	WP	—	—	—	Consult label of this and other brands of <i>Bt</i> available for specific pest uses.
Bifenthrin	warning	.667F	A	—	—	Greenhouse-grown ornamentals
Carbaryl	caution	50W, 80S	—	—	—	All crops
Chlorfenapyr	caution	2S	—	—	—	All crops
Chlorpyrifos	caution	20ME	8A	—	—	See label

¹Be sure to check precautions for phytotoxicity for each pesticide in table.

Table 5.4 - Guide to Pesticide and Formulations Recommended by Pest or Pest Group (cont.)

Pesticide	Signal Word	Foliar Spray	Aerosol	Smoke Fog Vapor	Soil	Remarks ¹
Caterpillars, Cutworms, Loopers, Armyworms (cont.)						
Cyfluthrin	warning	20WP	—	—	—	See label
Diflubenzuron	caution	25WSB	—	—	—	Armyworm listed on label
Fenpropathrin	warning	2.4EC	1A	—	—	For beet armyworm; see label
Fluvalinate	caution	2AF	—	—	—	All crops
Novaluron	caution	10SC	—	—	—	Armyworm listed on label
Permethrin	caution	3.2EC	—	—	—	All crops
Pyridalyl	caution	35WP	—	—	—	See label for insect species
Spinosad	caution	11.6SC	—	—	—	All crops
Tebufenozide	caution	2S	—	—	—	All crops
Tolfenpyrad	warning	EC	—	—	—	See label for phytotoxicity. For early instars only.
Centipedes (see Millipedes)						
Cyclamen Mite						
Chlorfenapyr	caution	2S	—	—	—	All crops
Endosulfan	danger	50W	—	—	—	See label
Fenazaquin	warning	200SC	—	—	—	All crops
Spiromesifen	caution	4F	—	—	—	Also labeled for broad mite
Fungus Gnats (Adults)						
Bifenthrin	caution	—	A	—	—	All crops
Fenpropathrin	warning	—	1A	—	—	All crops
Insecticidal soap	warning	—	—	—	—	See label, formulations vary
Permethrin	caution	3.2EC	—	—	—	See label for sensitive plants
Resmethrin	caution	2EC	1A	—	—	All crops
Ultra-fine oil	caution	—	—	—	—	See label
Fungus Gnats (Larvae)						
Acetamiprid	caution	70WSP 30SG	—	—	—	See label
<i>Bacillus thuringiensis</i>	non-toxic	—	—	—	AS	All crops
Cyromazine	caution	75WP	—	—	—	All crops
Diflubenzuron	caution	—	—	—	25WSB	See label
Fenpropathrin	warning	—	1A	—	—	All crops
Fenoxycarb	caution	25WP	—	—	—	All crops
Kinoprene	warning	II	—	—	—	All crops
Pyriproxyfen	caution	.86EC	—	—	—	See label
Leafminers						
Abamectin	warning	0.15EC	—	—	—	Flower crops, foliage plants
Acetamiprid	caution	70WSP 30SG	—	—	—	See label
Azadirachtin	caution	EC	—	—	—	All crops
Bifenthrin	warning	.667F	A	—	—	See label

¹Be sure to check precautions for phytotoxicity for each pesticide in table.

Table 5.4 - Guide to Pesticide and Formulations Recommended by Pest or Pest Group (cont.)

Pesticide	Signal Word	Foliar Spray	Aerosol	Smoke Fog Vapor	Soil	Remarks ¹
Fungus Gnats (Larvae) (cont.)						
Cyfluthrin	warning	20WP	—	—	—	See label
Cyromazine	caution	75WP	—	—	—	All crops
Diflubenzuron	caution	25WSB	—	—	—	See label
Dinotefuran	caution	20SG	—	—	20SG	Soil application as drench
Fenpropathrin	warning	—	1A	—	—	All crops
Fenoxycarb	caution	25WP	—	—	—	Lepidopterous leaf miners only all crops
Novaluron	caution	10SC	—	—	—	Serpentine, citrus leafminers only
Permethrin	caution	3.2EC	—	—	—	Chrysanthemum only
Spinosad	caution	11.6SC	—	—	—	All crops
Leafrollers						
Acephate	caution	75SP, 97	3A	—	—	Labeled on roses
Bifenthrin	warning	.667 F	A	—	—	Greenhouse-grown ornamentals
Chlorpyrifos	caution	20ME	—	—	—	See label
Cyfluthrin	warning	20WP	—	—	—	See label
Fenpropathrin	warning	—	1A	—	—	All crops
Mealybugs (Foliar)						
Acephate	caution	75SP, 97	3A	—	—	Labeled on foliage plants, orchids, anthurium, cacti, poinsettia
Acetamiprid	caution	70WSP 30SG	—	—	—	See label
Azadirachtin	caution	EC	—	—	—	All crops
<i>Beauveria bassiana</i>	caution	22WP, ES	—	—	—	All crops
Bifenthrin	warning	.667F	A	—	—	Greenhouse-grown ornamentals
Buprofezin	caution	70WSP	—	—	—	All crops
Chlorpyrifos	caution	20ME	8A	—	—	See label
Cyfluthrin	warning	20WP	—	—	—	See label
Dinotefuran	caution	20SG	—	—	20SG, 2G	Soil application as drench, granule
Fenpropathrin	warning	2.4EC	1A	—	—	See label
Fonicamid	caution	SG	—	—	—	See label for rate range
Fluvalinate	caution	22.3F	—	—	—	See label
Imidacloprid	caution	II	—	—	1%G	See label
Insecticidal soap	warning	—	—	—	—	Concentration varies with formulation; see label
Kinoprene	warning	II	—	—	—	See label
Methiocarb	warning	75WP	—	—	—	See label
Permethrin	caution	3.2EC	—	—	—	See label for sensitive plants
Pyrethrin	caution	—	A	—	—	See label
Spirotetramat	caution	240SC	—	—	240SC	Soil application as drench
Thiamethoxam	caution	25WG	—	—	25WG	See label

¹Be sure to check precautions for phytotoxicity for each pesticide in table.

Table 5.4 - Guide to Pesticide and Formulations Recommended by Pest or Pest Group (cont.)

Pesticide	Signal Word	Foliar Spray	Aerosol	Smoke Fog Vapor	Soil	Remarks ¹
Mealybugs (Root)						
Kinoprene	warning	II	—	—	—	All crops
Millipedes						
Chlorpyrifos	warning	50W	—	—	—	Outside building
Scale Insects						
Acephate	caution	75SP, 97	3A	—	—	See crops listed on label
Acetamiprid	caution	70WSP 30SG	—	—	—	See label
Buprofezin	caution	70WSP	—	—	—	All crops
Chlorpyrifos	caution	20ME	8A	—	—	See label
Cyfluthrin	warning	20WP	—	—	—	See label directions
Dinotefuran	caution	20SG	—	—	20SG, 2G	Soil application as drench, granules
Fenoxycarb	caution	25WP	0.6A	—	—	All crops, soft scales only
Fenpropathrin	warning	—	1A	—	—	See label
Insecticidal soap	warning	—	—	—	—	Formulations vary; see label
Kinoprene	warning	II	—	—	—	All crops
Pyriproxyfen	caution	.86EC	—	—	—	See label
Thiamethoxam	caution	25WG	—	—	25WG	Labeled for soft scales
Tolfenpyrad	warning	EC	—	—	—	See label for phytotoxicity
Shore Flies						
Cyromazine	caution	75WP	—	—	—	All crops
Diflubenzuron	caution	—	—	—	25WSB	See label
Fenoxycarb	caution	25WP	0.6A	—	—	All crops
Pyriproxyfen	caution	.86EC	—	—	—	See label
Slugs, Snails						
Metaldehyde	caution	—	—	—	bait	All crops
Methiocarb	warning	75WP	1A	—	—	See label
Sowbugs						
Cyfluthrin	warning	20WP	—	—	—	See label
Spider Mites						
Abamectin	warning	0.15EC	—	—	—	See label
Acequinocyl	caution	15SC	—	—	—	See label. Two-spotted spider mite.
Azadirachtin	caution	70	—	—	—	All crops
Bifenazate	caution	50SP	—	—	—	All crops
Bifenthrin	warning	.667 F	A	—	—	Greenhouse-grown ornamentals.
Chlorfenapyr	caution	2S	—	—	—	All crops
Chlorpyrifos	caution	20ME	8A	—	—	See label
Clofentezine	caution	5SC	—	—	—	All crops
Etoxazole	caution	5WDG	—	—	—	See label for resistance management
Fenazaquin	warning	200SC	—	—	—	All crops.

¹Be sure to check precautions for phytotoxicity for each pesticide in table.

Table 5.4 - Guide to Pesticide and Formulations Recommended by Pest or Pest Group (cont.)

Pesticide	Signal Word	Foliar Spray	Aerosol	Smoke Fog Vapor	Soil	Remarks ¹
Spider Mites (cont.)						
Fenbutatin oxide	danger	50WP	—	—	—	All crops
Fenpropathrin	warning	2.4EC	1A	—	—	See label
Fenpyroximate	warning	5SC	—	—	—	Labeled for other mite species
Fluvalinate	caution	22.3F	—	—	—	See label
Hexythiazox	caution	50DF	—	—	—	See label
Insecticidal soap	warning	25EC	—	—	—	Formulations vary; see label
Milbectin	caution	EC	—	—	—	Outdoor use only, eg. flowers, bedding plants, foliage plants.
Pyrethrin	caution	—	A	—	—	See label
Pyridaben	danger	75WP	—	—	—	See label
Spinosad	caution	SC	—	—	—	See label for rate range
Spiromesifen	caution	4F	—	—	—	See label for species
Ultra-fine oil	caution	—	—	—	—	See label for rate
Springtails						
Chlorpyrifos	warning	50W	—	—	—	See label
Thrips						
Abamectin	caution	0.15EC	—	—	—	All crops
Acephate	caution	75WP, 97	3A	—	—	All crops
Acetamiprid	caution	70WSP, 30SG	—	—	—	See label
Azadirachtin	caution	EC	—	—	—	All crops
<i>Beauveria bassiana</i>	caution	22WP, EC	—	—	—	All crops
Bifenthrin	warning	.667 F	—	—	—	See label
Chlorfenapyr	caution	2S	—	—	—	All crops
Chlorpyrifos	caution	ME	8A	—	—	See label
Cyfluthrin	warning	20WP	—	—	—	See label
Diazinon	caution	2FM	.5A	—	—	See label
Dinotefuran	caution	20SG	—	—	20SG, 2G	Soil application as drench, granules
Fenoxycarb	caution	25WP	A	—	—	All crops
Fenpropathrin	warning	—	1A	—	—	
Fonicamid	caution	SG	—	—	—	See label for rate range
Fluvalinate	caution	2AF	—	—	—	All crops
Imidacloprid	caution	II	—	—	1%G, 60WP	See label
Lambda-cyhalothrin	caution	10WSP	—	—	—	All crops
Methiocarb	warning	75WP	—	—	—	All crops
Novaluron	caution	10SC	—	—	—	See label for listed species
Pyridalyl	caution	35WP	—	—	—	See label for special instructions
Resmethrin	caution	—	2A	—	—	All crops
Spinosad	caution	11.6SC	—	—	—	All crops
Tolfenpyrad	warning	EC	—	—	—	See label for phytotoxicity

¹Be sure to check precautions for phytotoxicity for each pesticide in table.

Table 5.4 - Guide to Pesticide and Formulations Recommended by Pest or Pest Group (cont.)

Pesticide	Signal Word	Foliar Spray	Aerosol	Smoke Fog Vapor	Soil	Remarks ¹
Whiteflies						
Abamectin	caution	0.15E	—	—	—	See label
Acephate	caution	75SP	3A	—	—	All crops
Acetamiprid	caution	70WSP, 30SG	—	—	—	See label
Azadirachtin	caution	EC	—	—	—	All crops
<i>Beauveria bassiana</i>	caution	22WP, ES	—	—	—	See label
Bifenthrin	warning	.667 F	A	—	—	Greenhouse-grown ornamentals
Buprofezin	caution	70WSP	—	—	—	All crops
Chlorpyrifos	caution	20ME	8A	—	—	See label
Cyfluthrin	warning	20WP	—	—	—	See label
Diflubenzuron	caution	25WSB	—	—	—	See label
Dinotefuran	caution	20SG	—	—	20SG, 2G	Soil application as drench, granules
Endosulfan	danger	50WP	—	—	—	See label
Fenazaquin	warning	200SC	—	—	—	All crops, see label for phytotoxicity
Fenoxycarb	caution	25WP	0.6A	—	—	All crops
Fenpropathrin	warning	2.4EC	1A	—	—	See label
Flonicamid	caution	SG	—	—	—	See label for rate range
Fluvalinate	caution	2F	—	—	—	All crops
Imidacloprid	caution	II	—	—	1%G, 60WP	See label
Insecticidal soap	caution	L	—	—	—	See label
Kinoprene	caution	II	—	—	—	See label
Novaluron	caution	10SC	—	—	—	See label for listed species
Permethrin	caution	3.2EC	—	—	—	See label for sensitive plants
Pymetrozine	caution	50WG	—	—	—	All crops
Pyrethrin	caution	—	A	—	—	See label
Pyridaben	danger	75WP	—	—	—	See label
Pyriproxyfen	caution	.86EC	—	—	—	See label
Resmethrin	caution	2A 2EC	— —	— F	— —	All crops See label
Spiromesifen	caution	4F	—	—	—	See label for species
Spirotetramat	caution	240SC	—	—	240SC	Soil application as drench
Thiamethoxam	caution	25WG	—	—	25WG	See label
Tolfenpyrad	warning	EC	—	—	—	See label for phytotoxicity

¹Be sure to check precautions for phytotoxicity for each pesticide in table.

Table 5.5 - Guide to Pesticide Usage Cross Reference to Other Common Trade Names

Other trade or common names that are often found on labels, in advertising, or in trade journals are provided here for reference.

Abamectin - Avid	Diflubenzuron - Adept	Permethrin - Astro, Perm-Up
Acephate - Orthene, TR1300	Dinotefuran - Safari	Pymetrozine - Endeavor
Acequinocyl - Shuttle	Endosulfan - Thionex	Pyrethrin - Pt 1600, X-Clude, Pyrethrum
Acetamiprid - Tristar	Fenbutatin oxide - Promite	Pyridaben - Sanmite
Azadirachtin - Azatin, Neemazid, Ormazin, Triact, Azatrol	Fenoxycarb - Preclude, Precision	Pyridalyl - Overture
<i>Bacillus thuringiensis</i> - Dipel, Gnatrol	Fenpropathrin - Tame	Pyriproxyfen - Pyrigro, Distance
<i>Beauveria bassiana</i> - BotaniGard, Mycotrol, Naturalis-O	Fenpyroximate - Akari	Resmethrin - Pt 1200, SBP-1382
Bifenazate - Floramite	Flonicamid - Aria	Spiromesifen - Judo
Bifenthrin - Talstar, Attain	Fluvalinate - Mavrik	Spirotetramat - Kontos
Carbaryl - Sevin	Hexythiazox - Hexygon	Tebufenozide - Confirm
Chlorantraniliprole - Acelepryn	Insecticidal soap - M-Pede	Thiamethoxam - Flagship
Chlorfenapyr - Pylon	Kinoprene - Enstar	Thuricide - Dipel
Chlorpyrifos - DuraGuard, Duraplex	Lambda-cyhalothrin - Scimitar	
Cyfluthrin - Decathlon	Methiocarb - Mesurol, Grandslam	
	Novaluron - Pedestal	

Pesticide	Formulation	50 Gal	10 Gal	3 Gal	Precautions & Remarks
Abamectin (Avid, Sirocco) aphids, leafminers, spider mites, thrips, whiteflies	0.15EC	2.0-4.0 fl oz	0.75-1.5 T	0.75-1.5 t	Generic products exist. See label. Sirocco also contains bifenazate. See label for rate. 12-hr REI. SIGNAL WORD - WARNING
Acephate (Orthene) aphids, leafroller, mealybugs, scale crawler, thrips, whitefly	75SP 97	See label for rates.	See label for rates.	See label for rates.	Repeated applications may cause phy- toxicity. See label for rate and species list. Generics exist. 24-hr REI. SIGNAL WORD - CAUTION
mealybugs	3% aerosol	—	—	—	Apply 5-10 seconds/100 sq ft. Do not use under high temperature and humidity conditions or where gas heat- ing systems are unvented. See label for sensitive plant list. 24-hr REI. SIGNAL WORD - CAUTION
Acequinocyl (Shuttle) spider mites	15SC	3.2-6.4 fl oz	1.25-2.5 T	1.25-2.5 t	Do not use on miniature roses or impa- tiens. Use low rate on standard roses. See label for resistance management. 12-hr REI. SIGNAL WORD - CAUTION

Abbreviations: AF - aquaflo; W, WP - wettable powder; E, EC - emulsifiable concentrate; L - liquid; ME - microencapsulated; SP - sprayable or soluble powder; SC - spray concentrate; D - Dust; G - granular; A - aerosol; F - fog; SG - smoke generator; V - vapor; lb - pound; pt - pint; oz - ounce; fl oz - fluid ounce; cu ft - cubic feet; c - cup; T - tablespoon; t - teaspoon; gal - gallon(s)

Useful Equivalents 1 lb WP/100 gal = 1 T/1 gal; 2.0 T = 1 fl oz; 1 pt EC/100 gal = 1 t/1 gal; 16 fl oz = 1 pt; 3 t = 1 T; 2 pt = 1 qt

Table 5.5 - Guide to Pesticide Usage Cross Reference to Other Common Trade Names (cont.)

Rates of Application (T= Tablespoon; t= teaspoon)					
Pesticide	Formulation	50 Gal	10 Gal	3 Gal	Precautions And Remarks
Acetamiprid (Tristar) aphids, mealybug, leafhopper, whiteflies, thrips, scales, fungus gnat larvae, leafminers, caterpillars	70WSP, 30SG	See label for rates.	See label for rates.	See label for rates.	See label for restrictions. 70WSP in water soluble packets. 12-hr REI. SIGNAL WORD - CAUTION
Azadirachtin aphids, caterpillars, leafminers, mealybugs, thrips, whiteflies	various	See label for rates.	See label for rates.	See label for rates.	Product is available at several concentrations and sold under many trade names. 4-hr REI. SIGNAL WORD - CAUTION
Bacillus thuringiensis (Gnatrol) fungus gnats	AS	1.0-4.0 pts	3.0-13.0 oz	2.0-8.0 T	Consult label for proper rate. Use 3 weekly applications for heavy infestations. 4-hr REI. SIGNAL WORD - CAUTION
(Dipel) caterpillars, loopers, budworm, omnivorous leafroller, armyworm	various	See label for rates.	See label for rates.	See label for rates.	Many formulations exist. Check rate and use labeled rate only. Use full coverage foliar spray when larvae are small. Use lower rate for light infestations. 4-hr REI. SIGNAL WORD - CAUTION
Beauveria bassiana (BotaniGard) aphids, mealybugs, thrips, whiteflies	22WP, ES	See label for rates.	See label for rates.	See label for rates.	A mycoinsecticide. See label for rate for each pest.
Bifenazate (Floramite, Sirocco) spider mites	50SP	1.0-2.0 oz	—	—	See label for species controlled. Do not use in successive applications. Sold in water soluble bags. Sirocco also contains abamectin. See label for rate. 12-hr REI. SIGNAL WORD - CAUTION
Bifenthrin (Attain) aphids, armyworms, caterpillars, mealybugs, leafrollers, plant bugs, scale, mites, whiteflies	0.5%/A	1 lb can/3000 sq ft			Generic products exist. See label for total release directions. 12-hr REI. SIGNAL WORD - CAUTION
(Talstar) aphids, whiteflies, mealybugs, spider mites, leafroller, armyworms	0.667F	4.0-20.0 oz	0.8-4.0 oz	2.0-6.0 t	Apply as full-coverage foliar spray. Repeat as necessary. Do not handle plants till dry. Rate depends on pest. 12-hr REI. SIGNAL WORD - CAUTION
Buprofezin (Talus) leafhoppers, mealybugs, planthoppers, scales, whiteflies	70WSP	3.0-7.0 oz	0.6-1.8 oz	—	Consult label for proper rate. Sold in water-soluble bags. 12-hr REI. SIGNAL WORD - CAUTION

Abbreviations: AF - aquaflo; W, WP - wettable powder; E, EC - emulsifiable concentrate; L - liquid; ME - microencapsulated; SP - sprayable or soluble powder; SC - spray concentrate; D - Dust; G - granular; A - aerosol; F - fog; SG - smoke generator; V - vapor; lb - pound; pt - pint; oz - ounce; fl oz - fluid ounce; cu ft - cubic feet; c - cup; T - tablespoon; t - teaspoon; gal - gallon(s)

Useful Equivalents 1 lb WP/100 gal = 1 T/1 gal; 2.0 T = 1 fl oz; 1 pt EC/100 gal = 1 t/1 gal; 16 fl oz = 1 pt; 3 t = 1 T; 2 pt = 1 qt

Table 5.5 - Guide to Pesticide Usage Cross Reference to Other Common Trade Names (cont.)

Rates of Application (T= Tablespoon; t= teaspoon)					
Pesticide	Formulation	50 Gal	10 Gal	3 Gal	Precautions And Remarks
Carbaryl (Sevin) blister beetle, flea beetle, leafhoppers, leafrollers, mealybugs, plant bugs, thrips (exposed)	10D 50W 80SL	1.0 lb 10.0 oz	6.6 T 4.0 T	6.0 T 3.75 T	Apply a light covering of dust barely visible when completed. Treat when plants are dry and humidity is low. Use caution for greenhouse treatments if conditions are not suitable. 12-hr REI. SIGNAL WORD - WARNING
Chlorfenapyr (Pylon) spider mites, cyclamen mites, thrips, caterpillars, foliar nematodes	2S	1.3-2.6 fl oz	1.5-3.0 t	0.5-1.0 t	Labeled for greenhouse ornamentals. See label for thrips rate. 12-hr REI. SIGNAL WORD - CAUTION
Chlorpyrifos (Duraguard) aphids, leafhopper, leafminer, leafroller, mealybug, mites, scale, springtails, thrips, whiteflies	ME	25.0-50.0 oz	2.5-5.0 oz	1.5-3.0 T	Rates vary depending on pest. See label. 12-hr REI. SIGNAL WORD - CAUTION
Chlorpyrifos + cyfluthrin (Duraplex) aphids, caterpillars, mealybugs, mites, scales, thrips, whiteflies	8A	—	—	—	See label for special note re gas-heating systems. 12-hr REI. SIGNAL WORD - CAUTION
Clofentezine (Ovation)	5SC	1.0 oz	—	—	One application per crop cycle. Apply at first sign of mite activity. 12-hr REI. SIGNAL WORD - CAUTION
Cyfluthrin (Decathlon) caterpillars, lace bug, aphids, leafrollers, mealybugs, thrips, whiteflies, sowbugs	20WP	3.0-4.5 T	2.0-3.0 t	0.75-1.0 t	Addition of a spreader-sticker may improve control. See label. 12-hr REI. SIGNAL WORD - WARNING
Cyromazine (Citation) Leafminers, fungus gnats, shore flies	75WP	1.33 oz	—	—	Apply as foliar spray or drench; will not control adults. Sold in water-soluble pouches. SIGNAL WORD - CAUTION
Diflubenzuron (Adept) armyworms, fungus gnats, leafminers, shore flies, whiteflies	25WP	1.0 oz	—	—	Read label before using as a drench. Under cover uses are registered. Sold in water soluble bags. Rates differ for foliar feeders. Do not use on poinsettia. 12-hr REI. SIGNAL WORD - CAUTION
Abbreviations: AF - aquaflo; W, WP - wettable powder; E, EC - emulsifiable concentrate; L - liquid; ME - microencapsulated; SP - sprayable or soluble powder; SC - spray concentrate; D - Dust; G - granular; A - aerosol; F - fog; SG - smoke generator; V - vapor; lb - pound; pt - pint; oz - ounce; fl oz - fluid ounce; cu ft - cubic feet; c - cup; T - tablespoon; t - teaspoon; gal - gallon(s)					
Useful Equivalents 1 lb WP/100 gal = 1 T/1 gal; 2.0 T = 1 fl oz; 1 pt EC/100 gal = 1 t/1 gal; 16 fl oz = 1 pt; 3 t = 1 T; 2 pt = 1 qt					

Table 5.5 - Guide to Pesticide Usage Cross Reference to Other Common Trade Names (cont.)

Rates of Application (T= Tablespoon; t= teaspoon)

Pesticide	Formulation	50 Gal	10 Gal	3 Gal	Precautions And Remarks
Dinotefuran (Safari) aphids, scale, Japanese bee- tles, leafminers, mealybugs, thrips, whiteflies	20SG 2G	See label for rates.	See label for rates.	See label for rates.	For foliar insects. Apply as foliar spray or soil applications as drenches. See label for scale species. See label for vegetable transplant use. 12-hr REI. SIGNAL WORD - CAUTION
Endosulfan (Thionex) aphids, cyclamen mite, whitefly	50WP	0.5 lb	10.0 T	3.0 T	Use proper mask or respirator. EC may injure some chrysanthemums. Foliage and blooms should be dry. 24 HR REI. SIGNAL WORD - DANGER
Etoxazole (TetraSan)	5WDG	2-4 packets	—	—	Sold in water soluble packets. 12-hr REI. SIGNAL WORD - CAUTION
Fenazaquin (Magus) mites, whiteflies	200SC	6.0-12.0 fl oz	2.2-4.5 T	2.0 t -1.5 T	Maintain agitation during mixing. One application per crop cycle. Do not apply to roses. 12-hr REI.SIGNAL WORD - WARNING.
Fenbutatin oxide (Promite, Meraz)	50WP	1.0 lb soluble bag in 100.0- 200.0 gal	—	—	Do not add oil. Apply to foliage only on mums and pre-bract on poisetias. 24-hr REI. SIGNAL WORD - DANGER
Fenoxycarb (Preclude)	0.6A	5-10 seconds/ 100 sq ft	—	—	See label for dosage for specific pest; WP sold in 1.0 oz pouches. Insect growth regulator. 12-hr REI. SIGNAL WORD - CAUTION
(Precision) whiteflies, soft scales, fungus gnats, shore flies, lepidopterous leaf miners, and thrips	25WP	1.0-4.0 fl oz	—	—	
Fenpyroximate (Akari) spider mites	5SC	8.0-12.0 oz	3.0-4.5 T	1.0-1.5 T	See label for resistance management. 12-hr REI. SIGNAL WORD - WARNING
Fenpropathrin (Tame) aphids, beet army- worm, leafhop- pers, mealybugs, mites, whiteflies, Japanese beetle	2.4EC, 1A	2.67-8.0 oz	1.0-3.0 T	1.0-3.0 t	See label for dosage for specific pest, and for mixing instructions. Aerosol for- mulation contains acephate. 24-hr REI. SIGNAL WORD - WARNING
Flonicamid (Aria) aphids, mealybugs, thrips, whiteflies	SG	See label for rates			Each packet contains 20g of product. Registered for greenhouse and interi- orscapes. 12-hr REI. SIGNAL WORD - CAUTION
Abbreviations: AF - aquaflow; W, WP - wettable powder; E, EC - emulsifiable concentrate; L - liquid; ME - microencapsulated; SP - sprayable or soluble powder; SC - spray concentrate; D - Dust; G - granular; A - aerosol; F - fog; SG - smoke generator; V - vapor; lb - pound; pt - pint; oz - ounce; fl oz - fluid ounce; cu ft - cubic feet; c - cup; T - tablespoon; t - teaspoon; gal - gallon(s)					
Useful Equivalents 1 lb WP/100 gal = 1 T/1 gal; 2.0 T = 1 fl oz; 1 pt EC/100 gal = 1 t/1 gal; 16 fl oz = 1 pt; 3 t = 1 T; 2 pt = 1 qt					

Table 5.5 - Guide to Pesticide Usage Cross Reference to Other Common Trade Names (cont.)

Rates of Application (T= Tablespoon; t= teaspoon)					
Pesticide	Formulation	50 Gal	10 Gal	3 Gal	Precautions And Remarks
Fluvalinate (Mavrik) aphids, thrips, mites, white- flies, leaf-feeding caterpillars	2AF	2.0-5.0 fl oz	1.0 T-2.5 T	1.0 t-2.5 t	May repeat at 5- to 10-day intervals if needed. See label for precautions. 12-hr REI. SIGNAL WORD - CAUTION
Hexythiazox (Hexygon) spider mites	50DF	See label for rates	See label for rates	See label for rates	Rates differ for high- and low-volume applications. 12-hr REI. SIGNAL WORD - CAUTION
Imidacloprid (Marathon)	1%G, 60 WP, II	See label for rates	See label for rates	See label for rates	Generic products exist. Do not over irrigate following application. 12-hr REI. SIGNAL WORD - CAUTION
Insecticidal soap aphids, mealybugs, mites	50.5EC	4.0-10.0 pt	0.8-2.0 pts	8.0-20.0 T	See label. Repeated applications of high rates may cause plant damage. Numerous formulations are available. 12-hr REI.
	25EC	2.0 gal	50.0 oz	15.0 oz	
Kinoprene (Enstar) aphids, fungus gnats, mealybugs, scales, whitefly	II	2.5-5.0 oz	2.5-5.0 t	0.75-1.5 t	See label for usage directions. Labeled for carnations, mums, roses. Foliage should be dry. Fogging rate - 1 oz/3,000 cu ft 4-hr REI. SIGNAL WORD - WARNING
	Fog				
Lambda-cyhalothrin (Scimitar) adult leaf miners, aphids, armyworms, brown soft scale, caterpillars, mealy- bugs, spider mites, thrips, whiteflies	6C	0.75-2.5 oz	—	—	Generic products exist. See label for rates. 24-hr REI. SIGNAL WORD - CAUTION
Metalddehyde (Deadline, Metarex) slugs, snails	3.25% pellets	1.0 lb/1,000 sq ft			Apply bait only to soil surface around plants, not foliage or other plant parts. 12-hr REI. SIGNAL WORD - CAUTION
Methiocarb (Grandslam) (Mesurol) aphids, snails, slugs, western flower thrips	2% G	1.0 lb/ 1,000 sq ft			Only Mesurol labeled for thrips. Apply bait to soil around plants or flats but not on plant foliage. Do not apply to food crops. 24-hr REI. SIGNAL WORD - DANGER
	75WP	0.5-2.0 lbs	1.6-6.4 oz	0.5-2.0 T	
Milbectin (Ultiflora) mites	1% EC	4.0-8.0 fl oz	1.5-3.0 T	1.5-3.0 t	Outdoor field nurseries only on flow-ers, bedding plants, and foliage plants. 12-hr REI. SIGNAL WORD - CAUTION

Abbreviations: AF - aquaflo; W, WP - wettable powder; E, EC - emulsifiable concentrate; L - liquid; ME - microencapsulated; SP - sprayable or soluble powder; SC - spray concentrate; D - Dust; G - granular; A - aerosol; F - fog; SG - smoke generator; V - vapor; lb - pound; pt - pint; oz - ounce; fl oz - fluid ounce; cu ft - cubic feet; c - cup; T - tablespoon; t - teaspoon; gal - gallon(s)

Useful Equivalents 1 lb WP/100 gal = 1 T/1 gal; 2.0 T = 1 fl oz; 1 pt EC/100 gal = 1 t/1 gal; 16 fl oz = 1 pt; 3 t = 1 T; 2 pt = 1 qt

Table 5.5 - Guide to Pesticide Usage Cross Reference to Other Common Trade Names (cont.)

Rates of Application (T= Tablespoon; t= teaspoon)					
Pesticide	Formulation	50 Gal	10 Gal	3 Gal	Precautions And Remarks
Novaluron (Pedestal) thrips, caterpillars, whiteflies, leafminers	10SC	3.0-4.0 fl oz	4.0-5.0 tsp	1.0-1.5 tsp	See label for precautions. Do not use on poinsettias. 12-hr REI. SIGNAL WORD - CAUTION
Permethrin (Perm-up) leafminers, caterpillars, aphids, fungus gnats, mealybugs	3.2EC	10.0 oz	2.0 oz	1.0 T	Apply as full-coverage foliar spray. Listed rate is for leafminers; lower rate is for other pests. 12-hr REI. SIGNAL WORD - CAUTION
Pymetrozine (Endeavor) aphids, whiteflies	50SP	1.25-2.5 oz	—	—	Only sold in water soluble packets. 12-hr REI. SIGNAL WORD - CAUTION
Pyrethrin (X-clude) aphids, scale, mealybugs, spider mites, whiteflies	Aerosol	Use 5-10 second application for each 100 sq ft	Use 5-10 second application for each 100 sq ft	Use 5-10 second application for each 100 sq ft	See label. NO - REI. SIGNAL WORD - CAUTION
Pyridaben (Sanmite) mites, whiteflies	75WP	1-3 oz	—	—	Sold in 1 oz pouches. See label for dosage for specific pest. 12-hr REI. SIGNAL WORD - DANGER
Pyridalyl (Overture) thrips, caterpillars	35WP	4.0 oz	—	—	Only sold in water-soluble packets. 12-hr REI.. SIGNAL WORD - CAUTION
Pyriproxyfen (Distance, Pyrigro) whiteflies, fungus gnats, shoreflies, scale	0.86 EC	3.0-6.0 fl oz	0.5-1.0 fl oz	1.0-2.0 t	See label for restrictions on application per cropping cycle. Rate differs for scale. 12-hr REI. SIGNAL WORD - CAUTION
Resmethrin whiteflies	24% liquid	0.5 pt	3.3 T	1.0 T	Spray weekly to point of runoff for 4 weeks. Best results at 70° F. Foliage should be dry. Keep greenhouse closed 2-4 hours following aerosol treatments. 12-hr REI. SIGNAL WORD - CAUTION
	Fog	1.5 fl oz/10,000 cu ft	1.5 fl oz/10,000 cu ft	1.5 fl oz/10,000 cu ft	
whiteflies, fungus gnats, thrips, cucumber beetles, aphids	1% aerosol (PT 1200)	—	—	—	Apply 5-10 sec/100 sq ft of bench
Spinosad (Conserve) thrips, spider mites, dipterous leafminers, dipterous gall midges, lepidopterous larvae.	SC	3.0-11.0 fl oz	1.0-11.0 T	1.0-11.0 t	Compatible with IPM programs. See label for resistance management and rates for specific pests. 4-hr REI. SIGNAL WORD - CAUTION
Abbreviations: AF - aquaflo; W, WP - wettable powder; E, EC - emulsifiable concentrate; L - liquid; ME - microencapsulated; SP - sprayable or soluble powder; SC - spray concentrate; D - Dust; G - granular; A - aerosol; F - fog; SG - smoke generator; V - vapor; lb - pound; pt - pint; oz - ounce; fl oz - fluid ounce; cu ft - cubic feet; c - cup; T - tablespoon; t - teaspoon; gal - gallon(s)					
Useful Equivalents 1 lb WP/100 gal = 1 T/1 gal; 2.0 T = 1 fl oz; 1 pt EC/100 gal = 1 t/1 gal; 16 fl oz = 1 pt; 3 t = 1 T; 2 pt = 1 qt					

Table 5.5 - Guide to Pesticide Usage Cross Reference to Other Common Trade Names (cont.)

Rates of Application (T= Tablespoon; t= teaspoon)					
Pesticide	Formulation	50 Gal	10 Gal	3 Gal	Precautions And Remarks
Spiromesifen (Judo) mites, whiteflies	4F	1.0-2.0 fl oz	1.2-2.4 t	0.38-0.75 t	See label for species and number of applications per season. 12-hr REI. SIGNAL WORD - CAUTION
Spirotetramat (Kontos) aphids, whiteflies, mealybugs, spider mites	240SC	0.8 fl oz (25.0 ml)	0.2 fl oz (5.0 ml)	0.07 fl oz (2.0 ml)	See label for resistance management. Registered for vegetable transplants. Will not control heavy populations of spider mites. 24-hr REI. for sprays, no REI. for drench. SIGNAL WORD - CAUTION
Tebufenozide (Confirm) lepidopterous larvae	2E	2.0-8.0 oz	1.0-4.0 T	1.0-4.0 t	See label regarding spray adjuvants. 4-hr REI. SIGNAL WORD - CAUTION
Thiamethoxam (Flagship) aphids, whiteflies, mealybugs, soft scales	25WG	See label	—	—	See label for rate directly to soil or media. 12-hr REI. SIGNAL WORD - CAUTION
	.22G	See label	—	—	See label for granular product rate. 12-hr REI. SIGNAL WORD - CAUTION
Tolfenpyrad (Hachi-Hachi) aphids, leafhoppers, Lepidopteran early instars, scale, thrips, whitefly	15%EC	See label	—	—	See label for phytotoxicity. Rate for cuttings (cut flowers) is lower than other plants. 12-hr REI.. SIGNAL WORD - WARNING
Ultra-fine spray oil aphids, leafminers, whiteflies, mites, scales, mealybugs	6E	0.5-1.0 gal	13.0-26.0 oz	4.0-7.5 oz	Applicator should conduct phytotoxicity tests. 4-hr REI. SIGNAL WORD - CAUTION
Abbreviations: AF - aquaflo; W, WP - wettable powder; E, EC - emulsifiable concentrate; L - liquid; ME - microencapsulated; SP - sprayable or soluble powder; SC - spray concentrate; D - Dust; G - granular; A - aerosol; F - fog; SG - smoke generator; V - vapor; lb - pound; pt - pint; oz - ounce; fl oz - fluid ounce; cu ft - cubic feet; c - cup; T - tablespoon; t - teaspoon; gal - gallon(s)					
Useful Equivalents 1 lb WP/100 gal = 1 T/1 gal; 2.0 T = 1 fl oz; 1 pt EC/100 gal = 1 t/1 gal; 16 fl oz = 1 pt; 3 t = 1 T; 2 pt = 1 qt					

Organic Controls for Insect Pests of Floral Crops

Peter B. Schultz, Extension Entomologist, Hampton Roads AREC

Eric R. Day, Extension Entomologist, Virginia Tech

Table 5.6 - Organic Chemicals, Predators, and Pathogens

Product	Insects Controlled	Remarks
Chemical		
d-limonene	Imported fire ants	Provides quick kill.
Insecticidal soap	Works well on soft bodied insects, in particular aphids, mites, lacebugs, mealybugs	This product is sold under many trade names and is a fatty acid soap.
Spinosad	Many insect pests, including thrips, lepidopterous larvae, and leaf beetles	Entrust is for organic production.
Rotenone	Many insect pests including aphids, leafhoppers, weevils, Japanese beetles, flea beetles	Usually sold as a dust, but some formulations can be mixed in water.
Pyrethrin	Broad spectrum, works on a wide variety of insects	Usually sold mixed with other botanical insecticides.
Predators		
Lady beetles	Feed on aphids and other soft bodied insects	Lady beetles may leave to find other prey. <i>Cryptolaemus</i> for mealybug, <i>Delphastus</i> for whitefly. <i>Stethorus</i> for spider mites.
Lacewings	Aphids, scales, mealybugs, other soft bodied insects	Immature <i>Chrysoperla carnea</i> are called aphid lions.
Predatory bugs	thrips	Orius for all stages of western flower thrips
Predatory midges	Aphids, thrips, fungus gnat larvae	<i>Aphidoletes aphidimiza</i> for aphids
Predatory mites	Whitefly, spider mites, thrips, fungus gnat larvae	<i>Amblyseius swirskii</i> for whiteflies and thrips; <i>Phytoseilus persimilis</i> for red and 2-spotted spider mites; <i>Hypoaspis</i> for fungus gnat larvae; <i>Amblyseius californicus</i> for 2-spotted spider mite and carmine mite; <i>Amblyseilus cucumeris</i> for western flower thrips; <i>Amblyseilus andersoni</i> for red and 2-spotted spider mites.
Parasitic wasps	Leafminers, whiteflies	<i>Diglyphus isaea</i> for leafminers; <i>Encarsia formosa</i> and <i>Eretmocerus eremicus</i> for whiteflies.
Rove beetle	Fungus gnat larvae	Rove beetle for fungus gnat larvae
Pathogens		
<i>Bacillus thuringiensis</i>	Leaf-feeding caterpillars	Known as <i>Bt</i> , is sold under many trade names. A strain of this bacterium controls fungus gnats.
Entomopathogenic nematodes (<i>Steinernema</i> and <i>Heterorhabditis</i>)	Fungus gnats, shore flies, western flower thrips, root mealybugs, borers, root feeders	Rates are on product label; soil temperature should exceed 60 F. Apply late in the day, irrigate immediately.
Entomopathogenic fungi <i>Beauveria bassiana</i> , <i>Metarhizium anisopliae</i> (Met52EC), <i>Isaria fumosoroseus</i> (NoFly WP, Preferal)	whiteflies, thrips, aphids, mealybugs, fungus gnats, vine weevils, psyllids, plant bugs, beetles, leafhoppers	See label for proper material for target pest. <i>Beauveria</i> is sold under several trade names. Follow label for mixing directions, application timing and intervals and if a foliar spray or drench. NoFly WP can be applied with a cold fogger.

Weed Control in Greenhouses

Jeffrey F. Derr, Extension Weed Scientist, Hampton Roads AREC

Nonchemical Control

Hand-weeding and good sanitation are the safest ways to control weeds in greenhouses. Remove weeds from plugs or liners prior to planting. Use media that are free of weed seed or have been temporarily sterilized using steam or other methods. For steam sterilization of media, mix should be maintained at 180°F for at least 30 minutes. Some weed seed will not be controlled. Prevent weeds from flowering in and around the greenhouse. Allow the greenhouse to completely dry out between crops. Use concrete for the greenhouse floor. Clean up growing media that spill onto the floor.

Chemical Control

Most herbicides cannot be used in greenhouses due to the potential for chemical volatilization under high temperatures. Since greenhouses are enclosed structures, herbicide vapors are trapped around the crop and could cause severe injury. There are several herbicides that are registered for weed control under greenhouse benches. There are no preemergence herbicides registered for weed control in containers or flats located in a greenhouse. See the chapters on Home and Commercial Ornamentals for herbicides registered for annual and perennial flowers maintained outdoors.

Table 5.7 - Nonselective Herbicides Registered for Weed Control Under Greenhouse Benches

Chemical	Rate	Comments
Envoy Plus (clethodim)	0.5 fl oz + 1/3 fl oz nonionic surfactant/gal	Apply to weed foliage for control of annual bluegrass, crabgrass, bermudagrass, and other grassy weeds. Make sure that no ornamental grasses or other desired grasses are in the greenhouse. Will not control sedges or any broadleaf weed.
Finale (glufosinate)	1.5-4.0 fl oz/gal	Turn off air circulation fans during application. Contact nonselective herbicide with some systemic activity. No soil residual action.
Glyphosate (Roundup ProMax or other labeled formulations)	1.0-2.0 fl oz/gal check label for rates	Remove desired vegetation from the greenhouse and turn off air circulation fans prior to application. Systemic postemergence herbicide for control of all weeds. No soil residual action.
Reward (diquat)	0.75 fl oz + labeled rate of a nonionic surfactant/gal	Avoid spray drift to crops. Contact postemergence herbicide for control of all weeds. No residual action.
Scythe (pelargonic acid)	3.0%-7.0% solution	Avoid spray drift to crops. Contact postemergence herbicide for control of all weeds. No residual action. Has an odor that dissipates over time.
Acetic Acid (Weed Pharm)	Rate Varies	Organic Control. For liverwort control, mix one part Weed Pharm to two parts water. For control of grasses and broadleaf weeds use full strength. Contact nonselective postemergence herbicide. Do not allow spray to contact desired plants.

Diseases

David S. McCall, Research Associate, Plant Pathology, Virginia Tech

Fungicides play an important role in the successful management of turfgrasses, especially throughout the transition zone where no grasses experience ideal growing conditions. However, the use of fungicides is only one part of successful management of diseases. Practicing sound cultural techniques, such as proper fertilization, irrigation, and mowing strategies, provides a stand of turf with a greater ability to withstand attack by pathogens. Additional information on proper cultural practices is available in the following links:

- Spring and Summer Lawn Management Considerations for Cool-Season Turfgrasses: (<http://pubs.ext.vt.edu/430/430-532/430-532.html>)
- Spring and Summer Lawn Management Considerations for Warm-Season Turfgrasses (<http://pubs.ext.vt.edu/430/430-533/430-533.html>)
- Winter Management and Recovery Tips to Optimize Athletic Field Safety and Performance for Spring Sports (<http://pubs.ext.vt.edu/430/430-408/430-408.html>)

Below are the most common fungicide active ingredients that are used for turfgrass management, along with diseases that they control.

Table 6.1- Fungicides Labeled for Control of Various Turfgrass Diseases

Active Ingredient	Algae	Anthrachnose	Brown Patch	Copper spot	Dead Spot	Dollar Spot	Fairy Ring	Gray Leaf Spot	Large Patch	Leaf Spot/Melting Out	Microdochium Patch (Pink Snow Mold)	Powdery Mildew	Pythium Blight	Red Thread	Rusts	Spring Dead Spot	Summer Patch	Take-all Patch	Typhula Blight (Gray Snow Mold)	Yellow Patch
azoxystrobin		*	*				*	*	*	*	*	*	*	*	*	*	*	*	*	*
boscalid					*	*														
chloroneb													*						*	
chlorothalonil	*	*	*	*		*		*	*	*	*			*	*				*	
cyazofamid													*							
difenoconazole		*	*			*	*	*	*	*	*	*		*	*	*	*	*	*	*
etridiazole													*							
fenarimol		*	*	*		*					*	*		*		*	*	*	*	*
fludioxonil		*			*	*		*	*	*	*					*	*	*	*	*
fluopicolide + propamocarb													*							
fluzinam	*	*	*			*		*	*	*	*			*					*	
fluoastrobilin		*	*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
flutolanil			*				*							*					*	*
fosetyl-Al													*							
iprodione			*			*		*	*	*	*			*					*	
mancozeb	*		*	*		*		*	*	*			*	*	*					
mefenoxam													*							
metconazole		*	*			*	*	*	*	*	*			*		*	*	*	*	*
myclobutanil		*	*	*		*		*	*	*	*	*	*	*	*	*	*	*	*	*
PCNB		*	*	*	*			*	*	*			*	*	*	*	*	*	*	*
phosphonates													*							

These recommendations are not a substitute for pesticide labeling.

Always Read and Follow the Label

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Table 6.1- Fungicides Labeled for Control of Various Turfgrass Diseases (cont.)

Active Ingredient	Algae	Anthraxnose	Brown Patch	Copper spot	Dead Spot	Dollar Spot	Fairy Ring	Gray Leaf Spot	Large Patch	Leaf Spot/Melting Out	Microdochium Patch (Pink Snow Mold)	Powdery Mildew	Pythium Blight	Red Thread	Rusts	Spring Dead Spot	Summer Patch	Take-all Patch	Typhula Blight (Gray Snow Mold)	Yellow Patch
polyoxin-D zinc salt		*	*				*	*	*	*	*			*					*	*
propamocarb													*							
propiconazole		*	*		*			*		*	*	*	*	*	*	*	*	*	*	*
pyraclostrobin		*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
tebuconazole		*	*	*		*		*	*	*	*	*	*	*	*	*	*	*	*	*
thiophanate-methyl		*	*	*	*	*		*	*	*				*		*	*	*		*
thiram			*	*		*				*				*	*					*
triadimefon			*	*		*				*	*	*		*	*		*	*		*
trifloxystrobin		*	*					*		*				*	*		*			
triticonazole	*	*	*			*		*	*	*	*			*	*		*	*		*
vinclozolin			*			*				*	*			*						*

These recommendations are not a substitute for pesticide labeling.

Always Read and Follow the Label

Table 6.2 - Registered Trade Names of Common Active Ingredients Used for Control of Turfgrass Diseases by Professionals.

active ingredient	Trade name(s)
azoxystrobin	Heritage (50WG, TL, G), Headway G*, Renown*, Briskway*
boscalid	Emerald , Honor*
chloroneb	Andersons Fungicide V, Fungicide IX*
chlorothalonil	Daconil (Action*, Ultrex, WeatherStik, ZN), QualiPro Chlorothalonil, Docket, Echo Chlorothalonil, Enclave*, Pegasus, Primera One Chlorothalonil, Pro Solutions Thalonil, Concert*, Instrata*, Legend, Renown*, Reserve*, Spectro 90*, Disarm C*, Vitalonil*, TM/C*,
cyazofamid	Segway
difenoconazole	Briskway*
etridiazole	Terrazole 35WP , Terrazole L
fenarimol	Rubigan
fluazinam	Secure
fludioxonil	Medallion SC , Medallion WDG, Instrata*
fluopicolide + propamocarb	Stellar
fluoxastrobin	Disarm 480SC , Disarm C*, Disarm G, Disarm M*
flutolanil	Prostar
fosetyl-Al	Chipco Signature , QualiPro Fosetyl-Al
iprodione	26GT , 26019 Flo, Iprodione Pro 2SE, Enclave*, Nufarm Iprodione, Primera One Iprodione, QualiPro Ipro 2SE, Raven, Interface*, 26/36*, Dovetail*, Nufarm TM+IP*
mancozeb	Fore (Rainshield), Dithane, Junction*, Protect, Wingman

*Product is a preformulation of at least two active ingredients. **BOLD** products are generally considered to be the most common trade name. It is possible that not all products labeled for use in turf are listed in this table. Products listed in this table are included in the Virginia Department of Agriculture and Consumer Services Approved Pesticide Database (<http://www.kellysolutions.com/va/pesticideindex.htm>).

Always Read and Follow the Label. Many products have restrictions on site usage, yearly maximum use, application frequency, and/or personal protection equipment requirements. These recommendations are not a substitute for pesticide labeling.

Table 6.2 - Registered Trade Names of Common Active Ingredients Used for Control of Turfgrass Diseases by Professionals.

active ingredient	Trade name(s)
mefenoxam	Subdue MAXX , Subdue G, QualiPro Mefonoxam 2AQ
metconazole	Tourney
myclobutanil	Eagle 20EW , QualiPro Myclobutanil, Disarm M*, Lebanon Eagle G, Howard Johnson's Eagle G
PCNB	Turfcide10G, Turfcide 400, Andersons FFII
phosphonates	Alude, Appear, AgriFos, Exel LG, Fosphite, Fungi-Phite, K-Phite, Phorcephite, Phostrol, Primera Magellan, Quanta, Rampart, ReSyst
polyoxin-D zinc salt	Affirm , Endorse
propamocarb	Banol , Stellar*
propiconazole	Banner MAXX , Andersons Prophesy, Kestrel, Lesco Spectator, Nufarm Propiconazole, PrimeraOne Propiconazole, ProPensity, Propiconazole Select, Strider, Propimax, QualiPro Propiconazole, Savvi, Headway*, Headway G, Instrata*, Concert*
pyraclostrobin	Insignia , Honor*, PillarG*
tebuconazole	Torque , Enclave*, QualiPro Tebuconazole
thiophanate-methyl	3336 (WSP, FLO, Plus, G, DG Lite), 26/36*, Allban, Andersons Fluid Fungicide, Andersons Fungicide VII, Cavalier, Consyst*, Dovetail*, Fungicide IX*, Fungo, Lesco T-Storm, Lesco Twosome*, Nufarm TM+CTN*, Nufarm TM+IP*, Nufarm T-Methyl, Peregrine, PrimeraOne TM, QualiPro TM, QualiPro TM/C*, Spectro 90*, Systec, T-Bird, TM Select, Tee-1-Up*, Tee-Off, Topsin
thiram	Spotrete , Thiram Granuflo
triadimefon	Bayleton (Flo, 50DG, 50WSP, G), Andersons Bayleton G, Andersons Fungicide VII, Armada*, Tartan*
trifloxystrobin	Compass , Armada*, Tartan*, Interface*
triticonazole	Trinity , Triton WG, Triton FLO, Reserve*, PillarG*
vinclozolin	Curalan , Touche

*Product is a preformulation of at least two active ingredients. **BOLD** products are generally considered to be the most common trade name. It is possible that not all products labeled for use in turf are listed in this table. Products listed in this table are included in the Virginia Department of Agriculture and Consumer Services Approved Pesticide Database (<http://www.kellysolutions.com/va/pesticideindex.htm>). **Always Read and Follow the Label.** Many products have restrictions on site usage, yearly maximum use, application frequency, and/or personal protection equipment requirements. These recommendations are not a substitute for pesticide labeling.

6-4 *Turf: Diseases*

Insects

Rod R. Youngman, Extension Entomologist, and Curt Laub, Research Associate, Virginia Tech

Recommendations for management of major turfgrass pests are outlined below. The remarks column contains information on timing, pest thresholds, suggested detection and monitoring techniques, and cultural and biological control recommendations to aid turfgrass professionals to maximize control effectiveness. This is an excellent opportunity for turfgrass professionals to utilize the IPM approach and reduce environmental contamination.

Many materials are currently under examination due to the Food Quality Protection Act (FQPA). Users of organophosphates and carbamate pesticides should keep up to date with ongoing label cancellations.

Caution: Be sure to consider drainage, slope, type of soil, weather, and general area use to avoid contamination of water sources. Avoid using treated areas immediately after application.

Note: Unless indicated otherwise, the following recommendations for amount of product are given for 1,000 sq ft of area and in per acre amounts as well. Formulations other than those indicated may have different rates. Always follow directions on product labels. To ensure even distribution of soil insecticides apply at least one half inch of water immediately after application in order to move the material through the thatch layer.

White Grubs (grub/larval stage)

White grubs include several species of scarab beetles in the family *Scarabaeidae*. White grubs can be managed by some entomopathogenic nematodes. Not all nematode species (named on the product label under the “Active Ingredients” section) available commercially will provide adequate control. Products with *Steinernema riobrave* should not be used for grub control. Products with *Heterohabditis bacteriophora* are more effective. Entomopathogenic (insect killing) nematode products should be applied only when the pest is present. Apply nematodes late in the day to avoid exposure to UV light damage. Irrigate the day before and immediately after application. Early spring treatments are usually not effective because soil temperatures should be at least 60°F.

Beauvaria bassiana (white muscardine entomopathogenic fungus) products also provide effective control. Follow label instructions and water 0.5 inch immediately after application. Avoid fungicide applications for at least 4 days when using these products.

Several insecticides are available for grub management. These products should be applied at the labeled rate and watered in with 0.25 to 0.5 inch of water. Most insecticides provide the best control when used against early instar (smaller) grubs present from early to mid August. Populations high enough to warrant treatment are ≥ 8 grubs/sq ft on well-maintained turf, and 4 to 6 grubs per square foot or higher on unthrifty turf. White grubs stop feeding in September or October, so control during fall may not prove successful. Spring treatments generally are not effective either.

Cultural management: Reducing the thatch layer to <0.5 inch will help increase the penetration of any treatment applied to turfgrass. Also, avoid applying grubicides when soil is saturated or waterlogged.

Table 6.3 - Insecticides for White Grubs (larval stage)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
<i>Beauvaria bassiana</i>		16.0-32.0 oz	Use 100 gal water/A. Check label for details.
carbaryl (Sevin 10G)	1.9 lb	82.7 lb	Sevin 10G: Lawns, recreational, and ornamental turf.
(Sevin SL [4EC])	6.0 oz	2.0 gal	Sevin SL and 80WSP: Residential and nonresidential sites (check labels for details).
(Sevin 80WSP)	3.67 oz	10.0 lb	
chlorantraniliprole (Acelepryn 1.67SC)	0.184-0.367 oz	8.0-16.0 oz	Acelepryn 1.67SC: For residential, commercial, recreational turf, including golf courses and sod farms. Has moderate systemic activity. Acelepryn may be applied from early April to early Sept. for preventative and early curative control of all major white grub species infesting turfgrass. Use higher rate for late August or early Sept. applications due to fewer mid-instar grubs present at the time of application. Optimal results can be achieved if product is watered in (≥ 0.5 inch) immediately after application.

Table 6.3 - Insecticides for White Grubs (larval stage)(cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
chlorpyrifos (Dursban 50W)	1.46-2.93 oz	4.0-8.0 lb	RESTRICTED USE. Dursban 50W can only be used on sod farms and turfgrass grown for seed to control white grubs. For best results, treat from late July through early August to reach the newly hatched grubs that are actively feeding near the soil-thatch interface. Soil should be moist before treating. Water 0.5 to 1.0 inch immediately after treating to move AI into soil.
clothianidin (Arena 0.25G)	1.84-3.67 lb	80.0-160.0 lb	Arena 0.25G: Residential and nonresidential sites (check labels for details). For best results, treat just prior to egg laying or to early instar grubs of target pests. Treatment should be followed by sufficient water to move AI into soil.
(Arena 50WDG)	0.147-0.294 oz	6.4-12.8 oz	Arena 50WDG: Use high rate for control of Asiatic garden beetle grub.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G)	1.8-3.6 lb	80.0-160.0 lb	Aloft GC G and GC SC: RESTRICTED USE. Contact and systemic insect pest control for turf on residential and nonresidential sites including lawns, commercial, public, parks, recreational areas, athletic fields, golf courses and sod farms. For the granular formulation, apply enough water (≥ 0.5 inch) to release AI from carrier. Check labels for details.
clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	0.27- 0.44 oz	11.65-19.0 oz	
dinotefuran (Zylam 20SG)	1.0 oz	2.7 lb	Zylam 20SG: Residential and nonresidential sites, including sod farms. Optimum control can be achieved when applications are made prior to or at egg hatch of the target pests followed by sufficient irrigation or rainfall to move AI through the turf thatch layer. The AI in Zylam is highly systemic and has a high water solubility. It is highly mobile and resistant to biodegradation. These physical traits make the AI a good candidate for leaching into the ground water, particularly where the water table is shallow and roots are permeable. Caution must be taken when using this product. Do not graze treated areas or use clippings from treated areas for feed or forage. Keep children and pets off areas until spray has dried. Do not apply to areas that are water logged or saturated or frozen.
Entomopathogenic nematodes		100 million- 1 billion	
halofenozide (Mach 2 1.5G)	3.0 lb	133.0 lb	Mach 2 1.5G: Residential and nonresidential sites including sod farms. Mach 2 2SC: Nonresidential sites and sod farms (check labels for details). For best results for these products, reduce heavy thatch buildup to <0.5 inch and treat prior to egg hatch or when grubs are small (≤ 2 nd instar) and actively feeding (late July-early Aug). Also, these products are not dependent upon watering after treating to activate the AI; however, water is necessary to move the AI through the thatch layer. Under drought conditions it is recommended to water in these products.
(Mach 2 2SC)	2.9 oz	1.0 gal	

Table 6.3 - Insecticides for White Grubs (larval stage)(cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
imidacloprid (Merit 2F)	0.46–0.6 oz	1.25-1.6 pt	Merit 2F, 75WSP and 0.5G: Residential and nonresidential sites (check labels for details). Merit 2F and 75WSP can be used on sod farms, but not the 0.5G formulation. For best results, treat from early July to early August. Can also treat up to 45 days before the historical peak of adult flight to 2nd instar grub being targeted. Treatment should be followed by sufficient water to move AI into soil.
(Merit 75WSP)	1.6 oz (1 packet)/ 8,250-11,000 sq ft		
(Merit 0.5G)	1.4-1.8 lb	60.0-80.0 lb	
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G)	2.3-2.9 lb	100.0-125.0 lb	Allectus G and SC: Residential and nonresidential sites, but not for use on golf courses or sod farms. Allectus GC and GC SC: RESTRICTED USE. Golf courses and sod farms only.
(Allectus GC)	2.3-2.9 lb	100.0-125.0 lb	
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	1.32-1.65 oz	3.6-4.5 pt	For best results for all products, water within 24 hours of treating to move AI through the thatch layer.
imidacloprid (5%) and bifenthrin (4%) (Allectus SC)	1.32-1.65 oz	3.6-4.5 pt	
thiamethoxam (Meridian 25WG)	1.5-1.95 oz/5,000 sq ft	12.7-17.0 oz	Meridian 25WG: Residential and nonresidential sites (check label for details). For best results, treat from peak flight to peak egg hatch. Can also treat up to 45 days before historical peak of adult flight to 2nd instar grub being targeted. Treatment should be followed by sufficient water to move AI into soil.
trichlorfon (Dylox 6.2G)	3.0 lb	130.0 lb	Dylox 6.2G, 80 [SP], and 420SL: Residential, parks and golf course sites. For best results, thatch layer must be <0.5 inch at time of treatment. Treat from mid July to early August when grubs are young and actively feeding near soil surface. Treatment should be followed by sufficient water to move AI into soil.
(Dylox 80 [SP])	3.75 oz	10.2 lb	
(Dylox 420SL)	6.0-9.0 oz	300.0 oz	
			Dylox 80 [SP] and 420SL: Apply immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥9). Do not use treated area or clippings from treated areas for feed or forage.

Black Turfgrass Ataenius

Black turfgrass ataenius is the smallest white grub that attacks turfgrass in Virginia. The fully-grown grub reaches 0.31 inch (8 mm) in length. The size of the adult beetle varies from 1/8" to 1/4" (3.6-5.5 mm) in length. Black turfgrass ataenius has two generations per year in Virginia. The adult beetles overwinter in the thatch layer of the rough next to fairways or in wooded lots. The overwintering adults become active from mid-April to early May about the time when spring crocus and red bud are in bloom. A springtime pyrethroid application targeting the overwintering adults after they become active (typically the last week of April), but before peak egg laying has occurred, can provide effective control of not only the adults but also the first generation of new grubs. Applications targeting adults should not be watered in because the adults are in the thatch layer.

First generation adults are actively laying eggs in July. Second generation adults, which represent the overwintering stage, begin emerging from late August through September. Insecticides targeting second generation adults are not recommended.

Spring applications targeting the early instar grubs of the first generation should be timed to when Vanhoutte spirea or horse chestnut are in full bloom (May) or when black locust begins to bloom.

Insecticides targeting second generation grubs should be applied from mid-July (blooming stage of Rose of Sharon) to early August before the grubs have matured to the third (and final) instar to avoid serious damage to the turfgrass.

Insecticides recommended for annual white grubs are generally effective against black turfgrass ataenius grubs. Applications should be watered in because the grubs are feeding on turf roots beneath the thatch layer.

A degree day program (Wegner and Niemczyk 1981 in Haruo Tashiro, *Turfgrass Insects of the United States and Canada*) targets treatments to control the newly hatching first instar grubs. Based on a 55°F flight threshold, the program predicts that first generation eggs should begin to appear when 180-270 DD (degree days) have accumulated. Second generation eggs are expected to appear when 1,170-1,278 DD have accumulated, which coincides with the July blooming stage of Rose of Sharon. There are about 60-70 days between generations.

Thresholds for black turfgrass ataenius are not firm. Although 200-300 grubs per square foot have been reported, turf often shows damage at populations of 20 to 30 grubs per square foot, and populations of 50 per square foot can result in serious damage. However, damage often goes unnoticed in grass that is longer than 2.0 inches, properly fertilized, and not water-stressed.

To monitor for grubs, use a cup cutter and carefully check the thatch and area beneath it.

Cultural management: Reducing the thatch layer to <0.5 inch will help increase the penetration of any treatment applied to turfgrass. Also, avoid making soil insecticide applications when the soil is saturated or waterlogged.

Table 6.4 - Insecticides for Black Turfgrass Ataenius

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
Grub/larval stage			
acephate (Orthene Turf, Tree, and Ornamental Spray 97)	0.9-1.4 oz (use minimum 5 gal water)	2.45-3.81 lb	Golf courses and sod farms only. Treat when insects or their damage first appear. Water lightly (≤ 0.5 inch) after treating. Do not graze or provide livestock treated grass.
<i>Beauveria bassiana</i>		16.0-32.0 oz	Use 100 gal of water/A.
carbaryl (Sevin SL [4EC]) (Sevin 80WSP)	6.0 oz 3.67 oz	2.0 gal 10.0 lb	Sevin SL and 80WSP: Residential and nonresidential sites (check labels for details).
chlorantraniliprole (Acelepryn 1.67SC)	0.184-0.367 oz	8.0-16.0 oz	Acelepryn 1.67SC: Residential, commercial, recreational turf, including golf courses and sod farms. Has moderate systemic activity. Acelepryn may be applied from early April to early Sept. for preventative and early curative control of all major white grub species infesting turfgrass. Use higher rate for late August or early Sept. applications due to fewer mid-instar grubs present at the time of application. Optimal results can be achieved if product is watered in (≥ 0.5 inch) immediately after application.

Table 6.4 - Insecticides for Black Turfgrass Ataenius (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
clothianidin (Arena 0.25 G) (Arena 50WDG)	1.84-3.67 lb 0.147-0.294 oz	80.0-160.0 lb 6.4-12.8 oz	Residential and nonresidential sites (check labels for details). For best results, treat just prior to egg laying or to early instar grubs of target pests. Treatment should be followed by sufficient water to move AI into soil.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G)	1.8-3.6 lb	80.0-160.0 lb	Aloft GC G and GC SC: RESTRICTED USE. Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial, public, parks, recreational areas, athletic fields, golf courses, and sod farms.
clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	0.27- 0.44 oz	11.65-19.0 oz	For the granular formulation, apply enough water (≥ 0.5 inch) to release AI from carrier. Check labels for details. Time application to coincide with first generation black turfgrass grubs, which usually occurs in May. White grubs also will be controlled from an application for targeting black turfgrass ataenius.
dinotefuran (Zylam 20SG)	1.0 oz	2.7 lb	Zylam 20SG: Residential and nonresidential sites, including sod farms. Optimum control can be achieved when applications are made prior to or at egg hatch of the target pests followed by sufficient irrigation or rainfall to move AI through the turf thatch layer. The AI in Zylam is highly systemic and has a high water solubility. It is highly mobile and resistant to biodegradation. These physical traits make the AI a good candidate for leaching into the ground water, particularly where the water table is shallow and roots are permeable. Caution must be taken when using this product. Do not graze treated areas or use clippings from treated areas for feed or forage. Keep children and pets off areas until spray has dried. Do not apply to areas that are water logged or saturated or frozen.
halofenozide (Mach 2 1.5G) (Mach 2 2SC)	3.0 lb 2.9 oz	133.0 lb 1.0 gal	Mach 2 1.5G: Residential and nonresidential sites including sod farms. Mach 2 2SC: Nonresidential sites and sod farms (check labels for details). For best results for these products, reduce heavy thatch buildup to <0.5 inch and treat prior to egg hatch or when larvae are small (≤ 2 nd instar) and actively feeding (early June to early August). Also, these products are not dependent upon watering after treating to activate the AI; however, water is necessary to move the AI through the thatch layer. Under drought conditions, it is recommended to water in these products.
imidacloprid (Merit 2F) (Merit 75WSP)	0.46-0.6 oz 1.6 oz (1 packet)/ 8,250-11,000 sq ft	1.25-1.6 pt	Merit 2F, 75WSP and 0.5G: Residential and non-residential sites (check label for details). Merit 2F and 75WSP can be used on sod farms, but not the 0.5G formulation. For best results, treat from July to early August. You can also treat up to 45 days before the historical peak of adult flight to the 2nd instar grub being targeted. Treatment should be followed by sufficient water to move AI into soil.
(Merit 0.5G)	1.4-1.8 lb	60.0-80.0 lb	

6-10 Turf: Insects

Table 6.4 - Insecticides for Black Turfgrass Ataenius (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G)	2.3-2.9 lb	100.0-125.0 lb	Allectus G and SC: Residential and nonresidential sites, but not for use on golf courses or sod farms.
(Allectus GC)	2.3-2.9 lb	100.0-125.0 lb	
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	1.32-1.65 oz	3.6-4.5 pt	Allectus GC and GC SC: RESTRICTED USE. Golf courses and sod farms only. For best results for all products, water within 24 hours of treating to move AI through the thatch layer.
imidacloprid (5%) and bifenthrin (4%) (Allectus SC)	1.32-1.65 oz	3.6-4.5 pt	
thiamethoxam (Meridian 25WG)	1.5-1.95 oz/5,000 sq ft	12.7-17.0 oz	Residential and nonresidential sites (check label for details). For best results, treat from peak flight to peak egg hatch. Can also treat up to 45 days before historical peak of adult flight to 2nd instar grub being targeted.
trichlorfon (Dylox 80 [SP])	3.75 oz	10.2 lb	Residential, park, and golf course sites. For best results, thatch layer must be <0.5 inch at time of treatment. Treat when larvae are young and actively feeding near soil surface. Treatment should be followed by sufficient water to move AI into soil. Dylox 80 [SP] and 420SL: Apply immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥9). Do not use treated area or clippings from treated areas for feed or forage.
(Dylox 420SL)	6.9 oz	300.0 oz	
Adult stage			
bifenthrin (Talstar GC [flowable])	0.25-0.5 oz	10.0-20.0 oz	Residential and nonresidential sites (check labels for details). For best results to control overwintering adults, treat from mid-April to early May (usually bracketed by when spring crocus and redbud are in bloom). To control first generation adults, treatments should be timed to coincide with the blooming stage of Rose of Sharon in July.
(TalstarOne [7.9%=0.66 lb AI/gal])	0.25-0.5 oz	10.0-20.0 oz	
(Talstar EZ [granule])	1.15-2.3 lb	50.0-100.0 lb	
(Talstar GC [granule])	1.15-2.3 lb	50.0-100.0 lb	
(Talstar PL [granule])	1.15-2.3 lb	50.0-100.0 lb	
chlorpyrifos (Dursban 50W)	1.46 oz	4.0 lb	RESTRICTED USE. Dursban 50W can only be used on sod farms and turfgrass grown for seed for black turfgrass ataenius control. For best results, treat overwintering adult stage from mid-April to early May (usually bracketed by when spring crocus and redbud are in bloom). Repeat application may be needed within 1 to 2 weeks. Check label for details.
lambda-cyhalothrin (Scimitar [9.7%] GC 0.88 lb AI/gal)	7.0 ml (use 2-10 gal water)	10.0 oz	RESTRICTED USE. Residential and nonresidential sites. For best results, water lightly after treating (≤0.5 inch) to move AI into thatch layer. Check label for details.
spinosad (Conserve [11.6%] SC Turf and Ornamental [1.0 lb AI/gal])	1.2 oz	52.0 oz	Residential and nonresidential sites. Check label for details.

Annual Bluegrass Weevil

Golf course greens and fairways planted in creeping bentgrass, *Agrostis stolonifera*, often become infested with the weed, annual bluegrass, *Poa annua*. These two grass species are the main hosts on which ABW adults and larvae feed. A brief overview follows on ABW life history and description of important life stages. Knowing the seasonal development and identity of important life stages is critical to making one or two well-timed applications early rather than six or eight from May through August to control overlapping populations of ABW life stages.

In early spring around the time when *Forsythia* is in full bloom, ABW adults leave their overwintering sites in pine duff or other types of leaf litter and walk to annual bluegrass-infested bentgrass greens and fairways. The full bloom stage of the flowering dogwood typically marks the end of adult migration. The adults feed in the grass foliage above the thatch and can be easily detected upon close inspection. Two or three eggs are laid within leaf sheaths just above the crown. Newly hatched larvae feed within the leaf sheath and then move into the crown and roots where the most serious damage occurs. If unchecked, high populations of larger larvae (fourth and fifth instars) can kill the bentgrass, turning greens and fairways light brown despite adequate moisture and nutrients. The life cycle from egg to adult takes about 50-60 days in New England states, but may require fewer days in warmer southern states, and depending on location, ABW is capable of completing three or four generations per year. In the fall, ABW adults fly from golf greens and fairways to overwinter.

The ABW egg is pale yellow to white and oblong in shape. It is about 0.03 in long by 0.01 in wide. The larva is legless, has a brown head and creamy white body, and is rounded at both ends. The larva passes through five instars (i.e., sheds its skin four times) before pupating. The first instar is about 0.03 in long, whereas the fifth instar is about 0.20 in. The newly emerged ABW adult is light tan; it then turns brown with small areas of yellow scales and hairs mottled throughout. The body eventually turns dark charcoal gray after the brown and yellow scales wear off. The length of the adult varies from 1/8 in – 5/32 in, and the antennae are elbowed and attached near the tip of the snout where the chewing mouthparts are located.

ABW management remains largely pesticide driven. However, to avoid multiple insecticide applications, properly time the first application to when the adults begin to move from their overwintering sites onto golf greens to feed and lay eggs. Research has shown that the post-bloom stage of *Forsythia* species (referred to as the “1/2 green and 1/2 gold” stage) can be used on site as a phenological indicator for timing the adulticide application.

Adulticide products used widely from the mid- to late-1990s until now are pyrethroids such as Scimitar and Talstar. More recently, larvicide products such as Dylox initially, then Conserve, Provaunt and Acelepryn have become popular ABW management tools. However, years of repeated exposure to pyrethroids in some New England states has caused some ABW populations to become resistant. Fortunately, ABW resistance to insecticides is not widespread yet.

The obvious first step then is to be on the alert from late March through April (season and location dependent) to identify if ABW adults are on your course. At the same time be ready to take action if necessary. Probably the least expensive but still most effective approach for Virginia is to time one pyrethroid application at the 1/2 green and 1/2 gold stage. Experts caution that a second pyrethroid application three-four weeks later is often necessary for late arriving adults. In addition, neonicotinoids applied alone should not be relied on to control ABW adults. They need to be either followed up with or tank-mixed with a suitable pyrethroid. Allectus and Aloft are recent introductions of products labeled for ABW that combine a neonicotinoid with a pyrethroid.

Although the larvicide Acelepryn was only labeled for turf in 2008, DuPont received enough data from university efficacy trials and on the systemic nature of the active ingredient (chlorantraniliprole) to recommend applying Acelepryn at the “adult timing” stage, i.e., 1/2 green and 1/2 gold. The reason being is the importance of having the active ingredient in Acelepryn moving through the plant when the young ABW larvae take their first bite.

No matter what approach you take for combating ABW adults and larvae this year, it bears repeating that a well-timed adulticide early, and perhaps a second curative larvicide application two-three weeks later, will go a long way towards mitigating the need for additional insecticide applications, as well as furthering the delay in ABW resistance buildup to these products.

Table 6.5 - Insecticides for Annual Bluegrass Weevil

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
Larva stage			
chlorantraniliprole (Acelepryn 1.67SC)	0.275-0.46 oz	12.0-20.0 oz	Acelepryn 1.67SC: Residential, commercial, recreational turf, including golf courses and sod farms. Has moderate systemic activity. Apply Acelepryn at the "adult timing" stage, i.e., the post-bloom stage when <i>Forsythia</i> is 1/2 green and 1/2 gold, to kill the early larval instars in the spring. Apply ≥ 0.5 inch water immediately after application. Refer to introductory text and label for more details
dinotefuran (Zylam 20SG)	1.0 oz	2.7 lb	Zylam 20SG: Residential and nonresidential sites, including sod farms. Optimum control can be achieved when applications are made prior to or at egg hatch of the target pests followed by sufficient irrigation or rainfall to move AI through the turf thatch layer. The AI in Zylam is highly systemic and has a high water solubility. It is highly mobile and resistant to biodegradation. These physical traits make the AI a good candidate for leaching into the ground water, particularly where the water table is shallow and roots are permeable. Caution must be taken when using this product. Do not graze treated areas or use clippings from treated areas for feed or forage. Keep children and pets off areas until spray has dried. Do not apply to areas that are water logged or saturated or frozen.
halofenozide (Mach 2 2SC)	2.9 oz .	1.0 gal	Mach 2 2SC: Nonresidential sites and sod farms. For best results reduce heavy thatch buildup and treat prior to egg hatch or when larvae are in early instar stages. Mach 2SC is not dependent on watering in after treating to activate the AI; however, water is necessary to move the AI through the thatch layer. Under drought conditions, it is recommended to apply water after treating. Refer to introductory text and label for more details.
Imidacloprid (Merit 2F) (Merit 75WSP)	0.46-0.6 oz 1.6 oz (1 packet) /8,250-11,000 sq ft	1.25-1.6 pt	Merit 2F, 75WSP, 0.5G: Residential and nonresidential sites (check labels for details). Merit 2F and 75WSP can be used on sod farms, but not the 0.5G formulation. Treatment should be followed by sufficient water to move AI into soil. Refer to introductory text and label for more details.
(Merit 0.5G)	1.4-1.8 lb	60.0-80.0 lb	
indoxacarb (Provaunt [30% WDG])	0.275 oz	12.0 oz	Provaunt [30% WDG]: Residential and nonresidential sites. Label specifies lawn, golf courses, and other recreational turfgrass areas. For best results, do not water or mow for 24 hours after treating. If grass is maintained at a mowing height > 1.0 inch, then consider using the higher application rate if pest pressure is high. Refer to introductory text and label for more details.
spinosad (Conserve SC Turf and Ornamental [11.6%=1.0 lb AI/gal])	1.2 oz	52.0 oz	Conserve SC: Residential and nonresidential sites (check label for details). Refer to introductory text and label for more details.

Table 6.5 - Insecticides for Annual Bluegrass Weevil (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
Larva and Adult stage			
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G)	1.8-3.6 lb	80.0-160.0 lb	Aloft GC G and GC SC: RESTRICTED USE. Contact and systemic insect pest control on residential and nonresidential sites. For the granular formulation, apply enough water (≥ 0.5 inch) to release AI from carrier. Refer to introductory text and labels for more details.
clothianidin (24.70%) and bifenthrin (12.3%) (Aloft GC SC)	0.27-0.44 oz	11.65-19.0 oz	
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus GC)	1.7-2.9 lb	75.0-125.0 lb	Allectus GC and GC SC: RESTRICTED USE. Contact and systemic insect pest control for golf courses and sod farms only. For the granular formulation, apply enough water (≥ 0.5 inch) to release AI from carrier. Refer to introductory text and labels for more details.
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	0.9-1.65 oz	2.3-4.5 pt	
trichlorfon (Dylox 80 [SP])	3.75 oz	10.2 lbs	Dylox 80 [SP] and 420SL: Residential and nonresidential sites (check label for details). Apply immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e., pH ≥ 9). Do not use treated area or clippings from treated areas for feed or forage. Refer to introductory text and label for more details.
(Dylox 420SL [larvae])	5.2-6.9 oz	225.0-300.0 oz	
(Dylox 420SL [adults])	6.9 oz	300.0 oz	
Adult stage			
bifenthrin (TalstarOne [7.9%=0.66 lb AI/gal]) (Check other labels of Talstar products for annual bluegrass weevil)	0.25-5.0 oz	10.9-21.8 oz	Residential and nonresidential sites (check label for details). For best results using TalstarOne, do not water or mow for 24 hours after treating. Higher rates (≤ 20.0 oz/A) may be needed for grass > 1.0 inch in height. Refer to introductory text and label for more details.
lambda-cyhalothrin (Scimitar GC [9.7%=0.88 lb AI/gal])	7.0 ml	10.0 oz	RESTRICTED USE. Residential and nonresidential sites (check label for details). For best results, apply at recommended rates in 2-10 gals water/1,000 sq. ft. A nonionic wetting agent, penetrant, or similar adjuvant is recommended at label rates. Lightly irrigate after application with ≤ 0.5 inch water to move Scimitar GC into thatch layer. Refer to introductory text and label for more details.

Sod Webworm

Sod webworm damage is most severe during hot droughty conditions in mid- to late summer. Other contributing factors on turf are most noticeable in high-maintenance conditions and where grass is kept short. Two generations per year occur in Virginia. Initial damage symptoms are brown patches of turfgrass about 5-6 inches in diameter. Upon close inspection the leaves have been chewed back. If unchecked, these brown patches will increase in size and eventually kill the turf. For flushing larvae from thatch, 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 sod webworm caterpillars as they rise to the surface. Sod webworm densities of 15 per square yard warrant treatment. Young larvae, which are most susceptible to treatment, can be expected in turf about 2 weeks after adults are present, usually late June and again in early September. Unfortunately, by the time damage is noticeable, the larvae are not susceptible to Bt products because they are getting ready to pupate. Spring and early summer treatments may be effective against the larvae that have overwintered. Do not mow for 1 to 3 days after treatment.

Cultural management: Plant endophyte enhanced fescue and ryegrass. Damage is seldom noticeable in turf more than 2.5 inches in height.

Table 6.6 - Insecticides for Sod Webworm

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
acephate (Orthene Turf, Tree, and Ornamental Spray 97)	0.4-0.8 oz (use minimum 1-15 gal water)	1.0-2.0 lb	Golf courses and sod farms only. For best results, treat when insects appear. Repeat application may be necessary, but do not treat at more than 1-week intervals. Do not graze or provide livestock treated grass.
azadirachtin (Azatrol EC [0.0987 lb AI/gal])	≤1.3 oz (use 1-2 gal water)	≤57.0 oz (use 40-100 gal water)	Residential and nonresidential sites (check label for details). The most vulnerable pest stages are the early larval stages when populations are established, but before damage is noticeable. Avoid watering and mowing for 12 to 24 hours after treating, and repeat as needed every 7 days.
<i>Bacillus thuringiensis</i> var. Kurstaki (Dipel 150D)	See label		Check label for details.
beta-cyfluthrin (Tempo Ultra SC [11.8%=1.0 lb AI/gal])	4.0-8.0 ml	6.0-12.0 oz	Residential and nonresidential sites, but not for use on golf courses, sod farms, and sod grown for seed (check label for details). Do not water or mow for 24 hours after treating.
bifenthrin (Talstar GC [flowable]) (TalstarOne [7.9%=0.66 lb AI/gal]) (Talstar EZ [granule]) (Talstar GC [granule]) (Talstar PL [granule])	0.25 oz 0.18-0.25 oz 1.15 lb 1.15 lb 1.15 lb	10.0 oz 7.8-10.0 oz 50.0 lb 50.0 lb 50.0 lb	Residential and nonresidential sites (check labels for details). For best results using Talstar GC [flowable] and TalstarOne, do not water or mow for 24 hours after treating. Higher rates (≤20.0 oz/A) may be needed for grass >1.0 inch in height. For all granular treatments, water ≤0.1 inch immediately after treatment to release/activate AI from granule.
carbaryl (Sevin 10G) (Sevin SL [4EC]) (Sevin 80WSP)	1.4-1.9 lb 4.5-6.0 oz 2.75-3.67 oz	61.0-82.7 lb 1.5-2.0 gal 7.5-10.0 lb	Sevin 10G: Lawns, recreational, and ornamental turf. For best results, apply granules to dry turf. Water lightly after treatment to release AI from granule. Sevin SL and 80WSP: Residential and nonresidential sites (check labels for details). Do not water for 24 hours after treating.

Table 6.6 - Insecticides for Sod Webworm (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
chlorantraniliprole (Acelepryn 1.67SC)	0.046-0.092 oz	2.0-4.0 oz	Acelepryn 1.67SC: For residential, commercial, recreational turf, including golf courses and sod farms. Has moderate systemic activity. Provides excellent curative control of caterpillars (larvae) in turf. For optimal control, delay watering or mowing for 24 hours after application. If turf is maintained at >1 inch in height, higher rates may be required during periods of high pest pressure.
chlorpyrifos (Dursban 50W) (Dursban Pro)	0.75 oz 1.5 oz	2.0 lb 0.5 gal	Dursban 50W and Pro: RESTRICTED USE. Golf courses, road medians, and industrial plant sites. Dursban 50W: Can also be used on sod farms and turfgrass grown for seed. For best results for both products, turf should be moist at time of treatment; however, for sod webworm control, do not water or mow for 12 to 24 hours after treating.
clothianidin (Arena 0.25G) (Arena 50WDG)	1.84-3.67 lb 0.147-0.294 oz	80.0-160.0 lb 6.4-12.8 oz	Residential and nonresidential sites (check labels for details). For best results, treat just prior to egg laying or to early instar larvae of target pests. Treatment should be followed by sufficient water to move AI into soil.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G)	1.8-3.6 lb	80.0-160.0 lb	Aloft GC G and GC SC: RESTRICTED USE. Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formulation, apply enough water (≥ 0.5 inch), to release AI from the carrier. Check labels for details.
clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	0.27-0.44 oz	11.65-19.0 oz	
deltamethrin (Deltagard G)	2.0-3.0 lb	87.0-131.0 lb	Check label for details.
dinotefuran (Zylam 20SG)	1.0 oz	2.7 lb	Zylam 20SG: Residential and nonresidential sites, including sod farms. Optimum control can be achieved when applications are made prior to or at egg hatch of the target pests followed by sufficient irrigation or rainfall to move AI through the turf thatch layer. The AI in Zylam is highly systemic and has a high water solubility. It is highly mobile and resistant to biodegradation. These physical traits make the AI a good candidate for leaching into the ground water, particularly where the water table is shallow and roots are permeable. Caution must be taken when using this product. Do not graze treated areas or use clippings from treated areas for feed or forage. Keep children and pets off areas until spray has dried. Do not apply to areas that are water logged or saturated or frozen.
Entomopathogenic nematodes		100 million-1 billion	Check label for details.

Table 6.6 - Insecticides for Sod Webworm (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
halofenozide (Mach 2 1.5G) (Mach 2 2SC)	1.55 lb 1.5 oz	67.0 lb 0.5 gal	Mach 2 1.5G: Residential and nonresidential sites including sod farms. Mach 2 2SC: Nonresidential sites and sod farms (check labels for details). For both products, treat at first sign of pest damage. A single repeat application can be made if needed. Check labels for details.
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G) (Allectus GC)	1.2-2.9 lb 1.2-2.9 lb	50.0-125.0 lb 50.0-125.0 lb	Allectus G and SC: Residential and nonresidential sites, but not for use on golf courses or sod farms. Allectus GC and GC SC: RESTRICTED USE . Golf courses and sod farms only. For all products, water within 24 hours of application to move the AI through the thatch layer. Avoid mowing after treating until irrigation or rainfall has occurred.
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	0.67-1.65 oz	1.8-4.5 pt	
imidacloprid (5%) and bifenthrin (4%) (Allectus SC)	0.4-1.65 oz	1.1-4.5 pt	
indoxacarb (Provaunt [30% WDG])	0.046-0.092 oz	2.0-4.0 oz	Residential and nonresidential sites. Label specifies lawns, golf courses, and other recreational turfgrass areas. For best results, do not water or mow for 24 hours after treating. If grass is maintained at a mowing height >1.0 inch, then consider using the higher application rate if pest pressure is high.
lambda-cyhalothrin (Scimitar GC [9.7%=0.88 lb AI/gal])	3.4-7.0 ml (use 2-10 gal water)	5.0-10.0 oz	Scimitar GC: RESTRICTED USE . Residential and nonresidential sites (check label for details). Water lightly after treating (≤ 0.5 inch) to move AI into thatch layer.
spinosad (Conserve SC Turf and Ornamental [11.6%=1.0 lb AI/gal])	0.25 oz	10.0 oz	Residential and nonresidential sites (check label for details). For best results, treat during the late afternoon or early evening, and do not water or mow for 12 to 24 hours after treating.
trichlorfon (Dylox 6.2G) (Dylox 80 [SP]) (Dylox 420SL)	2.0 lb 2.5-3.75 oz 4.6-6.9 oz	87.0 lb 6.8-10.2 lb 200.0-300.0 oz	Dylox 6.2G, 80 [SP], and 420SL: Residential, parks, and golf course sites. For best results to control sod webworm larvae with Dylox 6.2G, treat in spring (May) to kill first generation larvae. Water lightly after treating to move AI into thatch layer. For best results using Dylox 80 [SP] and 420SL, do not water after treating. Apply immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥ 9). Do not use treated area or clippings from treated areas for feed or forage.

Chinch Bug

Chinch bugs are piercing-sucking insects that have two generations per year in Virginia. Chinch bugs can cause significant damage to turf when found in densities of 15 to 20 immature bugs (nymphs) per square foot. Damage usually occurs to turf in sunny areas with a heavy thatch layer that is somewhat droughty. Initial damage symptoms are small patches of turf that are yellow. As patches increase in size, the center turns brown with the expanding border of dead and dying grass with new grass turning from yellowish green to green, respectively. Areas planted with fine (red) fescue are especially at risk to chinch bugs. Chinch bugs may be sampled by floatation. Drive an approximate 4-inch diameter cylinder with open ends on both sides into the turf. Then pour in water at a rate that maintains the water level in the cylinder about 1 inch above the turfgass for 5 to 10 minutes. Chinch bugs will float to the surface where they can be easily counted. Insecticide treatment is often effective, but because chinch bugs are highly mobile, the area may be quickly recolonized. Therefore, an application in April to May followed by 1 to 2 additional applications at 2- to 3-week intervals are recommended for the first generation. Early treatment may provide season-long control (June-September). To spray, mix the suggested amount of insecticide in 15 to 30 gallons of water per 1,000 square feet. Do not mow or water the turf for 2 to 3 days after treatment. If the entomopathogenic fungus *Beauveria bassiana* is used as a control measure, do not apply fungicides immediately before or after application (see product label).

Cultural management: Plant endophyte enhanced fescue and ryegrass. Reduce the use of fine (red) fescue in sunny areas, reduce thatch, and avoid spring fertilization with high nitrogen content.

Table 6.7 - Insecticides for Chinch Bug

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
acephate (Orthene Turf, Tree, and Ornamental Spray 97)	0.9-1.8 oz (use 1-15 gal water to obtain good coverage).	2.45-4.9 lb	Golf courses and sod farms only. Apply as needed for adult population knockdown at 10- to 14-day intervals. Water lightly (≤ 0.5 inch) after treating. Do not graze or provide livestock treated grass.
<i>Beauveria bassiana</i>	16.0-32.0 oz		Use 100 gal water/A. Check label for details.
beta-cyfluthrin (Tempo Ultra SC [11.8%=1.0 lb AI/gal])	8.0 ml	12.0 oz	Residential and nonresidential sites, but not for use on golf courses, sod farms, and sod grown for seed (check label for details). For best results, water turf immediately after treating to move AI into thatch layer.
bifenthrin (Talstar GC [flowable]) (TalstarOne [7.9%=0.66 lb AI/gal]) (Talstar EZ [granule]) (Talstar GC [granule]) (Talstar PL [granule])	0.25-0.5 oz 0.5-1.0 oz 2.3-4.6 lb 2.3-4.6 lb 2.3-4.6 lb	10.0-20.0 oz 20.0-40.0 oz 100.0-200.0 lb 100.0-200.0 lb 100.0-200.0 lb	Residential and nonresidential sites (check labels for details). For best results using Talstar GC [flowable] and TalstarOne, water before treating to move AI into thatch layer. If thatch layer is excessive, use higher spray volumes. For all granular treatments, water ≤ 0.25 inch immediately after treating to release/activate AI from granule.
carbaryl (Sevin 10G) (Sevin SL [4EC]) (Sevin 80WSP)	1.9 lb 4.5-6.0 oz 2.75-3.67 oz	82.7 lb 1.5-2.0 gal 7.5-10.0 lb	Sevin 10G: Lawns, recreational turf, and ornamental turf. For best results, apply granules to dry turf. Water lightly after treating to release AI from granule. Sevin SL and 80WSP: Residential and nonresidential sites (check labels for details). For best results, water before treatment to move AI into thatch layer. Do not water for 24 hours after treatment.
chlorantraniliprole (Acelepryn 1.67SC)	0.184-0.46 oz	8.0-20.0 oz	Acelepryn 1.67SC: For residential, commercial, recreational turf, including golf courses, and sod farms. Has moderate systemic activity. For suppression of chinch bugs. Apply prior to egg hatch. Check label for details.

Table 6.7 - Insecticides for Chinch Bug (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
chlorpyrifos (Dursban 50W) (Dursban Pro)	0.75 oz 1.5 oz	2.0 lb 0.5 gal	Dursban 50W and Pro: RESTRICTED USE . Golf courses, road medians, and industrial plant sites. Dursban 50W: Can also be used on sod farms and turfgrass grown for seed. Check labels for details.
clothianidin (Arena 0.25G) (Arena 50WDG)	1.84-3.67 lb 0.294 oz	80.0-160.0 lb 12.8 oz	Residential and nonresidential sites (check labels for details). For best results, apply enough water to move AI to where target insects are active.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G) clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	1.8-3.6 lb 0.27-0.44 oz	80.0-160.0 lb 11.65-19.0 oz	Aloft GC G and GC SC: RESTRICTED USE . Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formulation, apply enough water (≥ 0.5 inch), to release AI from the carrier. Check labels for details.
deltamethrin (Deltagard G)	2.0-3.0 lb	87.0-131.0 lb	Residential and nonresidential sites (check label for details). For best results, treat when insects first appear. Use higher rates for subsurface pests and/or for extended residual control.
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G) (Allectus GC)	1.7-2.9 lb 1.7-2.9 lb	75.0-125.0 lb 75.0-125.0 lb	Allectus G and SC: Residential and nonresidential sites, but not for use on golf courses or sod farms . Allectus GC and GC SC: RESTRICTED USE . Golf courses and sod farms only.
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	0.9-1.65 oz	2.3-4.5 pt	
imidacloprid (5%) and bifenthrin (4%) (Allectus SC)	0.4-1.65 oz	1.1-4.5 pt	
lambda-cyhalothrin (Scimitar GC)	14.0 ml (use 2-10 gal water)	20.0 oz	RESTRICTED USE . Residential and nonresidential sites. For best results, water lightly after treating (≤ 0.5 inch) to move AI into thatch layer.
thiamethoxam (Meridian 25WG)	1.5-1.95 oz/5,000 sq ft	12.7-17.0 oz	Residential and nonresidential sites (check label for details). For suppression of chinch bugs, treat when young nymphs are first observed.
trichlorfon (Dylox 80 [SP]) (Dylox 420SL)	3.75 oz 4.6-6.9 oz	10.2 lb 200.0-300.0 oz	Residential, parks, and golf course sites. Check label for details. Apply immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥ 9). Do not use treated area or clippings from treated areas for feed or forage.

Billbugs

Billbugs have one generation per year. Effective control can be obtained by a single early-season treatment for adults in early April. Visually monitor for active adults during this period to predict where to treat and where problems might arise later in the season (billbug adults can often be seen crossing paved areas adjacent to turf). Damage from billbug larvae is often misdiagnosed as drought stress, white grub or chinch bug damage, or late spring greening. To recognize billbug damage, pull on the grass stems. They will break off near the crown and emit a fine sawdust-like frass (insect excrement) that has been packed inside the stems from larval feeding. If damage is severe, pull back the sod from the soil and you should find distinct patches of yellowish sawdust-like frass. Larval treatments should be applied in early June if there are 6 to 8 larvae per square foot. Billbug adults can be detected by mixing 3-4 tablespoons of dishwashing liquid in 2 gallons of water, and pouring this mixture evenly over 1 square yard of turf. Watch the area for 10-15 minutes, observing the billbugs as they rise to the surface.

Cultural management: Plant endophyte enhanced fescue and ryegrass in addition to other turf varieties (ryegrass and bluegrass) that are resistant to billbug feeding.

Table 6.8 - Insecticides for Billbugs (e.g., bluegrass billbug, hunting billbug)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
Grub/larval stage			
carbaryl (Sevin 10G) (Sevin SL [4EC]) (Sevin 80WSP)	1.9 lb 6.0 oz 3.67 oz	82.7 lb 2.0 gal 10.0 lb	Sevin 10G: Lawns, recreational turf, and ornamental turf. For best results, treat when larvae are actively feeding near soil surface. Water thoroughly after treating to release AI from granule. Sevin SL and 80WSP: Residential and nonresidential sites (check labels for details). For best results, treat when larvae are actively feeding near soil surface. Water soon after treatment.
chlorantraniliprole (Acelepryn 1.67SC)	0.184-0.46 oz	8.0-20.0 oz	Acelepryn 1.67SC: For residential, commercial, recreational turf, including golf courses, and sod farms. Has moderate systemic activity. Product should be applied when the overwintering stage adults are first observed. This usually occurs in late April or early May in regions with cool-season turf. Best control of the larval stage can be achieved by targeting the overwintering adult stage as it becomes active in the spring but before egg laying has occurred. An application at this time will also aid in control of white grubs. Check label for details.
clothianidin (Arena 0.25G) (Arena 50WDG)	1.84-3.67 lb 0.147-0.294 oz	80.0-160.0 lb 6.4-12.8 oz	Residential and nonresidential sites (check labels for details). For best results, apply enough water to move AI to where target insects are active.

Table 6.8 - Insecticides for Billbugs (e.g., bluegrass billbug, hunting billbug) (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
Grub/larval stage (cont.)			
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G)	1.8-3.6 lb	80.0-160.0 lb	Aloft GC G and GC SC: RESTRICTED USE. Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formulation, apply enough water (≥ 0.5 inch), to release AI from the carrier. Check labels for details. A spring application will control billbug larvae. Check labels for details.
clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	0.27-0.44 oz	11.65-19.0 oz	
dinotefuran (Zylam 20SG)	1.0 oz	2.7 lb	Zylam 20SG: Residential and nonresidential sites, including sod farms. Optimum control can be achieved when applications are made prior to or at egg hatch of the target pests followed by sufficient irrigation or rainfall to move AI through the turf thatch layer. The AI in Zylam is highly systemic and has a high water solubility. It is highly mobile and resistant to biodegradation. These physical traits make the AI a good candidate for leaching into the ground water, particularly where the water table is shallow and roots are permeable. Caution must be taken when using this product. Do not graze treated areas or use clippings from treated areas for feed or forage. Keep children and pets off areas until spray has dried. Do not apply to areas that are water logged or saturated or frozen.
halofenozide (Mach 2 1.5G)	3.0 lb	133.0 lb	Mach 2 1.5G: Residential and nonresidential sites, including sod farms.
(Mach 2 2SC)	2.9 oz	1.0 gal	Mach 2 2SC: Nonresidential sites and sod farms (check labels for details). For best results, reduce heavy thatch buildup to < 0.5 inch and treat prior to egg hatch (check labels for details). Also, these products are not dependent upon watering after treating to activate the AI; however, water is necessary to move the AI through the thatch layer. Under drought conditions it is recommended to water in these products.
imidacloprid (Merit 2F)	0.46-0.6 oz	1.25-1.6 pt	Merit 2F, 75WSP, and 0.5G: Residential and non-residential sites (check label for details). Merit 2F and 75WSP can be used on sod farms, but not the 0.5G formulation. For best results, treat from early July to early August. Also treat up to 45 days before the historical peak of adult flight to the 2nd larval instar being targeted. Treatment should be followed by sufficient water to move AI into soil.
(Merit 75WSP)	1.6 oz (1 packet) /8,250-11,000 sq ft		
(Merit 0.5G)	1.4-1.8 lb	60.0-80.0 lb	
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G)	1.7-2.9 lb	75.0-125.0 lb	Allectus G: Residential and nonresidential sites, but not for use on golf courses or sod farms.
(Allectus GC)	1.7-2.9 lb	75.0-125.0 lb	Allectus GC: RESTRICTED USE. Golf courses and sod farms only.
thiamethoxam (Meridian 25WG)	1.5-1.95 oz/5,000 sq ft	12.7-17.0 oz	Residential and nonresidential sites (check label for details). For best results, treat from peak flight to peak egg hatch. Can also treat up to 45 days before historical peak of adult flight to 2nd larval instar being targeted.

Table 6.8 - Insecticides for Billbugs (e.g., bluegrass billbug, hunting billbug) (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
Adult stage			
beta-cyfluthrin (Tempo Ultra SC [11.8%=1.0 lb AI/gal])	8.0 ml	12.0 oz	Residential and nonresidential sites, but not for use on golf courses, sod farms, and sod grown for seed (check label for details). For best results, treat when billbug adults first appear in the spring. This application will also aid in control of overwintering chinch bug adults.
bifenthrin (Talstar GC [flowable]) (TalstarOne [7.9%=0.66 lb AI/gal]) (Talstar EZ [granule]) (Talstar GC [granule]) (Talstar PL [granule])	0.25-0.5 oz 0.25-0.5 oz 1.15-2.3 lb 1.15-2.3 lb 1.15-2.3 lb	10.0-20.0 oz 10.0-20.0 oz 50.0-100.0 lb 50.0-100.0 lb 50.0-100.0 lb	Residential and nonresidential sites (check labels for details). For best results using Talstar products, treat when adult billbugs are first observed in April and May. Degree-day models have been developed to optimize application timing. This application will also aid in control of overwintering chinch bug adults.
chlorpyrifos (Dursban 50W) (Dursban Pro)	0.75-1.46 oz 1.5 oz	2.0-4.0 lb 0.5 gal	Dursban 50W and Pro: RESTRICTED USE . Dursban 50W: Can only be used on sod farms and turfgrass grown for seed for billbug control. Dursban Pro: Can only be used on golf courses, road medians, and industrial plant sites for billbug control. For both products, treat early in the season just prior to or coinciding with first appearance of adults (check labels for details).
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G) clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	1.8-3.6 lb 0.27-0.44 oz	80.0-160.0 lb 11.65-19.0 oz	Aloft GC G and GC SC: RESTRICTED USE . Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formation, apply enough water (≥ 0.5 inch), to release AI from the carrier. A spring application will control billbug larvae. Apply when overwintering adult billbugs are first observed, usually in April and May. Check labels for details.
deltamethrin (Deltagard G)	2.0-3.0 lb	87.0-131.0 lb	Residential and nonresidential sites (check label for details). For best results, treat when insects first appear.
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G) (Allectus GC)	1.7-2.9 lb 1.7-2.9 lb	75.0-125.0 lb 75.0-125.0 lb	Allectus G; Allectus SC: Residential and nonresidential sites, but not for use on golf courses or sod farms . Allectus GC; Allectus GC SC: RESTRICTED USE . Golf courses and sod farms only.
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	0.9-1.65 oz	2.3-4.5 pt	
imidacloprid (5%) and bifenthrin (4%) (Allectus SC)	0.4-1.65 oz	1.1-4.5 pt	
lambda-cyhalothrin (Scimitar GC [9.7%=0.88 lb AI/gal])	7.0 ml (use 2-10 gal water)	10.0 oz	RESTRICTED USE . Residential and nonresidential sites. For best results, water lightly after treating (< 0.5 inch) to move AI into thatch layer. Check label for details.

Armyworm

Up to three generations of armyworms occur per year in Virginia. Larvae appear in April, late June, and August-September. Armyworms feed on grass blades, causing skeletonizing by early instars and consumption of the whole leaf by later instars. Armyworms prefer cereal crops, so turf areas near farmland growing these crops are at higher risk; however, they typically are not a major pest of turfgrass. A detergent drench flushing technique is useful to determine if armyworms are present. 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, observing the armyworms as they rise to the surface. Treat when armyworms are first detected. If using entomopathogenic nematodes, apply late in the day and water before and after application.

Table 6.9 - Insecticides for Armyworm

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
acephate (Orthene Turf, Tree, and Ornamental Spray 97)	0.4-0.9 oz (use minimum 5 gal water)	1.0-2.5 lb	Golf courses and sod farms only. For best results, treat when insects appear. Repeat application at 2-week intervals may be necessary. Do not graze or provide livestock treated grass.
azadirachtin (Azatrol EC [0.0987 lb AI/gal])	≤1.3 oz (use 1-2 gal water)	≤57.0 oz (use 40-100 gal water)	Residential and nonresidential sites (check label for details). The most vulnerable pest stages to azadirachtin are the early larval stages when populations are established, but before damage is noticeable. Avoid watering and mowing for 12 to 24 hours after treating, and repeat as needed every 7 days.
beta-cyfluthrin (Tempo Ultra SC [11.8%=1.0 lb AI/gal])	4.0-8.0 ml	6.0-12.0 oz	Residential and nonresidential sites, but not for use on golf courses, sod farms, and sod grown for seed (check label for details). Do not water or mow for 24 hours after treating.
bifenthrin (Talstar GC [flowable]) (TalstarOne [7.9%=0.66 lb AI/gal]) (Talstar EZ [granule]) (Talstar GC [granule]) (Talstar PL [granule])	0.25 oz 0.18-0.25 oz 1.15 lb 1.15 lb 1.15 lb	10.0 oz 7.8-10.0 oz 50.0 lb 50.0 lb 50.0 lb	Residential and nonresidential sites (check labels for details). For best results using Talstar GC [flowable] and TalstarOne, do not water or mow for 24 hours after treating. Higher rates (≤20 oz/A) may be needed for grass > 1 inch in height. For all granular treatments, water ≤0.1 inch immediately after treatment to release/activate AI from granule.
carbaryl (Sevin 10G) (Sevin SL [4EC]) (Sevin 80WSP)	1.4-1.9 lb 1.5-3.0 oz 0.92-1.84 oz	82.7 lb 0.5-1.0 gal 2.5-5.0 lb	Sevin 10G: Lawns, recreational turf, and ornamental turf. For best results, apply granules to dry turf. Water lightly after treatment to release AI from granule. Sevin SL and 80 WSP: Residential and nonresidential sites (check labels for details). Do not water for 24 hours after treating.
chlorantraniliprole (Acelepryn 1.67SC)	0.046-0.092 oz	2.0-4.0 oz	Acelepryn 1.67SC: For residential, commercial, recreational turf, including golf courses, and sod farms. Has moderate systemic activity. Provides excellent curative control of caterpillars (larvae) in turf. For optimal control, delay watering or mowing for 24 hours after application. If turf is maintained at >1 inch in height, higher rates may be required during periods of high pest pressure.
chlorpyrifos (Dursban 50W) (Dursban Pro)	0.75 oz 1.5 oz	2.0 lb 0.5 gal	Dursban 50W and Pro: RESTRICTED USE . Golf courses, road medians, and industrial plant sites. Dursban 50W: Can also be used on sod farms and turfgrass grown for seed. For best results for both products, turf should be moist at time of treatment.
clothianidin (Arena 0.25G)	2.98-3.67 lb	130.0-160.0 lb	Residential and nonresidential sites (check label for details). Use minimum of 130 lb/A. Apply enough water to move AI to where target insects are active.

Table 6.9 - Insecticides for Armyworm (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G)	1.8-3.6 lb	80.0-160.0 lb	Aloft GC G and GC SC: RESTRICTED USE . Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formulation, apply enough water (≥ 0.5 inch), to release AI from the carrier. Check labels for details.
clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	0.27-0.44 oz	11.65-19.0 oz	
deltamethrin (Deltagard G)	2.0-3.0 lb	87.0-131.0 lb	Check label for details.
Entomopathogenic nematodes		100 million-1 billion	Check label for details.
halofenozide (Mach 2 1.5G)	1.55 lb	67.0 lb	Mach 2 1.5G: Residential and nonresidential sites, including sod farms. Mach 2 2SC: Nonresidential sites and sod farms (check labels for details). For both products, treat at first sign of damage. A single repeat application can be made if needed (check labels for details).
(Mach 2 2SC)	1.5 oz	0.5 gal	
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G)	1.2-2.9 lb	50.0-125.0 lb	Allectus G and SC: Residential and nonresidential sites, but not for use on golf courses or sod farms . Allectus GC and GC SC: RESTRICTED USE . Golf courses and sod farms only For all products, water within 24 hours of application to move the AI through the thatch layer. Avoid mowing after treating until irrigation or rainfall has occurred.
(Allectus GC)	1.2-2.9 lb	50.0-125.0 lb	
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	0.67-1.65 oz	1.8-4.5 pt	
imidacloprid (5%) and bifenthrin (4%) (Allectus SC)	0.4-1.65 oz	1.1-4.5 pt	
indoxacarb (Provaunt [30% WDG])	0.046-0.092 oz	2.0-4.0 oz	Residential and nonresidential sites. Label specifies lawns, golf courses, and other recreational turfgrass areas. For best results, do not water or mow for 24 hours after treating. If grass is maintained at a mowing height >1 inch, then consider using the higher application rate if pest pressure is high.
lambda-cyhalothrin (Scimitar GC [9.7%=0.88 lb AI/gal])	3.4-7.0 ml (use 2-5 gal water)	5.0-10.0 oz	Scimitar GC: RESTRICTED USE . Residential and non-residential sites (check label for details). For best results, do not water or mow for 12 to 24 hours after treating.
spinosad (Conserve SC Turf and Ornamental [11.6%=1.0 lb AI/gal])	0.25-1.2 oz	10.0-52.0 oz	Residential and nonresidential sites (check label for details). For best results, do not water or mow for 12 to 24 hours after treating. Low and high rates are based on whether larvae are small or large, respectively.
trichlorfon (Dylox 80 [SP])	2.5-3.75 oz	6.8-10.2 lb	Residential, park, and golf course sites. For best results, do not water after treating. Apply immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥ 9). Do not use treated area or clippings from treated areas for feed or forage.
(Dylox 420SL)	4.6-6.9 oz	200.0-300.0 oz	

Fall Armyworm

The fall armyworm has two to three generations per year in Virginia. It is the most cold intolerant of all armyworms and cutworms. Populations can reach damaging levels late in the season. Unlike armyworms in general, the fall armyworm is a major pest of turfgrass. Preferred hosts are bermudagrass, ryegrass, fescue, and bluegrass. All plant parts above ground are consumed. Monitoring and treatment strategies are similar to those for armyworms and cutworms.

Table 6.10 - Insecticides for Fall Armyworm

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
acephate (Orthene Turf, Tree, and Ornamental Spray 97)	0.4-0.9 oz (use minimum 5 gal water).	1.0-2.5 lb	Golf courses and sod farms only. For best results, treat when insects appear. Repeat application at 2-week intervals may be necessary. Do not graze or provide livestock treated grass.
azadirachtin (Azatrol EC [0.0987 lb AI/gal])	≤1.3 oz (use 1.0-2.0 gal water)	≤57.0 oz (use 40.0-100.0 gal water)	Residential and nonresidential sites (check label for details). The most vulnerable pest stages to azadirachtin are the early larval stages when populations are established, but before damage is noticeable. Avoid watering and mowing for 12 to 24 hours after treating, and repeat as needed every 7 days.
beta-cyfluthrin (Tempo Ultra SC [11.8%=1.0 lb AI/gal])	4.0-8.0 ml	6.0-12.0 oz	Residential and nonresidential sites, but not for use on golf courses, sod farms, and sod grown for seed (check label for details). Do not water or mow for 24 hours after treating.
bifenthrin (Talstar GC [flowable]) (TalstarOne [7.9%=0.66 lb AI/gal]) (Talstar EZ [granule]) (Talstar GC [granule]) (Talstar PL [granule])	0.25 oz 0.18-0.25 oz 1.15 lb 1.15 lb 1.15 lb	10.0 oz 7.8-10.0 oz 50.0 lb 50.0 lb 50.0 lb	Residential and nonresidential sites (check labels for details). For best results using Talstar GC [flowable] and TalstarOne, do not water or mow for 24 hours after treating. Higher rates (≤20 oz/A) may be needed for grass >1 inch in height. For all granular treatments, water ≤0.1 inch immediately after treatment to release/activate AI from granule.
carbaryl (Sevin 10G) (Sevin SL [4EC]) (Sevin 80WSP)	1.4-1.9 lb 1.5-3.0 oz 0.92-1.84 oz	82.7 lb 0.5-1.0 gal 2.5-5.0 lb	Sevin 10G: Lawns, recreational turf, and ornamental turf. For best results, apply granules to dry turf. Water lightly after treatment to release AI from granule. Sevin SL and 80WSP: Residential and nonresidential sites (check labels for details). Do not water for 24 hours after treating.
chlorantraniliprole (Acelepryn 1.67SC)	0.046-0.092 oz	2.0-4.0 oz	Acelepryn 1.67SC: For residential, commercial, recreational turf, including golf courses, and sod farms. Has moderate systemic activity. Provides excellent curative control of caterpillars (larvae) in turf. For optimal control, delay watering or mowing for 24 hours after application. If turf is maintained at >1 inch in height, higher rates may be required during periods of high pest pressure.
chlorpyrifos (Dursban 50W) (Dursban Pro)	0.75 oz 1.5 oz	2.0 lb 0.5 gal	Dursban 50W and Pro: RESTRICTED USE . Golf courses, road medians, and industrial plant sites. Dursban 50W: Can also be used on sod farms and turfgrass grown for seed. For best results for both products, turf should be moist at time of treatment.
clothianidin (Arena 0.25G)	2.98-3.67 lb	130.0-160.0 lb	Residential and nonresidential sites (check label for details). Use minimum of 130 lb/A. Apply enough water to move AI to where target insects are active.

Table 6.10 - Insecticides for Fall Armyworm (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G)	1.8-3.6 lb	80.0-160.0 lb	Aloft GC G and GC SC: RESTRICTED USE . Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formulation, apply enough water (≥ 0.5 inch), to release AI from the carrier. Check labels for details.
clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	0.27-0.44 oz	11.65-19.0 oz	
deltamethrin (Deltagard G)	2.0-3.0 lb	87.0-131.0 lb	Check label for details.
Entomopathogenic nematodes		100 million-1 billion	Check label for details.
halofenozide (Mach 2 1.5G)	1.55 lb	67.0 lb	Mach 2 1.5G: Residential and nonresidential sites including sod farms.
(Mach 2 2SC)	1.5 oz	0.5 gal	Mach 2 2SC: Nonresidential sites and sod farms (check labels for details). For both products, treat at first sign of damage. A single repeat application can be made if needed (check labels for details).
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G)	1.2-2.9 lb	50.0-125.0 lb	Allectus G and SC: Residential and nonresidential sites, but not for use on golf courses or sod farms .
(Allectus GC)	1.2-2.9 lb	50.0-125.0 lb	Allectus GC and GC SC: RESTRICTED USE . Golf courses and sod farms only.
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	0.67-1.65 oz	1.8-4.5 pt	For all products, water within 24 hours of application to move the AI through the thatch layer. Avoid mowing after treating until irrigation or rainfall has occurred.
imidacloprid (5%) and bifenthrin (4%) (Allectus SC)	0.4-1.65 oz	1.1-4.5 pt	
indoxacarb (Provaunt [30% WDG])	0.046-0.092 oz	2.0-4.0 oz	Residential and nonresidential sites. Label specifies lawns, golf courses, and other recreational turfgrass areas. For best results, do not water or mow for 24 hours after treating. If grass is maintained at a mowing height >1 inch, then consider using the higher application rate if pest pressure is high.
lambda-cyhalothrin (Scimitar GC [9.7%=0.88 lb AI/gal])	3.4-7.0 ml (use 2-5 gal water)	5.0-10.0 oz	Scimitar GC: RESTRICTED USE . Residential and nonresidential sites. For best results, do not water or mow for 12 to 24 hours after treating.
spinosad (Conserve SC Turf and Ornamental [11.6%=1.0 lb AI/gal])	0.25-1.2 oz	10.0-52.0 oz	Residential and nonresidential sites (check label for details). For best results, treat during the early morning or late afternoon, and do not water or mow for 12 to 24 hours after treating. Low and high rates are based on whether larvae are small or large, respectively.
trichlorfon (Dylox 80 [SP])	2.5-3.75 oz	6.8-10.2 lb	Residential, park, and golf course sites. For best results, do not water after treating. Apply immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥ 9). Do not use treated area or clippings from treated areas for feed or forage.
(Dylox 420SL)	4.6-6.9 oz	200.0-300.0 oz	

Cutworms

Cutworms typically have from two to four generations per year in Virginia. Cutworm populations of 3 to 8 caterpillars (larvae) per square yard may warrant treatment. To sample for cutworms, 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 cutworms as they rise to the surface. Most insecticides used for cutworms are stomach poisons because the larvae feed at night. Apply insecticides in the early evening for the best results. Unless specified on the label, do not water or mow for 24 hours after treating. Cutworms are highly mobile, so treated areas are likely to become re-infested from surrounding areas.

Cultural management: Plant endophyte enhanced fescue and ryegrass. Turf more than 2.5 inches in height requires less treatment for cutworms. Cutworm populations can be reduced if grass clippings are removed during mowing because cutworm moths lay their eggs at the tip of grass blades. If using entomopathogenic nematodes, apply late in the day and water before and after application.

Table 6.11 - Insecticides for Cutworms

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
acephate (Orthene Turf, Tree, and Ornamental Spray 97)	0.4-0.8 oz (use minimum 1-15 gal water)	1.0-2.0 lb	Golf courses and sod farms only. For best results, treat when insects appear. Repeat application may be necessary, but do not treat at more than 1-week intervals. Do not graze or provide livestock treated grass.
azadirachtin (Azatrol EC [0.0987 lb AI/gal])	≤1.3 oz (use 1-2 gal water)	≤57.0 oz (use 40-100 gal water)	Residential and nonresidential sites (check label for details). The most vulnerable pest stages to azadirachtin are the early larval stages when populations are established, but before damage is noticeable. Avoid watering and mowing for 12 to 24 hours after treating, and repeat as needed every 7 days.
beta-cyfluthrin (Tempo Ultra SC [11.8%=1.0 lb AI/gal])	4-8 ml	6.0-12.0 oz	Residential and nonresidential sites, but not for use on golf courses, sod farms, and sod grown for seed (check label for details). Do not water or mow for 24 hours after treating.
bifenthrin (Talstar GC [flowable]) (TalstarOne [7.9%=0.66 lb AI/gal]) (Talstar EZ [granule]) (Talstar GC [granule]) (Talstar PL [granule])	0.25 oz 0.18-0.25 oz 1.15 lb 1.15 lb 1.15 lb	10.0 oz 7.8-10.0 oz 50.0 lb 50.0 lb 50.0 lb	Residential and nonresidential sites (check labels for details). For best results using Talstar GC [flowable] and TalstarOne, do not water or mow for 24 hours after treating. Higher rates (≤ 20 oz/A) may be needed for grass >1 inch in height. For all granular treatments, water ≤ 0.1 inch immediately after treatment to release/activate AI from granule.
carbaryl (Sevin 10G) (Sevin SL [4EC]) (Sevin 80WSP)	1.4-1.9 lb 1.5-3.0 oz 0.92-1.84 oz	82.7 lb 0.5-1.0 gal 2.5-5.0 lb	Sevin 10G: Lawns, recreational turf, and ornamental turf. For best results, apply granules to dry turf. Water lightly after treatment to release AI from granule. Sevin SL and 80WSP: Residential and nonresidential sites (check labels for details). Do not water for 24 hours after treating.
chlorantraniliprole (Acelepryn 1.67SC)	0.046-0.092 oz	2.0-4.0 oz	Acelepryn 1.67SC: For residential, commercial, recreational turf, including golf courses, and sod farms. Has moderate systemic activity. Provides excellent curative control of caterpillars (larvae) in turf. For optimal control, delay watering or mowing for 24 hours after application. If turf is maintained at >1 inch in height, higher rates may be required during periods of high pest pressure.

Table 6.11 - Insecticides for Cutworms (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
chlorpyrifos (Dursban 50W) (Dursban Pro)	0.75 oz 1.5 oz	2.0 lb 0.5 gal	Dursban 50W and Pro: RESTRICTED USE . Golf courses, road medians, and industrial plant sites. Dursban 50W: Can also be used on sod farms and sod grown for seed. For best results for both products, turf should be moist at time of treatment.
clothianidin (Arena 0.25 G) (Arena 50WDG)	2.98-3.67 lb 0.294 oz	130.0-160.0 lb 12.8 oz	Residential and nonresidential sites (check labels for details). Arena 0.25G: Use minimum of 130 lb/A. Apply enough water to move AI to where target insects are active. Arena 50WDG: For suppression of cutworms. Use high rate.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G)	1.8-3.6 lb	80.0-160.0 lb	Aloft GC G and GC SC: RESTRICTED USE . Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formulation, apply enough water (≥ 0.5 inch), to release AI from the carrier. Check labels for details.
clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	0.27-0.44 oz	11.65-19.0 oz	
deltamethrin (Deltagard G)	2.0-3.0 lb	87.0-131.0 lb	Check label for details.
Entomopathogenic nematodes		100 million-1 billion	Check label for details.
halofenozide (Mach 2 1.5G) (Mach 2 2SC)	1.55 lb 1.5 oz	67.0 lb 0.5 gal	Mach 2 1.5G: Residential and nonresidential sites, including sod farms. Mach 2 2SC: Nonresidential sites and sod farms (check labels for details). For both products, treat at first sign of pest damage. A single repeat application can be made if needed. Check labels for details.
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G) (Allectus GC)	1.2-2.9 lb 1.2-2.9 lb	50.0-125.0 lb 50.0-125.0 lb	Allectus G and SC: Residential and nonresidential sites, but not for use on golf courses or sod farms . Allectus GC and GC SC: RESTRICTED USE . Golf courses and sod farms only.
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	0.67-1.65 oz	1.8-4.5 pt	For all products, water within 24 hours of application to move the AI through the thatch layer. Avoid mowing after treating until irrigation or rainfall has occurred.
imidacloprid (5%) and bifenthrin (4%) (Allectus SC)	0.4-1.65 oz	1.1-4.5 pt	
indoxacarb (Provaunt [30% WDG])	0.046-0.092 oz	2.0-4.0 oz	Residential and nonresidential sites. Label specifies lawns, golf courses, and other recreational turfgrass areas. For best results, do not water or mow for 24 hours after treating. If grass is maintained at a mowing height >1 inch, then consider using the higher application rate if pest pressure is high.

Table 6.11 - Insecticides for Cutworms (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
lambda-cyhalothrin (Scimitar GC [9.7%=0.88 lb AI/gal])	3.4-7.0 ml (use 2-5 gal water)	5.0-10.0 oz	Scimitar GC: RESTRICTED USE . Residential and nonresidential sites. For best results, do not water or mow for 12-24 hours after treating.
spinosad (Conserve SC Turf and Ornamental [11.6%=1.0 lb AI/gal])	0.8-1.2 oz	35.0-52.0 oz	Residential and nonresidential sites (check label for details). For best results for black cutworm, treat during the late afternoon or early evening, and do not water or mow for 12 to 24 hours after treating. Low and high rates are based on whether larvae are small or large, respectively.
trichlorfon (Dylox 6.2G) (Dylox 80 [SP]) (Dylox 420SL)	2.0 lb 2.5-3.75 oz 4.6-6.9 oz	87.0 lb 6.8-10.2 lb 200.0-300.0 oz	Dylox 6.2G, 80 [SP], and 420SL: Residential, parks and golf course sites. Dylox 6.2G: For best results, water lightly after treating to move AI into thatch layer. Dylox 80 [SP] and 420SL: For best results, do not water after treating. Apply immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥9). Do not use treated area or clippings from treated areas for feed or forage.

Green June Beetle

The green June beetle is one of the annual white grub species mentioned under “White Grubs;” however, it deserves singling out given differences in the behavior it exhibits compared to the other white grub species. Unlike the other species that crawl on their front (stomach or ventral) side and use their 3 pairs of legs in the process, the green June beetle grub crawls (or more correctly unglutes) on its back (dorsal) side with its three pairs of legs pointing up. Also, the green June beetle is nocturnal and will come up through the thatch layer at night to feed on the surface.

Monitor in late July the same way as for other white grubs. As few as 3 to 5 grubs per square foot can cause significant damage to golf fairways and greens. Treatment should be applied in late August to avoid damage from mounding caused by grub tunneling. Treatments applied in the late afternoon or early evening are better at targeting the nighttime surface-feeding grubs. Irrigate before application to attract the grubs to the surface.

Cultural management: Reducing the thatch layer to <0.75 inch will increase the penetration of any treatment applied to turfgrass. In addition, avoid applying grubicides when soil is saturated or waterlogged.

Table 6.12 - Insecticides for Green June Beetle

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
carbaryl (Sevin 10G) (Sevin SL [4EC]) (Sevin 80WSP)	1.4-1.9 lb 1.5-3.0 oz 0.92-1.84 oz	61.0-82.7 lb 0.5-1.0 gal 2.5-5.0 lb	Sevin 10G: Lawns, recreational turf, and ornamental turf. For best results, treat when grubs are feeding near the soil surface. Apply granules when grass is dry. Water lightly after treating to remove AI from granule. Sevin SL and 80WSP: Residential and commercial-use sites (check labels for details). Treat when grubs are feeding near soil surface. Water soon after treating.
chlorantraniliprole (Acelepryn 1.67SC)	0.184-0.367 oz	8.0-16.0 oz	Acelepryn 1.67SC: For residential, commercial, recreational turf, including golf courses, and sod farms. Has moderate systemic activity. Acelepryn may be applied from early April to early Sept. for preventative and early curative control of all major white grub species infesting turfgrass. Use higher rate for late August or early Sept. applications due to fewer mid-instar grubs present at the time of application. Optimal results can be achieved if product is watered in (≥0.5 inch) immediately after application.
chlorpyrifos (Dursban 50W) (Dursban Pro)	0.73 oz 1.5 oz	2.0 lb 0.5 gal	Dursban 50W and Pro: RESTRICTED USE. Golf courses, road medians, and industrial-plant sites. Dursban 50W: Can also be used on sod farms and sod grown for seed. For best results, treat from late July to early August. Soil should be moist before treating.
clothianidin (Arena 0.25G) (Arena 50WDG)	1.84-3.67 lb 0.147-0.294 oz	80.0-160.0 lb 6.4-12.8 oz	Residential and nonresidential sites (check labels for details). For best results, treat just prior to egg laying or to early instar grubs of target pests. Treatment should be followed by sufficient irrigation/rainfall to move AI into soil.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G)	1.8-3.6 lb	80.0-160.0 lb	Aloft GC G and GC SC: RESTRICTED USE. Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formulation, apply enough water (≥0.5 inch), to release AI from the carrier. Check labels for details.
clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	0.27-0.44 oz	11.65-19.0 oz	

Table 6.12 - Insecticides for Green June Beetle (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
dinotefuran (Zylam 20SG)	1.0 oz	2.7 lb	Zylam 20SG: Residential and nonresidential sites, including sod farms. Optimum control can be achieved when applications are made prior to or at egg hatch of the target pests followed by sufficient irrigation or rainfall to move AI through the turf thatch layer. The AI in Zylam is highly systemic and has a high water solubility. It is highly mobile and resistant to biodegradation. These physical traits make the AI a good candidate for leaching into the ground water, particularly where the water table is shallow and roots are permeable. Caution must be taken when using this product. Do not graze treated areas or use clippings from treated areas for feed or forage. Keep children and pets off areas until spray has dried. Do not apply to areas that are water logged or saturated or frozen.
halofenozide (Mach 2 1.5G) (Mach 2 2SC)	3 lb 2.9 oz	133.0 lb 1.0 gal	Mach 2 1.5G: Residential and nonresidential sites including sod farms. Mach 2 2SC: Nonresidential sites and sod farms (check labels for details).
imidacloprid (Merit 2F) (Merit 75WSP) (Merit 0.5G)	0.46-0.6 oz 1.6 oz (1 packet) /8,250-11,000 sq ft 1.4-1.8 lb	1.25-1.6 pt 60.0-80.0 lb	Merit 2F, 75WSP, and 0.5G: Residential and nonresidential sites (check label for details). Merit 2F and 75WSP can be used on sod farms, but not the 0.5G formulation. For best results, treat prior to egg hatch of the target pest. Treatment should be followed by sufficient irrigation/rainfall to move AI into soil.
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G) (Allectus GC)	2.3-2.9 lb 2.3-2.9 lb	100.0-125.0 lb 100.0-125.0 lb	Allectus G and SC: Residential and nonresidential sites, but not for use on golf courses or sod farms. Allectus GC and GC SC: RESTRICTED USE. Golf courses and sod farms only.
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	1.32-1.65 oz	3.6-4.5 pt	For best results for all products, water within 24 hours of treating to move AI through the thatch layer.
imidacloprid (5%) and bifenthrin (4%) (Allectus SC)	1.32-1.65 oz	3.6-4.5 pt	
thiamethoxam (Meridian 25WG)	1.5-1.95 oz/5,000 sq ft	12.7-17.0 oz	Meridian 25WG: Residential and nonresidential sites (check label for details). For best results, treat from peak flight to peak egg hatch. Can also treat up to 45 days before historical peak of adult flight to 2nd instar grub being targeted. Treatment should be followed by sufficient irrigation/rainfall to move AI into soil.
trichlorfon (Dylox 6.2G) (Dylox 80 [SP]) (Dylox 420SL)	3.0 lb 3.75 oz 6.9 oz	130.0 lb 10.2 lb 300.0 oz	Dylox 6.2G, 80 [SP], and 420SL: Residential, parks, and golf course sites. For best results, thatch layer must be <0.5 inch at time of treatment. Treat from mid-July to early August when grubs are young and actively feeding near soil surface. Treatment should be followed by sufficient water to move AI into soil. Apply Dylox 80 [SP] and 420SL immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥9). Do not use treated area or clippings from treated areas for feed or forage.

Clover Mite

Clover mites are more of a nuisance than a pest; however, they may build up populations near building foundations that can cause silvering of nearby turfgrass. The clover mite, as its name suggests, does not feed primarily on grasses. Their nuisance status occurs when they invade buildings. When crushed, they leave a red stain that can be difficult to remove. Populations high enough to warrant treatment usually occur in late winter or early spring and, occasionally, in the fall.

Table 6.13 - Insecticides for Clover Mite (and mites in general)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
azadirachtin (Azatrol EC ¹ [0.0987 lb AI/gal])	≤1.3 oz (use 1-2 gal water)	≤57.0 oz (use 40-100 gal water)	Residential and nonresidential sites (check label for details). The most vulnerable pest stages to azadirachtin are the early larval and nymphal stages when populations are established, but before damage is noticeable. Avoid watering and mowing for 12 to 24 hours after treating, and repeat as needed every 7 days.
bifenthrin (Talstar GC ² [flowable]) (TalstarOne ² [7.9%=0.66 lb AI/gal])	0.25-0.5 oz 0.25-0.5 oz	10.0-20.0 oz 10.0-20.0 oz	Residential and nonresidential sites (check labels for details). Use ≤10 gal water/1,000 sq ft when treating dense and/or long grass foliage.
chlorpyrifos (Dursban 50W) (Dursban Pro)	0.75 oz 1.5 oz	2.0 lb 0.5 gal	Dursban 50W and Pro: RESTRICTED USE . Golf courses, road medians, and industrial-plant sites. Dursban 50W: Can also be used on sod farms and sod grown for seed. For best results for both products, turf should be moist at time of treatment.
deltamethrin (Deltagard G)	2-3 lb	87.0-131.0 lb	Check label for details.
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC ²)	0.9-1.65 oz	2.3-4.5 pt	Allectus GC SC: RESTRICTED USE . Golf courses and sod farms only. Allectus SC: Residential and nonresidential sites, but not for use on golf courses or sod farms .
imidacloprid (5%) and bifenthrin (4%) (Allectus SC ²)	0.4-1.65 oz	1.1-4.5 pt	
lambda-cyhalothrin (Scimitar GC [9.7%=0.88 lb AI/gal])	3.4-7.0 ml (use 2-5 gal water)	5.0-10.0 oz	Scimitar GC: RESTRICTED USE . Residential and nonresidential sites (check label for details). For best results, do not water or mow for 12 to 24 hours after treating.

¹Check labels when treating for Bermudagrass mite.

²Check labels when treating for eriophyid mites.

Frit Fly

The frit fly is occasionally a pest on golf-course greens, collars, and tees. There are no action thresholds worked out for this pest. Damage can be recognized as yellowing of the central parts of the plant while the rest of the plant looks healthy. Cool-season grasses such as bluegrass or bentgrass are most susceptible to injury. Typically, bluegrass and/or bentgrass greens and tees, which are heavily irrigated, fertilized, and frequently mowed, produce many new shoots that are highly attractive egg-laying sites to the female frit fly.

Table 6.14 - Insecticides for Frit Fly

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G)	1.7-2.9 lb	75.0-125.0 lb	Allectus G and SC: Residential and nonresidential sites, but not for use on golf courses or sod farms .
(Allectus GC)	1.7-2.9 lb	75.0-125.0 lb	
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	1.32-1.65 oz	3.6-4.5 pt	Allectus GC SC and SC: RESTRICTED USE . Golf courses and sod farms only.
imidacloprid (5%) and bifenthrin (4%) (Allectus SC)	1.32-1.65 oz	3.6-4.5 pt	For best results for all Allectus formulations, water within 24 hours after treating to move AI through the thatch (check labels for details).

Mole Crickets

Mole crickets generally are not major pests of turf. However, they can cause serious damage in turf from tunneling in and beneath the thatch layer of sandy soils. Adult control is difficult to achieve in the early spring because the adults are actively seeking mates and continually invading preferred grassy areas. Areas that experience heavy adult pressure in the spring may warrant treating with maximum labeled rates and additional applications immediately prior to peak egg hatch.

Summer treatments targeting the young mole cricket nymphs are usually more effective in knocking down populations. The smaller size of the young nymphs (relative to the adults) makes them much more susceptible to insecticides. In addition, given that the nymphs must actively feed close to the surface to grow and develop, their exposure to insecticides is greatly increased. Treatments applied later in the summer may warrant higher rates and additional applications to control larger nymphs and young adults.

It is important to realize that as soils dry out, mole cricket nymphs and adults will burrow down substantially into the soil profile to remain in contact with moist soil. This is why most insecticide labels for mole crickets stress the point that if the soil is dry at the time of application, sufficient irrigation (but well short of waterlogging the turf) must be done BEFORE treating to provide favorable conditions that will drive the nymphs and adults up to the surface. The efficacy of most treatments will be greatly improved if pretreatment watering is done.

Table 6.15 - Insecticides for Mole Crickets

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
acephate (Orthene Turf, Tree, and Ornamental Spray 97)	0.8-1.4 oz (use 1-15 gal water)	2.0-3.9 lb	Golf courses and sod farms only. Treat when mole crickets or their damage first appear. For best results, water before treating to drive the adults and nymphs to the surface, especially if soil is dry, but do not water after treating. If possible, treat in the late afternoon or early evening. More than one treatment at higher rates may be required during the growing season to knock down existing populations. Do not graze or provide livestock treated grass.
beta-cyfluthrin (Tempo Ultra SC [11.8%=1.0 lb AI/gal])	8.0 ml	12.0 oz	Residential and nonresidential sites, but not for use on golf courses, sod farms, and sod grown for seed (check label for details). For best results, water before treating to drive the adults and nymphs to the surface, especially if soil is dry (check label for details).
bifenthrin (Talstar GC [flowable]) (TalstarOne [7.9%=0.66 lb AI/gal]) (Talstar EZ [granule]) (Talstar GC [granule]) (Talstar PL [granule])	0.25-0.5 oz 0.5-1.0 oz 2.3-4.6 lb 2.3-4.6 lb 2.3-4.6 lb	10.0-20.0 oz 20.0-40.0 oz 100.0-200.0 lb 100.0-200.0 lb 100.0-200.0 lb	Residential and nonresidential sites (check labels for details). For best results, water before treating to drive the adults and nymphs to the surface, especially if soil is dry. Treat in late afternoon or early evening, and then water in ≤ 0.5 inch immediately after treating (check labels for details).
chlorpyrifos (Dursban 50W)	1.47-2.2 oz	4.0-6.0 lb (use ≥ 50 gal water)	RESTRICTED USE. For mole cricket control, Dursban 50W can only be used on sod farms and sod grown for seed. For best results, treat when young nymphs are active. Water soil before treating, especially if soil is dry, to bring insects to surface. Treat in late afternoon or early evening.

Table 6.15 - Insecticides for Mole Crickets (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
clothianidin (Arena 0.25G) (Arena 50WDG)	1.84-3.67 lb 0.294 oz	80.0-160.0 lb 12.8 oz	Arena 0.25G and 50WDP: Residential and nonresidential sites (check label for details). Arena 0.25G: For suppression of mole crickets. Highest rate suggested. Arena 50WDG: For suppression of mole crickets. Use high rate. For best results water before treating to drive the adults and nymphs to the surface, especially if the soil is dry. Apply enough water to move AI to where target insects are active.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G)	1.8-3.6 lb	80.0-160.0 lb	Aloft GC G and GC SC: RESTRICTED USE. Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formulation, apply enough water (≥ 0.5 inch), to release AI from the carrier. Application should be made during peak adult flight and egg laying. Check labels for details.
clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	0.27-0.44 oz	11.65-19.0 oz	
dinotefuran (Zylam 20SG)	1.0 oz	2.7 lb	Zylam 20SG: Residential and nonresidential sites, including sod farms. Optimum control can be achieved when applications are made prior to or at egg hatch of the target pests followed by sufficient irrigation or rainfall to move AI through the turf thatch layer. The AI in Zylam is highly systemic and has a high water solubility. It is highly mobile and resistant to biodegradation. These physical traits make the AI a good candidate for leaching into the ground water, particularly where the water table is shallow and roots are permeable. Caution must be taken when using this product. Do not graze treated areas or use clippings from treated areas for feed or forage. Keep children and pets off areas until spray has dried. Do not apply to areas that are water logged or saturated or frozen.

Table 6.15 - Insecticides for Mole Crickets (cont.)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G)	2.9 lb	125.0 lb	Allectus G and SC: Residential and nonresidential sites, but not for use on golf courses or sod farms (check labels for details).
(Allectus GC)	2.9 lb	125.0 lb	
	(for Allectus G and GC, a single annual application may be made using 4.6-5.7 lb)	(for Allectus G and GC, a single annual application may be made using 200.0-250.0 lb)	Allectus GC SC and SC: RESTRICTED USE. Golf courses and sod farms only (check labels for details).
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	1.32-1.65 oz	3.6-4.5 pt	For best results for all Allectus formulations, water before treating to drive the adults and nymphs to the surface, especially if soil is dry. Treat in late afternoon or early evening, and then water in ≤ 0.5 inch immediately after treating (check labels for details).
	(for Allectus GC SC, a single annual application may be made using 2.64-3.3 oz)	(for Allectus GC SC, a single annual application may be made using 7.2-9.0 pt)	
imidacloprid (5%) and bifenthrin (4%) (Allectus SC)	1.32-1.65 oz	3.6-4.5 pt	
indoxacarb (Advion Mole Cricket Bait)	1.15-4.6 lb	50.0-200.0 lb	Residential and nonresidential sites, but not for use on sod farms and sod grown for seed. Do not allow livestock or domestic animals to consume the bait or graze in treated areas (check label for details). For best results, apply bait in spring to control adults before they lay eggs, and in late summer and fall to control large nymphs and newly emerged adults. Water soil before treating to bring mole crickets to surface, and treat infested areas in late afternoon. If necessary, treat again in 7 days. Rainfall or irrigation within 2-3 days after treating may reduce bait effectiveness.
lambda-cyhalothrin (Scimitar GC [9.7%=0.88 lb AI/gal])	7.0 ml	10.0 oz	RESTRICTED USE. Residential and nonresidential sites (check label for details). For best results, water before treating to drive nymphs and adults to the surface, especially if soil is dry. Also, use a non-ionic wetting agent, penetrant, or similar adjuvant. Use highest water application rates possible when treating. Immediately after treating, apply 0.25 to 0.5 inch of water (check label for details).
	(nymphs and young adults) (use 4-10 gal water)	(nymphs and young adults)	
	14.0 ml	20.0 oz	
	(adults) (use 4-10 gal water)	(adults)	
thiamethoxam (Meridian 25WG)	1.5-1.95 oz/5,000 sq ft	12.7-17.0 oz	Residential and nonresidential sites (check label for details). For suppression of mole crickets (check label for details).
trichlorfon (Dylox 6.2G)	3.0 lb	130.0 lb	Dylox 6.2G, 80 [SP], and 420SL: Residential, park, and golf course sites. For best results, thatch layer must be <0.5 inch at time of treatment (check labels for details). Apply Dylox 80 [SP] and 420SL immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥ 9). Do not use treated area or clippings from treated areas for feed or forage.
(Dylox 80 [SP])	3.75 oz	10.2 lb	
(Dylox 420SL)	6.0 oz	300.0 oz	

Weeds

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Weedy Grasses

There are several preemergence crabgrass killers available which will do an excellent job of controlling crabgrass and other annual grasses. Goosegrass is more difficult to control than most of the other annual grasses. Higher rates are suggested for goosegrass control and repeating herbicide application in May or June is suggested for best results.

Preemergence crabgrass killers kill seedlings as they germinate. Thus, it is necessary that they be applied in advance of crabgrass germination. Crabgrass usually germinates after April 15 in the mountains and March 15 in the Piedmont areas.

Midseason to late postemergent applications for annual grasses is considered to be less desirable than preemergent or early postemergent control. Late postemergent treatments will usually result in turfgrass discoloration and browning of crabgrass foliage, and later bare areas in a lawn. However, early postemergent treatments will provide excellent crabgrass control and allow turfgrass to begin to cover during the Summer and Fall. Goosegrass is very difficult to control with postemergent herbicides. It is possible to control crabgrass and allow a more difficult problem with goosegrass to develop without competition for the space left by the dying crabgrass. Arsenical herbicides may still be used on a restricted basis in golf and sod turf but are banned from residential and athletic turf. Fenoxaprop, mesotrione, quinclorac, topramezone, and metribuzin are used to control annual grasses in certain turfgrasses during late spring and summer.

Most perennial grasses are controlled by physical removal or by non-selective chemicals. Bermudagrass (aka wiregrass) can be controlled with multiple treatments of mesotrione, topramezone, fenoxaprop, or fluazifop each mixed with triclopyr and applied at 3-week intervals. Dallisgrass may be selectively controlled in warm-season turf with arsenical herbicides in golf or sod turf or with various sulfonylurea products applied repeatedly in the fall. Dallisgrass and other Paspalum sp. may be suppressed in cool-season turf with topramezone or mesotrione.

Table 6.16 - Annual Grass Control¹

In Bluegrass, Tall Fescue, Perennial Ryegrass, and Common Bermudagrass

Herbicide	Crabgrass	Goosegrass	Annual Bluegrass	Foxtail	Sandbur	Annual treatments ²
Preemergent						
Benfin	S	I	I	S	I	2
Bensulide	S	R	S	S	—	1-2
Bensulide + Oxadiazon	S	S	S	S	I	2
DCPA	S	I	I	S	I	2
Dithiopyr	S	I	I	S	—	1
Ethofumesate	—	—	S	—	—	2-3
Oryzalin	S	I	S-I	S	S-I	2
Oxadiazon	S	S	I	S	I	1
Pendimethalin	S	I	I	S	I	2
Prodiamine	S	I	I	S	—	1
Siduron	S	R	R	S	—	2
Benfin + Oryzalin	S	S-I	S-I	S	S-I	1
Benfin + Trifluralin	S	I	S-I	S	S-I	2
Postemergent						
Dithiopyr	S	I	I-R	S	—	1
DSMA, MSMA	S	I-R	R	S	S-I	2-6
Fenoxaprop	S	I	I-R	S	—	2
Dithiopyr + MSMA ³	S	I	I-R	S	S-I	1
Dithiopyr + fenoxaprop	S	S-I	I-R	S	—	1
Mesotrione	S	S-I	I-R	S	—	2-4
Quinclorac	S	I-R	R	S	—	1-2
Topramezone	S	S	R	S	—	1-3

¹The relative effectiveness of commonly used herbicides for selected weeds is using S = weed susceptible; I = intermediate, good control at times with high rates, sometimes poor, may require more than one treatment; R = resistant weeds in most instances.

²Lower label rates may require additional applications.

³Not for use in residential or athletic turf.

Table 6.17 - Preemergent

Application	Weed Problems	Chemical Rate/ 1000 sq ft	Remarks
New seeding bluegrass, tall fescue, perennial ryegrass, creeping bentgrass	Annual grasses: barn- yardgrass, crabgrass, foxtails	siduron (Tupersan 3.7oz of 50% WP)	Apply at time of seeding. Kills annual weedy grasses, but not annual bluegrass. For use on bluegrass, tall fescue, or perennial ryegrass. Do not use on bermudagrass.
		mesotrione (Tenacity 0.12 oz of 4FL)	Apply at time of seeding. Kills annual weedy grasses including goosegrass and suppresses annual bluegrass. Also kills many broad- leaves. For best results, repeat application at first mowing (usually 6 weeks after seeding). For use on bluegrass, tall fescue, and centi- pedegrass. Consult label regarding perennial ryegrass and fine fescue as some seeding restrictions may apply.
New seeding tall fescue, perennial ryegrass, bluegrass, bentgrass	Annual grasses: crabgrass, foxtails, barnyardgrass	quinclorac (Drive 0.28 oz of 75% DF)	Apply at time of seeding for fescue and ryegrass. Must use 7 days before or 28 days after bentgrass and bluegrass. Controls annual grasses and some broadleaf weeds, but not goosegrass or annual bluegrass.
Preemergent bermudagrass (during establishment from sprigs)	Annual grasses: crab- grass, goosegrass, foxtails	oxadiazon (Ronstar G 3.4 lb of 2% gran or Ronstar 2.2 oz of 50WP)	Apply at the time of sprigging and do not disturb soil surface after application. Provides preemer- gence control of the annual grasses and allows good establishment of bermudagrass sprigs. For use by commercial and landscape person- nel only. Ronstar is not for home lawns.
Preemergent bermudagrass, zoysia- grass (during establish- ment from seed)	Annual grasses: crabgrass, foxtails, barnyardgrass	quinclorac (Drive 0.19 oz of 75% DF)	Apply at time of seeding. Controls annual grasses and some broadleaf weeds, but not goosegrass or annual bluegrass.
Established turf bluegrass, tall fescue, perennial ryegrass, bermudagrass	Annual grasses: barn- yardgrass, crabgrass, foxtails	benefin (Balan 3.0 lb of 2.5% gran or 1.8 oz of 60DF)	Apply uniformly in late winter or early spring before crabgrass emergence. May be reap- plied after 2 months for continued crabgrass control. Reseeding should not be attempted for 6 weeks after application.
		bensulide (Betasan 7.5- 9.4 oz of 4EC or 1.9- 2.3 lb of 12.5% gran or 3.3 lb of 7% gran)	Same. Do not reseed within 4 months of appli- cation. If for some reason turfgrass must be reseeded, charcoal will inactivate this herbi- cide. Application may be repeated after 3 to 4 months for continued crabgrass control.
		DCPA (Dacthal 1/3 lb of 75% WP or 5.0 lb of 5% gran or 5.1 oz of 6FL)	Apply in the early spring before crabgrass emer- gence. Flowering of forsythia can be used as a guide for proper timing of application. In areas where late-germinating crabgrass is experienced, a second application of half the regular rate is necessary after 8 weeks. In addition to crabgrass control, the DCPA treatments will provide some preemergence control of sandbur and postemer- gence control of corn speedwell.
		dithiopyr (Dimension 1.5 oz of 1EC)	Apply prior to or at crabgrass emergence. On fall seeded turfgrasses, delay application to early Postemergence for improved tolerance.

Table 6.17 - Preemergent (cont.)

Application	Weed Problems	Chemical Rate/ 1000 sq ft	Remarks
Established turf bluegrass, tall fescue, perennial ryegrass, bermudagrass (cont.)		oxadiazon (Ronstar 3.4 lbs of 2% gran or Ronstar 2.2 oz of 50WP)	Apply in the early spring before crabgrass emer- gence. Oxadiazon is used on bluegrass, ber- mudagrass, tall fescue, and perennial ryegrass. Ronstar is not for use on home lawns.
		pendimethalin (Pendulum 2G 1.75 to 2.25 lbs or Pendulum Aqua cap 1.6 oz of 3.8 ME)	Apply in the early spring before crabgrass emergence. Professional applicators may also use PreM 60WDG. Must be reapplied after 6-8 weeks for continued crabgrass control.
	Annual grasses: barn- yardgrass, crabgrass, foxtails (cont.)	prodiamine (Barricade 0.40 oz of 65WG)	Apply in spring before crabgrass germination. Irrigation or rain is desirable within a week to 10 days after application. Wait 6 mo to overseed by broadcasting over the surface. This waiting period may be reduced to 4 mo by drilling seed directly into the soil.
		benefin + trifluralin (Team 2G 3.5 lb of 1.3 + 0.7 gran)	Apply in spring before crabgrass germination and repeat application to maintain late season control.
		bensulide + oxadiazon (Goosegrass/ Crabgrass Control 2.6 lb of 5.25 + 1.31 gran)	Apply in spring before crabgrass germination.
Goosegrass	oxadiazon (Ronstar 3.4 lb of 2% gran or Ronstar 2.2 oz of 50WP)	Apply uniformly in early spring before gooseg- rass germination. This treatment will also give crabgrass control. Oxadiazon provides a high level of goosegrass control from early spring application. Ronstar is not for use on home lawns.	
	pendimethalin (Pendulum Aqua cap 1.1 oz of 3.8 ME)	Apply in early spring and repeat after 6 weeks to improve late season goosegrass and crabgrass control.	
	prodiamine (Barricade 0.40 oz of 65WG)	Apply in spring before goosegrass germination. Irrigation or rain is desirable within a week to 10 days after application. Wait 6 mo to overseed by broadcasting over the surface. This waiting period may be reduced to 4 mo by drilling seed directly into the soil. Repeat application accord- ing to label directions for goosegrass control.	
	oxadiazon + bensulide (Goosegrass/ Crabgrass Control 2.6 lb of 1.31 + 5.25 gran)	Apply in early spring before goosegrass germi- nation. This treatment also controls crabgrass when applied as a preemergence. This product may be allowed on golf greens for goosegrass control; however injury must be acceptable.	
Established bermudagrass	Goosegrass, crabgrass	benefin + oryzalin (XL Herbicide 3.0 lb of 1% + 1% gran and repeat after 8 weeks)	Apply in spring before annual grass germination. Reseeding turfgrass areas should be delayed at least 6 weeks after application.
Established bermuda- grass (cont.)		oxadiazon (Ronstar 1.8 to 2.2 oz of 50WP or 3.4 lb of 2% gran)	Apply in early spring to dormant bermudagrass and irrigate to wash into soil surface. It is sug- gested for fairways, parks, golf courses and lawns. Ronstar is not for use on home lawns, putting greens or tees.

Table 6.17 - Preemergent (cont.)

Application	Weed Problems	Chemical Rate/ 1000 sq ft	Remarks
Established turf, bluegrass, tall fescue, bermudagrass, perennial ryegrass	Annual bluegrass	bensulide (Betasan 0.6 pt of 4EC or 2.25 lb of 12.5% gran or 4.1 lb of 7% gran)	Apply in late August before annual bluegrass germination. Do not overseed or reseed for 4 or more months. Application of activated charcoal will inactivate bensulide and allow reseeding of desirable grass. Spring treatments for crabgrass control do not provide sufficient residual activity for any appreciable annual bluegrass control in the Fall.
		Bensulide (Betasan 9.6 fl oz of 4EC) Dithiopyr (Dimension 1.84 fl oz of 1EC) Prodiamine (Barricade 0.5-1.0 fl oz of 4EC)	Apply in late August before annual bluegrass germination. Do not overseed or reseed for 4 months or as specified on label. Application of activated charcoal will inactivate herbicide and allow for reseeding of desirable grasses.
		ethofumesate (Prograss 1.5-2.0 oz of 1.5EC and repeat after 30 to 60 days)	Preemergence and early postemergence annual bluegrass control is obtained with this treatment. Apply to dormant bermudagrass and bluegrass in the fall and repeat the treatment at 30 to 60 days. First application may be made at 15 to 30 days after overseeding bermudagrass with perennial ryegrass. Do not apply after January 1 on bluegrass and bermudagrass turf. Initial treatments before bermudagrass goes dormant or treatments made after February 1 are likely to cause bermudagrass injury. These treatments may be made for annual bluegrass control during establishment and on established perennial ryegrass. With perennial ryegrass, application can be made in spring if annual bluegrass is emerging.
Established bermudagrass	Annual bluegrass	simazine (Princep DF 0.4 oz of 90DF or 0.75 oz of 4L)	Apply before annual bluegrass germinates. Do not overseed or seed for 4 months before or 6 months after treatment. May be used only in coastal plain area of Virginia. For control of a few broadleaf weeds, read label. Hybrid bermudagrasses are slightly more sensitive to simazine.

Table 6.18 - Postemergent

Application	Weed Problems	Chemical Rate/ 1000 sq ft	Remarks
Established turf, bluegrass, bermudagrass, tall fescue, perennial ryegrass	Annual grasses: crabgrass, foxtails, goosegrass	DSMA (Many formulations available. Must follow directions on label of container.) OR MSMA	Various formulations are available. Start in June when annual grass is in the 1 to 3 leaf stage and less than 1 inch tall. At least 3 applications at 7-day intervals are necessary for goosegrass control. Timing of application is critical. Apply when soil moisture is adequate for rapid growth of crabgrass and turf. Some discoloration of turfgrass is to be expected. Follow label instructions for use of individual formulations. Use lower rate when mid-day temperatures are 80°F or higher. Not for use in lawns or athletic fields.
Established turf, bluegrass, tall fescue, perennial ryegrass, fine fescue	Annual grasses: crabgrass, foxtail, goosegrass	fenoxaprop (Acclaim 1EC at 0.345 to 0.73 oz)	Turfgrasses should be more than one year old. The low rate is used early in year (about June 15) when crabgrass is in seedling stage (not tillered). As tillering becomes evident (1 to 3/ plant), the high rate is used for adequate control. The turfgrasses also become more tolerant in July as growth pattern begins to slow. Tank mixing with broadleaf herbicides tends to reduce effectiveness on crabgrass.
		dithiopyr (Dimension at 1.5 oz of 1EC)	Apply at emergence and up until tillering of crabgrass. Excellent control of crabgrass but only suppression of goosegrass is expected.
		Mesotrione (0.09-0.18 oz of 4SC)	Apply at emergence through tillering. Tillering plants require two applications at 3-week intervals. Plants exceeding 10 tillers often require 3 applications at 3-week intervals, especially if the lower rate must be used. Also controls goosegrass, nimblewill, creeping bentgrass, foxtail, barnyardgrass, and several other grass and broadleaf species. Suppresses bermudagrass. Do not use more than 0.5 lb ai/A in a single season.
		quinclorac (Drive 0.37 oz of 75DF)	Apply at emergence through tillering. Two applications may be needed on tillering crabgrass but do not exceed 2 lb ai/A during a season. Also controls several broadleaf weeds, especially clover. Does not control goosegrass. Read and follow label instructions. Avoid drift to desirable ornamental plants.
		Topramezone (Pylex 0.023 oz of 2.8SC)	Apply at emergence through tillering. Two applications may be needed on mature crabgrass of over 10 tillers or when lower rates are used. Add methylated seed oil adjuvant at 0.5% by volume. Controls goosegrass at any growth stage. Also controls foxtails and some other grasses and broadleaf weeds but does not control sedges.
		fenoxaprop or DSMA, MSMA + Preemergence	Use label rates of pendimethalin, dithiopyr, bensulide, DCPA, or siduron.
Established bermudagrass only	Goosegrass	metribuzin (0.125-0.25 oz of Sencor 75TH)	Metribuzin should be tank-mixed with DSMA or MSMA where labels do not prohibit this treatment, at the user's discretion. Apply to actively growing bermudagrass and goosegrass in 40 gallons of water/A (1 gal/1000 sq ft). Repeat in 2 to 3 weeks - 2 applications maximum/year. Do not use on golf greens. Expect some discoloration of the bermudagrass. Do not use on bluegrass, fescues, or perennial ryegrasses.

Table 6.18 - Postemergent (cont.)

Application	Weed Problems	Chemical Rate/ 1000 sq ft	Remarks
Established bermudagrass, zoysiagrass	Goosegrass	foramsulfuron (Revolver 0.6 fl oz of 0.19 EC)	Apply 2 to 3 times. May mix or apply in sequence with MSMA or metribuzin.
Established dormant bermudagrass	Annual bluegrass, other winter annual weeds	glyphosate (Roundup 0.28 oz of 4.0 lb/gal LC); add 0.5% nonionic surfactant	Apply with 1/2 gal of water/1000 sq ft to actively growing annual bluegrass and other winter annual weeds in late winter on dormant bermudagrass (must be applied before any bermudagrass greenup.)
Established bermudagrass, zoysiagrass only	Annual bluegrass, roughstalk bluegrass, perennial ryegrass	foramsulfuron (Revolver 0.4 fl oz of 0.19EC) trifloxysulfuron (Monument 0.007-0.011 oz of 75WG) rimsulfuron (Tranxit 0.046 oz of 25DF)	Apply any time after 50 percent bermudagrass greenup or during dormancy, but not within 1 month of greenup. Products may move in watershed or track onto surrounding cool-season grasses. Do not apply to saturated soils and irrigate 4 to 12 hours after treatment with 0.1 inch water.
Established turf	Dallisgrass (<i>Paspalum dilatatum</i>)	MSMA (Follow directions on container label)	Apply June through September when mid-day temperatures do not exceed 90°F. June to early July is best timing and has a better environmental condition for control. Two or three applications at 7- to 10-day intervals will be required for control. Not for use in lawns or athletic fields.
Established turf bluegrass, tall fescue, perennial ryegrass, bermudagrass	Yellow and purple nutsedge as well as other sedges.	halosulfuron (Sedgehammer 0.023 oz of 75WDG)	Apply when actively growing. Avoid applications when turf and nutsedge are under stress. A nonionic surfactant should be added at a rate of 0.25-0.50% V/V. Halosulfuron is not labeled for use on golf greens.
		sulfentrazone (Dismiss 0.35 oz of 4L)	Apply when sedges are actively growing. Ensure uniform coverage. Works quickly compared to other sedge herbicides. Weeds begin to brown within 3 days. Excessive rates or certain tank mixtures, especially fertilizers, may lead to temporary turf discoloration.
	Yellow nutsedge	bentazon (Basagran T/O 1.0 oz of a 4 lb/gal LC) MSMA (MSMA6 1.0 oz of 6 lb/gal LC)	Apply when actively growing. At least 2 applications at 10-day intervals will be required for control. A third application may be made if needed (no more than three/year). A crop oil should be added at 0.25% V/V. Not effective for purple nutsedge control. Bentazon is not labeled for use on golf greens. Perennial ryegrass has shown considerable injury in some cases.
Established turf bermudagrass	Purple nutsedge, wild onion, wild garlic	imazaquin (Image 0.5-1.0 oz of 1.5 lb/gal)	Apply when actively growing. Imazaquin may be tank-mixed with MSMA for control of yellow nutsedge. A nonionic surfactant should be added at 0.25% V/V.
Renovation of established turf	Tall fescue, quackgrass, bermudagrass, orchardgrass, nimblewill	glyphosate (Roundup 2.5 oz 4.0 lb/gal LC)	Allow 2 to 4 weeks without mowing before chemical treatment. See label for desirable plant size to treat. Allow 7 days before clipping the dead sod and vertical mowing to 1/4 inch deep into soil. Seed the desired turfgrass and irrigate as needed. Early fall applications coincide with seeding dates, but application can also be made at other times when undesirable grass is actively growing.

Table 6.18 - Postemergent (cont.)

Application	Weed Problems	Chemical Rate/ 1000 sq ft	Remarks
Established turf bluegrass, tall fescue, perennial ryegrass	Bermudagrass, quackgrass, orchardgrass, nimblewill	mesotrione (Tenacity 0.12 to 0.18 oz of 4SC)	Mix with triclopyr (Turflon Ester 0.5-0.75 oz of 4EC) for best results. Apply twice in spring after weeds are green and twice in early fall before frost. Repeat treatments at a 3-week interval. Do not apply triclopyr to bluegrass during mid summer. Mesotrione treatments may continue during midsummer at 3-week intervals if weeds persist. Rates may be lowered as the number of treatments is increased. Frequent applications at low rates control weeds far better than few applications at high rates.
		topramezone (Pylex 0.023 oz of 2.8SC)	Mix with triclopyr (Turflon Ester 0.5-0.75 oz of 4EC) for best results. Also, include 0.5% methylated seed oil adjuvant. Apply three times in fall at 3-week intervals not to exceed 4 fl oz Pylex per acre per year.

Moss Control

Moss gradually invades lawns in areas where the turfgrasses are growing poorly. The infested site may be described as wet, shady, highly acidic, and under low fertility. A program to control moss involves correcting the turfgrass growing conditions as much as possible. Remove as much moss as possible by raking, vertical mowing and aerifying to prepare a seed bed to reseed thin turfgrass areas. Select a species/cultivar adapted to the area conditions. Maintain optimum growing conditions for the turfgrass as fertility, pH, moisture (not excessive) and mowing height/frequency. The turfgrass density is very important to prevent further moss encroachment. Sometimes a shade tree may be removed to allow enough light for good turfgrass growth.

Chemical formulations for moss control usually contain iron, copper, or potassium salts of fatty acids as active ingredients. Ferrous sulfates and chelated iron products applied as liquid sprays are generally rapid and effective on moss. Dry formulations of ferrous sulfate monohydrate are available such as Moss Control Granules for Lawns containing 5% iron (follow label directions). Carfentrazone (Quicksilver T&O) is an herbicide for broadleaf control that can be used in lawns or putting greens for moss control. Apply 6.7 ounces Quicksilver T&O per acre or 0.15 ounce per 1,000 square feet twice at 3-week intervals. Moss discoloration is a sign of successful treatment and takes longer under cool conditions. Moss control is temporary and treatment may be required annually. Managers should improve conditions for turfgrass growth while minimizing the favorable environment for the moss. Read and follow label directions carefully.

Broadleaf Weeds

The herbicide response table that follows rates the susceptibility of common lawn weeds to weed killers. Annual weeds live only one year and should be treated in the seedling stage. Winter annuals germinate in the fall and should be controlled at that time. Spring germinating annuals, likewise, need to be treated in the spring. Biennial plants live 2 years and perennials live for 3 years or more. In general, broadleaf weeds respond best to weed killers when they are most actively growing and in the seedling stage. This is usually in the spring or fall. When equally effective, we prefer the fall application because of less likelihood of damage to ornamental and garden plants. Application of high rates of weed killer during hot dry conditions may brown desirable grasses. Effectiveness of postemergence broadleaf herbicides is better when rainfall or irrigation does not occur for 24 hours after application.

Most lawns that need treatment contain a variety of weeds which can best be controlled by a combination of ingredients. Many formulations are sold that contain more than one ingredient. It is necessary that label direction on the container be followed to get the proper application rate. When combinations are used, the results are additive and the individual rates are reduced, slightly. A combination of 2,4-D and dicamba (1.0 lb + 0.25 lb) or 2,4-D and mecoprop (1.0 lb + 1.0 lb) is very effective on a wide range of broadleaf weeds. We would consider this to be the best treatment for an average lawn with a variety of weeds. Knotweed, dock, and red sorrel are susceptible to dicamba. **Dicamba is soil-mobile** and should not be used in the root area of shallow-rooted trees or shrubs. The specific herbicide(s) should be selected according to the kinds of weeds present in the turf and the appropriate herbicides may be tank-mixed or purchased as a pre-mixed formulation.

6-44 Turf: Weeds

Combinations of 2,4-D + mecoprop + dicamba and other three-way mixtures are on the market. Follow label directions on the containers for proper application rates and directions. The low rate of dicamba in these three-way mixtures reduces the possibility of dicamba injury.

Triclopyr may be purchased as a formulation mixture with 2,4-D (Turflon D, Chaser) or clopyralid (Confront) or may be used as a tank-mixture with these herbicides. Some formulation mixtures are suggested for use by professional personnel in charge of weed control applications. Read the label for rates to use for specific weeds and turfgrass tolerances. Triclopyr should not be used on bermudagrass unless some injury can be tolerated and then lower label rates are suggested.

Newly seeded turf areas should not be treated with broadleaf weed killers until enough growth has occurred to allow two mowings. The broadleaf weed killers recommended for lawns are not particularly toxic to humans, pets, birds, or wildlife. They would create a problem only if ingested in large quantities. They are biodegraded by soil micro-organisms and their persistence in the soil would range from 2 to 4 weeks for 2,4-D, and possibly 6 months for dicamba.

The chemicals noted can be used safely at recommended rates on bluegrass, fescue, or common bermudagrass. The bentgrasses are susceptible to injury from 2,4-D; however, there are formulations containing low rates of 2,4-D in combination with other materials that may be safely used. Avoid application on bentgrasses when temperatures exceed 85° F.

The availability of many formulations of the various broadleaf herbicides which vary in amount of active ingredient makes it difficult to establish a general rate to apply to 1000 sq ft or to add to 1 gal of water. Directions on the container label should be used as a guide to determine the proper amount of formulation to use. With a 4.0 lbs/gal formulation, 1.0 qt contains 1.0 lb of active ingredient and a rate given in lb/A is equal to qt/A. To convert to small areas, 1.0 qt/A = 1-1/2 tbsp/1000 sq ft.

Table 6.19 - Conversion for Small Area Application

Rate Desired	Formulation available					
	1 lb/gal.	2 lb/gal.	4 lb/gal.	1 lb/gal.	2 lb/gal.	4 lb/gal.
	Quarts/Acre ¹			Tablespoons/1000 sq ft		
1/3 lb/A	1-1/2	3/4	3/8	2-1/4	1-1/8	9/16
1/2 lb/A	2	1	1/2	3	1-1/2	3/4
1 lb/A	4	2	1 ¹	6	3	1-1/2 ¹
1-1/2 lb/A	6	3	1-1/2	9	4-1/2	2-1/4
2 lb/A	8	4	2	12	6	3

¹One quart/A is equal to 1-1/2 tablespoons/1000 sq ft.

Two tablespoons is equal to 1.0 fluid ounce or 29.6 cc.

Table 6.20 - Preemergent Broadleaf Weed Control

Application	Weed Problem	Chemical	Remarks
Preemergent (Established turf)	Annual broadleaf weeds	DCPA (Dacthal 1/3 lb of 75% WP or 5.1 oz of 6FL or 5.0 lb of 5% gran)	DCPA will provide some preemergent control of prostrate and spotted spurge, common chickweed, carpetweed, purslane, and sandbur. Creeping speedwell may be controlled with high rates as a postemergence application in May or June.
		isoxaben (Gallery 3/8-1/2 oz of 75DF)	Apply uniformly in early spring prior to germination of target weeds such as: white clover, spotted spurge, yellow woodsorrel, or prostrate knotweed. Fall germinating weeds may require applications in late summer (common chickweed, henbit, dandelion, corn speedwell, shepherdspurse, broadleaf and buckhorn plantains). Is safe in and around various trees, shrubs, and groundcovers in May or June.

Table 6.21 - Broadleaf Weed Control in Bluegrass, Tall Fescue, Perennial Ryegrass, and Common Bermudagrass

The relative effectiveness of commonly used herbicides for selected weeds is listed in this table. See (!) for key.

Weeds which are intermediate in response should be given repeat treatment rather than increasing the rate of a single application. It may sometimes be desirable to treat at times other than those listed. When this is necessary, make sure that good growing conditions prevail and contact with desirable plants is prevented. Combination products may be more effective than individual chemicals on a particular weed. The herbicides listed may be purchased as a pre-mixed formulation or separately and tank-mixed as labels allow.

Use caution when applying triclopyr or clopyralid to bermudagrass-see label restrictions.

Weed	Classification	Response to Herbicides (lb/A) ¹								Preferred Time to Treat
		2, 4-D 1.5-2.0	Dicamba 0.33-0.5	2,4-D + Mecoprop 1+1	2, 4-D + Mecoprop + Dicamba	2, 4-D + Dicamba 1.0+0.33	2, 4-D + Dichlorprop + Mecoprop	2, 4-D+ Triclopyr 1.0+0.5	Triclopyr + Clopyralid 0.56+0.19	
Bedstraw	A	I-R	S	I	I-R	S	—	—	—	April & May
Bindweed	P	S	S	S-I	S	S	S	S	—	May & June
Bittercress	WA or B	S	S	S	S	S	S	S	—	Oct & Nov
Blackmedic	A, B, & P	R	S	I	S	S	S	S	S	April & May
Buttercup	WA, B, & P	S-I	I	S	S	S	S	I	S	Oct & Nov
Buttonweed Virginia	P	R	R	R	I-R	I	I	I	I	May & repeat
Carpetweed	SA	S	S	S	S	S	S	S	—	May & June
Catsear Dandelion	P	S-I	S	S	S	S	S	S	S	Oct & Nov
Chickweed Common	WA	R	S	S	S	S	S	S	S	Oct & Nov
Mouseear	P	I-R	S	S-I	S	S	S	S	S-I	Oct & Nov
Chicory	P	S	S	S	S	S	S	S	—	Oct & Nov
Cinquefoil Common	A	S	S	S	S	S	S	S	—	May & June
Clover Crimson	SA	S	S	S	S	S	S	S	S	May & June
Hop	SA	I	S	S	S	S	S	S	S	April & May
White	P	I	S	S	S	S	S	S	S	Oct & Nov
Daisy Oxeye	P	I	I	I	I	I	I	I	—	Oct & Nov or May
Dandelion	P	S	S	S	S	S	S	S	S-I	Oct & Nov
Dock	P	I	S	I	I	S	I	I	I	Feb - April
Dogfennel	P	R	S	I-R	I-R	S	I	I	S-I	Oct & Nov or April
Garlic Wild	P	I	I	I	I	S-I	I	—	—	Oct - Nov. & Feb - March

¹S = weed susceptible; I = intermediate, good control at times with high rates, sometimes poor, may require more than one treatment; R = resistant weeds in most instances; A = annual; SA = summer annual; WA = winter annual; B = biennial; and P = perennial.

Table 6.21 - Broadleaf Weed Control in Bluegrass, Tall Fescue, Perennial Ryegrass, and Common Bermudagrass (cont.)

Weed	Classification	Response to Herbicides (lb/A) ¹								Preferred Time to Treat
		2, 4-D 1.5-2.0	Dicamba 0.33-0.5	2,4-D + Mecoprop 1+1	2, 4-D + Mecoprop + Dicamba	2, 4-D + Dicamba 1.0+0.33	2, 4-D + Dichlorprop + Mecoprop	2, 4-D+ Triclopyr 1.0+0.5	Triclopyr + Clopyralid 0.56+0.19	
Geranium Carolina	WA	S	S	S	S	S	S	S	—	April - May
Ground Ivy	P	I-R	S-I	I	I	S-I	I	S-I	S-I	April - May
Hawkweed	P	S-I	S-I	S-I	S-I	S	S-I	S-I	I	Aug & Sept
Healall	P	S	S-I	S-I	S-I	S	S	—	—	Oct & Nov
Henbit	WA	I	S	I	S-I	S	S	S	S	Oct & Nov
Honeysuckle	P	S-I	S	S-I	S	S	S	S	—	May & June
Horsenettle	P	I-R	I	I-R	I-R	I	I	I	—	May & June
Horseweed	WA, SA	I	S	S-I	S-I	S	—	—	S	Oct or May
Knapweed Spotted	B	I	S	I	I	S	I	S	—	Oct & Nov
Knawel (German Moss)	WA	R	S	I	I	S	S	S-I	—	Oct & Nov
Knotweed	SA	R	S	I	I	S	I	—	—	March - April
Lambsquarters	SA	S	S	S	S	S	S	S	S	April & May
Lespedeza	SA	I-R	S	S-I	S	S	S	S	I	April & May
Mallow Common	SA	I-R	S-I	I	I	S-I	S-I	—	S-I	April & May
Mugwort	P	I-R	S-I	I-R	I-R	S-I	I	—	—	March
Mustards	WA & B	S	S	I	S-I	S	S	—	—	Oct & Nov
Onion Wild	P	I	I	I	I	S-I	I	—	—	Oct - Nov & Feb - March
Ornamental Plants	P	S-I	S	S-I	S-I	S	S	S	—	Most likely to injure April to June
Oxalis	A,P	I-R	R	I-R	I-R	I	S	I	I-R	April - May
Pennycress	A	S	S	S	S	S	—	—	—	Oct & Nov
Pepperweed	WA or B	S	S	S	S	S	S	—	S-I	Oct & Nov
Pigweed	SA	S	S	S	S	S	S	S	—	April & May
Plantains	P	S	I-R	S	S	S	S	S	S-I	Oct & Nov
Poison Ivy	P	I	S-I	I	I	S-I	I	S-I	I	June
Pony Foot	P	S	S-I	S-I	S-I	S	—	—	—	Oct & Nov
Poorjoe (Diodia)	A	S-I	—	S-I	S-I	S	—	—	—	May & June
Prostrate Spurge	SA	I	S	I	S-I	S	S-I	S-I	I	April - May

¹S = weed susceptible; I = intermediate, good control at times with high rates, sometimes poor, may require more than one treatment; R = resistant weeds in most instances; A = annual; SA = summer annual; WA = winter annual; B = biennial; and P = perennial.

Table 6.21 - Broadleaf Weed Control in Bluegrass, Tall Fescue, Perennial Ryegrass, and Common Bermudagrass (cont.)

Weed	Classification	Response to Herbicides (lb/A) ¹								Preferred Time to Treat
		2, 4-D 1.5-2.0	Dicamba 0.33-0.5	2,4-D + Mecoprop 1+1	2, 4-D + Mecoprop + Dicamba	2, 4-D + Dicamba 1.0+0.33	2, 4-D + Dichlorprop + Mecoprop	2, 4-D+ Triclopyr 1.0+0.5	Triclopyr + Clopyralid 0.56+0.19	
Purslane	SA	I	S	I	I	S	I	S-I	—	May & June
Red Sorrel Shepherds'	P	R	S	I	I	S	I	S-I	S-I	Oct & Nov
Purse	WA	S	S	S	S	S	S	S	S-I	Oct & Nov
Smartweed	SA	I-R	S	I-R	I	S	I	I	I	April & May
Sowthistle	WA	S	S	S	S	S	S	S	—	Oct & Nov
Speedwell Corn	SA or WA	R	R	R	R	I-R	I	I	I	April
Spotted Spurge	SA	I-R	S-I	S-I	S-I	S-I	S-I	S-I	I	May & June
Star-of-bethlehem	P	R	I-R	R	R	I-R	R	—	—	April
Teasel (Common)	B	S	S	S	S	S	S	S	-	April & May
Thistle Bull	B	S-I	S	S-I	S-I	S	S-I	S-I	—	Oct & Nov
Canada	P	I	I	I-R	I	I	I	I	S-I	Oct & Nov
Curl	B or P	S	S	S	S	S	S	S	—	April
Musk	B	S	S	S	S	S	S	S	I	April
Vegetables	A	S	S	S	S	S	S	S	S	Most likely to injure April to June
Violet	P	I-R	I	I-R	I-R	I	I	I	I	April
Wild Carrot	B	S	S	S	S	S	S	S	I	Oct & Nov
Wild Strawberry	P	R	S-I	R	I-R	S-I	I	I	—	Oct & Nov
Yarrow	P	I	S	I	I	S	I	I	—	Oct & Nov
Yellow Rocket	B or P	S-I	S-I	S-I	S-I	S	S	S	—	Oct & Nov
Yellow Woodsorrel	A	R	R	I-R	I	I	S	I	I-R	April & May

¹S = weed susceptible; I = intermediate, good control at times with high rates, sometimes poor, may require more than one treatment; R = resistant weeds in most instances; A = annual; SA = summer annual; WA = winter annual; B = biennial; and P = perennial.

Table 6.22 - Golf Course Putting Greens (Bentgrass or Bermudagrass)

Weed Problem	Chemical Rate/1000 sq ft	Remarks
Preemergent control of annual grasses	bensulide 7.0-9.4 oz (4.0 lb/gal formulation) or (6.0-8.0 lb of 3.6% gran) or (1.9-2.4 lb of 12.5% gran or 2.4-4.1 lb of 7% gran)	Apply uniformly in the late winter or early spring before crabgrass emergence. August or September application is used for annual bluegrass control. The higher rate is needed for annual bluegrass. For crabgrass, the lower rate is effective and may be repeated after 4 months for better continuous crabgrass control. Goosegrass control is generally poor with bensulide.
	bensulide + oxadiazon (Goosegrass/Crabgrass Control® 2.6 lb of a 5.25% + 1.31% gran)	For use on bermudagrass and bentgrass putting greens, apply with a properly calibrated drop spreader. Use only where goosegrass is heavy on the green during a prior year and the herbicidal side effects are tolerable. Irrigate the green immediately after application. Do not treat greens with less than desirable turf cover and root system.
Postemergent control of annual grasses	DSMA (Follow directions on container label).	Follow label directions. Discoloration of grass should be expected. Use only when mid-day temperatures are below 90°F. Goosegrass control will require 2 to 3 applications at 4- to 7-day intervals and is seldom 100% effective. Goosegrass will also require the higher rates. Other label formulations may be equally effective. Follow label directions for rates.
Postemergent control of broadleaf weeds	dicamba 1.0-2.0 tsp (4.0 lb/gal formulation)	Margin to tolerance is narrow. Excessive rates will kill grass. A teaspoon is 1/6 fluid ounce. Do not try to spot-treat on green or excessive rates will occur. Start spraying on apron and move across the green. Best to put on 1/2 rate in one direction and retreat with remaining 1/2 at right angles.
	mecoprop (MCP) 1.5-2.0 oz of 2.0 lb/gal formulation	Seaside, Arlington, and Congressional bents may be injured.
	2,4-D + MCP + dicamba 1.0 oz of Trex-San Bent OR 1.0 oz of Trimec Broadleaf Herbicide (Bent Formula)	A commercial mixture with a reduced rate of 2, 4-D which gives a good spectrum of weed control and increased margin of safety over dicamba alone. Do not over-apply. Slight yellowing may occur temporarily. Do not irrigate within 24 hours after application.
Postemergent control of moss	carfentrazone (QuickSilver 0.15 oz of 1.9EC)	Apply at 2-week intervals for at least 3 treatments. Moss will return unless suitable changes in greens management such as increased mowing heights, proper fertility, etc. are met.

Golf Course Fairways

Fairway weed control can be accomplished with the same weed killers listed in the first part of the turf section. The same rates and remarks will apply. See Growth Regulation section in this publication for suppression of annual bluegrass in fairway bluegrasses and perennial ryegrasses.

Golf Course Sand Traps

Weeds in sand traps present considerable problems in golf course management. EPTC (Eptam 5G) is used in sand traps. All weed growth must be removed before application. Eptam must be raked into the sand to a 2- to 3-inch depth immediately after application. It will not injure greens when blasted or tracked on the turf by players. Follow directions on the container label for correct rate and method of application.

Nonselective Control of Perennial Grasses

(Bermudagrass, Fescue, Nimblewill, Orchardgrass, Quackgrass)

Undesirable patches or clumps of perennial grasses can be treated with glyphosate (Roundup, Kleenup). Lightly wet the foliage of the undesirable grass in the spring or summer when it is actively growing. Follow label directions for rates of application and proper timing. Glyphosate has no soil residual and reseeding can occur as soon as the foliage has turned brown (7-10 days).

Weed Control in Driveways, Fence Lines, and Parking Areas

There are many good soil sterilants on the market that will give long-term control of weeds. These are discussed in the non-selective section of this guide. These materials are very powerful weed killers and not designed for homegrounds situations. Many trees and shrubs have been killed when application of soil sterilants was made within their root feeding areas. See glyphosate for nonselective weed control above.

Table 6.23 - Woody Plant Control Around Homes, Cabins, Buildings, Fence Lines, Trails, and Vacant Lots

Problem and Application Technique	Chemical and Application Rate	Remarks
Foliage Spray		
Honeysuckle	2, 4-D amine 1.5 oz of 3.8 lb/gal/1.0 gal water	Wet thoroughly all foliage and stems to runoff. Apply during active growth periods after full leaf stage in spring. Turf grasses will survive some drippage.
Honeysuckle, blackberry, poison ivy, Virginia creeper, wild rose, willow, many other shrubs and trees.	triclopyr (Brush-B-Gon 5.7%, mix 4.0 oz with 1.0 gal water)	Same as above.
Blackberry, poison ivy, Virginia creeper, and other woody plants. Also bermudagrass, quackgrass, nimblewill, other grasses.	glyphosate (Roundup 41%, mix 1.0-6.0 oz with 1.0 gal water)	Several formulations are available. Use according to label directions (Kleenup, Roundup, Blot-out, and others).

Growth Regulators

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Growth regulators are utilized to reduce the amount of mowing and trimming needed for maintaining turfgrass. The suggested growth regulator, applied before seedhead formation, will also inhibit the development of seedheads of cool-season turfgrasses for one season. Bermudagrass seedheads are inhibited for about 4 weeks.

Growth regulators are suggested for use on areas such as highways and other rights-of-way, industrial parks, schools, cemeteries, airports, and golf course roughs. They are particularly useful along fence lines, sloping areas, guard rails, and other areas difficult to mow and trim. A few growth regulators are available for well-maintained and extensively managed turfgrasses. These growth regulators are used for turfgrass growth suppression and/or annual bluegrass suppression.

Spring growth regulator application should be delayed until turfgrass reaches a desirable density. In many cases where mowing can be utilized, the regulator may be best applied after the first time the grass is clipped. This clipping will achieve a more neatly trimmed appearance for a longer period. Caution: the turfgrass stand does not become more dense after treatment; therefore, the turfgrass may remain at the density you see at the time of treatment. If thatch is showing through when the regulator is applied, it may continue to show for 6 to 8 weeks. Generally, after the period of turfgrass growth suppression, the foliage may even take on a darker green appearance.

The turfgrass should have a good appearance and be actively growing at the time of treatment with growth regulator. Any debris or clippings should be removed. For seedhead control, apply at least 2 weeks prior to seedhead emergence. Apply when rain is not expected for 24 hours.

Table 6.24 - Use of Growth Regulators

Application	Turfgrass Shoot Regulation	Chemical Rate/1000 sq ft	Remarks
Established rough turf (Highway rights-of-way, airports, cemeteries, parks and other cool season rough turfgrasses)	Tall Fescue and Bluegrass	mefluidide (Embark 0.4-0.6 oz of 2.0 lb/gal) OR amidochlor (Limit 1.8 oz of 4.0 lb/gal) OR mefluidide + chlorsulfuron (Embark at 0.18 oz of 2 lb/gal + Telar at 0.008 oz of 75% DF) OR imazethapyr + imazapyr (Event at 0.18 to 0.22 oz) OR imazethapyr + imazapyr + mefluidide (Event at 0.09 oz + Embark at 0.18 oz)	The introductory comments above provide useful information on where and when to apply PGRs. They are best utilized on medium- to low-managed turf but where frequent mowing has been necessary. Not used on residential turf around homes and apartments. The PGRs are most useful during the spring to reduce growth for 6 to 8 weeks. This period usually accounts for 60% of the year's total growth of fescue.
Established rough turf (Warm season turfgrass)	Bermudagrass (Common)	mefluidide (Embark PGR 1.5 oz of 2.0 lb/gal) OR flurprimidol (Cutless 50w rate varies with cultivar, see label)	Same as above. Time of application is usually later in spring after green-up and before peak period of vegetative growth. For hybrid bermudagrass, use Embark 2S at 0.4 to 0.6 oz/1000 sq ft. Flurprimidol is used on medium to high quality turfgrass. A 0.5-inch irrigation is needed within 24 hours after flurprimidol treatment.

Table 6.24 - Use of Growth Regulators (cont.)

Application	Turfgrass Shoot Regulation	Chemical Rate/1000 sq ft	Remarks
Established well-maintained turf	Bluegrass and Perennial Ryegrass in fairways and well maintained turfgrass areas	mefluidide (Embark 2S at 0.18 oz of 2 lb/gal OR Embark Lite at 1.2 to 1.8 oz of 0.2 lb/gal)	Apply in spring after greenup and before flush growth period. Embark suppresses annual bluegrass, especially seedhead development. The applications should be made prior to seedhead development in the annual bluegrass.
		flurprimidol (Cutless at 0.18 oz of 50 WP)	Apply in spring before major flush of growth but after greenup requiring mowing once or twice. This will also suppress annual bluegrass growth but allows seedhead development or flowering of the annual bluegrass.
		trinexapac (Primo at 0.75 oz of 1 lb/gal)	Apply in spring after greenup requiring mowing but before major flush of turfgrass growth. Reduce rate by 50% or more if mowing height is less than 0.5 inches (see label). Sequential applications are suggested at monthly intervals. Apply after turfgrass has been mowed. Do not apply in hot, dry weather or when turfgrass is under stress. Application rate varies with turfgrass species. Read label for further specifics. Annual bluegrass will be suppressed to a much greater extent than perennial bluegrass. Overseed this area if needed. Trinexapac is also suggested for edging along sidewalks, curbs, driveways, flower beds, fences, and parking areas. Make application at monthly intervals during active growth periods. Follow label directions.
		paclobutrazol (Fertilizer with TGR poa annua control at 2.9 lb of 0.42% or TGR turf Enhancer at 0.33 oz of 50WP)	Apply in spring after greenup occurs and mowing is required. Annual bluegrass is suppressed. Do not apply where area contains as much as 70% annual blue grass.

Forest Insects

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In addition to the major pests of forest trees, there are many kinds of insects that live in forests without occurring in damaging numbers. However, a few may develop occasionally into serious local infestations. Since both major and occasional pests tend to be cyclic and often scattered, ongoing surveys and monitoring by trained foresters are an essential part of forest pest management. Early detection of pests is essential to prevention of economic losses due to serious outbreaks.

Sound forest management practices are basic to effective integrated pest management. Proper site selection, stand density control, stand and tree vigor, and proper sanitation are among the most important. Under poor management and inadequate protection practices, salvage operations may be the only recourse. Pesticide applications may be utilized for prevention of potential insect population buildup and suppression of outbreaks that threaten the vigor as well as survival of trees. However, use of pesticides is not recommended without knowledge of pest status. Use pesticides only if pests are present or are predicted to be present from a standard or systematic sample survey. They should be used in settings where compatible with management and of limited risk to the environment.

Technical assistance is available from the Virginia Department of Forestry and the U.S. Forest Service, as well as the Virginia Cooperative Extension Service. State and federal forestry agencies may provide control services on a cost-sharing basis as well as survey and detection programs in cooperation with public and private forest land owners. Control programs for new, introduced, or as yet not established pests such as the gypsy moth are conducted by the Bureau of Plant Protection and Pesticide Regulation of the Virginia Department of Agriculture and Consumer Services with the Cooperation of the Animal and Plant Health Inspection Service, the USDA, the US Forest Service, the Virginia Department of Forestry, and Virginia Cooperative Extension.

Internet resources on forest insect pests:

<http://www.ento.vt.edu>

<http://www.idlab.ento.vt.edu/IDLab/Fact/Fact1.html>

<http://www.idlab.ento.vt.edu/IDLab/Fact/Fact2.html>

<http://fhpr8.srs.fs.fed.us/idotis/insects.html>

Table 7.1 - Insects and Insecticides (cont.)

Special Note: Some of the following chemicals may be restricted to conifers only or tree nurseries only; read the label and use only as directed.

Insect Host	Recommended Control	Remarks
Adelgids Balsam woolly adelgid	Carbaryl Chlorpyrifos Dormant oil Esfenvalerate Imidacloprid Permethrin	Scout regularly for adelgid or trees losing apical dominance; remove infested trees if practical. Spray bark and foliage to runoff. treat in June or when found May-October. If infested plants are few and scattered, rogue and burn, and spray trees in a 20 foot diameter circle around rogued trees. When removing infested trees, wrap trees in tarp so no adelgids fall off as the tree is removed.
Hemlock woolly adelgid (eastern and Carolina hemlock)	Dormant oil Imidacloprid Thiamethoxam	For soil applications of the systemic, amount applied is based on diameter of trunk at breast height. Applications should take place at bud break. Do not use on trees with less than 50% foliage. For dormant oil use 1% rate during the spring months and 2% during the fall or winter. For foliar applications, spray foliage and twigs to run off in early spring (March - April) or late fall (Oct. - Nov.).

Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honeybees. Follow precautionary instructions on labels and use protective equipment wherever specified.

Equivalents: 1 lb WP/100 gal = 1 Tablespoon/gal; 1 pt EC/100 gal = 1 teaspoon/gal

7-2 Low-Management Crops and Areas: *Forest Insects*

Table 7.1 - Insects and Insecticides (cont.)

Special Note: Some of the following chemicals may be restricted to conifers only or tree nurseries only; read the label and use only as directed.

Insect Host	Recommended Control	Remarks
Aphids (various hardwoods)	Azinphosmethyl Carbaryl Esfenvalerate Imidacloprid Malathion Permethrin	Thorough coverage of foliage for leaf-feeding aphids or twigs and branches for bark-feeding aphids. Treat when aphids are first seen. May occur throughout the season.
Aphids (cont.) (various conifers)	Azinphosmethyl Carbaryl Esfenvalerate Imidacloprid Malathion Permethrin	Aphids rarely harm forest trees; heavily infested seedlings can be sprayed. Thorough coverage of new shoots, twigs and branches. Treat when first seen. May occur throughout season. Provado: apply at 4.0-8.0 oz/A
Bark Beetles Ips engraver beetles Southern pine beetle Turpentine beetle (pines)	Bifenthrin Carbaryl Permethrin	Bark beetle impact can be prevented or reduced by growing trees at lower densities, thinning during rotation, and in general keeping the basal area at about 80 square feet. In forest stands, salvage timber with a buffer strip of uninfested trees at the active head(s) of the infestation as soon as possible. This is called "cut and remove." You can also cut and spray to remove the beetles in the trees or spray trees with insecticide before they are attacked for temporary protection. Where spraying is justified, thoroughly soak bark with spray. Do not allow spray to get into bodies of water or run off into waterways. Turpentine beetle infestations can be treated without felling by spraying the lower boles of infested and adjacent uninfested trees.
Borers	Permethrin	This chemical is registered for preconstruction lumber and logs against wood destroying insects.
Cankerworms (many hardwoods)	<i>Bacillus thuringiensis</i> (Bt) Carbaryl Diflubenzuron Tebufenozide	Apply treatment when egg hatch is complete and larvae are young, usually in early to mid- May. For all but Bt, do not allow spray or run off to get into bodies of water or streams. See label for aerial application dosage rates. Sticky banding of the trunk in the fall for fall cankerworm can be used to prevent wingless females from climbing the trees and mating with males. They also can be used to monitor activity.
Defoliators Caterpillars, beetles, etc.	<i>Bacillus thuringiensis</i> (Bt) Carbaryl Diflubenzuron Tebufenozide	There are many other insects that occasionally defoliate Virginia forests. The impact of defoliation depends primarily on host condition, time of year, and degree of foliage loss. Tree growth and vigor are reduced most by heavy defoliation early in the year. Trees that are in good health at the time of defoliation will survive. Trees already under stress at that time of defoliation will lose vigor and sometimes die from the effects of secondary agents and adverse environmental conditions.
Emerald Ash Borer (Ash)	Systemic insecticides Acephate Bidrin Emamectin benzoate Imidacloprid Contact insecticides Bifenthrin Carbaryl Cyfluthrin Permethrin	Systemics (Imidacloprid, acephate, bidrin, 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. Systemics must be applied before the trees show signs of infestation. Imidacloprid should be drenched and emamectin benzoate must be applied by direct tree injection by an arborist. After cutting trees, do not move wood out of area. Destroy, chip, or leave wood on site.

Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honeybees. Follow precautionary instructions on labels and use protective equipment wherever specified.

Equivalents: 1 lb WP/100 gal = 1 Tablespoon/gal; 1 pt EC/100 gal = 1 teaspoon/gal

Table 7.1 - Insects and Insecticides (cont.)

Special Note: Some of the following chemicals may be restricted to conifers only or tree nurseries only; read the label and use only as directed.

Insect Host	Recommended Control	Remarks
Fall Webworm (many hardwoods)	<i>Bacillus thuringiensis</i> (Bt) Carbaryl Diflubenzuron Tebufenozide	Rarely has significant impact on forest trees; high density populations rarely persist for more than two seasons. Stressed trees can be protected against defoliation impact by spraying the first webworm generation in mid- to late June. Treat first generation in mid- to late June and, if necessary, the second generation in mid- to late August.
Gypsy Moth (many hardwoods)	<i>Bacillus thuringiensis</i> (Bt) Carbaryl Diflubenzuron Tebufenozide	Treat when most larvae are in second instars and most oak leaves are at least half expanded. Most treatments are coordinated through local-state-federal cooperative suppression programs. Defoliation impact can be reduced through preventive forest management practices, including presalvage, thinning, sanitation, and manipulation of species composition, all done at least 5 years before invasion by the moth.
Mites Spruce spider mite (conifers, especially spruces, hemlock, Fraser fir in nurseries, and plantations. Seldom on pine)	Avid Clofentezine Dormant oil Etoxazole Floramite Spiromesifen	Treat in early spring and fall (usually late April and mid- September) when mites are most active; use oil as a dormant spray (make foliage oily)
Eriophyid mite (Needle Sheath Mite)	Carbaryl Chlorpyrifos Dimethoate Dormant oil	Treat as soon as detected (early spring); oils may alter foliage appearance.
Pine Tip Moth Nantucket pine tip moth (2 and 3 needle pines only)	Carbaryl Confirm Diflubenzuron Esfenvalerate Imidacloprid Imidan Permethrin Tebufenozide	Thoroughly wet all shoots and needles in the spring and repeat 1 to 2 times later in the summer. Pheromone traps are used to time male flight activity. A general rule is to treat 10 days after catching males in traps so that susceptible early instar larvae are at their first peak. The discrete generations that this rule depends on break down with each succeeding generation, of which there are three in Virginia.
Pine Webworm (white, Scots, red pine)	<i>Bacillus thuringiensis</i> (Bt)	Rarely contributes to seedling mortality. Spray only when webworm population density is high and seedling stocking marginal. Treat as soon as detected.
Sawflies Virginia pine sawfly, introduced pine sawfly, red-headed pine sawfly	Carbaryl Esfenvalerate Imidacloprid	Treat Virginia pine sawfly in April; introduced pine sawfly on white pine in June and September; red-headed pine sawfly, June to September. Since pine sawflies tend to avoid current season's foliage, defoliation is rarely total and trees can survive repeated infestations. See label for aerial application directions.
Scale Insects Pine needle scale, pine tortoise or scale, elongate hemlock scale, etc.	Carbaryl Dormant oil Malathion Permethrin	Treat for pine needle scale mid- to late May and mid- to late July; pine tortoise scale mid- June and July. For all other scale insects treat at crawler date. Scale insects rarely reach high densities or have serious impact on hardwood forests; spread of invading beech scale and associated beech bark disease can be slowed through salvage of infested trees. Spraying is not practical in the forest setting.
Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honeybees. Follow precautionary instructions on labels and use protective equipment wherever specified.		
Equivalents: 1 lb WP/100 gal = 1 Tablespoon/gal; 1 pt EC/100 gal = 1 teaspoon/gal		

7-4 Low-Management Crops and Areas: *Forest Insects*

Table 7.1 - Insects and Insecticides (cont.)

Special Note: Some of the following chemicals may be restricted to conifers only or tree nurseries only; read the label and use only as directed.

Insect Host	Recommended Control	Remarks
Tent Caterpillars Forest tent caterpillar (many hardwoods)	<i>Bacillus thuringiensis</i> (<i>Bt</i>) Carbaryl Diflubenzuron Malathion Tebufenozide	Treat for forest tent caterpillar when first leaves are fully expanded. Forest tent caterpillars occasionally cause extensive hardwood forest defoliation. They do not make the web tents in the crotch of the tree branches.
Eastern tent caterpillar (wild cherry)		Eastern tent caterpillar only have minor impact and should not be treated in the forest setting.
Weevils Pine reproduction weevils, Pales weevil, Eastern Pitchheating weevil. (conifers: feed on first year stumps and the base of recently dead trees as larvae. The adults may feed on live twigs.)	Esfenvalerate Imidan Permethrin	In forest plantations, wait one year to replant with seedlings if harvesting took place after June 1. Seedlings are currently treated in nursery beds prior to lifting under SLN registration; foresters and landowners can order seedlings that are already treated. In Christmas tree plantations, stump removal or stump treatment with insecticide (as described below) is recommended. Thoroughly soak stumps and ground surface 1 to 2 ft around stumps or slash prior to mid- March. Apply Imidan as 4% top dip for seedlings prior to planting. Follow label directions. For seedlings: Apply as a full coverage spray to seedlings immediately after planting. For stumps: Thoroughly soak stumps and ground surface around stumps or slash prior to mid- March. Only stumps or wood cut since previous summer need treatment. Dilute Asana in kerosene.
White Pine Weevil (eastern white pine, Scots pine, and Norway spruce: feed in the tops of trees only.)	Permethrin	Treat when plantations show 5% or more weeviled tips. Applications must be made prior to adult egg laying, usually April 1. Treat only 1.5 to 2 ft of the main terminal shoot, not the entire tree or laterals. A full 4 gal knapsack sprayer will treat approximately 200 terminal shoots.
Wood Borers		Heavily infested trees should be salvaged for fuel wood or felled and bucked to encourage predation of borer larvae by ants; if left standing, such trees serve as breeding grounds for borers that will infest and degrade additional trees. Spraying is impractical. Do not move infested wood out of area.
Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honeybees. Follow precautionary instructions on labels and use protective equipment wherever specified.		
Equivalents: 1 lb WP/100 gal = 1 Tablespoon/gal; 1 pt EC/100 gal = 1 teaspoon/gal		

Insecticide Recommendations for Fraser Fir Seedbeds and Liner Beds

Eric R. Day, Extension Entomologist, Virginia Tech

Table 7.2 - Soil Insects^{1,2}

Insects	Insecticide	Rates	Timing and Comments
Root Aphids	Imidacloprid		Treat when aphids are first discovered and completely water in granular material. Treat only if damage such as yellowing is observed. Most of the time root aphids are not present in damaging numbers.
White Grubs	<i>Bacillus Popillae</i> (Milky spore disease) for Japanese beetle only; not effective on other grub species.		White grubs include several species of scarab beetle larvae. Japanese beetle grubs are the only species that will be controlled adequately by milky spore products. Follow label instructions for application. 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 in the turf, control can be effective for years without further application. After application, the disease perpetuates and spreads by infecting and being transported by grubs. If another grub treatment is applied to an area treated with milky spore, this will slow the spread of the disease and is therefore not desirable. White grubs can also be controlled by entomopathogenic nematodes. Not all nematode species (named on the product label under the "Active Ingredients" section) available commercially will provide adequate control. Products with <i>Steinernema carpocapsae</i> should not be used for grub control. Entomopathogenic nematode products should be applied only when the pest is present. Apply nematodes late in the day to avoid exposure to UV light damage. Irrigate the day before and immediately after application. Early spring treatments are usually not effective because soil temperatures should be at least 60°F.
	<i>Beauveria bassiana</i>	1.0	
	Carbaryl (Sevin 10G)	1.4-1.9 lb	
	Ethoprop (Mocap 10G)	1.125 lb	
	Entomopathogenic Nematodes	1 billion/A	
	Halofenozide (Mach 2)	2.2 fl oz	
	Imidacloprid (Merit 0.75 WSP)	1.6 oz packet/11,000.0 ft ²	
	Lambda-Cyhalothrin (Scimitar)	3.0-7.0 mL	
Trichlorfon (Dylox 6.2)	3.0 lb		

(continued next page)

¹After transplanting from the liner bed to the field, consult the information listed under Christmas trees.

²Generally most soil insects are controlled with fumigants used for weed control prior to planting. The following is remedial control for insects detected after the bed is established.

7-6 Low-Management Crops and Areas: Seedbeds and Liner Beds

Table 7.2 - Soil Insects^{1,2} (cont.)

Insects	Insecticide	Rates	Timing and Comments
White Grubs (cont.)			<i>Beauveria bassiana</i> (an entomopathogenic fungus) products also provide control. Follow label instructions and water 1/2 inch immediately after application. Avoid fungicide applications when using these products. Several chemical insecticides are available for grub management. These products should be applied at the labeled rate and watered in with 1/4-1/2 inch of water. Most insecticides provide the best control when used against early instar grubs that are present in early to mid- August. Populations high enough to warrant treatment are 6 to 10 grubs/sq ft. White grubs stop feeding in September or October, so control during fall may not prove successful. Spring treatments usually are not effective. Cultural management: reducing thatch will increase penetration of any treatment applied to the turf.
Cutworms	Permethrin		Treat when cutworms are first discovered, avoid weedy growth as cutworm moths prefer to lay eggs in thick vegetation as well as low-lying places.

¹After transplanting from the liner bed to the field, consult the information listed under Christmas trees.

²Generally most soil insects are controlled with fumigants used for weed control prior to planting. The following is remedial control for insects detected after the bed is established.

Table 7.3 - Foliage And Stem Insects

Insects	Insecticide	Rates	Timing and Comments
Balsam Woolly Adelgid	Asana XL Bifenthrin Horticultural Oil Imidacloprid Permethrin		Treat when found in June or May–October with Asana XL or Lorsban. Spray bark and foliage to runoff. Use horticultural oil in winter during dormant periods. Horticultural oil may give the foliage an oily appearance and burn some tips.
Balsam Twig Aphid	Asana XL Bifenthrin Imidacloprid		Treat in about the first week of May or just prior to buds opening in the spring. Severe cases only need be treated as this insect is generally a cosmetic pest.
	Dormant oil		Use 1% rate for Dormant oil. Maintain temperature restrictions.
Spruce Spider Mite	Bifenthrin Insecticidal Soap Kelthane Mavrik Savey San Mite		Treat in early May or late September or when mites are found.
	Dormant oil		Dormant oil in late March will control mites in most situations.

Fungicide Recommendations for Conifer Seedbeds and Liner Beds

Mary A. Hansen, Extension Plant Pathologist, Virginia Tech

Table 7.4 - Diseases

Disease	Fungicide	Rates	Comments
Botrytis blight	Daconil Zn, Echo 720 (chlorothalonil)	See label for rates; rates vary with specific disease being controlled.	Begin applications in nursery beds when seedlings are 4 inches tall and when cool, moist conditions favor disease development. Make additional applications at 7- to 14-day intervals as long as conditions favorable for disease persist.
	Spectro 90WDG (chlorothalonil + thiophanate methyl)	Maximum rate = 5.7 lbs/A.	
Needle casts, tip blight	Bordeaux mixture (copper sulfate + hydrated lime)	8T product per gal water. To make fresh Bordeaux mixture, mix 8.0 lb copper sulfate plus 8.0 lb hydrated lime in 100 gal water.	For pines: make 3 applications: one as new growth starts, one as new needles emerge from the sheath, and one when needles are 2/3 of mature length. For blue spruce and Douglasfir: Apply when new needles are half developed. Repeat when needles are full length.
	Echo 720 (chlorothalonil)	See label for rates; rates vary with specific disease being controlled.	Make first application in spring when new shoot growth is 0.5-2.0 inches in length. For nursery beds, apply the highest rate specified on a 3-week schedule until conditions no longer favor disease development.
	Heritage (azoxystrobin)	3.2-8.0 fl oz/A	Apply as a foliar spray every 7-21 days, beginning prior to disease development. To avoid development of fungicide resistance, do not make more than four sequential applications before rotating with nonstrobilurin products.
	Kocide 3000 (copper hydroxide)	0.75-1.75 lbs/A	Begin applications in the spring at the initiation of new growth. Repeat at 7-30 day intervals when conditions favor disease. Maximum seasonal rate per acre is 66.7 lbs.
	Spectro 90WDG (chlorothalonil + thiophanate methyl)	Maximum rate = 5.7 lbs/A.	Apply at budbreak and repeat at 2-3 week intervals until needles are fully elongated and conditions no longer favor disease development.
	Tourney (metconazole)	1-4 oz/100 gal water per acre	Apply as a foliar spray. Repeat at 14-28 day intervals when conditions favor disease.
Phytophthora root rot	Alude, Agri-fos, Fosphite (phosphonate)	See comments for rates used with specific application method.	Can apply as foliar spray, soil drench, or bare-root dip. Foliar Spray: Apply 1 to 2 qts per 100 gal water or 2-4 tsp per gal water and spray to thoroughly wet all foliage. Repeat applications at 14- to 21-day intervals as needed. Soil drench: Apply 1 to 2 qts per 100 gal water or 2-4 tsp per gal water. Apply 1 gal of solution per sq yd. Follow application with irrigation. Apply at 14- to 21-day intervals as needed. Bare Root Dip: Mix 1 qt per 100 gal water or 2 tsp per gal water. Dip transplants in solution for 2 minutes immediately before transplanting. Keep roots submerged and ensure root mass is thoroughly wet.

¹Subdue products will only be effective when used in conjunction with good cultural practices; they will not overcome poor management practices, such as planting on sites with poor drainage. They will not revitalize trees with moderate to severe root rot.

7-8 Low-Management Crops and Areas: Seedbeds and Liner Beds

Table 7.4 - Diseases (cont.)

Disease	Fungicide	Rates	Comments
Phytophthora root rot (cont.)	Segway (cyazofamid)	3.0 to 6.0 fl oz per 100 gal water	Make applications every 14-28 days, rotating with a fungicide with a different mode of action between Segway applications.
	Subdue GR ¹ (mefenoxam)	Granular product; see comments section.	<u>Seedbeds and Plug Plantings:</u> Uniformly apply 6.0-30.0 lb/A (2.2-11.0 oz/1000 sq ft) in the spring and again in the fall. <u>2-0 Transplants:</u> Uniformly apply 12.0-60.0 lb/A (4.4-22.0 oz/1000 sq ft) in the spring and again in the fall. For best efficacy of granular products, 1/2 inch of irrigation or rainfall is required within 24 hours after application.
	Subdue WSP ¹ (mefenoxam)	Soil surface application only. See Comments for rates.	<u>Seedbeds and Plug Plantings:</u> Apply 15.0 oz/A (3 packets/A) in at least 50 gal of water in the spring and again in the fall. Follow with 0.5 to 1.0 inch of irrigation if rainfall is not expected within 24 hours. <u>2-0 Transplants:</u> Apply 15.0-30.0 oz/A (3 to 6 packets/A) in at least 50 gal of water in the spring and again in the fall. Follow with 0.5 to 1.0 inch of irrigation if rainfall is not expected within 24 hours.
	Subdue MAXX ¹ (mefenoxam)	See Comments for rates.	<u>Seedbeds and Plug Plantings:</u> Apply 1.25 pt/A in at least 50 gal of water in the spring and again in the fall. Follow with 0.5 to 1.0 inch of irrigation if rainfall is not expected within 24 hours. <u>2-0 Transplants:</u> Apply 2.50 pt/A in at least 50 gal of water in the spring and again in the fall. Follow with 0.5 to 1.0 inch of irrigation if rainfall is not expected within 24 hours. Foliar Application: Use 1.0 fl. oz. per 100 gal water and apply to runoff. Resistance Management: Make only one foliar application of Subdue MAXX before alternating with a non-Group 4 fungicide for sequential foliar applications.
	Avalon WDG, Fosetyl-AI (aluminum tris)	Foliar application: 2.5-5.0 lbs per 100 gal water Rates: Dip treatment: 2.5 lbs per 100 gal water.	Spray to wet. Make no more than one application every 30 days. Immediately before transplanting, thoroughly wet plant and root mass by dipping transplants in fungicide mixture. Use protective clothing when making dip treatments.

¹Subdue products will only be effective when used in conjunction with good cultural practices; they will not overcome poor management practices, such as planting on sites with poor drainage. They will not revitalize trees with moderate to severe root rot.

Weed Control in Fraser Fir Seedbeds and Liner Beds

Jeffrey F. Derr, Weed Scientist, Virginia Tech

Table 7.5 - Weed Control¹

Pest	Herbicide and Rate	Comments
Most Weed Species	dazomet (Basamid 350 lb/A or 8.0 lb/1000 sq ft)	Preplant soil fumigation. Incorporate after application. Irrigate or cover with plastic after application. Do not use below soil temperature of 43°F. Waiting period for seeding ranges from 10 to over 30 days.
Annual and Perennial Weeds	glyphosate (Roundup Pro 2.0-5.0 qt/A or 1.3-2.6 fl oz/gal, Roundup ProMax, 1.0-3.3 qt/A or 2.0 fl oz/gal, or other labeled formulation)	For site preparation prior to seeding. Apply when weeds are actively growing. Do not allow spray to contact desired foliage.
Many Annual Weeds	Goal 2XL (oxyflourfen) 1.0-4.0 pt/A or 0.4-1.4 fl oz/1000 sq ft or GoalTender 0.5-2.0 pt/A or 0.2-0.7 fl oz/1000 sq ft	Apply after seeding but prior to seedling emergence. Preemergence control of weeds from seed.
	Goal 2XL (oxyflourfen) 1.0-2.0 pt/A or 0.4-0.7 fl oz/1000 sq ft or GoalTender 0.5-1.0 pt/A or 0.2-0.37 fl oz/1000 sq ft	Postemergence control of weeds less than 4 inches tall plus residual control. Do not apply sooner than 5 weeks after fir emergence. Fir seedlings must be hardened off prior to spraying.
Annual and Perennial Grasses	Segment (sethoxydim) 2.0-3.0 fl oz/gallon	Postemergence control of most grasses. Spray to wet when grasses are actively growing. Will not control wild onion, yellow nutsedge, or any broadleaf weed.

¹After transplanting from the liner bed to the field, consult the information listed under Christmas trees.

Christmas Tree Insects

Eric R. Day, Extension Entomologist, Virginia Tech

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Peter B. Schultz, Extension Entomologist, Hampton Roads AREC

Chris Asaro, Chief, Entomology, Virginia Department of Forestry, Charlottesville

Early detection and accurate identification of insect pests is the key to prevention of serious damage and loss in Christmas tree plantations. Growers should be knowledgeable about the more common, injurious insects and mites - their recognition, host plants, damage, seasonal development, and habits. Chapter 10, Insects, in the "Christmas Tree Production Manual" is a helpful reference (Virginia Cooperative Extension Publication 420-075). The "Christmas Tree Pest Manual," Michigan State University publication E-2676, contains full-color illustrations to aid in identification as well as biological and chemical information.

Effective control depends on the timely and thorough application of recommended control measures. Control measures applied improperly or not in accordance with label directions are ineffective and a waste of time, materials, and labor, and may constitute a misuse of pesticides. Use pesticides only if pests are present or are predicted to be present from a standard or systematic sample survey.

Amounts of pesticide to use in preparing sprays or applying treatment are specified in this control guide. Even so, they should be determined from the label on the container of the pesticide at the time of application. Be sure to read **ALL** of the directions and precautions on the label before and at the time of application of each treatment. Use **ONLY** the recommended amounts of the formulation. For many insecticides listed, other formulations are available and registered for use: Carbaryl (Sevin) - 50 WP, 80S, 4F, and Sevimol; Dursban-2E and 50WP (Lorsban is the trade name for chlorpyrifos marketed for agricultural crops); Orthene - 9.4% EC and 15.6% EC; diazinon-4E and 50WP; Malathion-50% EC and 25WP; Dipel-3.2% WP, 6L, and 8L; Thuricide-32 LV, HP, and HPC. Formulation often depends on type of application as well as company marketing policy. Dusts are not recommended, since they are readily washed off by rain. WP residues are not as persistent as emulsifiable concentrates; although addition of a sticker often improves residual activity. Insecticides marked ** are restricted-use pesticides.

Major Insects and Mites Infesting Christmas Trees

Insects and mites vary in their host preferences and their severity on different hosts. The following list of pests associated with each type of tree is an aid in identifying potentially damaging species. The pests are listed in order of importance and occurrence generally. Most insects and the spruce mite tend to be localized on scattered trees rather than uniformly distributed through plantations.

Balsam Fir	white pine aphid	sawflies	pine webworm
balsam woolly adelgid	pine bark adelgid	eriophyid mites	aphids
aphids	sawflies	spruce mite	spittlebug
balsam twig aphid	bagworm	Red Pine	woolly pine scale
Blue (and Sitka) Spruce	pine needle scale	pine tip moth	Virginia Pine
spruce mite	pine webworm	sawflies	Virginia pine sawfly
white pine weevil	eriophyid mites	pine root collar weevil	pine tip moth
sawflies	Fraser Fir	pales weevil	pales weevil
aphids	balsam woolly adelgid	eastern pine weevil	pine webworm
cooley spruce gall adelgid	aphids	white pine aphid	White Fir
Douglas-Fir	spruce mite	Scotch Pine	aphids
spruce mite	eriophyid mites	pine tip moth	White Spruce
white pine weevil	balsam twig aphid	pine needle scale	spruce mite
cooley spruce gall adelgid	Norway Spruce	pine tortoise scale	white pine weevil
Eastern White Pine	white pine weevil	pine bark adelgid	sawflies
white pine weevil	eastern spruce gall adelgid	sawflies	aphids
pales weevil	aphids	pales weevil	
eastern pine weevil	pine needle scale	eastern pine weevil	

Fraser Fir Scouting Schedule for Insects and Mites

Scouting and Control Notes

(Specific chemical recommendations are in the following sections.)

Bagworm: *Scouting:* January: Look for overwintering bags. *Cultural Control:* Pick off and destroy bags in the fall and winter. Bags can be destroyed by dropping them in a can of kerosene or burying them at least 6" deep. *Chemical Control:* It is important to treat in mid-June when the larvae are small and susceptible to insecticides. Larger larvae with bags are not easily controlled. See the most recent Virginia Pest Management Guide for insecticides labeled for control of bagworms. *Biological Control:* Spraying with *Bacillus thuringiensis* (Bt, Dipel, Thuricide, etc.) in early to mid-June should give satisfactory control.

Spruce Spider Mite: *Scouting:* Start scouting in mid-April and continue scouting once a month until the first heavy frost. Walk through the plantation in a Z or W pattern. Pick a tree at random once every 50 feet. Check the shoot for mites or mite damage; you may need a 10X hand lens to see the mites. You should be examining at least 15 shoots per acre. Carry a sheet of paper with two columns marked to record the total number of shoots sampled and the total number of shoots with mites. The presence of damage alone is not enough; record it as positive if you find the mites or mite eggs. Based on research in North Carolina that is applicable to Virginia, the economic threshold is based on the size of the tree. On trees less than waist high, treat if the percentage of shoots with mites exceeds 40%. On trees waist high to year before sale, treat if the percentage of shoots with mites exceeds 20%. On trees at the year of sale, treat if the percentage of shoots with mites exceeds 10%. Use these guidelines for determining when to come back and sample again. If no mites or eggs are observed then return in 6-8 weeks. If less than 10% of the shoots have mites or eggs return in 4-5 weeks. If more than 10% of the shoots have mites or eggs return in 2 weeks. If there are more than 10 days of hot, dry weather check the trees sooner. *Cultural Control:* Avoid having bare earth under trees as this will reduce the number of predators on the tree and increase the number of Spruce Spider Mites. *Mechanical Control:* None known. *Chemical Control:* See Fact Sheet 444-235 for more detail.

Balsam Twig Aphid: *Scouting:* Start in early April to determine the amount of damage present. Walk through the field in a Z or W pattern. Scouting for Balsam Twig Aphid can be done at the same time as the Spruce Spider Mite scouting. *Threshold for Christmas Tree Growers:* Treat only if the trees are within 2 years of harvest. If more than 10% of the trees have at least one damaged twig then consider treating. The amount of damage an individual grower/buyer will tolerate is variable as some buyers consider a small amount of twig damage good because the upturned needles give the tree a silvery appearance. This may take a number of seasons of working with buyers to perfect how much damage you can leave and still not reduce your price. *Mechanical Control:* None known. *Cultural Control:* Maintain the trees in good growing condition and trees should continue to vigorously grow even with populations of Balsam Twig Aphid present. *Chemical Control:* Treat between mid-April and bud break. If you wait until after bud break, it is too late for control this season and you should postpone treatment until next year. See Fact Sheet 444-228 for more detail.

Balsam Woolly Adelgid (BWA): *Scouting:* The best time to scout is in July as the adelgids are covered with a white cottony wax and are easily observed. In the winter they are much smaller and lack the woolly covering making them much harder to see. Look also for the trees that are flattening out on the top or have a crooked leader; this is early damage from the BWA. Walk through the field in a Z or W pattern. *Threshold for Christmas Tree Growers:* Treat the entire block if an infestation is found. *Mechanical Control:* If only one or two infested trees are found, wrap the infested trees in a tarp and cut down and remove. You will still need to spot spray the surrounding trees. *Cultural Control:* Avoid excess use of nitrogen fertilizer. *Chemical Control:* See Fact Sheet 444-233 for more detail.

White Grubs: *General Comment:* White grubs are seldom a problem on plantations where a grass strip is maintained between the trees. Scouting should be performed in areas where new trees are to be planted or where yellowing or slow growth occurs on established trees. *Scouting:* Check especially in areas where trees are yellowing or not growing. Look also in areas with poor grass growth or where polecats or foxes are digging up grubs. In June lift up 1-foot-square sections of sod, five sites per 2 acres. *Threshold for Christmas Tree Growers:* Treat if you find on average more than 1 grub per hole and you have damage. *Mechanical Control:* None known. *Cultural Control:* Maintain as much grass growing between the trees as possible as the white grubs prefer to feed on grass roots and only move to tree roots when nothing else is available. *Chemical Control:* Treat with Diazinon or Oftanol in the same manner you would treat a lawn.

Table 7.6 - Fraser Fir Scouting Schedule for Insects and Mites¹

Virginia Tech IPM Program - Prepared by Eric R. Day

Pest Problem	Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Bagworm	Scouting		Scout										
	Treatment												
Spruce Spider	Scouting				Scout	(Scout)	(Scout)	(Scout)	(Scout)	(Scout)	(Scout)		
	Treatment												
Balsam Twig	Scouting				Scout	Scout							
	Treatment												
White Grubs	Scouting						Scout						
	Treatment												
Balsam Woolly Adelgid	Scouting							Scout					
	Treatment							Treat					

¹Modified in part from Fraser Fir IPM by Dr. Jill Sidebotton, N.C. Cooperative Extension

Spruce Scouting Schedule for Insects and Mites

Scouting and Control Notes

(Specific chemical recommendations are in the following sections.)

Bagworm: *Scouting:* January: Look for overwintering bags. *Cultural Control:* Pick off and destroy bags in the fall and winter. Bags can be destroyed by dropping them in a can of kerosene or burying them at least 6” deep. *Chemical Control:* It is important to treat in mid- June when the larvae are small and susceptible to insecticides. Larger larvae with bags are not easily controlled. *Biological Control:* Spraying with *Bacillus thuringiensis* (Bt, Dipel, Thuricide, etc.) in early to mid- June should give satisfactory control.

White Pine Weevil (WPW): *Scouting:* Look for resinous bleeding in late March or early April to find when adult females are feeding and laying eggs. Check trees also in June to determine which tops are actively infested with WPW. Check for a final time in fall to determine the percent of trees that are infested. *Threshold for Christmas Tree Farms and Forestry Plantations:* If fall surveys indicate that more than 5% of the trees were infested with WPW the previous season, plan on treating the whole plantation or block. *Mechanical Control:* Prune out and destroy infested tops in late June. Make sure stems are cut below where weevils are feeding. Tops must be cut before the weevils make exit holes and leave. *Cultural Control:* Remove all old unattended stands of white pine and Norway spruce that may be harboring populations of WPW. *Chemical Control:* Treat the terminal leader with a registered insecticide before the buds open. Do not treat the lateral shoots as they are not the infestation point. Apply the insecticide no later than late March or early April. For valuable specimen trees it may be necessary to treat each year. *Remarks:* Repeated terminal dieback caused by WPW can give trees an asymmetrical crooked appearance that is aesthetically pleasing to many people. Often the nice old gnarly pine tree has been given its appearance by repeated attacks by WPW.

Spruce Spider Mite: *Scouting:* Start scouting in mid-April and continue scouting once a month until the first heavy frost. Walk through the plantation in a Z or W pattern. Pick a tree at random once every 50 feet. Check the shoot for mites or mite damage; you may need a 10X hand lens to see the mites. You should be examining at least 15 shoots per acre. Carry a sheet of paper with two columns marked to record the total number of shoots sampled and the total number of shoots with mites. The presence of damage alone is not enough; record it as positive if you find the mites or mite eggs. Based on research in North Carolina that is applicable to Virginia, the economic threshold is based on the size of the tree. On trees less than waist high, treat if the percentage of shoots with mites exceeds 40%. On trees waist high to year before sale treat if the percentage of shoots with mites exceeds 20%. On trees at the year of sale, treat if the percentage of shoots with mites exceeds 10%. Use these guidelines for determining when to come back and sample again. If no mites or eggs are observed then return in 6-8 weeks. If less than 10% of the shoots have mites or eggs return in 4-5 weeks. If more than 10% of the shoots have mites or eggs return in 2 weeks. If there are more than 10 days of hot, dry weather check the trees sooner. *Cultural Control:* Avoid having bare earth under trees as this will reduce the number of predators on the tree and increase the number of Spruce Spider Mites. *Mechanical Control:* None known. *Chemical Control:* See Fact Sheet 444-235 for more detail.

7-14 Low-Management Crops and Areas: *Christmas Tree Insects*

Cooley Spruce Gall Adelgid and Eastern Spruce Gall Adelgid: *Scouting:* Start scouting in April and look for small tufts of cotton like material at the base of buds. Look again in August and September to determine when the galls have opened up. *Threshold for Christmas Tree Farms:* Treat when 5% of the trees have ten or more galls; spot spraying may work with smaller infestations. *Cultural Control:* Avoid planting Douglas fir within 500 yards of Norway Spruce. *Mechanical Control:* None known. *Chemical Control:* Treat with dormant oil in February or March. In severe cases treat with an insecticide in August or September just as the galls turn from brown to green and small openings are created for the adelgids to exit. Treatments can also be applied in April but this is trickier as it needs to be done when the small adelgid is feeding at the base of the needle just before the gall is formed. The adelgids will be covered with a small tuft of wax.

Table 7.7 - Spruce Scouting Schedule for Insects and Mites

Virginia Tech IPM Program - Prepared by Eric R. Day

Pest Problem	Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Bagworm	Scouting	Scout											
	Treatment			Pick				Spray					Pick
Cooley Spruce Gall Adelgid and Eastern Spruce Gall Adelgid	Scouting		Scout	Scout									
	Treatment		Treat	Treat									
White Pine Weevil	Scouting			Scout									
	Treatment			Spray		Prune	Prune						
Spruce Spider Mite	Scouting				Scout	(Scout)	(Scout)	(Scout)	(Scout)	(Scout)	(Scout)		
	Treatment					Spray				Spray			

Scotch Pine Scouting Schedule for Insects and Mites

Scouting and Control Notes

(Specific chemical recommendations are in the following sections.)

Bagworm: *Scouting:* January: Look for overwintering bags. *Cultural Control:* Pick off and destroy bags in the fall and winter. Bags can be destroyed by dropping them in a can of kerosene or burying them at least 6" deep. *Chemical Control:* It is important to treat in mid- June when the larvae are small and susceptible to insecticides. Larger larvae with bags are not easily controlled. See the most recent Virginia Pest Management Guide for insecticides labeled for control of bagworms. *Biological Control:* Spraying with *Bacillus thuringiensis* (Bt, Dipel, Thuricide, etc.) in early to mid-June should give satisfactory control.

Pine Tortoise Scale: *Scouting:* Look for darkened patches or branches on the side or top of the tree. Check the twigs and needles for the presence of the scale insects. High populations will cause browned dead shoots. The presence of honeydew (clear sticky droplets) will also indicate scales, but may also be from aphids, so it is important to identify the source. Ants, bees and wasps will feed on the honeydew and their activity may lead you to a scale infestation. *Threshold for Christmas Tree Farms and Forestry Plantations:* No known threshold but the presence **coupled** with objectionable damage will warrant treatment. Many trees will support low non-damaging populations. The pine needle scale is heavily fed upon by predators and parasites which control it most years. *Mechanical Control:* Remove infested branches or trees and burn. Works best if the infestation is localized. *Cultural Control:* If chronic problems with this scale are not resolved by chemical or mechanical control it is best to switch to non-susceptible hosts such as spruces, firs, hemlock, or white pine. *Chemical Control:* February or March - Treat with dormant oil. June - For severe cases two sprays 10-14 days apart are recommended during crawler emergence early in June. *Remarks:* Check wind break trees for infestation as scales may spread from these trees as new seedlings are set nearby.

Nantucket Pine Tip Moth: *Scouting:* March - Look for small copper-colored moths flying from trees when you shake the

branches or walk by the tree. At the same time assess the tree for damage from last year. *Cultural control:* July - For light infestations, simply shear off the damaged tips containing the insects. Ground beetles, ants and other scavengers should consume the tip moths once on the ground. *Chemical Control:* Late April - Treat with a residual insecticide such as dimethoate; cover all lateral branches and the leader. Additional spray dates: Late-June and Late-August - Treat again with dimethoate if damage is heavy. **See Fact Sheet 444-238 for more details.**

Pine Needle Scale: *Scouting:* Look for the white scales in the fall and winter and note which rows or blocks need treatment. In early May and early July wrap electrical tape, sticky side up, around twigs with high populations of scale. Treat one week after the first reddish-purple crawler is found. This will usually be about mid-May and mid- to late July. *Threshold for Christmas Tree Farms and Forestry Plantations:* Treat only if stunted growth, yellowing, or unsightly populations of scales are present. *Cultural Control:* Promote vigorous growth, as scales tend to cause more damage in poorly growing trees. *Chemical Control:* Apply a 2% dormant oil in late March when temperatures are above 45°F. The dormant oil may remove the waxy bloom on the needles and give the trees a dull appearance but this is temporary and will be hidden by the summer's flush of growth. It would be advisable to avoid dormant oils on the year of harvest. Dormant oil is also sold as superior oil or horticultural oil. Malathion or diazinon can be applied one week after the first crawler is found on the tape or in mid-May and late July. Carbaryl (Sevin®) or dimethoate can be used just as the eggs start to hatch, which is indicated as the date the first crawler is found on the tape. It is thought that applications timed for the summer generation are the most effective. *Remarks:* Crawlers are blown about by wind and carried inadvertently by birds. Adult scales do not have wings and this is the only way pine needle scales are moved about.

Sawflies: *Scouting and Thresholds for All Sawflies:* Check the upper sections of pine tree for colonies of sawflies on the tips of lateral branches or on the leader. Spot treat where you find them or treat the whole block if more than 5% of the trees are infested. *Mechanical Control:* Cut off and destroy infested branches. Dip sawflies in kerosene or bury 6" deep. *Cultural Control:* Avoid susceptible hosts; replant with spruce or white pine, which are less frequently attacked by sawflies. *Chemical Control:* Spot spray as you find colonies feeding. One method is to carry a small sprayer on the mower and stop and spray as you find the sawflies. Be sure to avoid having the tractor exhaust discharging on a nearby tree as you spray as it may burn a spot. If a whole block needs treatment, a mist blower or back-pack sprayer will work well.

Pine Spittle Bug: *Scouting and Thresholds for Pine Spittlebug:* In May through early July look for spittle masses on shoots and trunk and for dead and yellow twigs. From mid- June look for oval-shaped adults which will not have a spittle mass. Check trees of all ages in May and June. A small number of spittle masses indicate low population and little threat. If there are a large number of masses check the plantation again in the fall for dead shoots. If dead shoots are present in the fall plan to treat the next season. *Cultural Control:* Maintain trees in the best possible growing condition. Avoid planting the wrong tree in the wrong spot. Consult guides or enlist help from your local county forester on which trees are best suited for your farm or site. Vigorously growing trees rarely suffer damage from spittlebugs. Plant trees that are resistant to Diplodia tip blight. Two- and three-needle pines, such as Austrian pine, tend to have more problems with Diplodia. *Chemical Control:* Control spittlebugs by spraying for the adults about mid- July. To determine the best timing check spittle masses once a week starting in late June. When 95% are empty, usually in mid- July, treat with a registered insecticide. Treat the entire plantation. *Remarks:* Consult the fact sheet if you suspect you have the Saratoga spittlebug, although most growers will have the pine spittle bug.

7-16 Low-Management Crops and Areas: Christmas Tree Insects

Table 7.8 - Scotch Pine Scouting Schedule for Insects and Mites

Virginia Tech IPM Program - Prepared by Eric R. Day

Pest Problem	Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Bagworm	Scouting	Scout											
	Treatment		Pick				Spray					Pick	
Pine Tortoise Scale	Scouting		Scout										
	Treatment		Oil	Oil			Spray						
Nantucket Pine Tip Moth	Scouting			Scout									
	Treatment				Spray		(Spray)	Shear	(Spray)				
Pine Needle Scale	Scouting				Scout								
	Treatment					Spray							
Sawflies	Scouting					Scout	Scout	Scout					
	Treatment					Treat	Treat	Treat					
Pine Spittle Bugs	Scouting					Scout	Scout						
	Treatment							Spray					

White Pine Scouting Schedule for Insects and Mites

Scouting and Control Notes

(Specific chemical recommendations are in the following sections.)

Bagworm: *Scouting:* January: Look for overwintering bags. *Cultural Control:* Pick off and destroy bags in the fall and winter. Bags can be destroyed by dropping them in a can of kerosene or burying them at least 6" deep. *Chemical Control:* It is important to treat in mid- June when the larvae are small and susceptible to insecticides. Larger larvae with bags are not easily controlled. See the most recent Virginia Pest Management Guide for insecticides labeled for control of bagworms. *Biological Control:* Spraying with *Bacillus thuringiensis* (Bt, Dipel, Thuricide, etc.) in early to mid- June should give satisfactory control.

Pales Weevil: *Scouting:* In January count the number of stumps and determine if digging the stumps or spraying the stumps is the method of control. The other time to scout is in late summer and early fall on trees that are ready to be harvested. Check for resin covered wounds on small twigs and dead "flagged" twigs. These are places where weevils are feeding. *Mechanical Control:* Dig and remove new stumps where the tree was cut down less than one year ago, "first year stumps". *Cultural Control:* Let Christmas tree land lay fallow for one or two years before replanting and don't interplant new trees near stumps. *Chemical Control:* Purchase treated seedlings only; this will protect seedlings from pales weevil damage and more importantly will protect young trees from being infected with procerum root disease by the weevils. If you are interplanting seedlings next to stumps treat the stumps in February or March with Asana. These two pesticides can be mixed with diesel fuel or kerosene to increase their penetration into the bark. **See Fact Sheet 444-229 for more information.**

White Pine Weevil (WPW): *Scouting:* Look for resinous bleeding in late March or early April to find when adult females are feeding and laying eggs. Check trees also in June to determine which tops are actively infested with WPW. Check for a final time in fall to determine the percent of trees that are infested. *Threshold for Christmas Tree Farms and Forestry Plantations:* If fall surveys indicate that more than 5% of the trees were infested with WPW the previous season plan on treating the whole plantation or block. *Mechanical Control:* Prune out and destroy infested tops in late June. Make sure stems are cut below where weevils are feeding. Tops must be cut before the weevils make exit holes and leave. *Cultural Control:* Remove all old unattended stands of white pine and Norway spruce that may be harboring populations of WPW. *Chemical Control:* Treat the terminal leader with a registered insecticide before the buds open. Do not treat the lateral shoots as they are not the infestation point. Apply the insecticide no later than late March or early April. For valuable specimen trees it may be necessary to treat each year. Consult the latest Virginia Pest Management Guide for current labeled insecticides. *Remarks:* Repeated terminal dieback caused by WPW can give trees an asymmetrical crooked appearance that is aesthetically pleasing to many people.

Often the nice old gnarly pine tree has been given its appearance by repeated attacks by WPW.

Pine Bark Adelgid: *Scouting:* Check for the white cottony wax on the trunk and twigs. Look for abnormal abundant bud formation that gives the top of the tree a bushy broom like appearance. A profusion of twigs on the top of the tree is sometimes called witch's brooming. *Threshold for Christmas Tree Farms and Forestry Plantations:* This is rarely a pest and it is uncommon to have damage. If adelgids are present and more than 5% of tops are witch's broomed consider treating with an insecticide or oil. *Cultural Control:* Avoid applying excess nitrogen as this has been shown to increase populations of sucking insects on pines. Switch to a different species of tree other than white pine. *Mechanical Control:* None known. *Chemical Control:* Apply dormant oil at a 2% rate in March; this may temporarily slightly discolor the foliage but this will be covered by the summer flush of growth. Applications of a registered insecticide in May can be made instead for good control. *Remarks:* Try to educate your buyers that this is a mostly harmless pest that is found everywhere including yard trees.

Needle Sheath Mite *Scouting:* Check trees in March by checking 10 needle bundles on 10 trees randomly selected in each block. Pull open the needles and look with a 10X hand lens at the base for small pale mites. In addition to the mites you will probably see yellowing and stippling, particularly on the south side of the tree. It takes practice to observe the mites and if you are not sure of what you are finding a sub-sample of 10 needle bundles may be submitted to the Insect Identification Laboratory through your county extension agent. *Threshold for Christmas Tree Farms and Forestry Plantations:* If damage and mites are present it is advised to treat. *Cultural Control:* Switch to a different species of tree other than white pine. *Mechanical Control:* None known. *Chemical Control:* Treat with carbaryl (Sevin®) or dormant oil in March or April.

Pine Needle Scale: *Scouting:* Look for the white scales in the fall and winter and note which rows or blocks need treatment. In early May and early July wrap electrical tape, sticky side up, around twigs with high populations of scale. Treat one week after the first reddish-purple crawler is found. This will usually be about mid-May and mid- to late July. *Threshold for Christmas Tree Farms and Forestry Plantations:* Treat only if stunted growth, yellowing, or unsightly populations of scales are present. *Cultural Control:* Promote vigorous growth, as scales tend to cause more damage in poorly growing trees. *Chemical Control:* Apply a 2% dormant oil in late March when temperatures are above 45°F. The dormant oil may remove the waxy bloom on the needles and give the trees a dull appearance but this is temporary and will be hidden by the summer's flush of growth. It would be advisable to avoid dormant oils on the year of harvest. Dormant oil is also sold as superior oil or horticultural oil. After the first crawler is found on the tape or in mid- May and late July, an insecticide can be applied. It is thought that applications timed for the summer generation are the most effective. *Remarks:* Crawlers are blown about by wind and carried inadvertently by birds. Adult scales do not have wings and these are found on the tape.

Pine Spittle Bug: *Scouting and Thresholds for Pine Spittlebug:* In May through early July look for spittle masses on shoots and trunk and for dead and yellow twigs. From mid- June look for oval shaped adults which will not have a spittle mass. Check trees of all ages in May and June. A small number of spittle masses indicate low population and little threat. If there are a large number of masses check the plantation again in the fall for dead shoots. If dead shoots are present in the fall, plan to treat the next season. *Cultural Control:* Maintain trees in the best possible growing condition. Avoid planting the wrong tree in the wrong spot. Consult guides or enlist help from your local county forester on which trees are best suited for your farm or site. Vigorous growing trees rarely suffer damage from spittlebugs. Plant trees that are resistant to Diplodia tip blight. Two- and three-needle pines, such as Austrian pine, tend to have more problems with Diplodia. *Chemical Control:* Control spittlebugs by spraying for the adults about mid- July. To determine the best timing, check spittle masses once a week starting in late June. When 95% are empty, usually in mid- July, treat with a registered insecticide. Treat the entire plantation. *Remarks:* Submit a sample to the insect ID lab if you suspect you have the Saratoga spittlebug, although most growers will have the pine spittle bug.

White Pine Aphid: *Scouting and Thresholds for Christmas trees:* Check for sooty mold and yellowing in October to determine which areas of the planting have this aphid as it tends to occur in clumps and field edges. This aphid is more common on the upper sections of the tree. Fall scouting is important for finding populations on trees about to be harvested to insure that aphids will not emerge on trees that are brought indoors. In May and June again scout for the aphids and mark trees for spot spraying or spray entire blocks if more than 5% of the trees are infected. *Cultural control:* Avoid applying excess nitrogen as this has been shown to increase populations of sucking insects on pines. *Mechanical Control:* None known. *Chemical Control:* Treat with insecticidal soap or a registered insecticide in May or whenever you find the aphids. *Remarks:* This is the aphid that customers complain about when they find small black insects crawling on the tree and decorations.

7-18 *Low-Management Crops and Areas: Christmas Tree Insects*

Table 7.9 - White Pine Scouting Schedule for Insects and Mites

Virginia Tech IPM Program - Prepared by Eric R. Day

Pest Problem	Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Bagworm	Scouting	Scout											
	Treatment		Pick				Spray					Pick	
Pales Weevil	Scouting	Scout	Spray						Scout	Scout			
	Treatment												
White Pine Weevil	Scouting			Scout									
	Treatment			Spray		Prune	Prune		(Spray)				
Pine Bark Adelgid	Scouting			Scout									
	Treatment			Oil		Spray	Spray						
Needle Sheath Mite	Scouting			Scout									
	Treatment			Oil or spray									
Pine Needle Scale	Scouting				Scout								
	Treatment					Spray	Spray						
Pine Spittle Bugs	Scouting					Scout	Scout			Scout			
	Treatment							Spray					
White Pine Aphid	Scouting					Scout	Scout			Scout			
	Treatment					Spray	Spray						

Table 7.10 - Recommended Control

Insect	Name	Remarks
Adelgids General	Acephate (Orthene)	Treat in June or when found May-October. Spray bark and foliage to runoff. If infested trees are few and scattered, rogue and burn, and spray trees in a 20 ft diameter circle around rogued tree. When removing infested tree wrap it in a tarp so no adelgids fall off as the tree is removed from the field.
	Acetamiprid	
	Avermectin B1	
	Bifenthrin (Brigade)	
	Canola oil	
	Chlorpyrifos (Dursban)	
	Clothianidin	
	Deltamethrin (K-orthrin)	
Dinotefuran		

E-emulsifiable; EC-emulsifiable concentrate; WP-wettable powder; F-flowable; S-sprayable; SP sprayable powder; gal-gallon; pt-pint; lb-pound; tsp-teaspoon; tbs-tablespoon;

¹**RESTRICTED-USE** insecticide.

Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honey bees. Follow precautionary instructions on labels and use protective equipment wherever specified.

Equivalentents: 1 lb WP per 100 gal = 1 Tablespoon per gal; 1 pt EC per 100 gal = 1 teaspoon per gal

Table 7.10 - Recommended Control (cont.)

Insect	Name	Remarks
Adelgids General (cont.)	Fluvalinate	
	Imidacloprid	
	Limonen	
	Mineral oil - includes paraffin oil	
	Oxydemeton-methyl	
	Potassium laurate	
	Pyrethrins	
	Soybean oil	
	Spirotetramat	
	Sucrose octanoate	
Tall oil fatty acids, potassium salts		
Thiamethoxam		
	Zeta-Cyermethrin	Treat in June or when found May-October. Spray bark and foliage to runoff.
	Mixtures of Bifenthrin & Imidacloprid, or Clothianidin	If infested trees are few and scattered, rogue and burn, and spray trees in a 20 ft diameter circle around rogued tree.
	Mixtures of Imidacloprid & Bifenthrin, Clothianidin, Tebuconazole, Beta-cyfluthrin, or Cyfluthrin	When removing infested tree wrap it in a tarp so no adelgids fall off as the tree is removed from the field.
	Mixtures of Potassium laurate & Sulfur, or Pyrethrins	
	Mixtures of Pyrethrins & Oil of thyme, 2-Phenylethyl propionate, or Canola oil	
	Mixtures of Thiamethoxam & Lambda-Cyhalothrin	
balsam woolly adelgid	Acephate (Orthene), Asana, Esfenvalerate Dinotefuran, Imidacloprid, Mineral oil, Oxydemeton-methyl, Potassium laurate	Treat in June or when found May-October. Spray bark and foliage to runoff. If infested trees are few and scattered, rogue and burn, and spray trees in a 20 ft diameter circle around rogued tree. When removing infested tree wrap in a tarp so no adelgids fall off as the tree is removed from the field.
pine bark adelgid	Carbaryl (Sevin), Chlorpyrifos (Dursban), Dimethoate, Endosulfan, Mineral oil	Treat in May for crawlers. Strong spray streams help to penetrate cottony masses. Spray bark to runoff including twigs and small branches. Insecticidal soap is also registered for adelgids.
	Paraffin oil	Oil may remove "bloom" from needles; apply as dormant spray before buds swell.
spruce gall adelgid	Carbaryl (Sevin) Chlorpyrifos (Dursban) Endosulfan	Treat after galls have turned brown and opened in late August and September. Timing is more critical in spring: Treat before cottony egg masses appear at bases of buds or before new growth forms needles and bud scales have dropped, which is usually in April.
	Paraffin oil	Oil may remove "bloom" from needles; do not use on blue spruce. Apply as dormant spray before buds swell.

E-emulsifiable; EC-emulsifiable concentrate; WP-wettable powder; F-flowable; S-sprayable; SP sprayable powder; gal-gallon; pt-pint; lb-pound; tsp-teaspoon; tbs-tablespoon;

¹**RESTRICTED-USE** insecticide.

Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honey bees. Follow precautionary instructions on labels and use protective equipment wherever specified.

Equivalentents: 1 lb WP per 100 gal = 1 Tablespoon per gal; 1 pt EC per 100 gal = 1 teaspoon per gal

7-20 Low-Management Crops and Areas: *Christmas Tree Insects*

Table 7.10 - Recommended Control (cont.)

Insect	Name	Remarks
Aphids White pine aphid, spotted pine aphid, balsam twig aphid, spruce aphid	Asana, Esfenalaterate	Aphids are often on scattered individual trees, not all trees. Ants active on trees indicate those infested. Treat when aphids are first seen and before colonies enlarge. May appear at any time in the growing season. Provado should be applied at 4.0-8.0 oz/A. Treat for balsam twig aphid just before bud break or about late April.
	Carbaryl (Sevin)	
	Chlorpyrifos (Dursban)	
	Cygon, Dimethoate	
	Dinotefuran	
	Endosulfan	
	Gamma-cyhalothrin	
	Lambda-Cyhalothrin	
	Mineral oil	
	Paraffin oil	
Potassium laurate		
Bagworms	Rotenone	Treat when bagworms are small in mid-June. The larger the worms, the harder they are to kill. Sevin may cause spruce mite buildup on spruces and firs. If only a few trees are infested, remove and destroy bags, July-May.
	Acephate (Orthene)	
	Asana, Esfenvalerate, S- Fenvalerate	
	Azadirachtin	
	Bacillus thuringiensis subsp. Kurstaki	
	Beta-cyfluthrin	
	Biphenethrin (Brigade, Capture)	
	Carbaryl (Sevin)	
	Chlorantraniliprole	
	Chlorpyrifos (Dursban)	
	Clarified hydrophobic neem oil	
	Cyfluthrin	
	Cygon, Dimethoate	
	Deltamethrin (K-Othrin)	
	Diazol	
	Diflubenzuron, Difuron	
	Flubendiamide	
	Fluvalinate	
	Gamma-Cyhalothrin	
	Indoxacarb	
Lambda-Cyhalothrin		
Larvin, Thiodicarb		
Malathion		

E-emulsifiable; EC-emulsifiable concentrate; WP-wettable powder; F-flowable; S-sprayable; SP sprayable powder; gal-gallon; pt-pint; lb-pound; tsp-teaspoon; tbsp-tablespoon;

¹**RESTRICTED-USE** insecticide.

Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honey bees. Follow precautionary instructions on labels and use protective equipment wherever specified.

Equivalents: 1 lb WP per 100 gal = 1 Tablespoon per gal; 1 pt EC per 100 gal = 1 teaspoon per gal

Table 7.10 - Recommended Control (cont.)

Insect	Name	Remarks
Bagworms (cont.)	Methoxyfenozide	
	Permethrin	
	Pyrethrin	
	Spinosad	
	Spinosyn A	
	Tebufenozide	
	Zeta-Cypermethrin	
	Mixtures of Bifenthrin (Brigade, Capture) & Imidacloprid, or Clothianidin	
	Mixtures of Capsaicin & Allyl isothiocyanate	
	Mixtures of Carbaryl & Malathion	
	Mixtures of Imidacloprid & Bifenthrin, Fluvalinate, Beta-cyfluthrin, Cyfluthrin, or Clothianidin	
	Mixtures of K-Orthrin (Decamethrin) & Esbiol (S-Bioallethrin)	
	Mixtures of Permethrin & Systhane	
	Mixtures of Piperonyl butoxide & Pyrethrins	
	Mixtures of Potassium laurate & Pyrethrins, or Fats and glyceridic oils, margosa	
Mixtures of Rotenone & Cube resins		
Mixtures of Thiamethoxam & Lambda-Cyhalothrin		
Mites spruce spider mite (spruces, firs, cedar)	Acequinocyl	Treat in early May and/or mid- to late September before major buildup occurs, or when present otherwise. Multiple generations are most prolific with cool spring and fall weather. Treat with Savey before mites are present.
	Avermectin B1	
	Azadirachtin	
	Bifenazate	
	Bifenthrin (Brigade)	
	Clofentezine	
	Emamectin benzoate	
	Etoxazole	
	Fenbutatin-oxide	
	Gamma-cyhalothrin	
	Hexythiazox	
	Lambda-Cyhalothrin	
	Malathion	
	Paraffin oil	
	Potassium laurate	
	Spinosad	
	Spinosyn A	
	Spirodiclofen	
Spiromesifen		
Mixtures of Avermectin B1 & Bifenazate		
Mixtures of Fenbutatin-oxide & Acephate (Orthene)		
E-emulsifiable; EC-emulsifiable concentrate; WP-wettable powder; F-flowable; S-sprayable; SP sprayable powder; gal-gallon; pt-pint; lb-pound; tsp-teaspoon; tbsp-tablespoon;		
¹ RESTRICTED-USE insecticide.		
Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honey bees. Follow precautionary instructions on labels and use protective equipment wherever specified.		
Equivalentents: 1 lb WP per 100 gal = 1 Tablespoon per gal; 1 pt EC per 100 gal = 1 teaspoon per gal		

Table 7.10 - Recommended Control (cont.)

Insect	Name	Remarks
Mites Eriophyid mites (white pine, spruce, fir)	Avermectin B1	Treat in March or April, or when mites are found. They are active in cold weather, spring and fall. Oil sprays may remove needle "bloom."
	Carbaryl (Sevin)	
	Fenpyroximate	
	Lime sulfur	
	Milbemectin (A mixture of $\geq 70\%$ Milbemcin A4, & $\leq 30\%$ Milbemycin A3)	
	Mineral oil	
	Paraffin oil	
	Pyrethrins	
	Spirodiclofen	
	Spiromesifen	
Sulfur		
Rosette bud mites (fraser fir)	Avermectin B1	Treat between the last week of May and the third week of June. Treat 3-5 foot trees when more than 10% have damaged buds.
	Cygon, Dimethoate	
	Fenpyroximate	
	Lime sulfur	
	Mineral oil	
	Sulfur	
Mixtures of Avermectin B1 & Bifenazate		
Pine Tip Moth Nantucket pine tip moth (all 2 and 3 needled pines)	Acephate (Orthene)	Thoroughly wet all needles and shoots with full coverage spray. Treat in early to late April and repeat 1-2 times at 8-week intervals. Systemic: kills larvae in needles and new shoots before they cause serious damage. Full coverage spray of shoots and needles. Contact: kills young and larvae before mining needles and entering shoots. Treat when adults are active, repeat as indicated on the label, before larvae enter shoots.
	Asana, Esfenvalerate	
	Azinphos-Methyl, Gusathion	
	Bifenthrin (Brigade)	
	Carbaryl (Sevin)	
	Chlorpyrifos (Dursban)	
	Cygon, Dimethoate	
	Decemthion (Phosmet)	
	Imidacloprid	
	Permethrin	
	Piperonyl butoxide & Pyrethrins	
Pyrethrins		
Spinosyn A		
Pine Webworm	Azadirachtin	Treat for pine webworm (yellow-brown larvae) in July and August; pine false webworm (green sawfly larvae) in May and June. Apply full-coverage spray before nests become enlarged.

E-emulsifiable; EC-emulsifiable concentrate; WP-wettable powder; F-flowable; S-sprayable; SP sprayable powder; gal-gallon; pt-pint; lb-pound; tsp-teaspoon; tbs-tablespoon;

¹**RESTRICTED-USE** insecticide.

Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honey bees. Follow precautionary instructions on labels and use protective equipment wherever specified.

Equivalentents: 1 lb WP per 100 gal = 1 Tablespoon per gal; 1 pt EC per 100 gal = 1 teaspoon per gal

Table 7.10 - Recommended Control (cont.)

Insect	Name	Remarks
Sawflies redheaded pine sawfly	Asana, Esfenvalerate, S-Fenvalerate	Treat when larvae first appear, before extensive feeding occurs, May to September. Introduced pine sawfly has two generations, June and August. Redheaded pine sawflies may produce colonies at any time in the summer. BT is site labeled for ornamental pine trees.
	Azadirachtin	
	Chlorpyrifos (Dursban)	
	Malathion Spinosyn A	
introduced (European) pine sawfly	Acetamiprid	
	Asana, Esfenvalerate, S-Fenvalerate	
	Azadirachtin	
	Chlorpyrifos (Dursban)	
	Deltamethrin (K-othrin)	
	Diazinon	
	Gamma-cyhalothrin & Chlorpyrifos (Dursban)	
	Lambda-Cyhalothrin	
	Malathion	
	Spinosad Thiamethoxam	
Scale Insects pine needle scale, pine tortoise scale, woolly pine scale	Acetamiprid	Treat for crawlers of pine needle scale in mid- to late May and/or mid- to late July; pine tortoise scale mid- to late June; and woolly pine scale late June to early July. Use as dormant spray before buds swell. Not fully effective for pine needle scale. Oil spray may remove needle "bloom."
	Aliphatic petroleum hydrocarbons	
	Azadirachtin	
	Chlorpyrifos (Dursban)	
	Diazinon	
	Dinotefuran	
	Gamma-cyhalothrin	
	Gamma-cyhalothrin & Chlorpyrifos (Dursban)	
	Lambda-Cyhalothrin	
	Lime sulfur	
	Malathion	
	Oxydemeton-methy Paraffin oil Permethrin	
E-emulsifiable; EC-emulsifiable concentrate; WP-wettable powder; F-flowable; S-sprayable; SP sprayable powder; gal-gal-lon; pt-pint; lb-pound; tsp-teaspoon; tbs-tablespoon;		
¹ RESTRICTED-USE insecticide.		
Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honey bees. Follow precautionary instructions on labels and use protective equipment wherever specified.		
Equivalentents: 1 lb WP per 100 gal = 1 Tablespoon per gal; 1 pt EC per 100 gal = 1 teaspoon per gal		

Table 7.10 - Recommended Control (cont.)

Insect	Name	Remarks
Spittle Bugs	Acephate (Orthene)	Treat in mid- July when 95% of spit masses are empty.
	Acetamiprid	
	Asana, Esfenvalerate	A strong stream of water will often remove spittle bugs from the tree.
	Azadirachtin	
	Beauveria bassiana	
	Beta-cyfluthrin	
	Bifenthrin (Brigade)	
	Bromchlophos, Dibrom	
	Carbaryl (Sevin)	
	Chlorantraniliprole	
	Chlorpyrifos (Dursban)	
	Clothianidin	
	Cyfluthrin	
	Deltamethrin (K-othrin)	
	Endosulfan	
	Fenpropanate, Danitol	
	Gamma-cyhalothrin	
	Gusathion, Carfene	
	Imidacloprid	
	Lambda-Cyhalothrin	
	Malathion	
	Permethrin	
	Spirotetramat	
Tall oil fatty acids, potassium salts		
Thiamethoxam		
	Mixtures of Pyrethrins & Piperonyl butoxide, Canola oil or Sulfur	
	Mixtures of Imidacloprid & Cyfluthrin	
	Mixtures of Bifenthrin (Brigade, Capture) & Clothianidin, Carbaryl, Zeta-Cypermethrin, or Avermectin B1	
	Mixtures of Lambda-Cyhalothrin & Chlorpyrifos (Dursban), or Thiamethoxam	
	Mixtures of Capsaicin & Allyl isothiocyanate	

E-emulsifiable; EC-emulsifiable concentrate; WP-wettable powder; F-flowable; S-sprayable; SP sprayable powder; gal-gal-lon; pt-pint; lb-pound; tsp-teaspoon; tbs-tablespoon;

1RESTRICTED-USE insecticide.

Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honey bees. Follow precautionary instructions on labels and use protective equipment wherever specified.

Equivalents: 1 lb WP per 100 gal = 1 Tablespoon per gal; 1 pt EC per 100 gal = 1 teaspoon per gal

Table 7.10 - Recommended Control (cont.)

Insect	Name	Remarks
Weevils Pine reproduction weevils, Pales weevil, Eastern Pitchheating weevil. (coifers: feed on first year stumps and the base of recently dead trees as larvae. The adults may feed on live twigs.)	Esfenvalerate	In forest plantations, wait one year to replant with seedlings if harvesting took place after June 1. Seedlings are currently treated in nursery beds prior to lifting under SLN registration; foresters and landowners can order seedlings that are already treated. In Christmas tree plantations, stump removal or stump treatment with insecticide (as described below) is recommended. Thoroughly soak stumps and ground surface 1 to 2 ft around stumps or slash prior to mid-march. Apply Imidan as 4% top dip for seedlings prior to planting. Follow label directions. For seedlings: Apply as a full coverage spray to seedlings immediately after planting. For stumps: Thoroughly soak stumps and ground surface around stumps or slash prior to mid- March. Only stumps or wood cut since previous summer need treatment. Dilute Asana in kerosene.
	Imidan Permethrin	
Pales weevil	Asana Permethrin	Apply as a full coverage spray to seedlings immediately after planting. Dilute Asana in water.
White pine weevil	Acephate (Orthene)	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. Dilute Asana in kerosene. Spray only the main upright leader down to the first branched whorl, prior to April 1-10. Remove and destroy infested shoots before mid- June; do not leave them on the ground.
	Asana	
	Avermectin B1	
	Bifenthrin (Brigade)	
	Dinotefuran	
	Emamectin benzoate Imidacloprid Oxydemeton-methy	

E-emulsifiable; EC-emulsifiable concentrate; WP-wettable powder; F-flowable; S-sprayable; SP sprayable powder; gal-gallon; pt-pint; lb-pound; tsp-teaspoon; tbsp-tablespoon;

¹**RESTRICTED-USE** insecticide.

Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honey bees. Follow precautionary instructions on labels and use protective equipment wherever specified.

Equivalentents: 1 lb WP per 100 gal = 1 Tablespoon per gal; 1 pt EC per 100 gal = 1 teaspoon per gal

Christmas Tree Weeds

Jeffrey F. Derr, Extension Weed Scientist, Hampton Roads AREC

Weed control is considerably more complicated in crops with a long-duration cropping sequence such as Christmas trees. Perennial weeds are not likely to become a serious problem in annual crops since they can be removed either mechanically or chemically after harvest or before planting. Because perennial weeds such as poison ivy, brambles, shrubs, and small tree sprouts cannot be easily removed without serious risk to young Christmas trees, proper site preparation is critical to the long-range management of a tree plantation. After an effective site preparation program has been completed, preemergence herbicides may be used to prevent the re-establishment of annual grasses and broadleaf weeds. The maintenance of a weed-free strip in the planted row will increase tree survival and subsequent growth.

Sod Suppression in Fraser Fir

An alternative to mowing and/or complete vegetation control is sod suppression using low herbicide rates. The intent is to minimize weed competition while maintaining a groundcover to minimize soil erosion. Sod suppression treatments are generally applied in spring when grass has greened up but prior to budbreak of trees. Reapplication may be needed in mid- to late summer. Potential treatments include Roundup Original, Roundup Original plus Goal, Vantage plus Goal, and Vantage plus Goal plus Stinger. Check the individual herbicide labels for recommended rates of application.

Weed Control in Christmas Trees

Table 7.11 - Herbicides for Weed Control in Christmas Trees

Crop	Weed Problem	Chemical Rate/A	Remarks
Preemergence to weeds	Annual grasses and yellow nutsedge	metolachlor 1.2-2.4 lb Pennant Magnum 1.3-2.6 pt	Apply prior to nutsedge and annual grass emergence and prior to bud break. Combine with simazine for greater broadleaf control. For small areas apply 0.5-0.9 fl oz Pennant Magnum/1,000 sq ft.
	Annual grasses, yellow nutsedge, and certain annual broadleaf weeds	dimethenamid 0.98-1.5 lb ai (Tower 6EC 21.0-23.0 fl oz/A or 0.48-0.73 fl oz/1000 sq ft)	Apply to established plantings prior to weed emergence or include a postemergence herbicide to control emerged weeds. Can also be applied to new plantings after the soil has settled from rain or irrigation. Apply as a directed spray either prior to bud break or after new growth has hardened. Combine with a preemergence broadleaf herbicide for broader-spectrum control. Use a shielded spray if trees have been in the ground less than one year.
	Most annual grasses and certain annual broadleaf weeds	napropamide 4.0-6.0 lb (Devrinol 50DF 8.0-12.0 lb)	Apply prior to weed germination in fall or early spring. Rainfall or irrigation within 2-3 days after application is needed for maximum weed control. Tank mixing with other herbicides such as simazine improves the spectrum of broadleaf weeds controlled. For small areas apply 2.9-4.4 fl oz Devrinol 50DF/1,000 sq ft.
		oryzalin 2.0-4.0 lb (Surflan 4AS 2.0-4.0 qt, Surflan WDG 2.4-4.7 lbs, Oryzalin 4PRO 2.0-4.0 qt)	Apply to established plants (at least two weeks in containers) as a directed spray before weeds emerge. May be tank mixed with other herbicides such as simazine to control a greater spectrum of broadleaf weeds in field grown Christmas trees. Should be applied in the fall or early spring when rainfall is likely to activate the herbicide. For small areas, apply 1.5-2.9 fl oz Surflan 4AS or Surflan WDG 0.9-1.7 oz/1,000 sq ft.

Table 7.11 - Herbicides for Weed Control in Christmas Trees (cont.)

Crop	Weed Problem	Chemical Rate/A	Remarks
Preemergence to weeds (cont.)	Most annual grasses and certain annual broadleaf weeds (cont.)	pendimethalin 2.0-4.0 lb (Pendulum Aqua Cap 2.1-4.2 qt)	Apply to established plants as a directed spray prior to weed germination and budbreak. For small areas apply 1.6-3.2 fl oz Pendulum Aqua Cap.
	Most annual grasses and broadleaf weeds	flumioxazin 0.25-0.375 lb (SureGuard 8.0-12.0 oz)	Preemergence and early postemergence action. Apply as a directed spray to dormant trees prior to weed germination or to small emerged weed seedlings. Combine with a labeled postemergence herbicide for control of larger annual weeds or perennials. Can be applied overtop to dormant conifers. For small areas, apply 0.18-0.275 oz/1,000 sq ft.
		Indaziflam 0.036-0.075 lb (Marengo 7.5-15.5 fl oz)	Apply to established Christmas trees as a directed spray, ideally when the trees are dormant. Do not exceed 18.5 fl oz/acre/year. Long residual herbicide for preemergence control of many weeds. Include a postemergence herbicide for control of emerged weeds as indaziflam has limited postemergence activity.
		oxyfluorfen 1.0-2.0 lb (Goal 2XL 4.0-8.0 pt or Goaltender 2.0-4.0 pt)	Apply as overtop treatment to newly planted or established conifers before bud-break in the spring or after the foliage has hardened off. Preemergence control plus control of small weeds less than 3-4 inches in height. Will injure tender growth if applied after buds break dormancy. For small areas apply 1.5-2.9 fl oz Goal 2XL/1,000 sq ft.
		pronamide 1.0-2.0 lb (Kerb 50W 2.0-4.0 lb)	Fall application to fir or pine species established one growing season. High rate has given control of quackgrass and other cool-season perennial grasses like fescue, bluegrass and orchardgrass. For small areas, apply 0.7-1.4 oz Kerb 50W/1,000 sq ft. RESTRICTED USE.
	simazine 2.0-4.0 lb (Princep 4L 2.0-4.0 qt)	Make application after rainfall has firmed the soil around the roots of Christmas trees and before weeds start to emerge. Simazine may be applied in spring or fall but do not use more than one application of simazine/year or injury may result. Do not use on seedlings less than 2 years of age. For small areas, apply 1.5-2.9 fl oz Princep 4L/1,000 sq ft.	
Postemergence to weeds	Certain broadleaf weeds	clopyralid 0.09-0.25 lb (Stinger 1/4-2/3 pt)	Primarily controls legume and composite weeds (clover, vetch, thistles, ragweed, etc.). Use lower rates for small, actively growing weeds. Apply only to trees established at least one year. Can be applied overtop trees.

Table 7.11 - Herbicides for Weed Control in Christmas Trees (cont.)

Crop	Weed Problem	Chemical Rate/A	Remarks
Postemergence to weeds (cont.)	Emerged weeds	glyphosate 0.75-3.7 lb ae (Roundup Pro or Touchdown Pro 1.0-5.0 qt, Roundup ProMax 1.0-3.3 qt, or other labeled formulation; for wiper applications, use 1 part herbicide to 2 parts water; for cut stump treatments, use a 50-100% solution).	For site preparation, apply in strips in the fall prior to planting. Do not disturb treated soil for at least 7 days after treatment. Apply as a directed spray to pine, spruce or fir when trees are not in active growth. Conifers are most tolerant to glyphosate in the fall. Do not allow spray to contact foliage of Christmas trees, especially if earlier applications are made. For small-area application with a hand sprayer, use 2.0 oz/gal of water and lightly wet the foliage. There are other glyphosate formulations available. Check label for application rates.
		Glufosinate 0.5-1.5 lb ai (Finale 2-6 qt)	Apply as a directed spray, keeping the herbicide off the Christmas tree branches. Contact herbicide with some systemic action. Controls a wide range of annual and perennial weeds. Apply when weeds are small and actively growing. No residual control, add a preemergence herbicide for extended weed control. Ensure complete coverage of weed foliage. For spot spraying, mix 2-4 oz per gallon.
		paraquat 0.63-1.0 lb (Gramoxone Inteon 2.5-4.0 pt + nonionic surfactant 1.0-2.0 pt/100 gal)	Apply as a directed spray for contact kill of annual weeds. Perennial weeds will require repeat application. Do not allow spray to contact desired foliage. May be combined with other herbicides such as simazine for residual control. For small-area application, use 2/3 fl oz plus 0.5 fl oz spreader sticker/gal of water and lightly wet foliage. Thorough coverage is important.
Annual and perennial grasses		clethodim 0.07-0.24 lb (Envoy Plus 9.0-32.0 fl oz + 1.0% crop oil concentrate)	Apply to actively growing grasses. For spot treatment use a 0.44-0.85 fl oz/gal solution plus 1.0% crop oil concentrate. A repeat application may be required for perennial grasses control.
		fluazifop-P-butyl 0.25-0.375 lb (Fusilade II 16.0-24.0 fl oz + 0.5 pt nonionic surfactant/25.0 gal)	May be applied overtop of selected trees (see label) but should be used as a directed spray after bud break until new growth hardens. (For spot treatment with hand held sprayers, use 0.75 oz of Fusilade II plus 0.5 oz of surfactant/gal of water) 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. A repeat application may be necessary in 7-14 days on some perennial grasses.

Table 7.11 - Herbicides for Weed Control in Christmas Trees (cont.)

Crop	Weed Problem	Chemical Rate/A	Remarks
Postemergence to weeds (cont.)	Annual and perennial grasses (cont.)	sethoxydim 0.28-0.47 lb (Segment 36.0-60.0 fl oz)	May be applied overtop young trees or banded to conserve material. Use lower rates on annual grasses less than 6 inches tall and high rate on taller annual grasses and perennial grasses. Apply only to actively growing grass. Do not use under severe moisture stress. For spot treatment, use 2.0-3.0 fl oz Segment/gal of water. A repeat application may be needed to control perennial grasses.

Table 7.12 - Guide for Herbicide Selection – Christmas Trees¹

Herbicide	Fraser Fir	Norway Spruce	Scotch Pine	White Pine
Devrinol	X	X	X	X
Envoy	X	X	X	X
Fusilade	X	X	X	X
Goal	X	X	X	X
Gramoxone	X	X	X	X
Kerb	X	X	X	X
Marengo	X	X	-	X
Pendulum	X	X	X	X
Pennant	X	X	X	X
Segment	X	X	X	X
Princep	X	X	X	X
Roundup	X	X	X	X
Stinger	X	—	—	X
SureGuard	X	X	X	X
Surflan	X	X	X	X
Tower	X	X	—	—

¹An "X" indicates the herbicide is labeled for that particular species. Check the product label for a more complete listing of plants and directions for use.

Table 7.13 - Weed Susceptibilities to Preemergence Herbicides Labeled for Use in Christmas Tree Production¹

	Devrinol	Goal	Kerb	Pendulum	Pennant	Princep	SureGuard	Surflan	Tower	Marengo
Annual Grasses										
Crabgrass	E	F	F	E	G	F-G	F-G	E	G	E
Foxtails	E	F	F	E	G	G	F-G	E	G	G
Fall panicum	G	F	P	G	G	F-G	—	G	G	G
Annual Broadleaves										
Lambsquarters	G	G	F	G	P	E	E	G	P	F-G
Morningglory	N	F	P	P	N	G	G	P	N	P

¹E = 90% or greater control, G = 75 to 90% control, F = 50 to 75% control, P = slight control, and N = no control.

Table 7.13 - Weed Susceptibilities to Preemergence Herbicides Labeled for Use in Christmas Tree Production¹ (cont.)

	Devrinol	Goal	Kerb	Pendulum	Pennant	Princep	SureGuard	Surflan	Tower	Marengo
Annual Broadleaves (cont.)										
Ragweed	F	G	P	N	N	E	E	P	P	F-G
Smartweed	P	G	F	F	P	E	—	P	P	—
Perennial Grasses and Sedges										
Bermudagrass	N	N	P	N	N	P	N	N	N	N
Johnsongrass	P	N	P	P	N	P	N	P	N	—
Fescue	N	N	E	N	N	P	N	N	N	—
Yellow nutsedge	P	N	N	N	G	N	N	N	F-G	N
Perennial Broadleaves										
Poison ivy	N	N	N	N	N	N	—	N	N	—
Blackberry	N	N	N	N	N	N	—	N	N	—
Honeysuckle	N	N	N	N	N	N	—	N	N	—

¹E = 90% or greater control, G = 75 to 90% control, F = 50 to 75% control, P = slight control, and N = no control.

Table 7.14 - Weed Susceptibilities to Postemergence Herbicides Labeled for Use in Christmas Tree Production¹

	Fusilade	Envoy	Gramoxone	Segment	Roundup	Stinger	Finale
Annual Grasses							
Crabgrass	E	E	E	E	E	N	G
Foxtails	E	E	E	E	E	N	G
Fall panicum	E	E	E	E	E	N	G
Annual Broadleaves							
Lambsquarter	N	N	E	N	E	N	G
Morningglory	N	N	E	N	G	N	G
Ragweed	N	N	E	N	E	G	G
Smartweed	N	N	E	N	E	F	G
Vetch	N	N	F	N	P	G	G
Perennial Grasses and Sedges							
Bermudagrass	G	G	P	G	G	N	F
Johnsongrass	G	G	P	G	G	N	F

¹E = 90% or greater control, G = 75 to 90% control, F = 50 to 75% control, P = slight control, and N = no control.

Table 7.14 - Weed Susceptibilities to Postemergence Herbicides Labeled for Use in Christmas Tree Production¹ (cont.)

	Fusilade	Envoy	Gramoxone	Segment	Roundup	Stinger	Finale
Perennial Grasses and Sedges (cont.)							
Fescue	P-F	F	P	F	G	N	F
Yellow nutsedge	N	N	P	N	G	N	F
Perennial Broadleaves							
Canada thistle	N	N	P	N	G	G	F
Poison ivy	N	N	P	N	G	-	F
Blackberry	N	N	P	N	G	-	F
Honeysuckle	N	N	P	N	G	-	F
¹ E = 90% or greater control, G = 75 to 90% control, F = 50 to 75% control, P = slight control, and N = no control.							

Aquatic Weeds (Weed Control in Ponds and Lakes)

P. Lloyd Hipkins, Extension Weed Scientist, Virginia Tech

The use of pesticides in aquatic environments is quite restricted because these areas provide water for irrigation, recreation, and domestic uses. The recommendations in this section use the herbicide's common name. In the state of Virginia, there are over 100 different trade names for glyphosate and 2,4-D. Only those specifically labeled for aquatics may be used. It is important that chemicals used in these areas be applied strictly in accordance with label directions, as the label is the federal law.

Treatment of aquatic weeds should take place in the spring as the weeds begin active growth. It is important to adhere to this application suggestion, even if an infestation is small. Later in the season, weed density and maturity make control more difficult. Sampling the lake bottom in the late spring or early summer in areas heavily infested the year before should show when the growth begins. The treatment of dense weed growth can result in oxygen depletion during the decomposition of the dead plants. Severe oxygen depletion can cause a fish kill. Many times it may be necessary to treat only 1/3 to 1/2 of the impoundment at a time.

Recommendations for aquatic applications are based on rate per surface area, rate per acre foot, or parts per million (ppm). An acre foot is 1 acre of water 1 foot deep. For a pond with a gradual slope, acre feet may be determined approximately by multiplying 1/2 the depth at the deepest point, times the surface area. A pond with 1 surface acre and a gradual slope to a 10-foot depth at the deepest point would contain approximately 5 acre feet of water. It is important to get as accurate an estimate as possible. An acre foot of water weighs 2,700,000 pounds, therefore it will require 2.7 pounds of active ingredient to achieve 1 ppm.

There is a quick reference table at the end of this section with water-use restrictions after herbicide application. These restrictions must be followed. Where more than one herbicide is suggested for a specific aquatic weed, please refer to the herbicide information table to find a suitable product. For biological control of aquatic weeds with triploid sterile grass carp, please refer to the last paragraph in this section.

Table 7.15 - Relative Effectiveness of Aquatic Herbicides Recommended for Control of Selected Weeds

Aquatic Plant	endothall		2,4-D		fluridone	glyphosate	triclopyr	imazapyr	carfentrazone	flumioxazin
	copper	diquat	aquathol	hydrothol						
Algae										
Chara, Nitella	G	G		G						
Filamentous	G	G		G						E
Planktonic	G									
Submersed Weeds										
Bladderwort		G	P	P-F	F		E	P		
Coontail		E	E	E	G		E	G		G
Curly leaf pondweed		F	G				G			
Elodea (Brazilian)	F	E	E	P	G		G			
Fanwort							F			G
Hydrilla	F	F-E ¹	E	E	G		E			G
Leafy sago pondweed		G	G				G			E

E=excellent, G= good, F= fair, P= poor

¹Copper sulfate, copper complex, or copper carbonate may be added to improve hydrilla, Eurasian water milfoil, and water-meal control with diquat.

Table 7.15 - Relative Effectiveness of Aquatic Herbicides Recommended for Control of Selected Weeds

Aquatic Plant	endothall				2,4-D		fluridone	glyphosate	triclopyr	imazapyr	carfentrazone	flumioxazin
	copper	diquat	aquathol	hydrothol	granular	liquid						
Naiads							G					G
Parrotfeather		G	E	E	G		F-G		F-E	G		
Pondweeds		G	E	E			E					
Small (slender) Naiad		E	E	E			E					
Southern Naiad		G	P				P-G					G
Watermilfoil (Eurasian)		G-E ¹	E	E	E		G-E		G-E		G	G
Floating Plants												
Duckweed	P	G	P		P	F	E		P	G	G	E
Giant Duckweed		G	P		P		G			G		
Giant Salvinia	P	E	F				E	G		G		G
Mosquito fern (Azolla)		G-E			F		G-E				E	E
Water hyacinth	F	G			G-E	E	F	G	G	G	F-G	
Watermeal (<i>Wolffia</i> spp.)		P-F ¹					F					E
Emerged Plants												
Bull Rush							P	G	F	G		
Cattail		G			F		F	E	F	E		
Phragmites (comm. reed)								G	F	E		
Purple loosestrife									G-E	G-E		
Spatterdock					F	F	G	E	F	E		
Water primrose		G				G		E	G			
Water/marsh pennywort		F				G		G	G			G
Waterlily					G		G	E	G	E		
Watershield		F			E		F-E	E	E	E		

E=excellent, G= good, F= fair, P= poor

¹Copper sulfate, copper complex, or copper carbonate may be added to improve hydrilla, Eurasian water milfoil, and watermeal control with diquat.

Table 7.16 - Herbicide Information. IT IS IMPORTANT TO ALWAYS READ AND FOLLOW THE HERBICIDE LABEL.

Herbicide	Remarks
2,4-D	Rate depends on species and depth of water. Do not apply to water to be used for irrigation, agricultural sprays, watering dairy animals, or domestic water supplies. Average water temperature should be around 65°F at the time of treatment. Avoid drift to susceptible plants.
Aquashade, many dye products are available.	A blue dye that reduces light penetration in water for up to six weeks may be used to reduce filamentous algae growth in ponds, ornamental ponds or fountains, commercial fish ponds, and lakes. There must be little or no flow out of the pond. Additional applications are made to maintain acceptable shade. Aquashade is not effective when weed growth nears the surface.
carfentrazone	Rates vary according to target species. Retreatment of some plants may be required. Methylated seed oil or nonionic surfactant recommended for application on floating plants.
copper complex, copper sulfate, other copper products	For optimum control, spray over surface when algae first become visible. Expect temporary control. Repeat treatments are often necessary. Do not use copper sulfate in trout ponds. Hard water requires more copper sulfate than soft water. The copper complex formulation does not precipitate as fast as copper sulfate and usually provides more effective control results. Dilute copper complex with 9 parts of water and spray the surface. Break up the floating mats of filamentous algae before treatment. Water temperature should be about 60°F. Apply on a clear day. Corrosive to spray equipment. Water may be used immediately for swimming, fishing, irrigation, and potable water. Do not use copper complex in water containing trout if the carbonate hardness of the water does not exceed 50 ppm, as it may cause fish kill. Excessive rates may also cause fish kill. When treating chara or nitella, treat only 1/3 to 1/2 of pond at one time. Allow 7 to 14 days between applications.
diquat	Apply uniformly over the surface or inject below water surface. For submersed weeds, apply early in season by pouring directly into water in strips 40 ft apart. Later in season, as weeds reach surface, pour in strips 20 ft apart or inject a dilute solution. Avoid stirring the bottom mud. Retreatment may be necessary if regrowth occurs from underground vegetative parts. Diquat may be fatal if swallowed, inhaled, or absorbed through skin. Copper is sometimes added to improve hydrilla or watermeal control with diquat. Be sure to follow the label. When controlling cattail, thoroughly wet the blooms.
endothal, potassium salt	Granular materials are preferred for spot treatment or treating marginal areas of a pond. Water temperature should be 65°F or above. If areas of heavy vegetation are treated, treat in sections 5 to 7 days apart to prevent fish kill by oxygen depletion during vegetation decay. POISONOUS – follow label for safe handling. Rate will be dependent on most difficult weed to control in the pond.
flumioxazin	Rates vary according to target species and application method. Efficiency is significantly reduced in water with a pH greater than 8.5. Mix water should have a pH less than 7.0. A nonionic surfactant is recommended.
fluridone	Apply uniformly over the surface. Use the maximum labeled rate for the average depth of your pond. Do not apply when there is substantial outflow from the pond. Effects on plant will be gradual from 30 to 90 days for complete response. One treatment/year does not work as a spot treatment in small areas.
glyphosate	Glyphosate efficacy may be reduced if very hard water containing high concentrations of iron is used to prepare spray solutions. Vegetation must be on or above the surface for treatment to be effective. For floating or emersed weeds, apply to wet foliage above water but do not spray to run off. If applying from a boat, take care not to create waves that may wash the herbicide off floating leaves. Apply in 20.0 gal of water/A as a broadcast spray. Apply to actively growing cattail at the early- to full-bloom stage of growth. Apply when spatterdock, water lily, and water shield are in full bloom.
imazapyr	Rates vary according to target species. Retreatment of some plants may be required. The addition of a nonionic surfactant is recommended. When controlling phragmites, apply to green foliage after complete leaf elongation. Complete coverage is necessary.
triclopyr	Rates vary according to target species. The addition of a nonionic surfactant is recommended. When controlling purple loosestrife, apply to actively growing foliage at flowering. Follow-up spot treatments may be necessary.

Table 7.17 - Water-use Restrictions after Aquatic Herbicide Applications

Aquatic Herbicide	Water Use Restriction (days)				
	Irrigation	Fishing	Swimming	Livestock	Potable
copper sulfate	0 ¹	0	0	0	0
copper complex	0	0	0	0	0
carfentrazone	1-14	0	0	0-1	
diquat	2-5	0	1	1-5	3-5
endothall					
Aquathol K	7-25	3	1	7-25	7-25
Aquathol G	7	3	1	7-25	7-25
Hydrothol 191	7	0	1	14	7-25
fluridone	30	0	0	0	**
glyphosate	0	0	0	0	**
2,4-D	**	**	**	**	**
triclopyr	120	0	0	0	**
imazapyr	120	0	0	0	**
flumioxazin	5	0	0	0	0

¹0 = no restriction
** Varies, refer to label before use.

Table 7.18 - Herbicide Trade Names (See specific label for use.)

Common Name	Aquatic Trade Names
copper ¹	Komeen, Nautique, Captain, Clearigate, Cutrine Plus, Cutrine Ultra, and K-Tea
carfentrazone	Stingray
diquat	Reward, Weedtrine-D and Eliminator
endothall inorganic salts	Aquathol K and Aquathol Super K
endothall amine salts	Hydrothol 191 and Hydrothol Granular
fluridone	Sonar and Avast!
glyphosate	various trade names and formulations
2,4-D	various trade names and formulations
triclopyr	Renovate 3 and Garlon 3A
imazapyr	Habitat
flumioxazin	Clipper

¹Copper products may be formulated as copper sulfate pentahydrate, copper complexes, or copper carbonate.

Biological Control

With biological control, natural enemies are released to feed on aquatic weedy vegetation. Fish have been important in aquatic weed control. Triploid sterile grass carp have become the fish of choice for several weeds. Naiad, fanwort, hydrilla, coontail, various pondweeds, bladderwort, elodea, and chara are species usually controlled with the triploid sterile grass carp. Plants that are not preferred by the grass carp and, therefore, are not controlled very well include emergent tough or woody stem species such as cattail, waterlily, and rush. Filamentous algae, watermilfoil, Nitella, and watershield are not controlled very well.

Only the triploid sterile grass carp may be introduced into Virginia waters for aquatic weed control. A permit must be obtained from the Virginia Department of Game and Inland Fisheries. An application may be obtained by a request via telephone (804) 367-8629 or through the Web (<http://www.dgif.state.va.us/forms/PERM/PERM-001.pdf>). The application will not be processed without a detailed map(s) of the area. Application must also include the type of weeds and the percent of area covered, size (acres), primary use of the pond, number of fish required, and means for containment of the fish. The application requires a \$10 fee and a few weeks for granting approval. These fish may be stocked in relatively small impoundments where they can be readily contained. After receiving a permit, there are locations approved by the Department of Game and Inland Fisheries to purchase guaranteed triploid sterile grass carp.

Triploid sterile grass carp about 10 inches long are stocked in ponds at approximately 7 to 15/acre. A fisheries biologist may visit the site before issuing a permit.

Weed Control in Right-of-Way and Non-Crop Areas

P. Lloyd Hipkins, Extension Weed Scientist, Virginia Tech

The treatments given in this section are not for use in crop land unless otherwise indicated under a given crop section. Note: Most of the chemicals listed perform better when wetting agents are added at 0.25% of the total volume. Use nonionic substances such as Induce, Cide Kick, or other suitable wetting agents. Glyphosate, the active ingredient in the well known product Roundup, is now available under a wide range of product names with varying amounts of active ingredient per gallon. When using one of these products, consult the label closely for proper mixing and use instructions.

Avoid spraying in close proximity to desirable plants or streams. Do not allow products to contaminate water used for consumption or irrigation. **Dicamba and picloram are very soil mobile and active. They can move down slopes for considerable distances. Do not apply imazapyr where roots of desirable plants extend into the spray zone.**

Table 7.19 - Brush Control

Problem and Application Technique	Chemical and Application Rate	Remarks
Foliage Spray - Brush		
Ground applications often use volumes ranging from 100-500 gpa. Our research has shown good results with volumes as low as 30-60 gpa if uniform coverage can be obtained. Note: Drift control agents such as Nalcotrol or Polycontrol at labeled rates greatly reduce risk of off Right-of-Way damage. Use controlled size droplets to reduce risk off of the Right-of-Way damage wherever practical.	2,4-D + 2,4-DP + dicamba (Bk-800) 2.0-3.0 gal + surfactant 0.25% v/v	Apply as a coarse spray. Use higher rates for larger or more dense stands. DO NOT APPLY WHEN DAILY TEMP. IS EXPECTED TO EXCEED 85° F.
	fosamine (Krenite S) 8.0-12.0 lb/A (2.0-3.0 gal in 50.0-300.0 gal of water)	Apply from mid- June to early fall (prior to leaf coloration) to species listed on label. Susceptible species fail to leaf out the next spring and subsequently die. If rainfall occurs within 24 hours, effectiveness will be reduced. Thorough coverage is imperative for complete control.
	fosamine (Krenite S) 2.0 gal + imazapyr (Arsenal) 0.5-1.0 pt in 25.0-50.0 gal water	Apply from mid- June to early fall with a Radiarc or other CD sprayer. For use where certain legumes and other Krenite S resistant species occur.
	fosamine (Krenite S) 2.0 gal + glyphosate (Accord XRT) 1.0 gal in 25.0-50.0 gal water	Apply from mid- June to early fall prior to leaf color change.
	picloram + 2,4-D (Tordon 101) 1.0 gal/100 gal of water + surfactant 0.25% v/v	Apply uniformly over top of brush as a coarse spray. Use on all species during June and July.
	glyphosate (Roundup Pro or Accord XRT) 1.0-2.0 gal/100.0 gal of water	Wet foliage thoroughly after full leaf development. Do not store diluted chemical in metal containers or for more than 12 months before using.
	triclopyr amine (Garlon 3A) 0.5-1.0 gal + 2,4-D amine 2.0 gal/ 100.0 gal water + surfactant 0.25% v/v	Apply 100.0-400.0 gal/A when plants are actively growing. Use higher rates on resistant species or late in growing season applications.
	imazapyr (Arsenal) 0.5-1.0 lb ai/A	Apply in 50.0-200.0 gal water/A.
Metsulfuron (Escort) 4.0 oz + Fosamine (Krenite S) 1.0-1.5 gal	Apply in 50.0-100.0 gal water. Insure thorough coverage.	

Table 7.19 - Brush Control (cont.)

Problem and Application Technique	Chemical and Application Rate	Remarks
Foliage Spray - Brush (cont.)		
	aminocyclopyrachlor+ chlorsulfuron (Perspective) 3.0-11.0 oz/A + 0.25% nonionic surfactant v/v	Use where injury to grasses must be minimal. Apply in 10.0-100.0 gal water/A
	aminocyclopyrachlor + metsulfuron methyl (Streamline) 4.75-11.5 oz/A + 0.25% nonionic surfactant v/v	Apply in 10.0-100.0 gal water/A
	aminocyclopyrachlor + imazapyr + metsulfuron methyl (Viewpoint) 13.0-20.0 oz/A + 0.25% nonionic surfactant v/v	Apply in 10.0-100.0 gal water/A
Low-volume application to foliage aerial or ground. Note: Use wetting agents and drift control agents. Follow label recommendations. Use CDA sprayer such as Radiarc for ground sprays to help reduce drift. Thickeners such as Nalcotrol or Polycontrol help prevent drift.	picloram + 2,4-D (Tordon 101) 1.0-3.0 qt in 20.0-50.0 gal water/A + surfactant 0.25% v/v	Apply during the growing season.
	triclopyr (Garlon 3A, Garlon 4, or Garlon 4 Ultra) 2.0-3.0 gal/A + surfactant 0.25% v/v/A	Apply in 20.0-100.0 gal water. Do not apply Garlon 4 when temperatures are expected to exceed 85°F. For aerial application consult label.
	triclopyr (Garlon 3A, Garlon 4, or Garlon 4 Ultra) 0.5-1.0 gal + 1.0-2.0 gal 2,4-D or Tordon 101 (Picloram + 2,4-D) + surfactant 0.25% v/v	Same as above. Do not apply Garlon 4 when daily temperature is expected to exceed 85°F.
	imazapyr (Arsenal) 0.5-1.0 lb ai/A	Apply low-volume spray in 10.0-25.0 gal of water/A
	glyphosate (Accord XRT) 4.0% + imazapyr (Arsenal) 0.5% + water 95.5%	Apply at 8.0-10.0 gal/A.
Dormant Stems or Basal		
	dicamba (Banvel) 2.0-3.0 lb ai + 2,4-D 3.0-6.0 lb ai + 10.0-15.0 gal mineral oil emulsifier + enough water to make 100 gal total solution. Garlon 4 0.5-0.75 gal may be substituted for dicamba depending on species present.	Apply as broadcast treatment to dormant stems. Good control of most species. Oil-water emulsions require constant agitation.
	Garlon 4 Ultra 0.5 gal + Bk-800 1.5-2.0 gal + Cide Kick 2.0 gal/100.0 gal of water	Apply in late winter or early spring when temperatures are expected to remain above 34°F. Apply as a full stem spray.
	Garlon 4 Ultra 1.0 gal + Bk-800 2.0 gal + basal oil 7.0 gal (such as Hygrade, Arborchem, or similar products).	Apply any time (except when temperatures will exceed 85°F). Wet lower 2 ft of stems completely. Do not use near sensitive crops. Contains dicamba which may move considerable distances down slopes.
	Garlon 4 Ultra 1.0 gal + Bk-800 2.0 gal + 5.0 gal refined oil (such as Hygrade or Rite-way) + 93.0 gal water.	Apply as a dormant spray covering all stems completely. Contains dicamba which may move considerable distances down slopes.

Table 7.19 - Brush Control (cont.)

Problem and Application		
Technique	Chemical and Application Rate	Remarks
Stump Treatment		
	picloram + 2,4-D (Tordon 101-R) dicamba (Banvel CST) imazapyr (Stalker) garlon 4 (Pathfinder II)	Spray to wet the cut surface, especially the cambium area.
Soil Application		
(Dry material)	Tebuthiuron (Spike) as directed by label	Apply on all species during any season, except when ground is frozen, at base of clumps. Any tree with roots extending into treated area may be killed. Do not apply within 400 ft of desired plants or allow material to contaminate water used for irrigation or other domestic purposes. These materials may move down slopes for considerable distances. Apply broadcast spray between late winter and early summer. Consult the Spike label for specific application methods.
	hexazone (Velpar)	Apply 10.0-20.0 lb/A as directed on label.

General Weed Control - Mixture of Annual Grasses and Broadleaf Weeds

Caution. All use recommendations of herbicides as listed under this category must be regarded as **non-selective**. Therefore, do not use in crop areas except as shown under **Selective Chemical Weed Control Recommendations**. When treating land that will later be used to grow crops, observe all label precautions with respect to critical dosages, waiting intervals before cropping, and residue tolerances in the crops. Avoid spray drift onto crops and ornamentals to prevent injury and illegal residues. Do not apply soil sterilants within the root development area of adjoining crops, ornamentals, or other desirable species; also avoid use in areas where there is danger of chemical runoff.

Table 7.20 - Apply these Herbicides during the Growing Season as a Foliar Spray for General Weed Control

Herbicide	Application Rate ai/acre	Remarks
2,4-D amine + wetting agent (broadleaf weeds only)	2.0-4.0 qt/A + surfactant 0.25% v/v	Spray to wet all foliage; volume of spray/A will depend on height and density of growth. Apply when weeds are 3-4 inches high. Repeat applications when additional weeds appear.
glyphosate (Roundup Pro) (Accord XRT)	2.0-4.0 qt/A	Apply in 20.0-30.0 gal of water/A. Glyphosate is slow acting and may require 5-10 days before visible results occur. If rainfall occurs within 6 hours, effectiveness may be reduced. Do not use with galvanized spray equipment. Use of mechanical agitation or additional wetting agent will cause excessive foaming. Do not allow spray to drift to contact desirable plants. Glyphosate leaves no soil residue.
glyphosate (Roundup Pro) (Accord XRT) + sulfometuron (Oust) + wetting agent	1.0-2.0 qt + 2.0-4.0 oz of product	Gives season long control.
imazapyr (Arsenal)	0.5-1.0 pt product	Do not use near desired vegetation.

Table 7.21 - Apply these Herbicides when They Will Be Leached into the Soil by Precipitation or by Supplemental Irrigation

bromacil	2.4-4.8 lb/50-100 gal/A	Apply before or just after weeds emerge. Adequate rainfall must follow to move chemicals into root zone of weeds. Use lower volume for boom spraying, higher volume for offset nozzles. Continuous agitation of spray mixture is necessary to avoid settling-out in the spray tank. Nozzle screens of 50 mesh are desirable. Finer screens may clog. Where weeds are up, add 2 qt Roundup/acre to monuron and diuron; add to bromacil if weeds are over 6 inches high. Do not apply near desired plants.
diuron	2.4-4.8 lb/50-100 gal/A	
hexazone (Velpar)	2.0-12.0 lb/ 50-100 gal/A	
imazapyr (Arsenal)	0.5-1.0 pt/50-100 gal/A	
monuron	2.4-4.8 lb/50-100 gal/A	
surflometuron (Oust)	2.0-4.0 oz/50-100 gal/A	
Surflan AS	2.0-4.0 qt/50-100 gal/A	
Sahara	10.0-15.0 lb/50-100 gal/A	
Borate and mixture of borate with other herbicides, e.g., chlorate, monuron, bromacil, etc.	Variable, depending on the formulation	Several products are available. Follow manufacturer's directions.
hexazinone (Velpar L)	3.0-6.0 gal/A	Consult label for species controlled.

Table 7.22 - Specific Perennial Weeds (Except Woody Plants)*(See also SOIL STERILIZATION below for general nonselective control, including perennial weeds.)*

Weed	Chemical Rate ai/acre	Remarks
Bermudagrass (wiregrass)	glyphosate 3.0-4.0 lb ai/A (Roundup or Accord XRT 3.0-4.0 qt)	Best control is obtained when treatment is made at late stages of growth but prior to seed head emergence. See remarks for glyphosate under annual grasses and broadleaf weeds above. Repeat as needed.
Canada Thistle	clopyralid (Transline) 1.0-1.25 pt/A + surfactant 0.25%	Best control is obtained when treatment is applied at bloom.
	chlorosulfuron (Telar) 0.5-1.0 oz product/A + 0.25% surfactant	Apply to fall rosettes in 20.0-40.0 gal water/A. Significant grass damage may occur.
	aminopyralid (Milestone) 5.0-7.0 oz/A + 0.25% v/v nonionic surfactant	Apply late spring to early summer in 20.0-40.0 gal water/A.
Johnsongrass	glyphosate (Roundup Pro or Glypro Plus) 1.0-2.0 qt/A	Best control is obtained when applied in 20.0-25.0 gal water/A during late stages of growth, but prior to seedhead emergence.
	fenoxaprop + fluazifop (Fusion) 7.0- 9.0 oz + 0.25% surfactant/100.0 gal water	Apply when johnsongrass is up to 18 inches but prior to seedhead formation. Drought stress may reduce efficacy.
	fluazifop (Fusilade 2000) 1.0-1.5 qt/A with either 1.0% crop oil concentrate or 0.25% nonionic surfactant.	Apply when johnsongrass is 8-18 inches tall and before boot stage.
	glyphosate (Roundup Pro or Accord XRT) 1.0 qt + sulfometuron (Oust) 0.125 oz + 10.0-50.0 gal water/A	Apply at time of seedhead formation.
Honeysuckle	2,4-D 2.0-3.0 qt/100 gal water + 0.25% surfactant v/v	Apply in spring or early summer when plants are in full leaf and actively growing. Thoroughly wet all foliage and stems. Do not allow drift to desirable plants. Dicamba may move down slopes for considerable distances.
	glyphosate (Roundup Pro or Accord XRT) 3.0-4.0 qt/100.0 gal water	
	2,4-D 3.0 lb + dicamba 1.5 lb (1.5 gal Banvel 720)/100.0 gal water + 0.25% surfactant v/v	
	2,4-D 2.0 lb + triclopyr 1.0 lb (1.0 gal Crossbow)/ 100 gal water + 0.25% surfactant v/v	

Table 7.22 - Specific Perennial Weeds (Except Woody Plants) (cont.)

(See also SOIL STERILIZATION below for general nonselective control, including perennial weeds.)

Weed	Chemical Rate ai/acre	Remarks
Kudzu	2,4-D + 2, 4-DP + dicamba (Bk-800) 2.0 gal/100.0 gal of water + 0.25% surfactant v/v	Apply at 50.0-100.0 gal solution/A. Dicamba may move down slopes considerable distances.
	glyphosate (Roundup Pro or Accord XRT) 4.0 qts/100.0 gal water	Apply when actively growing.
	triclopyr 2.0-3.0 lb/A (0.67-1.0 gal Garlon 3A or 0.5-0.75 gal Garlon 4) + 0.25% surfactant v/v	Apply when actively growing. Do not apply Garlon 4 when temperatures are expected to exceed 85° F.
	fosamine (Krenite S) 1.5-2.0 gal/100.0 gal water	Apply from mid-summer to early fall.
	metsulfuron (Escort) 4.0 oz/100.0 gal water + 0.25% surfactant v/v	Apply when actively growing.
	dicamba (Vanquish) 2.0 qt/A in 20-30 gal water. Add 0.25% surfactant v/v.	Apply during late dormant season, March-April.
Milkweed (common And dogbane)	dicamba 1.5-2.0 lb (0.38-0.5 gal (Vanquish) + surfactant 0.25% v/v	Apply prior to flowering while plants are actively growing.
	dicamba 1.0 lb + 2,4-D 2.0 lb (1.0 gal Banvel 720)/A + surfactant 0.25% v/v	
	picloram 0.5 lb + 2,4-D 2.0 lb (1.0 gal Tordon 101)/A + surfactant 0.25% v/v	
	2,4-D 2.0 lb + triclopyr 1.0 lb (1.0 gal Crossbow) + 0.25% surfactant v/v	
Mugwort (wild chrysanthemum)	picloram (Tordon) 0.25 lb ai	Do not apply picloram within 100 ft of desirable plants or allow it to contaminate water. Picloram can move down slopes for considerable distances.
Mullen	2,4-D 2.0 lb + surfactant 0.25% v/v	Apply in early summer when in rosette stage. The hairy leaf surface makes this plant difficult to wet; therefore, the use of a surfactant is important.
Musk And Curled Thistles	2,4-D ester 2.0-3.0 lb/50.0-100.0 gal water + surfactant 0.25% v/v	Apply in mid-spring. Midday temperatures should be above 60°F for 2-3 days after application.
	dicamba 1.5 lb (0.38 gal Vanquish) + surfactant 0.25% v/v	Observe above-mentioned precautions when using dicamba.
	dicamba 1.0 lb + 2,4-D 2.0 lb (1.0 gal Banvel 720) + surfactant 0.25% v/v	
	chlorosulfuron (Telar) 0.25-0.5 oz product + surfactant 0.25% v/v	Apply in early spring. Will inhibit grass growth. Not for pastures. Add 0.5% Cide Kick or other wetting agent.
	clopyralid (Transline) 1.0-1.25 pts + surfactant 0.25% v/v	Apply from rosette to bud in 25.0-50.0 gal water/A.
	aminopyralid (Milestone) 5.0-7.0 oz + 0.25% v/v nonionic surfactant	Apply late spring to early summer in 20.0-40.0 gal water/A.
Poison Ivy	fosamine 6.0-8.0 lb (1.5-2.0 gal Krenite S)/100.0 gal water dicamba 1.0 lb + 2,4-D 2.0 lb (1.0 gal Banvel 720)/A + surfactant 0.25% v/v	Apply in late summer before leaf coloration. Thorough coverage is imperative. Apply during periods of active growth. Do not apply within 100 ft of desirable plants or allow dicamba to contaminate water used for irrigation or other domestic purposes. Dicamba may move down slopes for considerable distances.
	2,4-D 2.0-3.0 lb/100.0 gal water + surfactant 0.25% v/v.	

Table 7.22 - Specific Perennial Weeds (Except Woody Plants) (cont.)*(See also SOIL STERILIZATION below for general nonselective control, including perennial weeds.)*

Weed	Chemical Rate ai/acre	Remarks
	triclopyr 4.0 lb (1.0 gal Garlon 4 Ultra)/100.0 gal of water + surfactant 0.25% v/v	Thoroughly wet all foliage and stems. Density of cover will determine volume of spray/A. Spot treat regrowth as required. Thorough coverage and the use of a surfactant is imperative for good control.
	glyphosate 4.0 lb (1.0 gal Roundup Pro or Accord XRT)/100.0 gal water.	
Multiflora Rose	2,4-D 2.0 lb + triclopyr 1.0 lb (Crossbow 1.0 gal)/100.0 gal water + 0.25% surfactant.	Apply when actively growing.
	glyphosate 2.0-3.0 lb (0.50-0.75 gal Roundup Pro or Accord XRT)/100.0 gal water	
	metsulfuron (Escort) 0.75-1.0 oz product in 50.0 gal water/A + 0.25% surfactant	
	triclopyr amine (Garlon 3A) 1.5-3.0 lb (0.5-1.0 gal)/A + 0.25% surfactant	
	2,4-D + 2,4-DP + dicamba (BK-800) 2.0-2.5 gal/100.0 gal water + 0.25% surfactant	Apply when actively growing. Do not apply near desirable plants. Dicamba may move down slopes considerable distances.
	fosamine 8.0-12.0 lb (2.0-3.0 gal Krenite S)/100.0 gal water.	Apply from mid- summer to early fall prior to leaf color change. Thorough coverage is imperative.
Cedar	hexazinone 1.0 lb/10.0 gal water (1.0 lb Velpar 90% SP or 0.5 gal Velpar L)	When preparing the liquid mixture, with Velpar 90% SP, the water should be at room temperature to completely dissolve the powder. Spray 3.0 oz of the solution/2-inch basal diameter on the soil near the base of the stem. For spot control only. Do not treat large areas or every stem in dense stands because erosion may result. Hexazinone may move down slopes for considerable distances. Do not use near desirable plants.
	Krenite 3.0 gal/100.0 gal water	Apply after July 15. Wet foliage thoroughly.
	2,4-D 4.0-6.0 lb + dicamba 2.0-3.0 lb (2.0-3.0 gal Banvel 720)/100.0 gal water + 2.0 gal Cide Kick	Wet foliage thoroughly. Dicamba may move down slopes considerable distances.

Soil Sterilization

Soil sterilant chemicals, by definition, render the soil incapable of supporting plant growth for varying periods. The effect may be temporary, as with fumigants, or for an extended period (semi-permanent). In either case, the action is nonselective at rates specified for use as soil sterilants. Therefore, do not apply within the root development area of adjoining crops or desirable species. Do not use in crops or where there is danger of chemical runoff. **Note:** Since effectiveness varies considerably with the weed species, degree of infestation, soil and environmental conditions, several herbicidal materials and a range of rates are provided to allow selection of product and dosage based on specific need.

Lower rates (A) apply to annuals, biennials, shallow-rooted perennials, and seedling perennials;

Higher rates (B) apply to established deep-rooted and other hard-to-kill perennials. Read and follow directions on the label for further details.

Table 7.23 - Chemicals and Recommended Use

Soil sterilants are very potent plant killers and should not be used around the home grounds or near desirable plants; as with all pesticides, consult the label before use.

Herbicide	Application Rate ai/acre	Remarks
borate mixtures with sodium chlorate and/or other chemicals	variable	Follow instructions on the label. Apply as a spray on early growth to first bloom or broadcast as a soil treatment.
bromacil	(A) 3.0-6.0 (B) 10.0-25.0	If dense growth is present, results will be improved if vegetation is removed prior to treatment. Do not apply to frozen ground.
chlorate mixtures with borates or other chemicals	variable	Follow instructions on label. Fire hazard usually less than pure sodium chlorate but caution still is necessary.
diuron or monuron	(A) 5.0-20.0 (B) 20.0-80.0	Diuron gives somewhat longer soil sterility. Monuron is more effective on deep-rooted weeds.
hexazinone (Velpar)	(A) 1.8-4.5 (B) 5.4-10.8	Apply in early spring. Do not apply near desirable vegetation. Consult label for specific rates on different soil types.
imazapyr (Arsenal) (Topsoil)	0.5-1.0 lb 200-300 lb product/A	Do not apply near trees or other desired vegetation.
methyl bromide	1.0-1.5 lb/100 sq ft	Soil fumigant. Apply in concentrated form under vaporproof cover, when soil is moist, not wet, and in good tilth. Remove cover after 24-48 hours. Warning: methyl bromide is poisonous.
prometon (Pramitol)	(A) 10.0-15.0 (B) 20.0-60.0	Mix in water or oil. Provides quicker contact kill of top growth with oil. Apply to early growth up to first heading.
tebuthiuron (Spike) (Sprakil S-5)	(A) 4.0-6.0 (B) 6.0-16.0 40-120 lb product/A	Follow label directions. Do not apply near desirable vegetation. Tebuthiuron can move considerable distance down slopes.
diuron + imazapyr (Sahara)	10-15 lb product/A	Mix in 50-100 gal water.
diuron + tebuthiuron (Sprakil 13) (Sprakil 26)	150-400 lb product/A 150-300 lb product/A	Apply granules uniformly over area to be treated.

Bermudagrass Release, Rights-of-Way Only

glyphosate + sulfometuron	(Roundup Pro) 1.0 qt + (Oust) 1.0 oz + Cide Kick 1.0 qt	Apply in early spring or October for control of cool-season grasses (Ky 31 fescue, etc.) and weeds.
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Summer Grasses in Bermudagrass, Rights-of-Way Only

sulfometuron + glyphosate	(Oust) 0.25-0.5 oz + (Roundup Pro) 1.0-2.0 pt + Cide Kick 1.0 qt	Apply in June for control of dallis, broomsedge, johnson, and annual grasses in 50.0 gal of water.
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Always read the label before applying any pesticide. Use caution when applying herbicides on windy days or when temperature is above 85° F. Many herbicides exhibit soil activity and may cause damage or death to desirable plants if they contact the roots of such plants. This problem is compounded on steep terrain. Always use adequate personal protection clothing or devices as suggested or required by the label.

Table 7.23 - Chemicals and Recommended Use (cont.)

Soil sterilants are very potent plant killers and should not be used around the home grounds or near desirable plants; as with all pesticides, consult the label before use.

Herbicide	Application Rate ai/acre	Remarks
Stabilized Shoulders and Guard Rails		
glyphosate + diuron	(Roundup Pro) 2.0-4.0 qt + Karmex 2.0-4.0 lb	Apply in 50.0 gal of water in spring. Repeat if necessary. Keep off of desired vegetation. Do not apply more than 2 ft past guard rail or edge of shoulder to prevent erosion of soil. Will not control bermudagrass.
glyphosate + surflan	(Roundup Pro) 2.0-4.0 qt + Surflan 4.0 lb	
glyphosate + pendimethalin	(Roundup Pro) 2.0-4.0 qt + Pendulum 4.0 lb	

Always read the label before applying any pesticide. Use caution when applying herbicides on windy days or when temperature is above 85° F. Many herbicides exhibit soil activity and may cause damage or death to desirable plants if they contact the roots of such plants. This problem is compounded on steep terrain. Always use adequate personal protection clothing or devices as suggested or required by the label.

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