PEST MANAGEMENT GUIDE

Field Crops

2016

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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.**

Field Crops - 2016 - Chapter Section Table of Contents

Safe and Effective Use

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Introduction

The Pest Management Guide Series

The Virginia Pest Management Guide (PMG) series lists options for management of major pests: diseases, insects, nematodes, and weeds. These guides are produced by Virginia Cooperative Extension and each guide is revised annually. 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 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, contact your local Extension office. 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. Local Extension offices are listed in the telephone directory. There is also a complete list of all Virginia Cooperative Extension offices at www.ext.vt.edu/offices/ on the Internet.

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. 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 production 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 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 often result in 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, most commercial pesticide users, all aerial applicators, and growers who use restricted-use pesticides must be certified. 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.

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, a government purchase orders can be arranged by email: vcedistributioncenter@vt.edu

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.

A 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.

A major change to FIFRA, provided by a 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).
  - *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.

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 recer-

tification 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.
    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;

Acreage, 6. 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.

sample c. 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:

The restri 1. cted-use pesticide brand or product name;

2. The EPA registration number;

The total 3. amount of the restricted-use pesticide product applied;

4. The month, day, and year of application;

The locati 5. on 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 surpervised 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 application for 30 days after the expiration of the restricted-entry interval (REI). In addition, this information must be kept on file for two years. 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 of the application; and

6. Restricted entry interval for the pesticide (duration and expiration).

WPS application information and safety data sheets (SDSs) must be displayed at a central location within 24 hours of the end of an application, and before workers enter the treated area. Application information and SDSs must be posted for 30 days after the restricted-entry interval (REI) expires—and kept on file for two years following. On-file application information and SDSs must be available to workers, handlers, designated/authorized representatives (identified in writing), or treating medical personnel upon request.

Additionally, employers will be required to keep records of WPS training. 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.

[3]Year Mo/Date / [1]Time of Day	[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)

[1]Required for Worker Protection Standard

[2]Required for Federal Pesticide Recordkeeping Requirements, USDA

[3]Required 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 (if different than recorded in left column)	Certified Applicator's Name and Certificate Number	Date: (Month, Day, Year)	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* of Diluent (if used)	Type of Application Equipment

Prepared by Virginia Cooperative Extension and VDACS (Virginia Department of Agriculture and Consumer Services) Office of Pesticide Services, 2006.

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 or (804) 674-2400.

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.

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) 786-3798
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 (MC 0409)
302 Agnew Hall
460 West Campus Drive
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 Substanee (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: VAEmergencyResponsePlanningOrganizations.aspx (Navigation: DEQ, Programs, Air, Air Quality Planning & Emissions, SARA Title III, VA Emergency Response & Planning Organizations.)

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 or (804) 674-2400. 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.

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) 786-3798 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) 786-3798.

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.

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 susbstantial 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 a number of factors, including, droplet size, environmental conditions, and equipment configuration and operation.

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 22908
(800) 222-1222 or (800) 451-1428
www.medicine.virginia.edu/community-service/centers/brpc

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
(800) 222-1222 or (804) 828-9123
(Calls from Central and Eastern Va. only)
www.virginiapoison.org or www.vapoison.org

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

Pesticide Information Directory

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

The pages that follow include **Emergency Information, General Information, and Industry Associations**. In the blank lines provided, please take time to list your local phone numbers for these sources. In the case of an emergency, it might save a life, as well as possible added expense and inconvenience. Keep a copy of this guide, with this directory section marked, near your phone and/or in your service vehicle for future reference.

Emergency Information

Poisonings For Treatment:	If poisoned, have someone take you immediately to your nearest emergency room with the label of the container.	
My Nearest Poison Control Center Is Located At:	The blanks below are supplied for recording the name and telephone number of the nearest poison control center. Please refer to the Regional and Area Poison Control Centers listed previously in this section.	
	_____	
	_____	
	_____	
Phone number	_____	
Spills accidents and other related emergencies	CHEMTREC (for assistance) Chemical Transportation Emergency Center Industry assistance with clean-up procedures, etc.	*(800) 262-8200* *chemtrec.com/*
Accidents or **Incidents** that constitute a threat to any person, public safety and health, or the environment must be reported to:	Virginia Department of Agriculture and Consumer Services Office of Pesticide Services Field Operations	(804) 371-6560
For Assistance with Spills and Emergencies Take time to write your local emergency numbers in the space provided.	State Police	_____
	Fire Department	_____
	Ambulance	_____
	Virginia Department of Emergency Management (VDEM) **Emergency Operations Center** *pio@vdem.virginia.gov* - E-mail monitored during regular business hours. *http://www.vaemergency.gov/aboutus/locationscontact-us*	(804) 897-6500 (Mon-Fri) 8:15am-5pm **(804) 674-2400** **(800) 468-8892** 24 hours / day
	Local Emergency Services Coordinator	_____
	Local Emergency Response Council	_____

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/* or *vtpp.org*	_____ (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) 786-3798
Community Right-to-know Environmental Programs	**Department of Environmental Quality** 629 East Main Street P.O. Box 1105 Richmond, VA 23218 *http://www.deq.virginia.gov.*	(804) 698-4000 (800) 592-5482
EPA Cooperator for general pesticide information	**National Pesticide Information Center (NPIC)** Ag. Chemistry Extension Oregon State University 310 Weniger Hall Corvallis, OR 97331-6502 *npic.orst.edu/*	(800) 858-7378 M-F 11:00 am – 3:00 pm ET
Animal Poisonings Assistance	**Va.-Md. Regional College of Veterinary Medicine** 265 Duck Pond Drive Virginia Tech (0442) Blacksburg, VA 24061 *www.vetmed.vt.edu/* **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 *aspca.org/pet-care/animal-poison-control*	(540) 231-4621 (hospital) Ask your veterinarian to call on your behalf (888) 426-4435
RCRA & Superfund Industry Assistance Hotline	**EPA - Resource Conservation Recovery Act** (Superfund regulations) *www.epa.gov/rcraonline/* and *http://www2.epa.gov/rcra*	(800) 424-9346
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 15th 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/*
National Association of Landscape Professionals (NALP) 950 Herndon Parkway, Suite 450 Herndon, VA 20170	(800) 395-2522 (703) 736-9666 *www.landscapeprofessionals.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 develop 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 Protectlve 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

[1]Includes 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.

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

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

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

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

Length Of Row Required For One Acre:

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

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]	5.0 pt
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]

[1]Example: 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.

[2]Approximate 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

[1]1 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

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

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

Liquid

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

Dry

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 LD_{50}). 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	- nematicide
F	- fungicide	PGR	- plant growth regulator
Fum	- fumigant	R	- rodenticide
H	- herbicide	Rep	- repellent
H A	- harvest aid (defoliant)	T	- termiticide
I	- insecticide	V	- vertebrate control

Toxicity

Toxicity is the quality, state, or degree of being poisonous. The toxicities listed here are oral. Oral LD_{50} (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 LD_{50}, the higher the toxicity. Dermal LD_{50} ratings are in most cases higher (lower in toxicity) than oral ratings.

When registering pesticides, the Environmental Protection Agency (EPA) uses acute LD_{50} 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 LD_{50} ratings due to some special property of the chemical. For example, chlorothalonil has a very low toxicity (LD_{50} 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 (LD_{50}) is relative to the concentration of active ingredient in question and the body weight of the victim.

All LD_{50} ratings listed here are for technical grade compounds; however, pesticide products are not sold as 100 percent concentrations. To find the LD_{50} 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]	Agri-Mek, Avid, various	I/Mi	Syngenta, various	300
acephate	Orthene, various	I	Amvac, BASF, various	866-945
acetamiprid	Assail, Tristar	I	United Phosphorus, Cleary	314-417
acetic acid	vinegar	H	various	331
acetochlor	Breakfree, Confidence, Degree, Harness, Surpass	H	Dow AgroSciences, DuPont, Monsanto	2,953
acifluorfen	Blazer, Storm	H	United Phosphorus	2,025
Agrobacterium radiobacter	Galltrol-A	B	AgBioChem	low toxicity
alachlor[1]	Bullet, Intrro, Lariat, Micro-Tech	H	Monsanto	~1,000
aldicarb[1]	Meymik, Temik	I	Ag Logic, Bayer	1
allethrin	various	I	various	680-1,000
allyl isothiocyanate	Dominus	Rep	Engage Agro USA	151
aluminum phosphide[1]	Phosfume, Phostoxin, Weevil-Cide	Fum	Degesch, Douglas, United Phosphorus	0.3
ametryn	Evik	H	Syngenta	1,110
ametoctradin	Orvego, Zampro	F	Bayer	> 2,000
amicarbazone	Xonerate	H	Arysta	> 2,000
aminocyclopyrachlor	Method	H	Bayer	> 5,000
4-aminopyridine[1]	Avitrol	Av	Avitrol Corp	20-29
aminopyralid	Milestone	H	Dow AgroSciences	> 5,000
amitraz[1]	Apivar	H	Arysta	800
ancymidol	A-Rest, Abide	PGR	Fine Americas, Sepro	4,500
asulam	Asulox	H	United Phosphorus	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
azoxystrobin	Abound, Dynasty, Headway, Heritage, Quadris	F	Syngenta, various	> 5,000
Bacillus cereus	Pix Plus	PGR	Arysta	> 5,000
Bacillus firmus	Nortica, Vovito	N	Bayer	> 5,000
Bacillus licheniformis	Roots Ecoguard	F	Novozymes	> 5,000
Bacillus pumilus	Ballad Plus, Sonata, Yield-Shield	F	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
Bacillus sphaericus	Fourstar, Vectolex, Vectomax, Spheratax	I	Advanced Microbiologics, Fourstar, Valent	> 5,000
Bacillus subtilis	Companion, Serenade, Rhapsody	F	AgraQuest, Growth Products	> 5,000
Bacillus thuringiensis	DiPel, various	I	various	> 5,000
Beauveria bassiana	balEnce, Botaniguard, Mycotrol, Naturalis	I	Jabb, LAM, Troy Biosciences	> 5,000
benefin (benfluralin)	Balan, Team	H	Dow AgroSciences, various	> 10,000
bensulide	Prefar	H	Gowan, various	770
bentazon	Basagran, Rezult	H	Arysta, BASF, various	1,100
bifenazate	Acramite, Floramite, Sirocco	Mi	Chemtura, OHP	> 5,000
bifenthrin[1]	Talstar, various	I	FMC, various	54.5
bispyribac-sodium	Tradewind, Velocity	H	Valent	4,111
BLAD	Fracture	F	FMC	> 5,000
borax	various	I	various	4,500-6,000
Bordeaux Mixture	Copper/Sulfur	F	various	low toxicity
boric acid	various	I	various	low toxicity
boscalid	Emerald	F	BASF	> 2,000
brodifacoum	Final, Talon, various	R	Bell Labs, Syngenta, various	0.27
bromacil	Hyvar, various	H	Bayer, various	5,200
bromadiolone	Contrac, 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	H, PGR	Chemtura	890-1,540
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
carbofuorfen	Acifluorfen 2, Avalanche, Levity	H	various	> 5,000
carboxin	Vitavax	F	various	3,820
carfentrazone-ethyl	Aim, various	H	FMC, various	> 5,000
chlorantraniliprole	various	I	DuPont, Syngenta, various	> 5,000
chlorethoxyfos[1]	SmartChoice	I/Mi	Amvac	1.8-4.8
chlorfenapyr	Phantom, Pylon	I/Mi	BASF	441
chlorimuron ethyl	Cemax, Classic	H	Agsurf, DuPont	4,102
chlormequat chloride	Citadel, Cycocel, Chlormequat	PGR	various	> 5,000
chlorophacinone[1]	Rozol	R	Liphatech	3.15
chloropicrin[1]	Tri-Pic	Fum	Triest	250
chlorothalonil	Bravo, Chloronil, various	F	Syngenta, various	> 10,000
chlorpropham	Shield, various	H, PGR	Aceto Ag, Decco	3,800

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
chlorpyrifos[1]	Dursban, Lorsban	I	Dow AgroSciences, various	135-163
chlorsulfuron	Telar	H	Bayer	5,545
chlorthal	Dacthal	H	Amvac	3,000
cholecalciferol	Agrid 3, Terad 3	R	Bell	352
clethodim	Envoy, Select, Volunteer	H	Valent, various	1,630
clofentezine	Apollo, Ovation	Mi	Makhteshim-Agan, Everris	> 5,200
clomazone	Command	H	FMC	2,077
clopyralid	Lontrel	H	Dow AgroSciences	> 4,300
cloransulam-methyl	FirstRate	H	Dow AgroSciences	> 5,000
clothianidin	Arena, Belay, Poncho	I	BASF, Valent	> 5,000
copper chelate	Cutrine, various	H(aq)	Applied Biochemists	0.50-2.00
copper hydroxide	Kocide, various	F/B	DuPont, Sepro, various	1,000
copper sulfate	Bluestone, various	H(aq), F/B	various	470
coumaphos[1]	Checkmite +, Co-Ral	I/A	Bayer, Mann Lake	56-230
m-cresol	Gallex	B	Agbiochem	242
creosote[1]	coal tar	F/I	various	885
cyantraniliprole	Exirel, Ference, Fortenza, Mainspring, Verimark, Zyrox	I	DuPont, Syngenta	> 5,000
cyazofamid	Ranman, Segway	F	various	> 5,000
cyclanilide	Finish, Stance, Terminate	PGR	Bayer, NuFarm	> 5,000
cycloate	Ro-Neet	H	HelmAgro	2,000-3,190
cyflufenamid	Torino	F	Gowan	> 5,000
cyflumetofen	Nealta, Sultan	Mi	BASF	> 2,000
cyfluthrin[1]	Tempo, Tombstone, various	I	Bayer, Loveland, various	400
(gamma-) cyhalothrin[1]	Declare, Proaxis	I	Cheminova	50
(lambda-) cyhalothrin[1]	Demand, Karate, Warrior, various	I	Syngenta, various	79
cymoxanil	Curzate, Tanos	F	DuPont	1,100
cypermethrin[1]	Ammo, Demon, Fastac	I	various	250-4,150
cyproconazole	Alto	F	Syngenta	1,020
cyprodinil	Vangard	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, Dazide	PGR	various	8,400
dazomet	Basamid, various	Fum	various	520
decanol	Royaltac, various	PGR	various	18,000
deet	OFF, various	Rep	SC Johnson, various	8,500

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
deltamethrin	Deltadust, Deltagard, various	I/Mi	Bayer, various	> 5,000
diazinon[1]	Diazion	I	various	1,250
dicamba	Banvel, Engenia, Vanquish, various	H	BASF, Syngenta, various	1,707-6,764
dichlobenil	Casoron	H	various	> 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
diclosulam	Strongarm	H	DowAgroSciences	> 5,000
dicrotophos[1]	Bidrin, Inject A Cide	I	Amvac, Mauget	22
difenacoum	various	R	various	<1
difenoconazole	Dividend, Inspire	F	Syngenta	1,453
difethialone	Generation, Hombre, various	R	Liphatech	1-7
diflubenzuron[1]	Advance, Dimilin	IGR, T	BASF, Chemtura	> 4,640
diflufenzopyr-sodium	no stand-alone products	H	BASF	> 5,000
dikegulac sodium	Augeo, Atrimmec, Pinscher	PGR	various	18,000-31,000
dimethoate	Dimethoate	I	various	290-325
dimethomorph	Forum, Stature	F	BASF	3,900
dinotefuran	Venom	I	Valent	2,804
diphacinone	various	R	various	3
diquat dibromide	Diquat, Enforcer, Reward, Weedtrine-D	H	various	231
disulfoton[1]	Di-Syston	I	Bayer	12.7
dithiopyr	Dimension, various	H	Dow AgroSciences, various	3,600
diuron	Karmex	H	various	3,400
dried blood	various	Rep	various	low toxicity
egg solids	various	Rep	various	34,600
emamectin[1]	Enfold, Proclaim	I	Syngenta	76-89
endosulfan	Thionex	I	Makhteshim Agan	40
endothall	Aquathol, Hydrothal	H/H(aq)	United Phosphorus	51
EPTC	Eptam	H	Gowan	1,630
esfenvalerate[1]	Asana, various	I	Valent, various	75-458
ethaboxam	Intego	F	Valent	> 5,000
ethalfluralin	Curbit, Sonalan, Strategy	H	Dow AgroSciences, Loveland	> 10,000
ethephon	Cerone, Ethrel, Florel	PGR	Bayer, various	4,000
ethofenprox	Zenivex	I	Wellmark	> 40,000
ethofumesate	Ethotron, Poa Constrictor, Prograss	H	Bayer, United Phosphorus	6,400
ethoprop (ethoprophos)[1]	Mocap	I/N	Amvac	62

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
etoxazole	Beethoven, Tetrasan, Zeal	Mi, IGR, Mi	BASF, Valent	> 5,000
etridiazole	Banrot, Terrazole, Truban	F	various	1,077
famoxadone	Tanos	F	DuPont	> 5,000
fatty acid salts/soaps	various	I/Mi, H, PGR, Rep	various	50 - > 5,000
fenamidone	Fenstop, Reason	F	Bayer, OHP	> 5,000
fenazaquin	Magister, Magus	Mi	Gowan	134
fenbuconazole	Indar	F	Dow AgroSciences	> 2,000
fenbutatin-oxide (hexakis)[1]	Meraz, Vendex	Mi	United Phosphorus	2,630
fenhexamid	Captevate, Decree, Elevate	F	Arysta, Sepro	> 2,000
fenoxaprop-p-ethyl	Acclaim, Double Check, Tacoma	H	Bayer, Loveland, Winfield	4,670
fenpropathrin[1]	Danitol, Tame	A/I	Valent	70
fenpyrazamine	Protexio	F	Valent	> 2,000
fenpyroximate	Akari, Portal	I/Mi	Nichino, Sepro	480
fentin hydroxide[1]	Agri-Tin, Super Tin	F/I/Mi	NuFarm, United Phosphorus	160
ferbam	Ferbam	F	Taminco	> 17,000
ferric sodium EDTA	Slug and Snail Killer	M	various	low toxicity
fipronil[1]	Frontline, Regent, Termidor	I/Mi/T	Bayer, BASF	336
flazasulfuron	Katana	H	PBI Gordon	> 5,000
flonicamid	Aria, Beleaf	I	FMC	> 2,000
florasulam	Defendor	H	Dow AgroSciences	> 5,000
fluazifop-P-butyl	Fusilade	H	Syngenta, various	3,680
fluazinam	Omega, Secure	F	Syngenta	> 5,000
flubendiamide	Belt, Synapse, Tourismo, Vetica	I	Bayer, Nichino	> 2,000
flucarbazone-sodium	Finesse, Everest, Sierra	H	Arysta, DuPont, Syngenta	> 5,000
fludioxonil	Maxim, Medallion	F	Syngenta	> 5,000
fluensulfone	Nimitz	N	Makhteshim Agan	> 2,000
flufenacet	Axiom, Define	H	Bayer	589-1,617
flumetralin	Prime +, various	PGR	Syngenta, various	> 5,000
flumetsulam	Python	H	Dow AgroSciences	> 5,000
flumiclorac-pentyl	Action, Resource	H	Amvac, Valent	> 5,000
flumioxazin	Broadstar, Clipper, Gangster, Payload, SureGuard, Valor	H/H(aq)	Valent	> 5,000
fluometuron	Cotoran, Shotaran	H	various	6,416-8,900
fluopicolide	Adorn, Presidio, Stellar	F	Valent	> 5,000
fluopyram	Ilevo	F/N	Bayer	> 2,000
fluoxastrobin	Aftershock, Disarm, Evito	F	Arysta, Loveland	> 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
flupyradifurone	Sivanto	I	Bayer	> 2,000
fluridone	Avast, Sonar	H (aq)	Alligare, Sepro	> 10,000
fluroxypyr	Position, Starane, Vista	H	Dow AgroSciences	> 2,405
flurprimidol	Cutless, Topflor	PGR	Sepro	709-914
fluthiacet-methyl	Cadet	H	FMC	> 5,000
flutolanil	Moncoat, Prostar	F	Bayer, Nichino	> 10,000
flutriafol	Fortix	F	Arysta	1,140
fluvalinate	Apistan, Mavrik	I	Wellmark	260-280
fluxopyroxad	Systiva, Xzemplar	F	BASF	> 2,000
folpet	Fungitrol	F	International Specialty Products	> 10,000
fomesafen	Sinister	H	Helena	1,250-2,000
formic acid	Mite-Away	Mi	Nod Apiary Products	110
fosamine ammonium	Krenite	H	Bayer	10,200
fosetyl-Al	Aliette, various	F	Bayer, various	5,800
furfural	Multiguard Protect	F/N	Agriguard	65
gibberellic acid	GibGro, ProGibb	PGR	various	630
Gliocladium virens	Soil Gard	F	Certis	low toxicity
glufosinate-ammonium	Finale, Ignite, Liberty, Rely, Remove, various	H	Bayer, various	1,620-2,000
glyphosate	Accord, Rodeo, Roundup, various	H	Dow AgroSciences, Monsanto, various	4,050-5,600
halosulfuron-methyl	Sandea, Sedgehammer, various	H	Monsanto, Nufarm, various	1,287
harpin protein	Axiom, various	B, I, F, N, PGR	various	low toxicity
hexaflumuron	Shatter	T, IGR	Dow AgroSciences	> 5,000
hexazinone	Velossa, Velpar	H	DuPont, Helena	1,690
hexythiazox	Hexygon, Onager, Savey	Mi	Gowan	> 5,000
hydramethylnon	Amdro	I	various	1,131-1,300
hydroprene	Gentrol, various	IGR	various	> 34,600
IBA	Hormodin, various	PGR	various	100 (mice)
imazalil	Fungaflor	F	Whitmire	227-343
imazamox	Beyond, Clearcast, Raptor	H/ H(aq)	BASF, Sepro	> 5,000
imazapic	Cadre, Plateau	H	BASF, NuFarm	> 5,000
imazapyr	Arsenal, Chopper, Habitat, various	H	BASF, Sepro, SSI Maxim	> 5,000
imazaquin	Image	H	BASF	> 5,000
imazethapyr	Pursuit	H	BASF	> 5,000
imazosulfuron	Celero, League	H	Valent	> 5,000
imidacloprid	Admire, Advantage, Merit, various	I/A	Bayer, various	450
imiprothrin	see metaflumizone	---	---	---

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
indaziflam	Alion, Esplanade, Marengo, Specticle	H	Bayer, OHP	> 2,000
indoxacarb	Advion, Avaunt, Steward	I	DuPont	268-1,732
iodosulfuron	Autumn	H	Bayer	2,678
ipconazole	Acceleron, Rancona, Vortex	F	Bayer, Chemtura, Monsanto	> 5,000
iprodione	Eclipse, Rovral, various	F	FMC, Sipcam Agro, various	3,500
isoxaben	Gallery	H	Dow AgroSciences	> 10,000
isoxaflutole	Balance	H	Bayer	> 5,000
kasugamycin	Kasumin	F	Arysta	> 5,000
kinoprene	Enstar	IGR	Wellmark	4,900-5,000
kresoxim-methyl	Sovran	F	BASF	> 5,000
lactofen	Cobra, Phoenix	H	Valent	> 5,000
linuron	Linex, Lorox	H	Tessenderlo Kerley	1,500-4,000
magnesium phosphide[1]	Fumi-Cel, Fumi-Strip, Magtoxin	Fum	Degesch	0.3
malathion	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, various	H	various	700-800
mecoprop	MecoMec, various	H	PBI/Gordon, various	930
mefenoxam	see metalaxyl-M	—	—	—
mefluidide	Embark	H/PGR	PBI/Gordon, various	> 4,000
mepiquat chloride	various	PGR	various	464
mepiquat pentaborate	Pentia	HA/ PGR	BASF	500
mesotrione	Callisto, Tenacity	H	DuPont, Syngenta	> 5,000
metaflumizone	Altrevin, Siesta	I	BASF	1,800
metalaxyl-M (mefenoxam)	Apron, Subdue	F	various	1,040
metaldehyde	Deadline, various	M	various	630
metam-sodium[1]	Vapam, various	Fum	Amvac, various	1,800
metconazole	Caramba, Metlock, Quash, Tourney	F	BASF, Valent	660
methamidophos[1]	Monitor	I	Bayer	17
methiocarb[1]	Mesurol	I/M/Rep	Gowan	15-35
methomyl[1]	Lannate, Nudrin, various	I/N	DuPont, various	17-24
methoprene	Altosid, various	IGR	Wellmark Intl., various	34,600
methoxyfenozide	Intrepid, Troubadour	I	Dow AgroSciences, Helena	> 5,000
methyl anthranilate	various	Rep	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

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
metolachlor	Cinch, Dual, Pennant , various	H	DuPont, Syngenta, various	2,780
metrafenone	Vivando	F	BASF	> 5,000
metribuzin	Metribuzin, Sencor, Tricor	H	Bayer, various	1,100-2,300
metsulfuron-methyl	Ally, Cimarron, Escort, various	H	Bayer, DuPont, various	> 5,000
mineral oil	Dormant Oil, various	I/Mi	various	low toxicity
MSMA	MSMA, Target	H	Drexel, Luxembourg	1,700
myclobutanil	Eagle, Laredo, various	F	Dow AgroSciences, various	1,600-2,290
NAA	Dip'nGrow, Pomaxa, RootMaster	PGR	Valent, various	1,000
NAD	Amid-Thin, Rootone	PGR	Amvac, Bayer	1,000
naled	Dibrom, Trumpet	I	Amvac	430
naphthalene	"moth balls"	Fum/I /Rep	various	50-500
napropamide	Devrinol	H	United Phosphorus	5,000
neem	see azadirachtin	—	—	—
nicarbazin	Ovocontrol	Av	Innolytics, LLC	10,000
nicosulfuron	Accent	H	DuPont	> 5,000
norflurazon	Solicam	H	Tessenderlo Kerley	> 9,400
Nosema locustae	Nolo Bait	I, M & R	M&R Durango	low toxicity
novaluron	Diamond, Pedestal, Rimon	I	Chemtura, Makhteshim Agan	> 5,000
noviflumuron	Recruit	T, 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, Treetech	F	various	low toxicity
paclobutrazol	Bonzi, Cambistat, Piccolo, Profile, Trimmit	PGR	various	5,346
paradichlorobenzene	"moth balls"	I/Rep	various	500-5,000
paraquat[1]	Gramoxone, various	H	Syngenta, various	150
pendimethalin	Pendulum, Prowl, various	H	BASF, Scott's, various	1,250
penoxsulam	Galleon, Sapphire	H/H(aq)	Dow AgroSciences, Sepro	> 5,000
pentachloronitrobenzene	Blocker, Terraclor, Turfcide	F	Amvac	1,650-12,000
penthiopyrad	Fontelis, Velista, Vertisan	F	DuPont	> 5,000
permethrin[1]	Ambush, Pounce, various	I	Amvac, FMC, various	4,000
phenmedipham	Spin Aid	H	Bayer	> 4,000
phenothrin	Bedlam, various	I	MGK, various	> 5,000
phorate[1]	Thimet	I	Amvac	2-4
phosmet	Imidan	I	Gowan	147-316

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
phosphine gas[1] (hydrogen phosphide)	Eco_2Fume, VAPORPH_3OS	I/Mi, Fum	Cytec Ind.	0.3
phostebupirim[1]	Aztec[1] (w/cyfluthrin)	I	Bayer	2.9-3.6
picaridin	Cutter, Off, various	Rep	S.C. Johnson, various	4,743
picloram[1]	Tordon K, various	H	Dow AgroSciences, various	8,200
picoxystrobin	Approach	F	DuPont	> 5,000
pinoxaden	Axial	H	Syngenta	> 5,000
piperalin	Pipron	F	Sepro	2,500
piperonyl butoxide	(used as a synergist)	I	various	> 7,500
polybutene	Hot Foot, various	Rep	various	low toxicity
polyoxin D	Affirm, Endorse, Ph-D, Veranda	F	Arysta	> 5,000
potassium bicarbonate	Armicarb, Kaligreen, Milstop	F	various	500-5,000
primisulfuron-methyl	Beacon	H	Syngenta	5,050
prodiamine	Barricade, various	H	Syngenta, various	> 5,000
prohexadione calcium	Anuew, Apogee, Kudos	PGR	BASF, Cleary, Fine	> 5,000
prometon	Pramitol, various	H	various	2,980
prometryn	Caparol, CottonPro	H	Syngenta, Makhteshim Agan	5,235
pronamide[1] (propyzamide)[1]	Kerb	H	Dow AgroSciences	5,620-8,350
propamocarb hydrochloride	Banol, Previcur, Proplant	F	Bayer, Lesco, Sipcam	8,600
propargite	Omite	Mi	Chemtura	2,200
propiconazole	Alamo, Banner, Tilt, various	F	Syngenta, various	1,517
propoxur	Invader, various	I/Mi	FMC, various	95-104
propyzamide[1]	see pronamide	—	—	—
prosulfuron	Peak	H	Syngenta	4,360
prothioconazole	Proline	F	Bayer	> 6,200
pymetrozine	Endeavor, Fulfill	I/Mi	Syngenta	5,820
pyraclostrobin	Cabrio, Headline, Insignia	F	BASF	> 5,000
pyraflufen-ethyl	Edict, Venue	H, HA	Nichino	> 5,000
pyrethrum	Pyrethrins	I	various	584-900
pyridaben	Nexter, Sanmite	I/Mi	Gowan	820-1,350
pyridalyl	Overture	I	Valent	> 5,000
pyrimethanil	Scala	F	Bayer	4,149
pyriproxyfen	Distance	IGR	Valent	4,733
pyrithiobac-sodium	Pyrimax, Pysonex, Staple	H	Agsurf, DuPont, Makhteshim Agan	4,000
pyroxasulfone	Zidua	H	BASF	> 2,000
pyroxsulam	GR1, PowerFlex	H	Dow AgroSciences, DuPont	> 2,000
quinclorac	Facet, various	H	BASF, various	> 2,610
quinoxyfen	Quintec	F	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 LD_{50} Values for White Rats-Oral (mg/kg) Technical
quizalofop-p-ethyl	Assure II, Targa	H	DuPont, Gowan	1,182-1,210
resmethrin[1]	Scourge	I	Bayer, various	> 2,500
rimsulfuron	Matrix, various	H	DuPont, various	> 5,000
rotenone[1]	CFT Legumine, Prenfish, Prentox	V	Central Garden & Pet Co.	132-1,500
saflufenacil	Detail, Integrity, Sharpen, Treevix	H	BASF	> 2,000
sethoxydim	Poast, Rezult, various	H	BASF, various	2,676-3,200
siduron	Tupersan, various	H	various	> 7,500
silica/silicon dioxide	various	I	various	3,160
simazine	Princep, various	H	Syngenta, various	> 5,000
sodium bentazon	Basagran, Rezult B, various	H	Arysta, BASF, various	1,100-2,063
sodium chlorate	Defol, various	H	Drexel, various	1,200
sodium chloride	TABLE SALT	---	Morton, various	3,320
sodium cyanide[1]	M-44	V	USDA-APHIS-WS	6.4
sodium fluoroacetate[1]	1080	V	USDA-APHIS-WS	0.22
spinetoram	Delegate, Radiant	I	Dow AgroSciences	> 5,000
spinosad	SpinTor, Tracer, various	I/Mi	Dow AgroSciences, various	> 5,000
spiromesafen	Forbid, Judo, Oberon	I/Mi	Bayer, OHP	> 2,500
spirotetramat	Kontos, Movento	I	Bayer, OHP	> 2,000
starlicide[1]	Compound DRC-1339, Starlicide Complete	Av	USDA-APHIS-WS, VIrbac AH	1,770
streptomycin sulfate	Agri-Mycin, various	F	various	> 10,000
sulfentrazone	Authority, Spartan, various	H	FMC, various	2,855
sulfometuron-methyl	Oust, various	H	Bayer, various	> 5,000
sulfosulfuron	Certainty, Outrider	H	Monsanto	> 5,000
sulfoxaflor	Closer, Transform	I	Dow AgroSciences	1,000
sulfur	Thiolux, various	F, I/Mi	various	low toxicity
sulfuryl fluoride[1]	Profume, Vikane, Zythor	Fum	Dow AgroSciences, Ensystex II	100
tebuconazole	various	F	various	4,000
tebufenozide	Confirm, Mimic	I	Gowan, Valent	> 5,000
tebupirionfos[1]	see phostebupirim[1]	—	—	—
tebuthiuron	Spike, various	H	Dow AgroSciences, various	579
tefluthrin[1]	Force, Precept	I/Mi	Monsanto, Syngenta	20-35
tembotrione	Laudis	H	Bayer	> 2,000
temephos	Abate	I	Clarke	8,600-13,000
terbacil	Sinbar	H	Tessenderlo Kerley	> 5,000
terbufos[1]	Counter	I	Amvac	1.6
tetrachlorvinphos	Rabon	I/Mi	Bayer, various	4,000-5,000
tetraconazole	Domark, Mazinga	F	Isagro, Sipcam Agro	1,248
tetramethrin	various	I	various	4,640

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
thiabendazole	Mertect	F	Syngenta	3,810
thiacloprid	Calypso	I	Bayer	621
thiamethoxam	Actara, various	I/Mi	Syngenta, various	1,563
thiencarbazone-methyl	no stand-alone products	H	Bayer	> 2,000
thidiazuron	Ginstar, various	HA	Bayer, various	> 5,000
thifensulfuron-methyl	Harmony, various	H	DuPont, various	> 5,000
thiophanate methyl	3336, Spectro, Topsin	F	Cleary, various	7,500
thiram	Spotrete, various	F/Rep	Cleary, various	780
tolclofos-methyl	Rizolex	F	Valent	5,000
tolfenpyrad	Apta, Hachi-Hachi, Torac	I	Nichino, Sepro	260-386
topramezone	Armezon, Frequency, Impact, Pylex	H	Amvac, BASF	> 2,000
triadimefon	Bayleton, various	F	Bayer, various	317-568
triadimenol	Baytan	F	Bayer	700-1,200
tribenuron-methyl	Express	H	DuPont	> 5,000
tribuphos (tribufos)	DFT 6, Folex 6, Vestage	HA	Amvac, Loveland, Red Eagle	250
trichlorfon	Dylox	I	Bayer	560-630
Trichoderma harzianum	Rootshield, Turfshield	F	Bioworks	low toxicity
triclopyr	Garlon, various	H	Dow AgroSciences, various	713
trifloxystrobin	Compass, Flint, Gem	F	Bayer, OHP	> 4,000
trifloxysulfuron-sodium	Envoke, Monument	H	Syngenta	> 5,000
triflumizole	Procure, Terraguard, Viticure	F	Chemtura	2,230
trifluralin	Preen, Treflan, various	H	Dow AgroSciences, various	> 10,000
trinexapac-ethyl	Primo, various	PGR	Syngenta, various	> 5,000
triticonazole	Trinity	F	BASF	> 5,000
uniconazole	Concise, Sumagic	PGR	Fine, Valent	2,020
vinclozolin	Curalan, Touche	F	BASF	> 10,000
warfarin	Rodex	R	Bell, Hacco, various	186
zinc phosphide[1]	various	R	Bell, Hacco, various	45.7
ziram	Ziram	F	United Phosphorus, Taminco	1,400
zoxamide	Gavel, Zing, Zoxium	F	Gowan	> 5,000

Protecting Honey Bees

Troy Anderson, Assistant Professor of Insect Toxicology, Virginia Tech

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

Causes of Honey Bee Poisoning

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

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

Ways to Reduce Honey Bee Poisoning

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

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

Group I. Highly Toxic

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

Abamectin

Acetamiprid, Assail, Tristar

Acramite (bifenazate)

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

Acephate

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

Advantage

Ambush (permethrin)

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

Apollo, Ovation (clofentezine)

Asana (esfenvalerate)

Avaunt (Advion) (indoxacarb)

Avid (avermectin)

Azodrin (monocrotophos)

Baygon (propoxur)

Baytex (fenthion)

Baythroid (cyfluthrin)

Bidrin (dicrotophos)

Capture, Annex, Brigade (bifenthrin)

Carzol

Cidial (phenthoate)

Clutch (clothianidin)

Commodore (lambda-cyhalothrin)

Comply (fenoxycarb)

Curacron (profenofos)

Cygon (dimethoate)

Cymbush

Danitol (fenopropathin)

Dasanit (fensulfothion)

DDVP (dichlorvos)

Decis (decamethrin)

Delegate, Radiant (spinetoram)

Denim (emamectin benzoate)

Dibrom (naled)

De-fend, Dimate (dimethoate)

Diazinon (spectracide)

Dimecron (phosphamidon)

Dinotefuran

Dursban, Eradex (chlorpyrifos)

Ectrin (fenvalerate)

Endigo

Envidor (spirodiclofen)

EPN

Ethyl guthion (azinphos-ethyl)

Famphos (famphur)

Ficam (bendiocarb)

Flagship (thiamethoxam)

Folimat

Fipronil

Furadan F (carbofuran)

Fury (zeta-cypermethrin)

Guard Star (permethrin)[1]

Guthion (azinphos-methyl)

Imidan (phosmet)

Karate

Lannate D (methomyl)

Lindane

Lorsban (chlorphyrifos)

Malathion

Matacil (aminocarb)

Mesurol (methiocarb

Monitor (methamidophos)

Nexter (pyridaben)

Nudrin (methomyl)

Orthene (acephate)

Parathion

Pay Off (flucythrinate)

Phosphamidon

Pirimiphos-methyl (Execute, Actellic)

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

Pounce (permethrin)

Prallethrin

Proaxis (gamma-cyhalothrin)

Proclaim (emamectin)

Provado (imidacloprid)

Pydrin (fenvalerate 0.1 lb/A)[2]

Pylon, Phantom (chlorfenapyr)

Pyramite

Rebelate (dimethoate)

Resmethrin

Scout (tralomethrin)

Sevin (carbaryl)[3]

Sniper

Spectracide

Steward (indoxacarb)

Sumithion (fenitrothion)

Supracide (methidathion)

Swat (bonyl)

Synthrin (resmethrin)

Talstar

Tameron (methamidophos)

Tefluthrin (Force)

Temik (aldicarb)

TEPP

Tralomethrin (Saga)

Trimax

Vapona (dichlorvos)

Venom (dinotefuran)

Warrior (lambda-cyhalothrin)

Zectran (mexacarbate)

Zephyr (Agri-Mek) (abamectin)

Zeta-cypermethrin

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

Group II. Moderately Toxic

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

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

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

Group III. Relatively Nontoxic

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

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

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

Fungicides

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

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

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

Herbicides, Defoliants and Desiccants

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

[1] Slightly toxic to honey bees

Insect Control in Field Crops

Curt Laub, Research Associate, Virginia Tech

Note: before applying any insecticide to a crop, make sure that a definite insect problem exists. If you are unable to make this determination, contact your local county Extension agent for advice or assistance. Use pesticides only when necessary.

Grain Crops, Soybeans, Forages

Cultural Control Methods

Although the recommendations in this publication deal primarily with chemical control, the use of insecticides on field crops should be considered supplementary to insect control by cultural methods. In many instances, growers who follow accepted cultural practices can expect little trouble from insect pests. This is especially true in the case of insects attacking conventionally tilled field corn.

Some of the most beneficial cultural methods for problem insects affecting field crops are plowing, fertilization, and crop rotation. Deep and clean plowing in the spring destroys insects in the soil (corn earworms and root aphids) and in dead stalks (European corn borer), as well as those feeding on winter weeds and clover (root webworms and cutworms). Proper fertilization gives corn and other field crops the ability to outgrow insect attacks. Rotating corn prevents trouble with corn root aphids and corn rootworms.

In addition to cultural methods, there are field crop varieties on the market that are resistant to certain insects. For example, some of the field corn varieties show resistance to corn leaf aphids and at least two of the varieties of wheat recommended in Maryland are resistant to Hessian fly.

Alfalfa Weevil

There are two cultural control tactics that can be utilized to reduce alfalfa weevil damage. In the late fall, remove the alfalfa for hay or by grazing. This removes the overwintering egg-laying sites for the adult weevils, and will help reduce the number of alfalfa weevil larvae attacking the crop the following spring. Early harvest can sometimes be used in the spring instead of insecticide sprays, if the crop has obtained sufficient growth before larval feeding damage becomes severe.

Potato Leafhopper

Spring-planting alfalfa with a companion crop of oats will help prevent soil erosion, and also reduce potato leafhopper infestations in the first summer cutting of alfalfa.

True Armyworm

In no-till corn planted into winter rye cover crop, research at Virginia Tech has shown that rotary mowing of the rye cover crop after it has initiated seed heads will not only kill the cover crop, but also will dramatically reduce the number of armyworm larvae early in the growing season when the corn is susceptible to damage from armyworm feeding. If mowing is to be used to kill the winter cover crop, corn planting should follow as soon as possible after mowing to facilitate coulter penetration of the rye mulch.

Northern and Western Corn Rootworms

Rotating corn with any other crop [except for squash, pumpkin, etc. (Cucurbitaceae)] for one year will control corn rootworms, since the eggs of these pests are laid in corn fields during the summer.

Note: Any insecticide applied to a crop in bloom will kill honey bees and other pollinating insects. The magnitude of bee loss can be lessened considerably by spraying in late afternoon or evening.

Table 4.1 - Chemical Class, Oral LD_{50}, Worker Re-entry Time, and Toxicity of Some of the Insecticides Recommended in this Publication

		Toxicity to Mammals				Worker re-entry time in days	Toxicity[3] to		
Insecticides	**Trade name**	**Chemical class[1]**	**Oral LD_{50}[2]**	**Acute oral**	**Acute dermal**		**Birds**	**Fish**	**Bees**
Acephate	Orthene	OP	361	Moderate	Moderate	*	Moderate	Low	NA
Bacillus thuringiensis	Dipel, Thuricide	LO	—	Very low	Very low	*	Very low	Very low	Very low
Carbaryl	Sevin	C	500	Low	Low	*	Low	Very low	High
Chlorpyrifos	Dursban, Lorsban	OP	163	Moderate	Moderate	*	Moderate	NA	NA
Diazinon	Diazinon	OP	76	Moderate	Moderate	*	Moderate	High	High
Dimethoate	Dimethoate	OP	215	Moderate	Moderate	*	Moderate	Low	High
Disulfoton	Di-Syston	OP	2	High	High	*	Moderate	NA	Moderate
Ethion		OP	70	Moderate	Moderate	1	High	High	Low
Ethoprop	Mocap	OP	62	High	High	*	Moderate	NA	NA
Fenvalerate	Pydrin	P	450	Moderate	Low	*	NA	High	High
Malathion		OP	1,000	Low	Low	*	Low	High	High
Methidathion	Supracide	OP	25-65	High	Moderate	*	NA	NA	NA
Methiocarb	Mesurol	C	130	Moderate	Low	*	High	High	High
Methomyl	Lannate, Nudrin	C	17	High	Moderate	*	Low	NA	NA
Microencapsulated methyl parathion	Penncap-M	OP	270	Low	Low	*	High	High	High
Permethrin	Ambush, Pounce	P	4,000	Low	Low	*	NA	High	High
Phorate	Thimet	OP	1	High	High	*	Moderate	NA	Moderate
Phosmet	Imidan	OP	147	Moderate	Low	*	Moderate	NA	NA
Terbufos	Counter	OP	4	High	High	*	High	High	NA
Thiodicarb	Larvin	C	66	Moderate	Low	*	NA	NA	Moderate

*Worker cannot enter a treated field without protective clothing until the spray has dried or the dust has settled.
[1]C = carbamate; CH = chlorinated hydrocarbon; LO = living organism; OP = organophosphate; P = pyrethroid.
[2]Based on technical product.
[3]NA = Not available

Table 4.2 - Restricted and General-use Pesticides

Insecticide	Restricted (R)[1] or general (G) use	Insecticide	Restricted (R)[1] or general (G) use
Acephate	G	Malathion	G
Azinphosmethyl	R 3	Methidathion	R 6
Bacillus thuringiensis	G	Methiocarb	G
Carbaryl	G	Methomyl	R 4, 8
Chlorpyrifos	G	(microencapsulated)	R 2, 4, 6, 8
Diazinon	G	Monocrotophos	R 6, 8
Dimethoate	G	Parathion	R 2, 3, 6, 7, 8
Disulfoton	R 2, 3	Permethrin	R 7
Ethion	G	Phorate	R 2, 6, 8
Ethoprop	R 2	Phosmet	G
Fenvalerate	R 7	Thiodicarb	G

[1]Reasons for restrictions are as follows: R 1 = acute oral toxicity; R 2 = acute dermal toxicity; R 3 = acute inhalation toxicity; R 4 = accident history; R 5 = possible oncogenicity; R 6 = effects on birds; R 7 = effects on fish or other aquatic life; and R 8 = effects on terrestrial wildlife.

Forages: Alfalfa and Other Legumes

Curt Laub, Research Associate, Virginia Tech

Alfalfa Weevil

Sampling to Determine Whether Control Measures Are Needed

When the alfalfa starts growing in the spring, walk through the field at least once a week and closely inspect alfalfa tips for feeding injury. When damage and weevil larvae are observed, systematic sampling should be conducted (using the procedure described below) at least once weekly (or more frequently if weevil populations are approaching the action threshold) until the fields are sprayed, harvested, or the weevil season is over. If you are required to spray early and you use a short-residual insecticide, wait 2 to 3 weeks after spraying and resume the sampling program.

Equipment needed to sample a field includes a 3- to 5-gallon bucket, a shallow dishpan, a clipboard with pencil and paper, and tape measure or folding rule. Mentally divide the field into 6 equal sections and walk to the approximate center of the first section. Randomly pull 10 entire stems and place them, tip end first, into the bucket. Be careful to hold the bucket under each stem tip as it is pulled to catch any weevil larvae that may fall off. When the ten stems are collected, grasp them firmly by the base and shake them vigorously against the sides of the bucket for 5 to 10 seconds. As you are shaking the stems, hold the clipboard over the top of the bucket to prevent larvae from being thrown out. Pour the contents of the bucket into the shallow dishpan and count the total number of all weevil larvae.

Randomly select two of the stems from your sample and measure their lengths. Record the number of larvae and the two stem lengths on your clipboard. Walk to the approximate center of the other 5 sections of field and repeat the sampling procedure. Note: in a fairly large field (greater than 20 acres) you may wish to take a few extra samples to improve your sampling accuracy. When you have finished the field, total the larvae and stem lengths for all six sample sites. Determine the average number of larvae/stem by dividing the total by 60 (10 stems at 6 sites) and the average stem length by dividing by 12. Then refer to the decision-making chart, Fig. 4.1. Plot your average number of larvae/stem against stem height. If the point falls near or above the economic threshold line, either harvest or treat the field with a short-residual insecticide. If the point falls below the threshold line, no control measures are recommended; sample again in 5 to 7 days. More frequent sampling may be desired if population levels are approaching the threshold and daily temperatures are above 70° F. **Note: these thresholds are intended for alfalfa growing under adequate fertility and soil moisture conditions. Under drought stress conditions, when alfalfa is growing slowly, the threshold should be lowered by about 0.5 weevil per stem.**

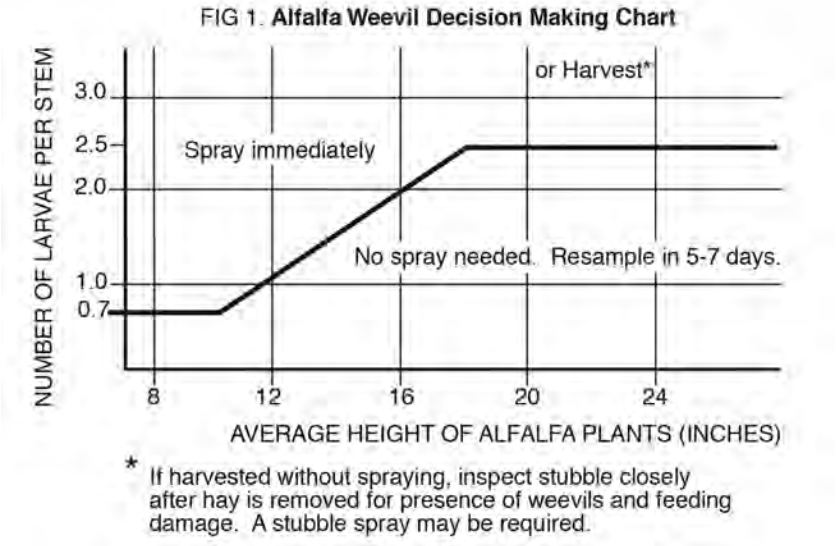


Fig. 4.1. Decision-making chart for determining the need to apply insecticides for alfalfa weevil control.

Spray or Harvest for Weevil Control?

In weevil control zone A, roughly east of the Blue Ridge Parkway, (Fig. 4.2), good survival of overwintering weevil eggs and warm temperatures often result in early larval hatch, causing damage when alfalfa is less than 6 inches tall. Population surveys should be initiated early. If 50 percent of the tips have been damaged and the alfalfa is less than 6 inches tall, spray as soon as possible. In zones B and C, however, the need to control alfalfa weevil varies from year to year, and field sampling should be conducted to determine population levels. Harvesting often can be used as an effective weevil control tactic, if enough growth is present to justify the harvesting process. Yield sacrificed in the first cutting by early harvest will be compensated in 2nd and subsequent cuttings. Cutting alfalfa early assures high quality hay with high protein and TDN, and reduces chance of losing hay to rainy weather later in the season. Early cutting also gives the second growth of alfalfa a head start before the potato leafhopper adults appear in early June. The decision to cut or spray should be based on favorable hay-making weather and time scheduling with other farm operations. If hay is cut before the bud stage in the first cutting, second and subsequent cuttings should be allowed to reach 0.10 bloom before cutting to insure adequate storage of root carbohydrates. Alfalfa may be harvested early only once during the growing season without reducing stand density or longevity.

Determining the Need for Stubble Sprays

If insecticide sprays are used prior to harvest of the first cutting, stubble sprays are seldom necessary. However, if no sprays have been used, or if the field has been cut early because of a heavy weevil infestation, stubble sprays **may** be necessary. Within a week after the hay has been removed from the field, closely inspect the growing shoots of the alfalfa for the presence of larvae or signs of feeding. No formal sampling plan or economic thresholds are available for this crop stage, but, generally, if weevil larvae are easily found, shoot damage is occurring, or regrowth appears delayed, a stubble spray should be applied. Adult weevils can occasionally cause severe damage to regrowth, but because the adult weevils usually hide under the alfalfa crown during the day, they are not easily seen.

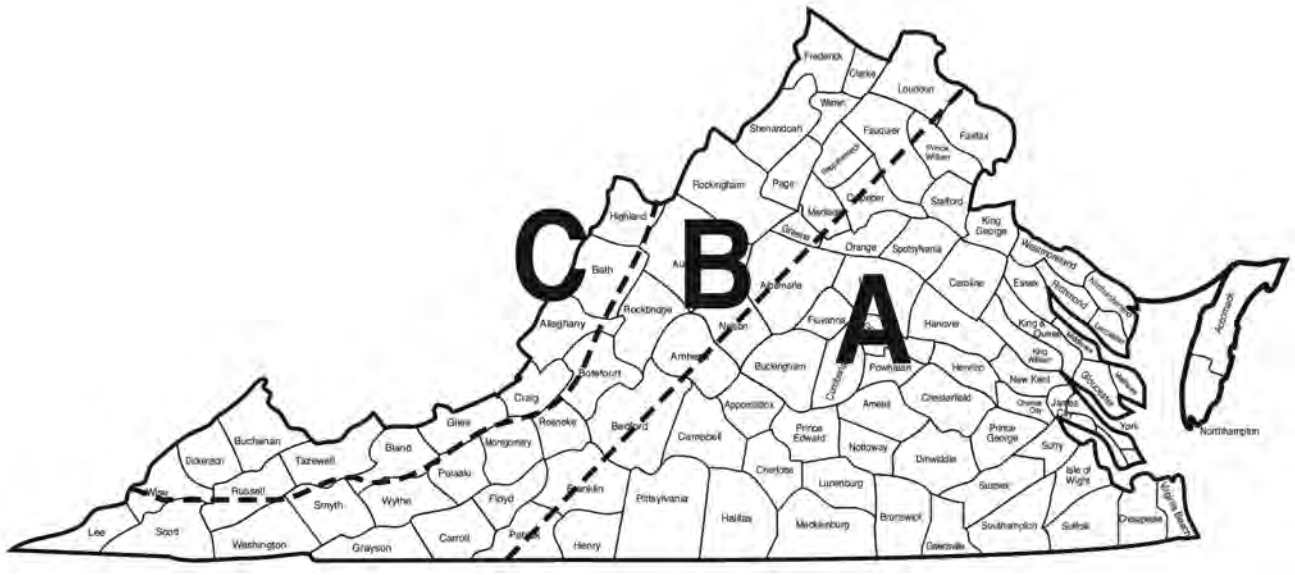


Fig. 4.2. Alfalfa Weevil Control Zones

The dividing line between Zone A and Zone B is roughly the Blue Ridge Parkway.

The line dividing Zone B and Zone C roughly follows the county lines.

Table 4.3 - Recommended Insecticides for Control of Alfalfa Weevil

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	1.6-2.8 oz	hay harvest: 7 grazing: 7	**RESTRICTED USE.** Maximum product allowed per cutting is 5.6 oz/A. Maximum product allowed per crop season is 22.4 oz/A.
chlorpyrifos (Lorsban 4E)	0.5-1 lb	1.0-2.0 pt	1 pt: 14 > 1 pt: 21	Some temporary yellowing may occur after application, but this will disappear within a week and not cause yield loss. Do not apply if nearby bees are clustered outside of hives and bees are foraging in the area to be treated. Do not apply more than 4 times/year or more than once/cutting.
chlorpyrifos, zeta-cypermethrin (Stallion [3.03 lb AI/ gal prod])	—	9.25-11.75 oz	7 cutting, grazing, or harvesting seed	**RESTRICTED USE.** Do not make applications of Stallion or other products containing chlorpyrifos <10 days apart. Maximum 32.5 oz product/A/season. Product is highly toxic to bees if exposed to direct application to alfalfa.
indoxacarb (Steward EC)	0.065-0.11 lb	6.7-11.3 oz	7	Apply no more than once per cutting. A total of 45 oz/A may be applied/season.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	forage harvest: 1 hay harvest: 7	**RESTRICTED USE.** Apply as required by scouting. **Ground application**: use 10 to 20 gal water/A. **Aerial application:** use 2 to 10 gal water/A. Apply in sufficient water for full coverage. Do not apply >0.12 pt/A/cutting. Do not apply >0.48 pt/A/ season.
methomyl (Lannate LV 2.4)	0.9 lb	3.0 pt	7	**RESTRICTED USE.** 48 hour re-entry interval. Also labeled for beet armyworm.
phosmet (Imidan 70-W)	1.0 lb	1-1.3 lb	7	**RESTRICTED USE.** Follow safety precautions on label. Do not apply more than once/cutting. Five day restricted entry interval.
permethrin (Pounce 25WP) (Ambush 25WP)	 0.1-0.2 lb 0.1-0.2 lb	 6.4-12-8 oz 6.4-12.8 oz	 ≤ 0.1 lb AI/A: 0 > 0.1 lb AI/A: 14	**RESTRICTED USE.** Do not apply more than 0.2 lb AI/A per cutting. When honey bees are foraging, apply during early morning or evening.
zeta-cypermethrin (Mustang Max)	0.014-0.025 lb	2.24-4.0 oz	cutting/grazing: 3 seed harvest: 7	**RESTRICTED USE.** Minimum 7 days between applications. Maximum 0.025 lb AI/cutting. Maximum 0.075 lb AI/season.

Note: to avoid injury to honey bees, do not apply insecticides during bloom.

Potato Leafhopper

Sampling Methods and Action Thresholds

Although several natural enemies prey upon potato leafhoppers in alfalfa, damaging levels of leafhopper are often reached, requiring insecticide application or harvest management. Leafhopper infestations are highly variable from field to field and from year to year; therefore, monitoring of individual fields is required for effective pest management decision-making. Leafhoppers are most easily sampled using a standard 15-inch diameter sweep net. At each of 6 randomly selected sites in a field, take 10 pendular sweeps with the net (swinging it back and forth in front of you) as you walk. One sweep equals one stroke of the net. After the last sweep, quickly grab the net to prevent insects from escaping. Carefully unfold the net, working your way toward the bottom. Count the number of leafhopper adults and nymphs as they emerge and leafhoppers in the bottom of the net. In fields with high leafhopper infestations, many leafhopper nymphs can be seen on the top and edge of the sweep net before the net is opened to examine the contents. Include these in your count. At each sample site, also measure and record the lengths of two randomly selected stems.

Record the total number of leafhoppers for all 6 sites and divide by 60 to determine the number of leafhoppers per sweep. Divide the total stem length by 12 to estimate average stem length. Then go to the Decision Making Chart shown in Fig. 4.3.

Using the Decision Making Chart

(Fig. 4.3) From the average number of leafhoppers per sweep and the average height of the plants, draw horizontal and vertical lines until they intersect. If the intersection point is above the treatment line, spray or harvest (see below) as soon as possible; if the intersection falls below the line, resample in 5 to 7 days. As can be seen from this chart, the economic threshold is variable, depending on plant height.

For example, if you collected 30 leafhoppers in 60 sweeps for an average of 0.5 leafhoppers per sweep, and your average plant height was 4 inches, spraying would be indicated by the chart. If your average plant height was 12 inches for the same leafhopper count, no spray would be indicated. Keep in mind that this decision-making chart is intended for general use, and individual fields may vary considerably in plant response to the leafhopper feeding depending on soil moisture, fertility, and cultivar.

Spray or Harvest?

Alfalfa should be harvested whenever the crop is in 10 percent or more flower regardless of leafhopper levels. Insecticidal control is most effective if applied early in the crop's growth (assuming leafhopper densities are above the economic threshold), since the spray will protect the alfalfa during the most susceptible stage of growth. As the alfalfa grows in height, the economic return on investment for insecticidal control is reduced but can still be justified if damaging population levels are present. Beyond a crop height of 14 inches, the value of insecticidal control becomes marginal, since considerable clogging of the plant's vascular tissue will have already occurred.

If plants are greater than 14 inches tall and leafhopper numbers are above the treatment threshold (see Decision-Making Chart), two management options are recommended. If the leafhopper count is above the treatment line but less than 2.3 per sweep, and the crop is showing 80 percent or more bud and less than 10 percent flower, harvest as soon as weather conditions are favorable. If the crop is not yet flowering, wait 7 to 10 days, then harvest. If the leafhopper count is greater than 2.3 per sweep, harvest as soon as the alfalfa shows 25 percent bud. Harvest as soon as possible if considerable damage has already occurred.

Harvesting will remove the damaged stems and allow new growth to begin. Newly-planted fields established in the spring are often so severely stunted by potato leafhoppers that harvesting would not produce a significant amount of hay. The crop should still be clipped to remove weeds and the damaged plants.

Determining the Need for Stubble Sprays

Harvesting alfalfa has been shown to kill most potato leafhopper nymphs and many adults. The adults are highly mobile and most adult leafhoppers surviving harvest will leave the field. Even though high numbers of leafhoppers may be present in the field prior to cutting, stubble sprays are not necessarily needed to protect the next cutting. Ideally, the alfalfa should be sampled with a sweep net (as described above) about a week after harvest, or as soon as the alfalfa starts to grow back. If leafhoppers are present at levels greater than 0.4/sweep, spraying is recommended. If sampling the regrowth is not feasible, and high numbers of leafhoppers were present before harvest, a stubble spray on the regrowth may be a good protective measure, especially if green alfalfa was left in the field following harvest. For best results, wait about 5 to 7 days after harvest, or until 4 to 6 inches of new growth has appeared.

Table 4.4 - Recommended Insecticides for Control of Potato Leafhopper

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0065-0.0125 lb	0.8-1.6 oz	hay harvest: 7 grazing: 7	**RESTRICTED USE.** Maximum product allowed per cutting is 5.6 oz/A. Maximum product allowed per crop season is 22.4 oz/A.
dimethoate (Dimethoate 4EC)	0.25-0.5 lb	0.5-1.0 pt	10	Dimethoate also will control aphids and grasshoppers. Make only one application/ cutting.
carbaryl (Sevin 80 Solpak) (Sevin 4F)	 1.0 lb 1.0 lb	 1.25 lb 2.0 pt	 7 7	Highly toxic to bees; avoid spraying weeds in bloom or alfalfa beyond 10 percent bloom.
chlorpyrifos (Lorsban 4E)	0.25-0.5 lb	0.5-1.0 pt	0.5 pt: 7 1 pt: 14	Some temporary yellowing may occur after application, but this will disappear within a week and not cause yield loss. Do not apply if nearby bees are clustered outside of hives and bees are foraging in the area to be treated. Do not apply more than 4 times/ year or more than once/cutting.
chlorpyrifos, zeta-cypermethrin (Stallion [3.03 lb AI/ gal prod])	—	5.0-11.75 oz	7 cutting, grazing, or harvesting seed	**RESTRICTED USE.** Do not make applications of Stallion or other products containing chlorpyrifos <10 days apart. Maximum 32.5 oz product/A/season. Product is highly toxic to bees if exposed to direct application to alfalfa.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.015-0.025 lb	0.96-1.60 oz	forage harvest: 1 hay harvest: 7	**RESTRICTED USE.** Apply as required by scouting. **Ground application**: use 10 to 20 gal water/A. **Aerial application**: use 2 to 10 gal water/A. Apply in sufficient water for full coverage. Do not apply >0.12 pt/A/cutting. Do not apply >0.48 pt/A/season.
phosmet (Imidan 70-W)	1.0 lb	1-1.3 lb	7	Follow safety precautions on label. Do not apply more than once/cutting. Five day restricted entry interval.
permethrin (Pounce 25WP) (Ambush 25WP)	 0.1-0.2 lb 0.05-0.2 lb	 6.4-12.8 oz 3.2-12.8 oz	 ≤0.1 lb AI/A: 0 >0.1 lb AI/A: 14	**RESTRICTED USE.** Do not apply more than 0.2 lb AI/A/ cutting. When honey bees are foraging, apply during early morning or evening.
zeta-cypermethrin (Mustang Max)	0.014-0.025 lb	2.24-4.0 oz	cutting/grazing: 3 seed harvest: 7	**RESTRICTED USE.** Minimum 7 days between applications. Maximum 0.025 lb AI/cutting. Maximum 0.075 lb AI/season.

Note: do not wait until yellowing occurs. Materials should be used as a preventative treatment after leafhoppers first appear.

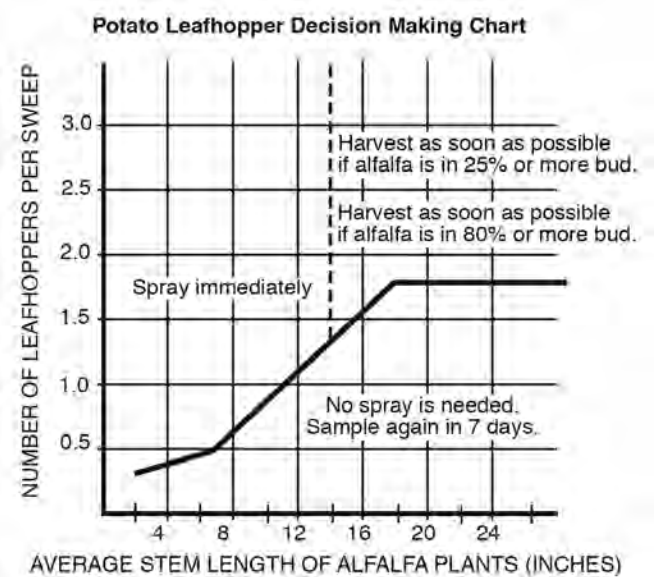


Fig. 4.3. Decision-making chart for determining the need to apply insecticides for potato leafhopper control.

Grasshopper

Table 4.5 - Grasshopper

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0155-0.022 lb	2.0-2.8 oz	hay harvest: 7 grazing: 7	**RESTRICTED USE.** Maximum product allowed per cutting is 5.6 oz/A. Maximum product allowed per crop season is 22.4 oz/A.
carbaryl (Sevin 80 Slopak) (Sevin 4F)	0.5-1.5 lb 0.5-1.5 lb	0.67-1.875 lb 0.5-1.5 qt	7	Grasshoppers usually cause problems only during drought and in new fall seedlings. Use the lower rate for nymphs on small plants or sparse vegetation. Use the higher rate for adults or applications to dense vegetation.
chlorpyrifos, zeta-cypermethrin (Stallion [3.03 lb AI/ gal prod])	—	9.25-11.75 oz	7 cutting, grazing, or harvesting seed	**RESTRICTED USE.** Do not make applications of Stallion or other products containing chlorpyrifos <10 days apart. Maximum 32.5 oz product/A/season. Product is highly toxic to bees if exposed to direct application to alfalfa.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	forage harvest: 1 hay harvest: 7	**RESTRICTED USE.** Apply as required by scouting. **Ground application**: use 10 to 20 gal water/A. **Aerial application:** use 2 to 10 gal water/A. Apply in sufficient water for full coverage. Do not apply >0.12 pt/A/cutting. Do not apply >0.48 pt/A/season.
malathion (Malathion 5EC, Malathion 57EC)	1.0-1.5 lb	1.5-2.0 pt	0	Spray may be applied by air or ground equipment. **Dilute application**: use 20 to 60 gal water/A. **Concentrate application**: use ≥5 gal water/A.
zeta-cypermethrin (Mustang Max)	0.017-0.025 lb	2.8-4.0 oz	cutting/grazing: 3 seed harvest: 7	**RESTRICTED USE.** Minimum 7 days between applications. Maximum 0.025 lb AI/cutting. Maximum 0.075 lb AI/season.

Armyworm, Cutworm

Table 4.6 - Armyworm (AW), Cutworm (CW)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	AW 0.0125-0.022 lb CW 0.0065-0.0125 lb	1.6-2.8 oz 0.8-1.6 oz	hay harvest: 7 grazing: 7	**RESTRICTED USE.** Maximum product allowed per cutting is 5.6 oz/A. Maximum product allowed per crop season is 22.4 oz/A. Effective against small armyworm larvae up to 2nd instar.
carbaryl (Sevin 80 Solpak) (Sevin 4F)	1.0-1.5 lb 1.0-1.5 lb	1.25-1.875 lb 1.0-1.5 qt	7 7	Apply when insects begin to cause injury. A 5% Sevin bait at 20 lb/A also is effective against cutworms.
chlorpyrifos, zeta-cypermethrin (Stallion [3.03 lb AI/gal prod])	—	AW 9.25-11.75 oz CW 2.5-11.75 oz	7 cutting, grazing, or harvesting seed	**RESTRICTED USE.** Do not make applications of Stallion or other products containing chlorpyrifos <10 days apart. Maximum 32.5 oz product/A/season. Product is highly toxic to bees if exposed to direct application to alfalfa.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC]) armyworm use: cutworm use:	 0.02-0.03 lb 0.015-0.025 lb	 1.28-1.92 oz 0.96-1.60 oz	 forage harvest: 1 hay harvest: 7	**RESTRICTED USE**. Apply as required by scouting. **Ground application**: use 10 to 20 gal water/A. **Aerial application**: use 2 to 10 gal water/A. Apply in sufficient water for full coverage. Do not apply >0.12 pt/A/cutting. Do not apply >0.48 pt/A/season.
permethrin (Pounce 25WP) (Ambush 25WP)	 0.05-0.2 lb 0.05-0.2 lb	 3.2-12.8 oz 3.2-12.8 oz	 ≤0.1 lb AI/A: 0 >0.1 lb AI/A: 14	**RESTRICTED USE.** Do not apply more than 0.2 lb AI/A/cutting. When honey bees are foraging, apply during early morning or evening.
methomyl (Lannate LV) (Lannate SP)	0.225 - 0.9 lb	AW 1.5-3.0 pt CW 0.75-3.0 lb AW 0.5-1.0 pt CW 0.25-2.0 pt	7	**RESTRICTED USE.** Do not apply to dormant or semi- dormant alfalfa when minimum daily temp. is ≤50°F. Wait 7 days after application before grazing or feeding livestock.
zeta-cypermethrin (Mustang Max)	0.014-0.025 lb	AW 2.8-4.0 oz CW 2.24-4.0 oz	cutting/grazing: 3 seed harvest: 7	**RESTRICTED USE.** Minimum 7 days between applications. Maximum 0.025 lb AI/cutting. Maximum 0.075 lb AI/season.

Pea Aphid

Sampling/Decision Making

The need to treat for pea aphids is rare (1 year in 10) in Virginia, Maryland, and Delaware because lady bird beetles, wasp parasites, and other beneficial insects usually control this pest. The best sampling technique requires the same 15-inch sweep net used for potato leafhoppers. Ten sweeps at 10 random locations should be used to sample both the aphids and beneficials. If 50 or more aphids per sweep are collected and no beneficials are present, it is recommended that the field be cut early. Avoid spraying first crop because sprays will kill alfalfa weevil parasites.

Table 4.7 - Recommended Insecticides for Controlling Pea Aphids

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.022 lb	2.8 oz	hay harvest: 7 grazing: 7	**RESTRICTED USE.** Maximum product allowed per cutting is 5.6 oz/A. Maximum product allowed per crop season is 22.4 oz/A.
chlorpyrifos, zeta-cypermethrin (Stallion [3.03 lb AI/ gal prod])	—	9.25-11.75 oz	7 cutting, grazing, or harvesting seed	**RESTRICTED USE.** Do not make applications of Stallion or other products containing chlorpyrifos <10 days apart. Maximum 32.5 oz product/A/season. Product is highly toxic to bees if exposed to direct application to alfalfa.
dimethoate (Dimethoate 4EC)	0.25-0.5 lb	0.5-1.0 pt	10	Make only one application/ cutting.
malathion (Malathion 5EC) (Malathion 57EC)	1.0-1.5 lb	1.5-2.0 pt	0	**RESTRICTED USE.** Warm weather favors parasites and predators of aphids; thus control may not be required if the weather forecast predicts a warm trend. Spray may be applied by air or ground equipment. **Dilute application**: use 20 to 60 gal water/A. **Concentrate application**: use ≥5 gal water/A.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	forage harvest: 1 hay harvest: 7	**RESTRICTED USE.** Apply as required by scouting. **Ground application**: use 10 to 20 gal water/A. **Aerial application**: use 2 to 10 gal water/A. Apply in sufficient water for full coverage. Do not apply >0.12 pt/A/cutting. Do not apply >0.48 pt/A/season.
methomyl (Lannate LV) (Lannate SP)	0.45 - 0.9 lb	 1.5-3.0 pt 0.5-1.0 pt	7	**RESTRICTED USE.** Do not apply to dormant or semi- dormant alfalfa when minimum daily temp. is ≤50°F. Wait 7 days after application before grazing or feeding livestock.
permethrin (Pounce 25WP) (Ambush 25WP)	 0.05-0.2 lb 0.05-0.2 lb	 3.2-12.8 oz 3.2-12.8 oz	 ≤0.1 lb AI/A: 0 >0.1 lb AI/A: 14	**RESTRICTED USE.** Do not apply more than 0.2 lb AI/A per cutting. When honey bees are foraging, apply during early morning or evening. When pea aphid densities are heavy, use maximum rate. A second application may be necessary if pest densities remain above the economic threshold.
zeta-cypermethrin (Mustang Max)	0.014-0.025 lb	2.24-4.0 oz	cutting/grazing: 3 seed harvest: 7	**RESTRICTED USE.** Minimum 7 days between applications. Maximum 0.025 lb AI/cutting. Maximum 0.075 lb AI/season.

Orchardgrass, Timothy, and Bermudagrass

Curt Laub, Research Associate, Virginia Tech

The immature stage of white grubs (i.e., Japanese beetle grubs and other related species) and billbug grubs (i.e., bluegrass billbug, hunting billbug, etc.) are the most important root-feeding pests on orchardgrass hay in Virginia. With the exception of Karate and Warrior (billbug supression), none of the insecticides labeled for orchardgrass hay include these insects on their labels. The products listed below target surface feeders and insects found in the thatch layer. Ongoing research in Virginia is working to address this problem for billbugs. Recent research conducted in Virginia showed that conspicious "paired" feeding-holes on young orchardgrass leaves in April indicate the presence of billbugs moving into fields. More importantly, these paired feeding holes, which are found within the first 15-20 feet of a field's border, begin showing up at about the same time or several days earlier than the first billbug adults are found in pitfall traps. **Be sure your crop is listed on the product label before you spray.**

Table 4.8 - Orchardgrass Hay

Pests	Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
armyworms, cutworms, army cutworm, cereal leaf beetle, green cloverworm, meadow spittlebug	beta-cyfluthrin (Baythroid XL)	0.0125-0.015 lb	1.6-1.9 oz	grass for pasture, rangeland and seed: 0 grazing grass for hay: 0 harvest grass in mixed stands with alfalfa: 7 harvest 7 grazing	**RESTRICTED USE.** For grass grown for hay, pasture, seed, or rangeland, the maximum Baythroid XL allowed per 5-day interval is 0.022 lb AI/A (2.8 oz/A). The maximum Baythroid XL allowed per crop season or cutting is 0.089 lb AI/A (11.3 oz/A) For grass in mixed stands with alfalfa, the maximum Baythroid XL allowed per cutting is 0.022 lb AI/A (2.8 oz/A). The maximum Baythroid XL allowed per crop season is 0.089 lb AI/A (11.3 oz/A). Check label for additional details.
fall armyworm (1st & 2nd instar) yellowstriped armyworm (1st & 2nd instar) Lygus bug, stink bugs, leafhoppers, Japanese beetle (adult), June beetle (adult), grasshoppers, grass thrips, tarnished plant bug (refer to label for additional pests)	beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	2.6-2.8 oz		
armyworm, fall armyworm, striped grass looper, chinch bugs, thrips, range caterpillar, range crane fly, essex skipper, ticks	carbaryl (Sevin XLR Plus and Sevin SL)	1.0-1.5 lb	1.0-1.5 qt	14 harvest or grazing	**Caution.** Apply as needed by scouting. Up to 2 applications per year may be made but not more often than once every 14 days. Do not exceed a total of 3 qts/A/year.
	carbaryl (Sevin 80 Solpak)	1.0-1.5 lb	1.25-1.875 lb	14 harvest or grazing	**Caution.** Up to 2 applications per year may be made but not more often than once every 14 days. Do not exceed a total of 3.75 lbs product/A/year.

Table 4.8 - Orchardgrass Hay (cont.)

Pests	Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
army cutworm, cutworms, Essex skipper, range catepillar, striped grasslooper	lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.015-0.025 lb	0.96-1.6 oz	0 grazing 0 cut for forage 7 harvest after last application	**RESTRICTED USE.** Apply as required by scouting. Timing and frequency of applications should be based on locally determined economic thresholds. Use sufficient water for full coverage. Use ≥2 gal by air and ≥7 gal by ground.
billbug species (suppression only), beet armyworm, blue stem midge, cereal leaf beetle, chinch bug, crickets, true armyworm, yellowstriped armyworm, fall armyworm, English grain aphid, bird cherry-oat aphid, Russian wheat aphid, sugarcane aphid, greenbug [aphid] (for aphid species best control is obtained before insects begin to roll leaves), flea beetles, leafhoppers, spittlebugs, stink bugs, thrips, grasshoppers, green June beetle (adult), Japanese beetle (adult), webworms	lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz		Do not apply >0.03 lb AI (1.92 oz product)/A/cutting for pastures, rangeland, and grass grown for seed. A minimum retreatment interval of 30 days is required for pastures and rangeland receiving 0.03 lb AI/A which have not been cut between applications. Do not apply >0.09 lb AI (5.76 oz product)/A/season. Check label for further details.
armyworms, aphids, cereal leaf beetle, grasshoppers, leafhoppers	malathion (Malathion 5EC)	15.0-20.0 oz	1.5-2.0 pt	0 harvest or grazing	**Warning.** REI = 12 hours. Maximum 1 application per cutting

Table 4.8 - Orchardgrass Hay (cont.)

Pests	Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
cutworms, flea beetles, meadow spittlebug, potato leafhopper, webworms, blue alfalfa aphid, green peach aphid (Refer to label for additional pests.)	zeta-cypermethrin (Mustang Max)	0.014-0.025 lb	2.24-4.0 oz	0 forage or hay	**RESTRICTED USE.** Apply minimum 2 gal/A by air or 10 gal/A by ground. Use sufficient water to ensure thorough coverage of foliage. Applications ≥7 days apart for hay and forage. Maximum of 0.025 lb AI/A/ cutting. Maximum 0.10 lb AI/A/season.
armyworms, cereal leaf beetle, grasshoppers, plant bugs (including *Lygus* spp. and stinkbugs) (Refer to label for additonal pests.)	zeta-cypermethrin (Mustang Max)	0.0175-0.025 lb	2.8-4.0 oz	0 forage or hay	**RESTRICTED USE.** Apply minimum 2 gal/A by air or 10 gal/A by ground. Use sufficient water to ensure thorough coverage of foliage. Applications ≥7 days apart for hay and forage. Maximum of 0.025 lb AI/A/ cutting and Maximum 0.10 lb AI/A/ season.

Table 4.9 - Timothy Hay[1]

Pests	Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
cereal rust mite[2]	carbaryl (Sevin XLR Plus)	1.0-1.5 lb	1.0-1.5 qt	14 harvest or grazing	**Caution.** Apply with ground equipment only with adequate water for complete coverage (10-50 gal by ground). *Apply at approximately 4 weeks after green-up in the spring.* Treatment is recommended in fields with a previous history of cereal rust mite and/or when 25% of the plant tillers exhibit curled tips of the new leaf blades within several weeks of green-up. In general, one application at 1.0-1.5 qt/A should provide control. If needed, a second application can be made at least 14 days after the first application. A maximum of 2 applications/year may be made. Do not exceed a total of 3.0 qt/A/cutting.

[1] Note: The following recommendation for timothy hay is made as permitted under FIFRA Section 2(ee).

[2] The cereal rust mite, *Abacarus hystrix*, is a very small eriophyid mite (approximate length of an adult mite is 0.008 inch) that infests several grass species, with timothy being a preferred host. The deeply grooved timothy blades seem to be preferred over the smoother leaf blades of orchardgrass and other forage grasses. In Maryland, populations of more than 3,220 cereal rust mites per square inch (i.e., 500 mites per square cm) have been reported. Initial damage symptoms include lengthwise curling-up (or 'piping-up') of the leaf blade followed by the distal ends of the grass blades turning yellow then brown with the lower leaves drying out.

Cultural control option: Maryland research has shown that cereal rust mite may be controlled culturally by removing most of the aboveground growth immediately before or after the first fall frost. This action removes potential egg-laying sites.

Table 4.10 - Bermudagrass Pasture

Pests	Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
fall armyworm, armyworm, striped grass looper	methomyl (Lannate LV)	3.6-14.4 oz	0.75-3.0 pt	7 grazing 3 cutting for hay	**RESTRICTED USE.** **(Danger Poison)** 48 hour restricted entry interval. Refer to label for proper handling and application instructions. Do not apply more than 3 pt product/A/crop. Do not make more than 4 applications/crop.

Corn

Curt Laub, Research Associate, Virginia Tech

Seedcorn Maggot

Seedcorn Maggot Sampling/Decision Making

Preventive treatment is advised on early and no-till plantings before soil is warm enough to promote quick germination. Old sod fields, pasture, heavily manured fields and fields with previous histories of seedcorn maggot damage should be treated regardless of planting time or type of tillage.

Table 4.11 - Recommended Pesticides for Controlling Seedcorn Maggot

Insecticide (Formulation)	Amount active ingredient	Amount product	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.022 lb AI/A (based on 30-inch row spacing)	0.12-0.16 oz/1,000 row ft 2.0-2.8 oz/A	grain or fodder: 21 Green forages after last application: 0	**RESTRICTED USE.** Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Row width adjustment: for row spacing <30 inches, adjust rate of product not to exceed 2.8 oz/A. Note: Diminished control may occur when rates are decreased below recommended minimum rates per 1,000 row ft.
bifenthrin (Capture LFR)	0.04-0.16 lb AI/A	3.4-13.6 oz/A 0.2-0.78 oz/1000 row ft	—	Apply 5- to 7-inch band (T-band) over open furrow or in-furrow with the seed. Maximum 0.1 lb/A/season as an at-plant application. Maximum 0.3 lb/A/season of at-plant plus foliar applications of other bifenthrin products. Use of Capture LFR is prohibited in all coastal counties.
clothianidin (Poncho 600)	0.25-0.5 mg AI/ kernel	1.13-2.26 oz/80,000 seeds	—	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin and eyes.
thiamethoxam (Cruiser 5FS)	0.25 mg AI/ kernel	1.13 oz/80,000 seeds	—	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin and eyes.

Note: Check labels of the various granular and liquid soil insecticides for information and product efficacy on seedcorn maggot control.

Wireworms

Wireworm Sampling/Decision Making

First-year corn following established sod is frequently attacked by wireworms. Early sampling before planting should include bait stations. Two paired bait stations per acre are made by placing 0.5 cup of an equal mixture of untreated corn/wheat in the soil 4 inches deep and 9 inches wide. Set bait stations in fields to be planted at least 3 weeks before the planting date. Check by digging in about 2 weeks and record the number of wireworms for each station. Economic thresholds for wireworms have not been established on corn; however, if an average of 1 or more wireworms per bait station are found, a soil insecticide should be applied in the seed furrow to protect the germinated seed and newly-emerged seedlings.

Table 4.12 - Recommended Pesticides for Controlling Wireworms

Insecticide (Formulation)	Amount active ingredient per 1,000 row ft	Amount product per 1,000 row ft	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.022 lb AI/A (based on 30-inch row spacing)	0.12-0.16 oz/1,000 row ft 2.0-2.8 oz/A	grain or fodder: 21 Green forages after last application: 0	**RESTRICTED USE.** Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Row width adjustment: for row spacing <30 inches, adjust rate of product not to exceed 2.8 oz/A. Note: Diminished control may occur when rates are decreased below recommended minimum rates per 1,000 row ft.
bifenthrin (Capture 1.15G)	0.032-0.096 oz	3.2-8.0 oz (3.5-8.7 lbs/A)	30	**RESTRICTED USE.** Apply in-furrow at planting. **Use highest rate for heavy pest pressure.**
bifenthrin (Capture LFR)	0.04-0.16 lb/ AI/A	3.4-13.6 oz/A 0.2-0.78 oz/ 1000 row ft	—	Apply 5- to 7-inch band (T-band) over ope fur-row or in-furrow with the seed. Maximum 0.1 lb/ A/season as an at-plant application. Max-imum 0.3 lb/A/season of at-plant plus foliar applica-tions of other bifenthrin products.Use of Capture LFR is prohibited in all coastal counties.
chlorpyrifos (Lorsban 15G)	2.4 oz	8.0 oz	35 grain, 14 silage, 14 grazing	Apply at planting in a 6- to 7-inch band over the row, in front of the presswheel and incorporate the granules into the top 1 inch of soil. Can also be applied in-furrow.
clothianidin (Poncho 250)	0.25-0.5 mg AI/ kernel	1.13-2.26 oz/80,000 seeds	—	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin and eyes.
ethoprop (Mocap 15G Lock'N Load)	1.2 oz	8.0 oz	—	**RESTRICTED USE.** Apply at planting in a 6- to 7-inch band on the row **over a closed seed furrow.** Mix the granules with the top 0.5 inch of soil.
fipronil (Regent 4SC)	0.12 oz (min. 30-in rows)	0.24 oz	—	**RESTRICTED USE.** Make 1 in-furrow application at planting only. Apply in 1 gal water/A directly into the seed furrow. **Do not apply more than 0.13 lb AI/A or 4.2 fluid oz of Regent 4SC/A.**
phorate (Thimet 20G) Lock & Load, SmartBox, EZLoad	1.2 oz	4.5-6.0 oz	30	**RESTRICTED USE.** Apply at planting in a 7-inch band over the row, in front of or behind the presswheel and lightly incorporate. **Do not apply Thimet in-furrow.**
tefluthrin (Force 3G)	0.12-0.15 oz	4.5-5.0 oz	30	**RESTRICTED USE.** Apply in-furrow at planting for best control. Rotational crops may be planted 30 days after application.

Table 4.12 - Recommended Pesticides for Controlling Wireworms (cont.)

Insecticide (Formulation)	Amount active ingredient per 1,000 row ft	Amount product per 1,000 row ft	Time limits: days before harvest	Remarks
terbufos (Counter 20G SmartBox®)	0.9-1.2 oz	4.5-6.0 oz	30	**RESTRICTED USE.** Apply at planting in 7-inch band over the row, in front of or behind the presswheel and lightly incorporate. Can also be applied in-furrow. **If application is made at planting, do not makepostemergence or cultivation time treatments of Counter.** Use of Accent or Beacon herbicides following Counter applications may result in crop injury.
thiamethoxam (Cruiser 5FS)	0.25 mg AI/ kernel	1.13 oz/80,000 seeds	—	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin and eyes.

White Grubs

White Grub Sampling/Decision Making

Spring planting into former soybean fields or old sod fields are often at risk for white grubs and, to a lesser extent, wireworms. In most years, white grub species stop feeding to pupate in mid- to late May in Virginia. Late-planted corn and conventional-tilled corn are at lower risk from white grubs.

Insecticidal seed treatments for seed and root feeders like white grubs are now applied by the manufacturer and must be ordered at the time the seed order is placed; usually from late fall to early winter. A fall soil sampling method for predicting spring-planted cornfields with economic infestations of white grubs is described below.

Compact Method (CM) Soil Sampling Strategy: Fall and spring research-based action thresholds in corn

The CM is a soil sampling strategy for white grubs that provides timely and useful information for pest management decision-making. The CM is based on an 8-inch square by 6-inch deep volume of soil that is hand-sifted for white grubs on a green plastic leaf collection bag placed on the ground next to the sample site. The CM is as accurate as the traditional 12-inch square/ standard method, but is about 57% faster, with much lower sample fatigue. The CM soil sampling strategy was designed for fall sampling as a means to provide producers with a field-specific pest management tool for better managing white grubs on their farms. Using the CM for spring soil sampling of white grubs before planting corn is as useful as fall sampling with the CM. However, keep in mind that sampling in the fall gives you more time to make a decision about white grub management than sampling in the spring.

Definition of Action Threshold (AT): Levels of pest populations at which control should be implemented to avoid significant damage to the crop (determined from research-based relationship of pest levels on yields).

Thresholds: The fall AT is ≥1.6 white grubs per CM soil sample. The spring AT is ≥1.04 white grubs per CM soil sample.

The following represents the minimum number of compact method samples needed per field to be 95 percent confident your sample average is within the specified percentage of the actual field mean:

25% 3 to 4 samples/field (about 10-15 minutes)
20% 5 to 6 samples/field (about 20-25 minutes)
15% 10 samples/field (about 30-40 minutes)
10% 22 samples/field (about ≥1.5 hours)

One point of caution, although soil sampling for white grubs works well in most soils: it is easier to hand sift lighter, sandier soils than heavier soils which do not break apart easily. No data is available for muck soils.

Table 4.13 - Recommended Pesticides for Controlling White Grubs

Insecticide (Formulation)	Amount active ingredient per 1,000 row ft	Amount product per 1,000 row ft	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.022 lb AI/A (based on 30-inch row spacing)	0.14-0.16 oz/1,000 row ft 2.5-2.8 oz/A	grain or fodder: 21 Green forages after last application: 0	**RESTRICTED USE.** SUPPRESSION ONLY. Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Row width adjustment: for row spacing <30 inches, adjust rate of product not to exceed 2.8 oz/A. Note: Diminished control may occur when rates are decreased below recommended minimum rates per 1,000 row ft.
bifenthrin (Capture 1.15G)	0.032-0.096 oz	3.2-8.0 oz (3.5-8.7 lbs/A)	30	**RESTRICTED USE.** Apply in-furrow at planting. **Use highest rate for heavy pest pressure.**
bifenthrin (Capture LFR)	0.04-0.16 lb AI/A	3.4-13.6 oz/A 0.2-0.78 oz/1000 row ft	—	Apply 5- to 7-inch band (T-band) over open furrow or in-furrow with the seed. Maximum 0.1 lb/A/season as an at-plant application. Maximum 0.3 lb/A/season of at-plant plus foliar applications of other bifenthrin products. Use of Capture LFR is prohibited in all coastal counties.
chlorpyrifos (Lorsban 15G)	2.4 oz	8.0 oz	35 grain, 14 silage, 14 grazing	Apply at planting in a 6- to 7-inch band over the row, in front of the presswheel and incorporate the granules into the top 1 inch of soil. Can also be applied in-furrow.
clothianidin (Poncho 250)	0.25-0.5 mg AI/ kernel	1.13-2.26 oz/80,000 seeds	—	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin and eyes. Note: Research conducted in Virginia, with partial funding from the VCB, has indicated that the lowest rate of this product gives inconsistent control of white grubs.
phorate (Thimet 20G) Lock & Load, SmartBox, EZLoad	1.2 oz	4.5-6.0 oz	30	**RESTRICTED USE.** Apply at planting in a 7-inch band over the row, in front of or behind the presswheel and lightly incorporate. **Do not apply Thimet in-furrow.**
tefluthrin (Force 3G)	0.12-0.15 oz	4.0-5.0 oz	—	**RESTRICTED USE.** Available only in SMARTBOX closed handling system. Apply as needed by scouting. Apply in furrow at planting for best control. Rotational crops may be planted 30 days after application.
terbufos (Counter 20G SmartBox®)	0.9-1.2 oz	4.5-6.0 oz	30	**RESTRICTED USE.** Apply at planting in a 7-inch band over the row, in front of or behind the presswheel and lightly incorporate. Can also be applied in-furrow. **If application is made at planting, do not make postemergence or cultivation time treatments of Counter.** Use of Accent or Beacon herbicides following Counter applications may result in crop injury.
thiamethoxam (Cruiser 5FS)	0.25 mg AI/ kernel	1.13 oz/80,000 seeds	—	See previous remarks. Note: Research conducted in Virginia, with partial funding from the VCB, has indicated that the lowest rate of this product gives inconsistent control of white grubs.

Baited Wire Trap Procedure for Scouting

Seedcorn maggot, wireworms, and white grubs can be scouted before planting

The wire trap itself consists of a 2-ft long by 3-inch wide strip of 0.25-inch hardware cloth (see image below). To strengthen the hardware cloth strip and to facilitate the placement of the corn seed bait, the strip should be bent lengthwise at a 90° angle. Use only corn seeds that have **not been treated** with an insecticidal seed treatment for bait. About 2 weeks before planting, place 20 seeds about 1 inch apart in each wire trap and then bury the baited wire trap 2 inches deep in the soil. Install at least 1 baited wire trap for every acre of corn to be planted. Remove the traps from the soil after 2 weeks and determine the average number of seeds with feeding damage in the wire traps. The following suggested guidelines may help you determine whether your field is at risk to wireworms, seedcorn maggots, or white grubs.

Suggested Treatment Guidelines Using the Baited Wire Trap Method

Conditions for using the baited wire trap method for field corn

1. Unless continuous corn fields have already been scouted for corn rootworms, baited wire traps should only be used in fields in which corn typically is grown in rotation with soybeans, alfalfa, sorghum, or peanuts (see exceptions below for explanation).

2. Refer to the following suggested treatment guidelines for seedcorn maggots, wireworms, and annual white grubs to determine if a granular insecticide may be needed at planting to prevent serious stand loss.

Seedcorn maggot

A granular insecticide may be needed at planting if the average number of seeds damaged by seedcorn maggots in the baited wire traps is **25 percent** or more; otherwise, an insecticidal seed treatment should be sufficient.

Wireworms

A granular insecticide may be needed at planting if the average number of seeds damaged by wireworms in the baited wire traps is **10 percent** or more; otherwise, an insecticidal seed treatment should be sufficient.

Annual white grubs (i.e., grubs with a 1-year life cycle: Japanese beetle, green June beetle, etc.):

A granular insecticide may be needed at planting if the average number of seeds damaged by annual white grubs in the baited wire traps is **5 percent** or more. **Note: unlike seedcorn maggot and wireworms, insecticidal seed treatments are not labelled for control of white grubs.**

Default

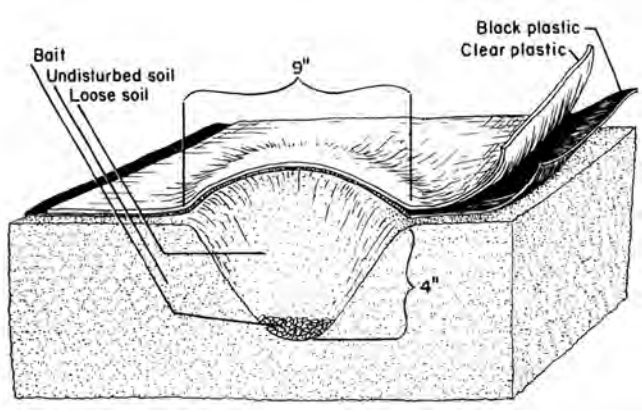
If you are unable to discern which pest is responsible for damaging the corn seeds in the baited wire traps, and if the average number of seeds damaged in the baited wire traps is **5 percent** or more, then a granular insecticide may be needed at planting to prevent serious stand loss.

Exceptions

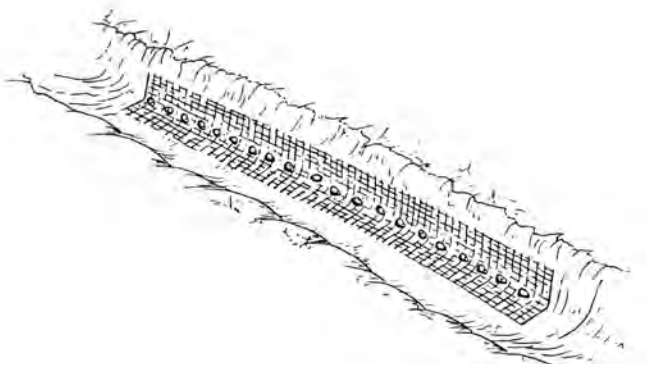
Cropping situations in which the producer is encouraged to make an in-furrow, T-band, or banded over-the-row application of a granular insecticide when planting field corn (**and not just rely on an insecticidal seed treatment**) are the following:

a. when planting corn in old sod or pasture fields, because severe damage from wireworms may occur. Less frequently, damage may occur from true white grubs (i.e., *Phyllophaga* spp. with 2- to 3-year life cycles).

b. when a field is in continuous corn production, because of the potential for corn rootworm damage, and because the low rate of seed treatments do not control corn rootworms.



Bait Station (Cross Section)



Baited Wire Trap

Corn Root Aphid

Corn root aphids are a sporadic pest of field corn in Virginia. Planting field corn no-till in fields with a history of corn root aphid problems can lead to serious root injury if a proper soil insecticide has not been applied at planting. Corn root aphids injure corn by piercing the roots with their stylet-like mouthparts and extracting the sap. The growth of infested corn plants often is stunted and, under severe infestations, may be arrested at a height of only 10 inches.

The ability of this aphid to infest corn roots is highly dependent upon certain species of ants commonly known as corn field ants. Shortly after germination, the ants begin carrying the aphids to the developing corn roots. Aphid numbers increase rapidly once in contact with the roots; females are capable of producing 40 to 50 live nymphs each, and generations can be as short as eight days during warm growing conditions. The ants benefit from this relationship by harvesting the droplets of honeydew produced by the aphids while feeding on the roots.

To determine if a field is at risk to corn root aphids, no-till fields should be scouted for the presence of anthills before planting because, unlike conventionally tilled fields, no-till fields are more likely to have established ant colonies. It should be kept in mind, however, that it is possible for a field to have anthills present without the presence of corn root aphids. Although no specific label reference to corn root aphids has been found among the list of insecticides currently available for use on field corn, application of a granular insecticide at planting to control wireworms or corn rootworms may alleviate a corn root aphid problem. In addition, two cultural practices which can play a role in minimizing corn root aphid infestations are deep tillage every other year to weaken ant colonies, and crop rotation to prevent the buildup of large ant and aphid populations.

Billbug

The southern corn billbug and maize billbug are known to occur throughout the coastal plain of North Carolina and in the Tidewater Region of southeastern Virginia. Unlike other areas of Virginia, the relatively higher organic matter content and poorer drainage characteristics of the soils in southeastern Virginia are two factors considered favorable to billbug infestations.

Both adult and immature stages of billbugs damage corn seedlings. Adult billbugs chew into the side of corn seedlings and feed on the inner plant tissue. Eggs are deposited by females within the feeding cavity and hatch in 4 to 15 days. The legless larvae feed in and around the taproot for several weeks. There is only one generation per year. Damaged seedlings which survive infestation typically are stunted, or otherwise deformed, and may exhibit excessive suckering and rows of transverse holes on the leaves.

Rotation is considered the least expensive and most effective method of controlling billbug infestations provided that corn is rotated about 0.25 mile from its previous location. When rotation is not possible, it is suggested that border rows and volunteer clumps of corn be inspected for billbug infestations. If an insecticide is to be used to control billbugs, it should be applied when billbugs are first observed or at the first indication of feeding damage.

Table 4.14 - Preemergence Use of Insecticides to Control Billbugs

Note: at-plant granular insecticide applications are not considered to be as effective as postemergence applications for controlling billbugs.

Insecticide (Formulation)	Amount active ingredient per 1,000 row ft	Amount product per 1,000 row ft	Time limits: days before harvest	Remarks
chlorpyrifos (Lorsban 15G)	1.2-2.4 oz	8.0 oz	35 grain, 14 silage, 14 grazing	Apply at planting in a band or T- band. Do not apply in-furrow.
clothianidin (Poncho 1250)	1.25 mg AI/ kernel	5.64 oz/80,000 seeds	–	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin. Follow up foliar sprays may be needed under heavy pest pressure.
terbufos (Counter 20G SmartBox®)	0.9-1.2 oz	4.5-6.0 oz	30	**RESTRICTED USE.** Apply at planting in a 7-inch band over the row, in front of or behind the presswheel and lightly incorporate. Can also be applied in-furrow. **If application is made at planting, do not make postemergence or cultivation time treatments of Counter.** Use of Accent or Beacon herbicides following Counter applications may result in crop damage.
thiamethoxam (Cruiser 5FS)	1.25 mg AI/ kernel	5.64 oz/80,000 seeds	—	See previous remarks.

Table 4.15 - Postemergence Use of Insecticides to Control Billbugs

Insecticide (Formulation)	Amount active ingredient per 1,000 row ft	Amount product per 1,000 row ft	Time limits: days before harvest	Remarks
chlorpyrifos (Lorsban 4E)	1.0 lb/A	2.0 pt/A	35 grain, 14 silage, 14 grazing	Apply with sufficient water to ensure a minimum spray volume of 20-40 gal/A and 40 psi by ground. On corn less than 6 inches tall, apply spray in a 9-12 inch wide band over the row. On corn over 6 inches tall, apply the insecticide spray using drop nozzles directed at the base of the plant.

Cutworm

Cutworm Sampling/Decision Making

Late-planted, minimum-till fields with heavy spring weed growth on poorly drained soils are the most likely to encounter cutworms. Corn fields should be checked twice a week from the spike through the 5th-leaf stage. Leaf feeding is the first sign that cutworms are present. Look for small, irregular holes in leaves and cut plants. Note any leaf feeding that may have resulted from cutworms too small to cut plants and check these areas again in 24 to 48 hours. If cutworms are present, examine at least 10 sets of 20 plants throughout the field and record the percentage of cut or damaged plants. At the same time, look under clods and dig 1 to 2 inches deep around the bases of damaged plants to find cutworms. Record the average size and number of cutworms.

As a general guideline, before the 3rd- to 5th-leaf stage, a rescue treatment should be applied if 10% or more of the young plants show fresh leaf feeding and cutworms are present. At the 3rd- to 5th-leaf stage, treatment should be applied if 5% of the plants are cut and there are 4 or more cutworms per 100 plants.

Table 4.16 - Preemergence Use of Insecticides to Control Cutworms

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
Optimum® AcreMax™ 1				Product allows growers to reduce their corn rootworm refuge by placing it in the bag. An in-the-bag product that contains 90% of a Pioneer® brand hybrid with Herculex® XTRA (CRW/CB/LL/RR2) insect protection, and 10% of a Pioneer hybrid – same genetic family – with the Herculex 1 trait (CB/LL/RR2), which serves as the corn rootworm refuge. AcreMax, or some other suitable corn borer refuge corn, allows growers the flexibility to plant their corn borer refuge up to 1/2 mile away.
beta-cyfluthrin (Baythroid XL)	0.0065-0.0125 lb	0.8-1.6 oz	grain or fodder: 21 Green forages after last application: 0	**RESTRICTED USE.** Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4. Minimum application volume (water): 10 gal/A by ground, 2 gal/A by air.
bifenthrin (Capture LFR)	0.04-0.16 lb	3.4-13.6 oz 0.2-0.78 oz/ 1000 row ft	—	**RESTRICTED USE.** Insecticide must be preplant incorporated (PPI) and can be tank mixed with PPI herbicides. Product should be applied no deeper than intended planting depth. Use of product is prohibited in all coastal counties.
chlorpyrifos (Lorsban 4E)	0.5 - 1.0 lb	1.0-2.0 pt	35 grain, 14 silage, 14 grazing	Broadcast – use minimum of 20 gal water/A.
chlorpyrifos (Lorsban 15G)	1.2 oz/1,000 row ft	8.0 oz/1,000 row ft	35 grain, 14 silage, 14 grazing	At plant band or T-band application.
chlorpyrifos zeta-cypermethrin (Stallion [3.03 lbs AI/gal prod])	—	3.75-11.75 oz	30 grain and storage, 60 forage	**RESTRICTED USE.** For grain, silage, seed. Make only one at-plant application in-furrow, band, or T-band treatment; minimum 4-inch band.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	**RESTRICTED USE.** Broadcast apply as necessary to maintain control.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.015-0.025 lb	0.96-1.60 oz	21	**RESTRICTED USE.** Apply by ground or air using sufficient water for full coverage. **Aerial application**: Use ≥2 gal water/A. Do not apply >0.48 pt/A/season. Do not apply >0.24 pt/A after silk initiation. Do not apply >0.12 pt/A after milk stage.
permethrin (Ambush 25WP)	0.1-0.2 lb	6.4-12.8 oz	30 grain and fodder (stover), 0 forage	**RESTRICTED USE.** Apply from 5 days before planting up to emergence. Band or Broadcast—use minimum 10 gal finished spray/A by ground or 2 gal/A by air.

Table 4.16 - Preemergence Use of Insecticides to Control Cutworms (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
permethrin (Pounce 25WP)	0.1-0.2 lb	4.0-8.0 oz	30 grain and fodder (stover), 0 forage	**RESTRICTED USE.** See previous remarks.
tefluthrin (Force 3G)	0.12-0.15 lb	3.0-4.0 oz/1,000 row ft	—	**RESTRICTED USE.** Apply at planting in a 7-inch band over the row, in front of or behind the presswheel. Do not apply as either a band or T-band unless the granules can be incorporated into the top 1 inch of soil using tines, chains, or other suitable equipment. Rotational crops may be planted 30 days after application.
zeta-cypermethrin (Mustang Max)	0.001 lb	0.16 oz/1,000 row ft	30 grain and stover, 60 forage	**RESTRICTED USE.** Apply as in-furrow, band, or T-band, using a minimum 4-inch band.

Table 4.17 - Postemergence Use of Insecticides to Control Cutworms

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0065-0.0125 lb	0.8-1.6 oz	grain or fodder: 21 Green forages after last application: 0	**RESTRICTED USE.** Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4. Minimum application volume (water): 10 gal/A by ground, 2 gal/A by air.
bifenthrin (Capture LFR)	0.047-0.062 lb	4.0-5.3 oz	—	**RESTRICTED USE.** Insecticide must be preplant incorporated (PPI) and can be tank mixed with PPI herbicides. Product should be applied no deeper than intended planting depth. Use of product is prohibited in all coastal counties.
bifenthrin zeta-cypermethrin (Hero [1.24 lbs AI/ gal prod])	0.025-0.06 lb	2.6-6.1 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** For grain, silage, and seed. Use of Hero on corn is prohibited in all coastal counties. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
carbaryl (Sevin XLR Plus)	2.0 lb	2.0 qt	0	For optimum control, apply 12-inch band over the row using sufficient water to ensure thorough coverage of treated plants. Broadcast— use minimum 20 gal water/A.
carbaryl (Sevin 4F)	2.0 lb	2.0 qt	0	See previous remarks.
chlorpyrifos (Lorsban 4E)	0.5-1.0 lb	1.0-2.0 pt	35 grain 14 silage 14 grazing	Use sufficient water to ensure thorough coverage of treated plants.

Table 4.17 - Postemergence Use of Insecticides to Control Cutworms (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
chlorpyrifos zeta-cypermethrin (Stallion [3.03 lbs AI/ gal prod])	—	3.75-11.75 oz	30 grain and fodder (stover), 60 forage	**RESTRICTED USE.** Do not make second application of Stallion or any other product containing chlorpyrifos within 10 days of first application. Do not apply in tank mixes with Steadfast or Lighting herbicides.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	**RESTRICTED USE.** Use sufficient water to ensure thorough coverage of treated plants.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.015-0.025 lb	0.96-1.60 oz	21	**RESTRICTED USE.** Apply as required by scouting, usually at intervals of 7 or more days. Apply by ground or air using sufficient water for full coverage. **Aerial application**: use ≥2 gal water/A. Do not apply >0.48 pt/A/season. Do not apply >0.24 pt/A after silk initiation. Do not apply >0.12 pt/A after milk stage.
methomyl (Lannate LV) (Lannate SP)	 0.45 lb 0.45 lb	 1.5 pt 0.5 lb	3 forage 21 ears 21 fodder	**RESTRICTED USE.** Apply when insects first appear. Use sufficient water to ensure thorough coverage of treated plants.
permethrin (Ambush 25WP)	0.1-0.2 lb	6.4-12.8 oz	30 grain and fodder (stover), 0 forage	**RESTRICTED USE.** See previous remarks.
permethrin (Pounce 25WP)	0.1-0.2 lb	4.0-8.0 oz	30 grain and fodder (stover), 0 forage	**RESTRICTED USE.** Use minimum 2 gal finished spray/A by air or 10 gal/A by ground. Apply prior to brown silk stage.
zeta-cypermethrin (Mustang Max)	0.008-0.0175 lb	1.28-2.8 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** Use minimum 10 gal water/A.

Armyworm

True Armyworm Sampling/Decision Making

No-till fields planted into a small grain cover crop, pastures, or weedy fields all have a high risk for armyworm infestation. Survey field edges where margins border small grains or large grassy areas and watch for damaged plants. If armyworm damage is seen, examine 20 plants at each of 5 locations within the field and record the percentage of damaged plants, the average size, and the severity of injury.

Armyworms usually migrate from small grains starting in late May. Spot treatments may be warranted if infestations are confined to small areas. Control for armyworms is recommended if 35 percent or more of the plants are infested and 50 percent or more defoliation is seen on the damaged plants, provided that larvae average less than 0.75 inch long. Worms greater than 1.25 inches in length usually have completed their feeding.

Table 4.18 - Preemergence Use of Insecticides to Control Armyworms

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
Optimum® AcreMax™ 1				Product allows growers to reduce their corn rootworm refuge by placing it in the bag. An in-the-bag product that contains 90% of a Pioneer® brand hybrid with Herculex® XTRA (CRW/CB/LL/RR2) insect protection, and 10% of a Pioneer hybrid – same genetic family – with the Herculex 1 trait (CB/LL/RR2), which serves as the corn rootworm refuge. AcreMax, or some other suitable corn borer refuge corn, allows growers the flexibility to plant their corn borer refuge up to 1/2 mile away.
beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	1.6-2.8 oz	grain or fodder: 21 Green forages after last application: 0	**RESTRICTED USE.** Effective against 1st and 2nd instars only. Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4. Minimum application volume (water): 10 gal/A by ground, 2 gal/A by air.
bifenthrin (Capture LFR)	0.04-0.16 lb	3.4-13.6 oz 0.2-0.78 oz/1000 row ft	—	**RESTRICTED USE.** Insecticide must be preplant incorporated (PPI) and can be tank mixed with PPI herbicides. Product should be applied no deeper than intended planting depth. Use of product is prohibited in all coastal counties.
chlorpyrifos (Lorsban 4E)	0.5-1.0 lb	1.0-2.0 pt	35 grain, 14 silage, 14 grazing	Broadcast-use minimum of 20 gal water/A.
permethrin (Pounce 25WP)	0.1-0.2 lb	4.0-8.0 oz	30 grain and fodder (stover), 0 forage	**RESTRICTED USE.** Apply from 5 days before planting up to emergence. Band or Broadcast use minimum of 10 gal finished spray/A by ground or 2 gal/A by air.
permethrin (Ambush 25WP)	0.1-0.2 lb	6.4-12.8 oz	30 grain and fodder (stover), 0 forage	**RESTRICTED USE.** See previous remarks.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	**RESTRICTED USE.** Broadcast apply as necessary to maintain control.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	21	**RESTRICTED USE.** For control of small larvae only. Apply as required by scouting, usually at intervals of 7 or more days. Apply by ground or air using sufficient water for full coverage. **Aerial application**: use ≥2 gal water/A. Do not apply >0.48 pt/A/season. Do not apply >0.24 pt/A after silk initiation. Do not apply >0.12/A pt after milk stage.

Table 4.19 - Postemergence Use of Insecticides to Control Armyworms

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
Bacillus thuringiensis (Biobit WP)	—	0.5-2.0 lb	0	Make initial application when economically-damaging populations exist. Applications must be made to early instars — repeat as necessary.
Bacillus thuringiensis (Javelin WG)	—	0.5-1.5 lb	0	See previous remarks.
beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	1.6-2.8 oz	grain or fodder: 21 Green forages after last application: 0	**RESTRICTED USE.** Effective against 1st and 2nd instars only. Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4. Minimum application volume (water): 10 gal/A by ground, 2 gal/A by air.
bifenthrin (Capture LFR)	0.047-0.062 lb	4.0-5.3 oz	—	**RESTRICTED USE.** Insecticide must be preplant incorporated (PPI) and can be tank mixed with PPI herbicides. Product should be applied no deeper than intended planting depth. Use of product is prohibited in all coastal counties.
bifenthrin zeta-cypermethrin (Hero [1.24 lb AI/gal prod])	0.04-0.1 lb	4.0-10.3 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** For grain, silage, and seed use. Use of Hero on corn is prohibited in all coastal counties. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
carbaryl (Sevin XLR Plus)	1.0-2.0 lb	1.0-2.0 qt	0	See previous remarks.
carbaryl (Sevin 4F)	1.0-2.0 lb	1.0-2.0 qt	0	See previous remarks.
chlorpyrifos (Lorsban 4E)	0.5-1.0 lb	1.0-2.0 pt	35 grain, 14 silage, 14 grazing	Use sufficient water to ensure thorough coverage of treated plants.
chlorpyrifos zeta-cypermethrin (Stallion [3.03 lbs AI/gal prod])	—	9.25-11.75 oz	30 grain and fodder (stover), 60 forage	**RESTRICTED USE.** Do not make second application of Stallion or any other product containing chlorpyrifos within 10 days of first application. Do not apply in tank mixes with Steadfast or Lighting herbicides.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	**RESTRICTED USE.** Use sufficient water to ensure thorough coverage of treated plants.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	21	**RESTRICTED USE.** For control of small larvae only. Apply as required by scouting, usually at intervals of 7 or more days. Apply by ground or air using sufficient water for full coverage. **Aerial application**: use ≥2 gal water/ A. Do not apply >0.48 pt/A/season. Do not apply >0.24 pt/A after silk initiation. Do not apply >0.12/A pt after milk stage.

Table 4.19 - Postemergence Use of Insecticides to Control Armyworms (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
methomyl (Lannate LV) (Lannate SP)	 0.225-0.45 lb 0.225-0.45 lb	 0.75-1.5 pt 0.25-0.5 lb	3 forage 21 ears 21 fodder	**RESTRICTED USE.** Apply when insects first appear. Use sufficient water to ensure thorough coverage of treated plants.
permethrin (Pounce 25WP)	0.1-0.2 lb	4.0-8.0 oz	30 grain and fodder (stover), 0 forage	**RESTRICTED USE.** Use minimum 2 gal finished spray/A by air or 10 gal/A by ground. Apply prior to brown silk stage.
permethrin (Ambush 25WP)	0.1-0.2 lb	6.4-12.8 oz	30 grain and fodder (stover), 0 forage	**RESTRICTED USE.** Use minimum 2 gal finished spray/A by air or 10 gal/A by ground. Apply prior to brown silk stage.
zeta-cypermethrin (Mustang Max)	0.02-0.025 lb	3.2-4.0 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** Use minimum 10 gal water/A.

Slugs and Snails

Slug, Snail Sampling/Decision Making

Slugs can become serious pests in no-till fields during spring periods of cool, wet weather. Fields with heavy layers of manure, crop refuse, or thick weed cover are at higher risk from slugs. Because slugs feed at night and hide during the day in the mulch and surface trash near the seedlings, they often are not suspected of being the cause of the shredded leaves on the young corn seedlings. Yet slugs can be found during the day by turning over clods of dirt and surface trash near the seedlings. It is suggested that samples be taken from the area around 5 plants in 10 locations of the field to determine the average number of slugs associated with each plant. Populations of 5 or more slugs around each plant at the spike through the 3rd-leaf stage may be economic, especially if injury is heavy, plant growth is slow, and cool, wet conditions prevail. During dry, warm weather, 10 or more slugs per plant may be tolerated. Also, corn seedlings that have reached the 3rd-leaf stage of growth generally are able to outgrow feeding damage by slugs.

Cultural practices which may help reduce slug populations include reduction in the use of manure, shift to conventional tillage practices for at least one season, and minimum tillage to reduce the amount of surface trash.

Table 4.20 - Postemergence Use of Insecticides to Control Slugs and Snails

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
metaldehyde (Deadline M-Ps)	0.4-1.6 lb	10.0-40.0 lb	0	For best results, apply product in evening. Especially beneficial if applied following rain or watering. It should be noted that most corn-producing states are suggesting an application rate of 12 to 15 lb/A, if banded over or along side the row after the plants have emerged. Recent Delaware field trials indicate good results against slugs using 10 lb Deadline M-Ps/A broadcast with a cyclone spreader. Spreader must be calibrated to deliver at least 5 pellets/sq ft. Slugs generally stop feeding in 2-3 hours and die within 2-3 days.

Table 4.20 - Postemergence Use of Insecticides to Control Slugs and Snails (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
methomyl[1] (Lannate LV)	0.45 lb	1.5 pt	21	**RESTRICTED USE.** Maximum number of applications per season: 10. Maximum product per crop season: 7.5 pts. Apply at 5-7 day intervals to maintain control. Slugs mainly feed in the early evening, at night, or in cool morning hours. Slugs are most active when weather conditions are moist and cool. It is recommended to apply product in early evening through early morning when slugs are active and feeding.

Stalk Borer

Stalk Borer Sampling/Decision Making

Good weed control can help eliminate some stalk borer egg-laying sites, but overwintering eggs may be laid on fall-planted small grains such as rye. A postemergence insecticide application is suggested **only** if the larvae **have not bored** into the stalks. Given this restriction, a treatment may be warranted if more than 4, 6, or 10 percent of the plants at the 2nd-, 3rd-, or 4th-leaf stages exhibit signs of stalk borer feeding damage. Refer to sampling procedures for true armyworm.

An alternative strategy for managing stalk borer infestations is to apply a burndown herbicide **at least 10 days before** corn is planted. The slightly earlier burndown herbicide application means that a suitable alternative host (i.e., corn) will not be available to the stalk borer larva as it emerges from its herbicide-treated host. As a consequence of this action, the exposed larvae are subject to a much higher mortality rate from such factors as predation, starvation, and adverse environmental conditions.

Table 4.21 - Preemergence Use of Insecticides to Control Stalk Borers

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
DO NOT rely on a preemergence burndown herbicide and combination insecticide application to control stalk borer.				
beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	1.6-2.8 oz	grain or fodder: 21 Green forages after last application: 0	**RESTRICTED USE.** Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4. Minimum application volume (water): 10 gal/A by ground, 2 gal/A by air.
bifenthrin (Capture LFR)	0.04 lb	3.4 oz	—	**RESTRICTED USE.** Insecticide must be preplant incorporated (PPI) and can be tank mixed with PPI herbicides. Product should be applied no deeper than intended planting depth. Use of product is prohibited in all coastal counties.
bifenthrin (Capture LFR)	0.04-0.16 lb AI/A	3.4-13.6 oz/A	—	Apply 5- to 7-inch band (T-band) over open furrow or in-furrow with the seed. Maximum 0.1 lb/A/season as an at-plant application. Maximum 0.3 lb/A/season of at-plant plus foliar applications of other bifenthrin products. Use of Capture LFR is prohibited in all coastal counties.

Table 4.21 - Preemergence Use of Insecticides to Control Stalk Borers (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
bifenthrin zeta-cypermethrin (Hero [1.24 lbs AI/ gal prod])	0.04-0.10 lb	4.0-10.3 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** For grain, silage, and seed. Use of Hero on corn is prohibited in all coastal counties. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
chlorpyrifos (Lorsban 4E)	1.0 lb	2.0 pt	35 grain, 14 silage, 14 grazing	Apply approximately 11 days **after** application of Roundup herbicide or 3 to 5 days **after** complete burndown with Gramoxone (paraquat). **DO NOT** use Lorsban 4E in combination with a burndown herbicide for control of stalk borer.
chlorpyrifos zeta-cypermethrin (Stallion [3.03 lbs AI/ gal prod])	—	9.25-11.75 oz	30 grain and fodder (stover), 60 forage	**RESTRICTED USE.** For foliar use only. Do not make second application of Stallion or any other product containing chlorpyrifos within 10 days of first application. Do not apply in tank mixes with Steadfast or Lighting herbicides.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	**RESTRICTED USE.** Application must be made early in migration from grassy areas to corn, before stalk borers enter plants.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	21	**RESTRICTED USE.** Must be applied before larva bores into stalk. Apply as required scouting. Apply by ground or air using sufficient water for full coverage. **Aerial application**: use ≥2 gal water/A. Do not apply >0.48 pt/A/season. Do not apply >0.24 pt/A after silk initiation. Do not apply >0.12 pt/A after milk stage.
permethrin (Pounce 25WP)	0.1-0.2 lb	4.0-8.0 oz	30 grain and fodder (stover), 0 forage	**RESTRICTED USE.** Apply when or shortly before stalk borer larvae move into corn from surrounding weeds, grasses, or rye cover crop. Mowing or application of a burndown herbicide is suggested to initiate movement. Use minimum 2 gal finished spray/ac by air or 10 gal/A by ground. Apply prior to brown silk stage.
permethrin (Ambush 25WP)	0.1-0.2 lb	6.4-12.8 oz	30 grain and fodder (stover), 0 forage	**RESTRICTED USE.** See previous remarks.
zeta-cypermethrin (Mustang Max)	0.017-0.025 lb	2.72-4.0 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** Use minimum 10 gal water/A.

Garden Symphylan

Garden Symphylan Sampling/Decision Making

Because of its sensitivity to low soil moisture, garden symphylans frequently will move up and down as much as 2 to 3 ft in the soil profile. Thus, it is possible to observe typical feeding symptoms of root hair pruning and purple leaves without garden symphylans being present. No sampling method is available. Treat only if field history indicates that heavy infestations are likely.

Table 4.22 - Postemergence Use of Insecticides to Control Garden Symphylan

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
terbufos (Counter 20G SmartBox®)	0.9-1.2 oz oz/1,000 row ft	4.5-6.0 oz oz/1,000 row ft	30	**RESTRICTED USE.** Apply at planting in a 7-inch band over the row, in front of or behind the presswheel and lightly incorporate. Can also be applied in-furrow. **If application is made at planting, do not make postemergence or cultivation time treatments of Counter.** Use of Accent or Beacon herbicides following Counter applications may result in crop injury.
chlorpyrifos (Lorsban 15G)	1.2 oz/1,000 row ft	8.0- oz/1,000 row ft	35 grain, 14 Silage, 14 grazing	Apply at planting in a 6- to 7- inch band over the row, in front of the presswheel and incorpo rate the granules into the top 1 inch of soil.

Western Corn Rootworm

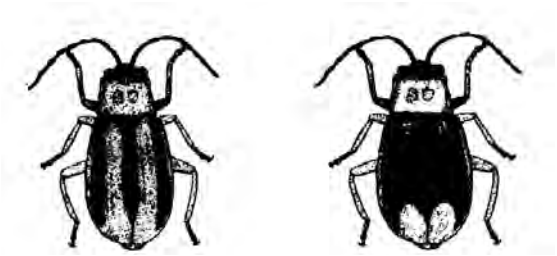


Fig. 4.5 Western Corn Rootworm Adults

Markings range from distinct black and yellow regions (left) to a 'blotchy' black (right).

There is one generation of western corn rootworm (WCR) per year. In late summer, adults lay eggs in soil **in cornfields**. Eggs overwinter in the soil and hatch the following spring. Larvae (grubs) immediately search for corn roots on which to feed, and then pupate in the soil. Adults (beetles) emerge from late June through August and fly to corn plants to feed and mate.

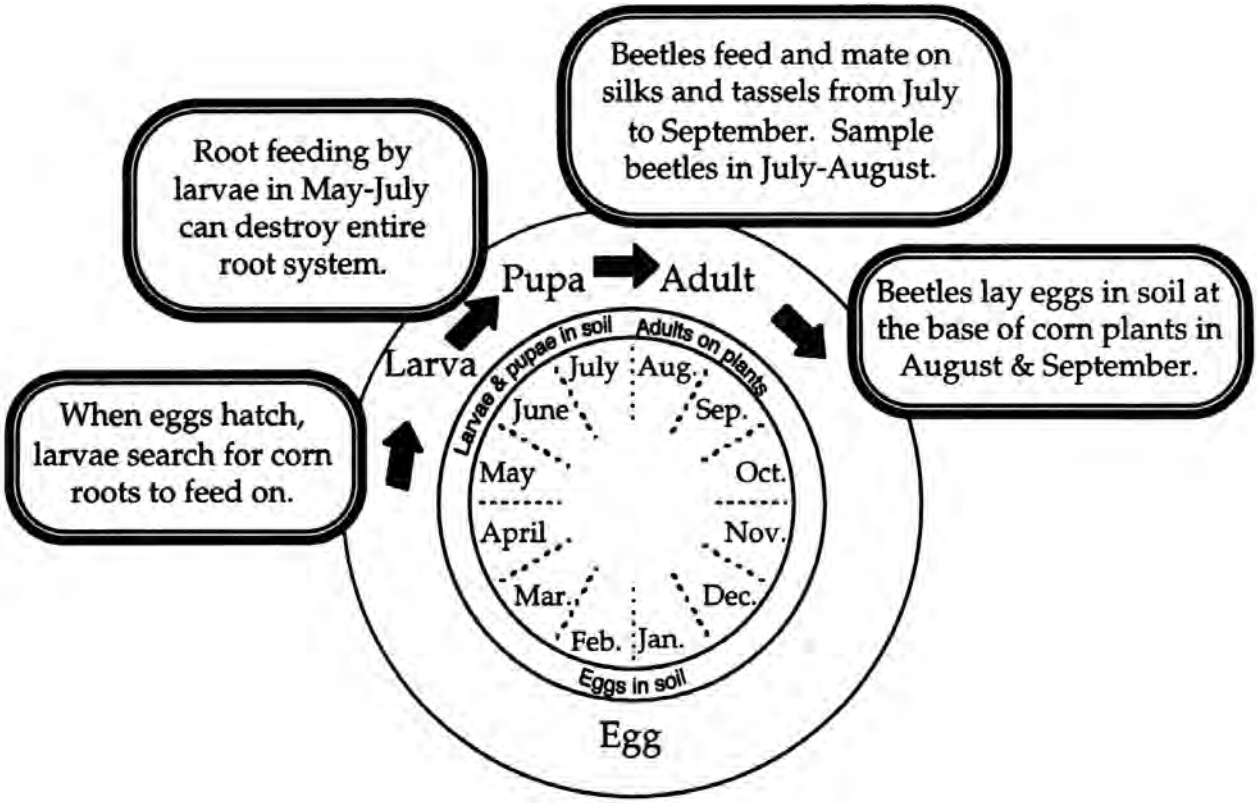


Fig. 4.6 Western corn rootworm life cycle in Virginia

Larvae feed almost exclusively on corn roots, so control is easily accomplished through crop rotation. However, many farmers do not have the option of rotating out of corn, thus the next best control measure is to apply a granular insecticide at planting. As the life cycle indicates, treatment of first year corn to control WCR is not necessary. Also, rootworm populations in subsequent years of continuous corn may not be large enough to warrant treatment. Economic damage thresholds for rootworm beetles have been developed by correlating beetle populations in a particular field with subsequent larval feeding damage occurring the following year.

Sampling

Western corn rootworm beetles should be sampled in July and August to determine whether a control measure is needed the following year. Two methods for scouting corn rootworm beetles are described here.

Yellow sticky card method

Place 4 x 6 inch Olson® (available from Olson Products, P. O. Box 1043, Medina, OH 44258) two-sided yellow sticky cards (traps) in cornfields starting in early July. Use the table below to determine how many traps to install. Place traps about 300 feet apart and at least 100 feet in from all field edges. Place a series of traps along the same corn row. When approaching the field edge, cross over about 30 rows and place another series of traps along a row until the entire field is covered. Use flags to mark the location of each trap. Use continuous flagging (forestry tape) when crossing rows and to mark the start of the trap line. Attach traps to corn plants at a height of about 4 feet. Break off any leaves on the plant and adjacent plants that could possibly stick to a trap. Monitor the traps every 9 to 10 days, recording the number of western corn rootworm beetles on each trap. At each site remove the release paper from the unused side of the trap and re-install the trap on the corn stalk with the fresh side exposed. Install new traps every other visit.

Table 4.23 - Determining the number of traps to place in a field

Field Size (Acres)	Number of Traps per Field
1 to 5	3
6 to 10	6
11 to 15	9
16 to 20	13
21 to 25	16
26 to 30	19
31 to 35	23
36 to 40	26
41 to 45	30
46 to 50	34
51 to 55	37
56 to 60	40

Decision Making

After counting the rootworm beetles on all traps, determine the average number of beetles per trap per week using the following formula:

Average beetles per trap per week = ***Total Beetles ÷ No. of usable traps ÷ No. of days since last sampled x 7***

If a field has 20 or more rootworm beetles per trap per week, that field is above threshold and should be rotated out of corn or treated with a granular insecticide at corn planting next year for rootworm control. Once a field exceeds the threshold there is no need to scout it again this year.

If trap catch never reaches 20 beetles per trap per week, the field is below threshold and no treatment is recommended for rootworm control the following year. Scouting can be discontinued if trap counts decline for three consecutive sampling periods.

2. Ear zone count method

Survey fields 4 or 5 times from the second week in July through the third week in August to estimate the number of western corn rootworm beetles in the field. Count the corn rootworm beetles in the ear zone of 50 corn plants throughout each field. The ear zone is the area from the upper surface of the leaf just below the ear to the lower surface of the leaf just above the ear, and includes the ear and ear leaf. Calculate the average number of beetles per ear zone. When scouting fields that have been in corn more than one year, an average count of 1.0 beetle or more per ear zone indicates that a granular insecticide should be applied if the field is to be planted in corn the following year. When scouting first year corn, control for rootworms the following year if the average count is 0.75 beetles or more per ear zone, because primarily egg-laying females migrate to new cornfields.

Syngenta recently received EPA registration for two trait stacks:

Agrisure Viptera® 3220 E-Z Refuge® ™ trait stack offers dual modes of action for control of multiple above-ground lepidopteran pests and corn borer.

Agrisure® 3122 E-Z Refuge trait stack is intended for use in areas where corn rootworm and lepidopteran pest management are primary concerns.

What the two products have in common: Products feature 5 percent blended refuge in a bag for convenience and easy compliance, glyphosate tolerance, and, in cotton-growing regions, you will need to plant a supplemental 20 percent refuge.

Table 4.24 - Western Corn Rootworm

Insecticide (Formulation)	Amount active ingredient per 1,000 row ft	Amount product per 1,000 row ft	Time limits: days before harvest	Remarks
bifenthrin Capture 1.15 G	0.006 lb	8.0 oz (8.7 lbs/ac)	30	**RESTRICTED USE.** Apply at planting in a 5- to 7-inch band over the row, in front of the press wheel. Granules must be incorporated into the top one inch of soil. Apply in-furrow only for light to moderate pest pressure. Do not apply to soil where there is greater than 30% cover of crop residue remaining.
Capture LFR (see label for details)	0.08-0.2	0.39-0.98 oz (6.8-17.0 oz/ac)		
terbufos (Counter 20G SmartBox®)	0.9-1.2 oz	4.5-6.0 oz	30	**RESTRICTED USE.** Apply at planting in a 7-inch band over the row, in front of or behind the press wheel and lightly incorporate. Can also be applied in-furrow. **If application is made at planting, do not make postemergence or cultivation time treatments of Counter.** Use of Accent or Beacon herbicides following Counter applications may result in crop injury.
tefluthrin (Force 3G)	0.12-0.15 oz	4.0-5.0 oz	–	**RESTRICTED USE.** Apply at planting in a 7-inch band over the row, in front of or behind the presswheel and incorporate the granules into the top 1 inch of soil. Can also be applied in-furrow. Rotational crops may be planted 30 days after application.
chlorpyrifos (Lorsban15G)	1.2 oz	8.0 oz	35 grain, 14 silage, 14 grazing	Apply at planting in a 6- to 7-inch band over the row, in front of or behind the presswheel and incorporate the granules into the top 1 inch of soil. Can also be applied in-furrow.
fipronil (Regent 4SC)	0.12 oz (min. 30-in rows)	0.24 oz	–	**RESTRICTED USE.** Make 1 in-furrow application at planting only. Apply in 1 gal water/A directly into the seed furrow. **Do not apply more than 0.13 lb AI/A or 4.2 fluid oz of Regent 4SC/A.**
clothianidin (Poncho 1250)	1.25 mg AI/ kernel	5.64 oz/80,000 seeds	–	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin.
thiamethoxam (Cruiser 5FS)	1.25 mg AI/ kernel	5.64 oz/80,000 seeds	–	See previous remarks.

Table 4.25 - Bt proteins active against western corn rootworm

Protein*	Product	First Marketed
Cry3Bb1	YieldGard	2003
mCry3A	Agrisure	2006
Cry34/35Ab1	Herculex, Optimum	2005
eCry3.1Ab	Duracade	2014

*Resistance by western corn rootworm (WCR) to Bt hybrids expressing either the Cry3Bb1 or mCry3A protein has been documented in individual Midwestern cornfields since 2009.

In Virginia in 2014 and 2015 a corn rootworm Bt hybrid expressing the Cry3Bb1 protein experienced considerable root damage and lodging from WCR feeding. This was the first confirmed instance in Virginia of potential resistance by WCR to a rootworm Bt hybrid.

To preserve the efficacy of Bt traits against WCR:

Rotate out of corn every 3 to 4 years to break the corn rootworm life cycle.

Rotate mode of action by planting a hybrid with a different Bt trait or multiple Bt traits for rootworm, or plant a conventional hybrid with a soil insecticide.

Follow refuge compliance: A refuge of non-Bt corn is used to delay the development of resistance to the Bt toxin.

Corn Rootworm Resistance Management

(Adapted from Marlin Rice, Iowa State University.)

EPA requires companies to ensure that 20 percent of the planted acreage of Bt rootworm hybrids be set aside where non-Bt corn will be grown to serve as a refuge. These refuge acres will support populations of corn rootworm not exposed to the Bt protein and reduce the possibility of corn rootworm developing resistance to Bt corn. The corn rootworm population in the refuge will help prevent resistance development by cross-breeding with any insects that may emerge from the Bt cornfield. This resistance management strategy was developed as a condition of registration, and EPA requires monitoring and documentation to show these measures are followed.

The following information on refuge requirements was modified from a Monsanto publication, "YieldGard Rootworm Insect Resistance Management-2003 IRM Guide."

Refuge Requirements

On each farm, up to 80 percent of corn acres may be planted with Bt rootworm corn. Plant at least 20 percent of the corn acres to a corn refuge that does not contain a Bt technology for control of corn rootworms. The corn refuge can be treated for corn rootworm larvae and other soil pests with soil-applied, seed-applied, or foliar-applied insecticides. The corn refuge can be treated with a non-Bt insecticide to control late-season pests such as European corn borer; however, the Bt rootworm corn also must be treated. Corn refuge options include Bt corn borer hybrids, Roundup Ready corn, and conventional corn, but no other Bt product for corn rootworm management.

Plant the refuge within or adjacent to the Bt rootworm cornfield. The corn refuge can be separated by a ditch or farm road but not by another field. Adjacent refuge fields must be owned by or managed by the grower.

Refuge Planting Requirements

Any corn hybrid that does not contain a Bt technology for control of western or northern corn rootworm and is planted within or adjacent to the Bt rootworm field corn can serve as a refuge.

Plant a refuge on every farm where Bt rootworm corn hybrids are planted.

Plant the refuge at the same time as Bt rootworm corn.

Effectiveness of the refuge can be reduced if the plant stand and plant vigor are decreased. The result of fewer, less thrifty plants translates into fewer susceptible insects in the refuge.

Mixing non-Bt seed with Bt rootworm seed for use in the refuge is not permitted.

Plant the refuge and the Bt rootworm corn in fields with similar crop history. For example, if the field planted to Bt rootworm was corn the previous year, then the refuge also must be planted in a field that was planted to corn the previous year.

Refuge Configuration Options

The refuge on each farm may be arranged in a number of configurations. These options offer the flexibility to easily incorporate an effective corn refuge into farm operations.

Options include the following:

- Plant a corn refuge adjacent to each Bt rootworm cornfield.
- Plant a corn refuge as large strips or blocks within a Bt rootworm field.
- Split the planter to alternate at least 4 (preferably 6) consecutive rows of corn refuge with Bt rootworm corn.
- Plant field perimeters or end rows to a corn refuge.

Stacked Bt corn hybrids contains different Bt proteins that kill more than one pest, for example one Bt protein for above-ground feeders such as European corn borer plus another protein for Western corn rootworm. Below are refuge option guidelines for stacked Bt products, but also read the product use guides for help implementing a corn rootworm resistance management plan for your farm.

1. **Common refuge for both corn borers and corn rootworms in non-cotton-growing counties.** The common refuge must be planted with corn hybrids that do not contain Bt technologies for the control of corn rootworms or corn borers. The refuge area must represent at least 20% of the stacked Bt acres. It can be planted as a block adjacent to the stacked Bt field, perimeter strips, or in-field strips. If perimeter strips are implemented, the strips must be at least 4 (preferably 6) rows wide. If strips within the stacked Bt field are implemented, then at least 4 (preferably 6) consecutive rows could be planted. The common refuge can be treated with a soil-applied or seed-applied insecticide to control rootworm larvae and other soil pests. The refuge can also be treated with a non-Bt foliar insecticide for control of late season pests if pest pressure reaches an economic threshold for damage; however, if rootworm adults are present at the time of a foliar application, then the stacked Bt field must be treated in a similar manner.

2. **Separate refuge areas for corn borers and corn rootworm in non-cotton-growing counties.** Acceptable corn borer refuge options are either a non-Bt conventional corn hybrid or a Bt corn rootworm single stack hybrid. Unacceptable corn borer refuge options are Bt lepidopteran single stack hybrids that target corn borers, cutworms, corn earworm, or armyworms. The refuge must represent at least 20% of the grower's stacked Bt corn acres, and must be planted within a 1/2 mile of the stacked Bt field. The corn borer refuge can be treated with a soil-applied or seed-applied insecticide for corn rootworm larval control, or a non-Bt foliar-applied insecticide for corn borer control if pest pressure reaches an economic threshold for damage. The corn rootworm refuge must be planted with a non-Bt corn rootworm-protected hybrid, but can be planted with Bt hybrids that control corn borers. The corn rootworm refuge must represent at least 20% of the grower's stacked Bt corn acres and be planted as an adjacent block, perimeter strips, or in-field strips. The corn rootworm refuge can be treated with a soil-applied or seed-applied insecticide to control rootworm larvae and other soil pests. The refuge can also be treated with a non-Bt foliar insecticide for control of late season pests; however, if rootworm adults are present at the time of foliar applications then the stacked Bt field must be treated in a similar manner. Growers who fail to comply with the IRM requirements risk losing access to the product.

3. Common and separate refuges for Bt corn grown in cotton-growing counties must be 50% of the Bt acres.

Adapted from:
Sharlene R. Matten, Ph.D., IRM Team Leader
USEPA/OPP/BPPD (7511c), 1200 Pennsylvania Ave., NW, Washington D.C. 20460

European Corn Borer (ECB)

First Generation

The potential for first-generation damage in field corn during the whorl stage is impossible to predict prior to planting. The best strategy is to scout each field and apply a whorl application of a granular or liquid insecticide if the ECB infestation exceeds the treatment threshold (see Decision Making below). Historically, not all fields need to be treated with insecticides every year because statewide economic infestations have occurred in only 3 out of the last 22 years. Furthermore, many corn hybrids are able to tolerate moderate levels of leaf and stalk injury without economic yield loss. **Also, corn grown for silage rarely needs to be treated for ECB.**

The decision to treat a first generation ECB infestation should be based on the following two criteria: (1) the number of plants exhibiting fresh whorl feeding damage, and (2) the presence of live larvae. ECB mortality typically is very high during the first 3 to 5 days after egg hatch. Plant resistance, natural enemies, and adverse environmental conditions are major causes of ECB larval mortality.

Sampling Begin checking for whorl feeding damage when the plants with extended leaves are 17 inches. Randomly select 5 sets of 20 consecutive plants from throughout the field. Determine the percentage of plants that exhibit fresh whorl feeding. Note: newly hatched larvae feed on the leaves, causing a characteristic "window pane" or "shothole" type of damge that is readily visible as the whorl unrolls. In addition, dissect 2 infested plants from each sample of 20 plants and look for live larvae in the whorl of the stalk. Check weekly or more frequently.

Decision Making. Treatment is suggested if 80 percent or more of the plants exhibit whorl feeding damage and if 80 percent or more of the damaged plants (i.e., 8 out of the 10 dissected plants) have at least 1 live larva per plant.

Second Generation

Although second generation ECB are more likely to attack corn that has been planted late, all corn grown for grain should be scouted when plants with extended leaves are 17 to 24 inches.

Sampling. To assess the potential for economic damage, begin scouting for egg masses when second generation moths emerge and begin egg-laying. The presence of ECB moths in areas bordering a field can be used to indicate a likely infestation. To survey for these moths, walk along the grassy sides of the field and look for large numbers of moths flying when disturbed. However, if no other information is available, it is suggested that scouting for egg masses be initiated the last week of June and continued at 2 to 3 day intervals through the third week of July. Randomly select 5 sets of 20 consecutive plants from throughout the field. Count the number of egg masses found on each plant. ECB moths usually lay their eggs in masses on the undersides of leaves, 2 or 3 leaves below the ear; however, because they can be laid anywhere, it is suggested that every leaf be inspected for egg masses.

Decision Making. To reduce a potential economic loss from second generation ECB in field corn grown for grain, an insecticide treatment is warranted if 35 percent or more of the plants in the pre- to post-tasseling stage of development have at least 1 egg mass per plant.

General Guidelines for Use of Bt Corn in Virginia

The USEPA has identified specific cotton-growing counties in Virginia where corn growers who plant Bt corn hybrids for corn borers or other lepidopterous insects (such as cutworms, armyworms, etc.) and/or corn rootworms also must plant a 50 percent non-Bt corn refuge.

The Virginia counties subject to the 50 percent corn refuge requirement are: Dinwiddie, Franklin City, Greensville, Isle of Wight, Northampton, Southampton, Suffolk City, Surrey, and Sussex.

Most Bt corn borer hybrids on the market today are targeted at controlling the corn borers and corn rootworms. These pests are capable of causing serious damage to corn and are considered two of the most important insect pests of corn in the U.S. Annual costs associated with corn borer and corn rootworm management and crop loss across the U.S. are estimated at more than $2 billion.

What Is Bt Corn?

A Bt corn hybrid refers to a corn plant that has been genetically engineered to express a crystalline protein derived from a common soil bacterium, *Bacillus thuringiensis*. Although researchers have identified numerous strains of Bt proteins, only a handful have been incorporated into the current lines of commercial corn hybrids. Bt proteins are highly toxic to European corn borer and corn rootworm larvae. In general, Bt corn plants with the genetic events BT11 and MON810 (YieldGard) express the Bt protein throughout the plant tissue including the green tissue, silk, pollen, and kernels.

European Corn Borer Life Cycle

European corn borer is a moth that has two main generations per year in Virginia. It overwinters as a fifth instar larva inside pieces of corn stalks, and it has a host range of over 200 plant species. The main damage caused by corn borer larvae results from tunnels bored into the stalk about two weeks before silking. A cornfield that averages one or more tunnels per stalk can expect a yield reduction of about 5%. Despite the fact that it is relatively simple to scout for this pest during the growing season, few growers in Virginia actually do. Their main reasons for not scouting are based on years of observing low levels of stalk breakage and ear drop at harvest.

What Other Corn Pests Are Controlled by Bt Hybrids?

The events BT11 (Syngenta Seeds) and MON810 (Monsanto, YieldGard Corn Borer) provide good control of late-season corn earworm and fall armyworm. These events only provide partial control of armyworm. The event TC1507 (Pioneer/Dupont and Dow AgroSciences Herculex I Insect Protection) protects against black cutworm and fall armyworm, as well as European corn borer. The events MON863 (Monsanto, YieldGard Rootworm) and MIR604 (Sygenta, Agrisure) offers excellent protection from corn rootworms.

Pest Risk Philosophy

The inability to identify at planting which cornfields will be at risk of European corn borer infestation means that the decision to plant a Bt corn hybrid must depend on factors other than pest presence. From a grower's perspective, such factors might include:

1) A philosophy of general pest risk aversion

2) A field's previous pest history (marginal value at best for European corn borer)

3) An attempt to minimize buildup of corn earworm populations that might otherwise pose a threat to soybeans late in the season

4) A perceived indirect benefit of reducing mycotoxin infections associated with stalk tunneling and ear feeding insects

Unfortunately, clear-cut answers to the above scenarios, as well as others you may think of, are not available. Nevertheless, it is possible to develop reasonable guidelines for use of Bt corn hybrids in Virginia if the question is approached from the standpoint of pest potential and the economics of control.

Results of 1997-1999 Field Studies Conducted in Eastern Virginia

From 1997-1999, European corn borer damage was surveyed in 172 non-Bt cornfields in eastern Virginia, and the performance of selected Bt corn hybrids grown in eastern Virginia was evaluated. Details of these studies can be found in Virginia Cooperative Extension publication 424-031, *Virginia Corn Hybrid and Management Trials,* for each of the study years. For complete details, please consult the following URLs for 1997, 1998, and 1999, respectively: *http://www.ext.vt.edu/pubs/grains/424-031/424-031.html*; *http://www.ext.vt.edu/pubs/grains/424-031-98/424-031-98.html*; *http://www.ext.vt.edu/pubs/grains/424-031-99/424-031-99.html*; The following points summarize the results:

1. Of 172 surveyed fields, only 2% (3 fields) had exceeded the economic threshold for damage (i.e., one or more, >0.5-inch tunnels per stalk).

2. Three years of field tests in eastern Virginia under both irrigated and non-irrigated conditions, and in the absence of economic infestations of European corn borer, revealed that Pioneer 3394 (a non-Bt corn hybrid) consistently produced grain yields as good as or better than those of the Bt corn hybrids.

3. A multi-year doublecrop corn hybrid study showed that late-planted corn (i.e., corn planted after the first week in June) is at severe risk of European corn borer damage. Also, recent survey results of European corn borer damage in non-Bt cornfields of western Virginia were similar to those of surveys conducted in eastern Virginia. Of 78 surveyed fields, less than 8% (6 fields) had exceeded the economic threshold for damage.

General Guidelines for Planting Bt Corn Borer Hybrids in Virginia

1. Most corn (≥90%) planted timely in Virginia (i.e., from April to early May) will likely not realize an economic benefit from Bt corn because of the lack of European corn borer pressure early in the season.

2. It is strongly recommended that Bt corn be planted anywhere late-planted corn (i.e., corn planted mid- to late May or later) is grown in Virginia because of the increasing risk of corn borer damage.

EPA Refuge Requirements for Planting Bt Corn Hybrids

In corn growing areas where cotton is not grown, a maximum of **80% Bt corn acres** can be planted **if 20% of the remaining corn acres are planted to a non-Bt corn hybrid.** The non-Bt corn refuge can be located up to **1/2 mile** from the Bt corn field if it is not treated with any foliar insecticides for European corn borer. If there is a possibility that the refuge will be treated with insecticides for European corn borer, then the refuge needs to be within **1/4 mile** of the Bt corn field. Under no circumstances should sprayable Bt insecticides be applied to the non-Bt corn refuge.

In corn growing areas where cotton is also grown, a maximum of **50% Bt corn acres** can be planted **if 50% of the remaining corn acres are planted to a non-Bt corn hybrid.** The refuge must be located within **1/2 mile** of the Bt corn field, and if at all possible it should be placed within **1/4 mile** of the Bt corn field.

Acceptable Refuge Planting Schemes

1. Separate non-Bt corn fields within 1/4 to 1/2 mile (see above comments)
2. In-field non-Bt corn strips or blocks within the Bt field
3. Split the planter to alternate at least 4 (preferably 6) consecutive rows of corn refuge with the Bt corn borer corn.
4. Planting pivot corners to non-Bt corn
5. Planting field perimeters or end rows to non-Bt corn

For details on YieldGard Plus resistance management plan for European corn borer and western corn rootworm go to the following: *http://www.pioneer.com/canada/crop_management/05YGPL.pdf* and review the "2005 YieldGard Plus Use Guide."

Syngenta receives EPA registration for two convenient refuge in a bag trait stacks featuring top performing insect control.

Agrisure Viptera® 3220 E-Z Refuge® ™ trait stack offers dual modes of action for control of multiple above-ground lepidopteran pests and corn borer.

Agrisure® 3122 E-Z Refuge trait stack is intended for use in areas where corn rootworm and lepidopteran pest management are primary concerns.

What the two products have in common: Products feature 5 percent blended refuge in a bag for convenience and easy compliance, glyphosate tolerance, and, in cotton-growing regions, you will need to plant a supplemental 20 percent refuge.

The traits will be available from Syngenta's Garst®, Golden Harvest® and NK® seed brands for the 2013 planting season.

Table 4.26 - European Corn Borer (ECB)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
Optimum® AcreMax™ 1				Product allows growers to reduce their corn rootworm refuge by placing it in the bag. An in-the-bag product that contains 90% of a Pioneer® brand hybrid with Herculex® XTRA (CRW/CB/LL/RR2) insect protection, and 10% of a Pioneer hybrid – same genetic family – with the Herculex 1 trait (CB/LL/RR2), which serves as the corn rootworm refuge. AcreMax, or some other suitable corn borer refuge corn, allows growers the flexibility to plant their corn borer refuge up to 1/2 mile away.
Bacillus thuringiensis (Agree WG)	0.038-0.076 lb	1.0-2.0 lb	0	Apply when small, newly-hatched larvae are present and actively feeding. Use sufficient water for thorough spray coverage. Use high rate for heavy infestations.
Bacillus thuringiensis (Dipel 10G)	1.0 lb	10.0 lb	0	**First generation:** Make whorl application shortly after egg hatch and before larvae bore into the stalks. **Second generation:** Apply when egg-mass counts reach or exceed the economic threshold.
beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	1.6-2.8 oz	grain or fodder: 21 Green forages after last application: 0	**RESTRICTED USE.** Application must be made prior to the larva boring into the plant. Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4. Minimum application volume (water): 10 gal/A by ground, 2 gal/A by air.

Table 4.26 - European Corn Borer (ECB) (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
bifenthrin zeta-cypermethrin (Hero [1.24 lb AI/gal prod])	0.04-0.1 lb	4.0-10.3 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** For grain, silage, and seed. Use of Hero on corn is prohibited in all coastal counties. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
carbaryl (Sevin XLR Plus)	1.5-2.0 lb	1.5-2.0 qt	0	For optimum control, use minimum 3 gal water/A by air or 15 gal/A by ground.
carbaryl (Sevin 4F)	1.5-2.0 lb	1.5-2.0 qt	0	See previous remarks.
chlorpyrifos (Lorsban 15G)	0.9-1.2 oz/1,000 row ft	6.0-8.0 oz/1,000 row ft (band application) 5.0-6.5 lb (broadcast by air)	35 grain, 14 silage, 14 grazing	Uniformly broadcast granules over the plants by air or directly into whorls by ground. Do not exceed 2 applications/season. Do not graze or harvest for silage within 14 days of last treatment.
chlorpyrifos (Lorsban 4E)	0.5-1.0 lb	1.0-2.0 pt	35 grain, 14 silage, 14 grazing	**First generation:** Apply when 25 to 50% of plants show pinholefeeding or leaf-feeding scars. Ground applications should be directed into the whorl. **Second generation:** Apply when egg-mass counts reach or exceed the economic threshold. Do not graze or harvest for silage within 14 days of last treatment.
chlorpyrifos zeta-cypermethrin (Stallion [3.03 lbs AI/gal prod])	—	9.25-11.75 oz	30 grain and storage, 60 forage	**RESTRICTED USE.** For grain, silage, seed. Make only one at-plant application in-furrow band or T-band treatment; minimum 4-inch band.
fipronil (Regent 4SC)	0.12 oz (min. 30-in rows)	0.24 oz	—	**RESTRICTED USE.** For control of first generation only. Make 1 in-furrow application at planting only. Apply in 1 gal water/A directly into the seed furrow. **Do not apply more than 0.13 lb AI/ A or 4.2 fluid oz of Regent 4SC/A.**
esfenvalerate (Asana XL)	0.04-0.05 lb	7.8-9.6 oz	21	**RESTRICTED USE.** **First generation:** Apply when eggs are in blackhead stage or starting to hatch. Ground application suggested— use 20-30 gal carrier/A and direct spray to both sides of leaves. **Second generation:** Apply when eggs are in blackhead stage or starting to hatch. Good coverage above, below, and in the ear zone is essential.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	21	**RESTRICTED USE.** Must be applied before larva bores into stalk. Apply as required by scouting, usually at intervals of 7 or more days. Apply by ground or air using sufficient water for full coverage. **Aerial application**: use ≥2 gal water/A. Do not apply >0.48 pt/A/season. Do not apply >0.24 pt/A after silk initiation. Do not apply >0.12 pt/A after milk stage.

Table 4.26 - European Corn Borer (ECB) (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
permethrin (Ambush 25WP)	0.1-0.2 lb	6.4-12.8 oz	—	**RESTRICTED USE.** See previous remarks.
permethrin (Pounce 1.5G)	0.1-0.15 lb	6.7-10.0 lb	—	**RESTRICTED USE.** Foliar use—direct granules into the whorl. Do not apply more than 0.4 lb AI/A after brown silk stage.
permethrin (Pounce 25WP)	0.1-0.2 lb	4.0-8.0 oz	—	**RESTRICTED USE.** Foliar spray—use minimum 1 gal finished spray/A by air or 10 gal/A by ground. Apply prior to brown silk stage.
zeta-cypermethrin (Mustang Max)	0.017-0.025 lb	2.72-4.0 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** Use minimum 10 gal water/A. 60 forage

Flea beetle

Flea Beetle Sampling/Decision Making

Flea beetles rarely require control; however, treatment may be necessary if 10 or more flea beetles are present on young corn seedlings at the 1- to 2-leaf stage of growth. No preemergence treatments are recommended for control of flea beetles.

Table 4.27 - Flea Beetle

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0065-0.0125 lb	0.8-1.6 oz	grain or fodder: 21 Green forages after last application: 0	**RESTRICTED USE.** Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4. Minimum application volume (water): 10 gal/A by ground, 2 gal/A by air.
bifenthrin zeta-cypermethrin (Hero [1.24 lb AI/gal prod])	0.025-0.026 lb	2.6-6.1 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** For grain, silage, and seed. Use of Hero on corn is prohibited in all coastal counties. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
carbaryl (Sevin XLR Plus)	1.0-2.0 lb	1.0-2.0 qt	0	Optimum timing and good coverage are essential to control.
carbaryl (Sevin 80S)	1.0-2.0 lb	1.25-2.5 lb	0	See previous remarks.
chlorpyrifos (Lorsban 4E)	0.5-1.0 lb	1.0-2.0 pt	35 grain, 14 silage, 14 grazing	Use sufficient water to ensure thorough coverage of treated plants.

Table 4.27 - Flea Beetle (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
chlorpyrifos zeta-cypermethrin (Stallion [3.03 lbs AI/ gal prod])	—	9.25-11.75 oz	30 grain and storage, 60 forage	**RESTRICTED USE.** For grain, silage, seed. Make only one at-plant application in-furrow band or T-band treatment; minimum 4-inch band.
clothianidin (Poncho 600)	0.25-0.5 mg AI/ kernel	1.13-2.26 oz/80,000 seeds	—	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin and eyes.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	**RESTRICTED USE.** Use sufficient water to ensure thorough coverage of treated plants.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	21	**RESTRICTED USE.** Apply as required by scouting. Apply by ground or air using sufficient water for full coverage. **Aerial application**: use ≥2 gal water/A.
methomyl (Lannate LV) (Lannate SP)	0.225-0.45 lb 0.225-0.45 lb	0.75-1.5 pt 0.25-0.5 lb	3 forage, 21 ears, 21 fodder	**RESTRICTED USE.** Use sufficient water to ensure thorough coverage of treated plants.
permethrin (Ambush 25WP)	0.1-0.2 lb	6.4-12.8 oz	30 grain and stover, 0 forage	**RESTRICTED USE.** See previous remarks.
permethrin (Pounce 25WP)	0.1-0.2 lb	4.0-8.0 oz	30 grain and stover, 0 forage	**RESTRICTED USE.** Use minimum 2 gal finished spray/A by air or 10 gal/A by ground.
terbufos (Counter 20G SmartBox®)	0.9-1.2 oz	4.5-6.0 oz	30	**RESTRICTED USE.** Apply at planting in a 7-inch band over the row, in front of or behind the press wheel and lightly incorporate. Can also be applied in-furrow. **If application is made at planting, do not make postemergence or cultivation time treatments of Counter.** Use of Accent or Beacon herbicides following Counter applications may result in crop injury.
zeta-cypermethrin (Mustang Max)	0.017-0.025 lb	2.72-4.0 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** Use minimum 10 gal water/A. 60 forage

Grasshoppers

Grasshopper Sampling/Decision Making

Damage may occur during mid- to late-summer, especially during periods of drought. Examine fields next to pastures and other grassy areas where grasshoppers overwinter and develop. Treatment of these adjacent breeding sites before the young grasshoppers move into the corn field may reduce the area that must be sprayed later. Treatment of non-cropped areas is suggested when young grasshoppers reach 20 per square yard. Treat field margins when young grasshoppers enter the field from roadsides. Treatment of entire field is seldom necessary; however, field sprays may be justified when 5 to 8 grasshoppers per square yard are present during the silking period.

Table 4.28 - Grasshoppers

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0165-0.022 lb	2.1-2.8 oz	grain or fodder: 21 Green forages after last application: 0	**RESTRICTED USE.** Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4. Minimum application volume (water): 10 gal/A by ground, 2 gal/A by air.
bifenthrin zeta-cypermethrin (Hero [1.24 lb AI/gal prod])	0.025-0.026 lb	2.6-6.1 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** For grain, silage, and seed. Use of Hero on corn is prohibited in all coastal counties. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
carbaryl (Sevin XLR Plus)	0.5-1.5 lb	0.5-1.5 qt	0	Use lower rate for nymphs on small plants. Use higher rate for mature grasshoppers.
carbaryl (Sevin 4F)	0.5-1.5 lb	0.5-1.5 qt	0	See previous remarks.
chlorpyrifos (Lorsban 4E)	0.25-0.5 lb	0.5-1.0 pt	35 grain, 14 silage, 14 grazing	Use sufficient water to ensure thorough coverage of treated plants.
dimethoate (Dimethoate 4EC)	0.5 lb	1.0 pt	14	Do not make more than 3 applications/year. Do not feed or graze within 14 days of last application.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	**RESTRICTED USE.** Apply as necessary to maintain control.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	21	**RESTRICTED USE.** Apply as required by scouting. Apply by ground or air using sufficient water for full coverage. **Aerial application**: use ≥2 gal water/A.
malathion (Malathion 8EC)	0.61 lb	0.61 pt	0	For young grasshoppers only. Spray may be applied by air or ground equipment. **Dilute application**: use 20 to 60 gal water/A. **Concentrate application**: use ≥5 gal water/A.
zeta-cypermethrin (Mustang Max)	0.017-0.025 lb	2.72-4.0 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** Use minimum 10 gal water/A.

Spider Mite

Spider Mite Sampling/Decision Making

Spider mite populations often seem to explode as plants reach the grain-fill period, especially during extended hot, dry weather when the plants are stressed. Sprays applied for other insect pests during mid-summer can devastate the mite predator complex and thus may increase mite populations. If corn has not dented, treatment may be warranted if mite colonies are present along the midribs on the lower surfaces of one-third to one-half of the leaves on 50 percent of the plants. This can also be expressed as 15 to 20 percent of the total leaf area covered with mite colonies, and mites are beginning to colonize significant areas of the field.

Table 4.29 - Spider Mite

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
bifenthrin zeta-cypermethrin (Hero [1.24 lb AI/gal prod])	0.1 lb	10.3 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** For grain, silage, and seed. Use of Hero on corn is prohibited in all coastal counties. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
dimethoate (Dimethoate 4EC)	0.33-0.5 lb	0.67-1.0 pt	14	Do not make more than 3 applications/year. Do not feed or graze within 14 days of last application.

Corn Leaf Aphid

Corn Leaf Aphid Sampling/Decision Making

Aphids are rarely a problem because infestations either build up too late, or they are controlled by beneficial insects such as lady beetles, lacewings, and parasitic wasps. Economic infestations may occur in mid-summer inside the leaf whorl surrounding the developing tassel. If treatment is considered it should be applied before 50 percent of the tassels emerge to be most effective. Unfold the whorl leaves of 20 plants at each of 5 locations in the field and note the severity of aphid colonies and any natural enemy activity. Treatment may be needed when 25 percent of the plants are heavily infested and natural enemy activity is low.

Table 4.30 - Corn Leaf Aphid

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
bifenthrin zeta-cypermethrin (Hero [1.24 lb AI/gal prod])	0.04-0.1 lb	4.0-10.3 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** For grain, silage, and seed. Use of Hero on corn is prohibited in all coastal counties. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
chlorpyrifos zeta-cypermethrin (Stallion [3.03 lbs AI/gal prod])	—	9.25-11.75 pt	30 grain and storage, 60 forage	**RESTRICTED USE.** For grain, silage, seed. Make only one at-plant application in-furrow band or T-band treatment; minimum 4-inch band.

Table 4.30 - Corn Leaf Aphid (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
malathion (Malathion 5EC)	1.0 lb	1.5 pt	0	Spray may be applied by air or ground equipment. **Dilute application**: use 20 to 60 gal water/A. **Concentrate application**: use ≥5 gal water/A.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	21	**RESTRICTED USE.** Suppression only. Apply as required by scouting, usually at intervals of 7 or more days. Apply by ground or air using sufficient water for full coverage. **Aerial application:** use ≥2 gal water/A. Do not apply >0.48 pt/A/season. Do not apply >0.24 pt/A after silk initiation. Do not apply >0.12 pt/A after milk stage.
zeta-cypermethrin (Mustang Max)	0.017-0.025 lb	2.72-4.0 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** Use minimum 10 gal water/A.

Japanese Beetle

Japanese Beetle (Adult Feeding) Sampling/Decision Making

Damage is caused when the adult beetles prevent pollination by clipping silks during the early stage of silking. Begin scouting in mid-July before pollination to determine the number of beetles present and the potential for silk clipping damage. Pollination takes place during a period of about 36 hours. If the silks are wilted and/or have turned brown, pollination is complete and further silk feeding will not affect yields. Examine 20 plants in each of 5 locations in the field to determine the stage of pollination, the number of beetles per plant, and the percentage of plants with silks cut back to 0.5 inch or less. An insecticide application may be necessary if 50 percent of the plants have silks cut back to 0.5 inch or less, there is an average of more than 3 Japanese beetles per silk, and the plants are still pollinating.

Table 4.31 - Japanese Beetle

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	1.6-2.8 oz	grain or fodder: 21 Green forages after last application: 0	**RESTRICTED USE.** Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4. Minimum application volume (water): 10 gal/A by ground, 2 gal/A by air.
bifenthrin zeta-cypermethrin (Hero [1.24 lb AI/gal prod])	0.04-0.1 lb	4.0-10.3 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** For grain, silage, and seed. Use of Hero on corn is prohibited in all coastal counties. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
carbaryl (Sevin 80S)	1.0-2.0 lb	1.25-2.5 lb	0	Direct spray to fresh silks. If corn has been pollinated, there usually is no need for control. Most earworm and borer insecticides also will control Japanese beetles.

Table 4.31 - Japanese Beetle (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
chlorpyrifos zeta-cypermethrin (Stallion [3.03 lbs AI/ gal prod])	—	9.25-11.75 oz	30 grain and storage, 60 forage	**RESTRICTED USE.** For grain, silage, seed. Make only one at-plant application in-furrow band or T-band treatment; minimum 4-inch band.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	21	**RESTRICTED USE.** Apply as required by scouting. Apply by ground or air using sufficient water for full coverage. **Aerial application**: use ≥2 gal water/A.
zeta-cypermethrin (Mustang Max)	0.017-0.025 lb	2.72-4.0 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** Use minimum 10 gal water/A.

Fall Armyworm

Fall Armyworm Sampling/Decision Making

Damage occurs during mid-summer through harvest. Scout at least weekly all late plantings of both silage or grain corn before tassel emergence. Examine 20 consecutive plants at each of 5 locations in the field for the presence of whorl feeding. Larvae feed in the whorls of the plants causing a shredded or ragged appearance. They may burrow deep into the whorls and feed on the growing tips. Plants infested with fall armyworms often recover and grow normally without any significant effect on yield. Control at the whorl stage is usually not practical, particularly by air, and should not be attempted unless 75 percent of the plants exhibit whorl feeding and one or more larvae per plant are found. This threshold drops to 50 percent if 2 or more larvae per plant are found. Spray young plants when fall armyworms infest 15 to 20 percent of the plants.

Table 4.32 - Fall Armyworm

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
Optimum® AcreMax™ 1				Product allows growers to reduce their corn rootworm refuge by placing it in the bag. An in-the-bag product that contains 90% of a Pioneer® brand hybrid with Herculex® XTRA (CRW/CB/ LL/RR2) insect protection, and 10% of a Pioneer hybrid – same genetic family – with the Herculex 1 trait (CB/LL/RR2), which serves as the corn rootworm refuge. AcreMax, or some other suitable corn borer refuge corn, allows growers the flexibility to plant their corn borer refuge up to 1/2 mile away.
beta-cyfluthrin (Baythroid XL)	0.022 lb	2.8 oz	grain or fodder: 21 Green forages after last application: 0	**RESTRICTED USE.** Effective against 1st and 2nd instars only. Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4. Minimum application volume (water): 10 gal/A by ground, 2 gal/A by air.

Table 4.32 - Fall Armyworm (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
bifenthrin zeta-cypermethrin (Hero [1.24 lb AI/gal prod])	0.04-0.1 lb	4.0-10.3 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** For grain, silage, and seed. Use of Hero on corn is prohibited in all coastal counties. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
carbaryl (Sevin XLR Plus)	1.0-2.0 lb	2.0-4.0 pt	0	Optimum timing and good coverage are essential for effective control.
carbaryl (Sevin 80S)	1.0-2.0 lb	1.25-2.5 lb	0	See previous remarks.
carbaryl (Sevin 4F)	1.0-2.0 lb	2.0-4.0 pt	0	See previous remarks.
chlorpyrifos zeta-cypermethrin (Stallion [3.03 lbs AI/gal prod])	—	9.25-11.75 oz	30 grain and storage, 60 forage	**RESTRICTED USE.** For grain, silage, seed. Make only one at-plant application in-furrow band or T-band treatment; minimum 4-inch band.
methomyl (Lannate LV) (Lannate SP)	 0.225-0.45 lb 0.225-0.45 lb	 0.75-1.5 pt 0.25-0.5 lb	 3 forage 21 ears 21 fodder	**RESTRICTED USE.** Lannate is considered the insecticide of choice for fall armyworm control. Apply at high rate in a minimum of 50 gal water/A. Spray must be directed into the whorls. Zero days to harvest for ears or 3 days to livestock grazing and feeding.
zeta-cypermethrin (Mustang Max)	0.02-0.025 lb	3.2-4.0 oz	30 grain and stover, 60 forage	**RESTRICTED USE.** Use minimum 10 gal water/A.

Small Grains

D. Ames Herbert Jr., Extension Entomologist, Tidewater AREC

Armyworm

Sampling

Armyworms should be detected while they are still small and easier to control. Check fields once each week starting the 2nd week of May. Examine first the debris and undergrowth on the ground surface along field margins and lodged areas. Small worms usually are found curled in a C-shape around the bases of the plants or under the debris and winter annual weeds. Armyworm frass or droppings also may be found on the soil surface. If small armyworms are present in these areas, obtain 10 to 20 worm counts at 50-pace intervals throughout the field. Note the average size of the worms, and whether any defoliation of the flag leaf and/or head clipping has occurred.

Decision Making

Parasites, diseases, insect predators, and birds usually keep armyworms under control in small grains. However, the effectiveness of these natural control agents is reduced during cool, wet springs and during growing seasons that follow years of drought.

As a general rule, barley should be treated if the number of armyworms exceeds one per linear foot between rows and most of the worms are greater than 0.75-inch long. In wheat, armyworms tend to nibble on the tips of kernels rather than clip heads; thus, populations of two to three worms per linear foot between rows are required to justify control. In high management wheat fields with 4-inch rows, treatment is recommended when armyworm levels exceed 3 to 5 per square foot of surface area, or per linear foot of row.

Note that wheat fields with mixed infestations of armyworms and sawfly caterpillars may need treatment even if worm counts of each pest do not exceed threshold levels. Also, if the grain crop is close to harvest or the majority of armyworms are longer than 1.5 inches and no head clipping has occurred, control may not be needed.

Table 4.33 - Recommended Insecticides for Armyworm Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.014-0.019 lb	1.8-2.4 oz	30	Do not graze or forage within 7 days.
chlorantraniliprole (Prevathon)	0.047-0.067 lb	14.0-20.0 oz	14	
chlorantraniliprole + lambda-cyhalothrin (Besiege)	0.05-0.078 lb	5.0-8.0 oz	30	**RESTRICTED USE.**
lambda-cyhalothrin (Kaiso 24WG) (Karate Z) (Warrior T)	 0.015-0.25 lb 0.02-0.03 lb 0.02-0.03 lb	 1.0-1.67 oz 1.28-1.92 oz 2.56-3.84 oz	 30 30 30	**RESTRICTED USE.** Do not apply more than 7.68 oz per acre per season. Wheat, wheat hay, and triticale only (Kaiso).
methomyl (Lannate LV) (Lannate SP)	 0.225-0.45 lb 0.225-0.45 lb	 0.75-1.5 pt 0.25-0.5 lb	 7 7	**RESTRICTED USE.** Do not graze or feed treated forage or hay to livestock within 10 days of last treatment.
microencapsulated methyl parathion (Penncap-M 2F)	0.5-0.75 lb	2.0-3.0 pt	15	**RESTRICTED USE.** Do not apply within 15 days of harvest or grazing.
spinetoram (Radiant SC)	0.023-0.047 lb	3.0-6.0 oz	21	Do not apply within 21 days of grain or straw harvest or within 3 days of forage, fodder, or hay harvest.

Table 4.33 - Recommended Insecticides for Armyworm Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
spinosad (Blackhawk) (fall armyworm)	 0.025-0.074 lb 0.038-0.074 lb	 1.1-3.3 oz 1.7-3.0 oz	 21 21	Barley, buckwheat, oats, rye, triticale, wheat. Do not apply within 21 days of grain or straw harvest or within 3 days of forage, fodder, or hay harvest.
zeta-cypermethrin (Mustang Max)	 0.011-0.025 lb	 1.76-4.0 oz	 14	**RESTRICTED USE.** Wheat and triticale only.

Aphids

Grain Aphids at Tillering during Fall and Early Spring

Sampling

Grain aphids usually are held in check by their natural enemies, which include predators, parasites, and fungal diseases. When looking for aphids, it is important to recognize these natural enemies. Check grain fields each week starting in the fall or early spring if damage symptoms are evident. Infestations of aphids, particularly the greenbug and corn leaf aphid, occasionally build up in the fall. Symptoms are often first noticed as circular, yellow to brown spots with dead plants in the center. These spots may increase in size if the infestation is allowed to persist. To determine aphid activity on tillering grain, examine 20 sites throughout the field. Each site should consist of at least 5 linear feet of a row. Look at areas in the field that are showing plant stress symptoms. Aphid damage may be confused with moisture stress and/or nitrogen deficiency. Count the number of aphids on small plants and, if aphids are numerous, estimate the numbers per linear foot of a row of larger plants. Make a tally of the proportion of each species, particularly if greenbugs are present.

Decision Making

Treatment during the fall and early spring is not often necessary, but may be needed if infestations are threatening and the weather is unusually mild. Treatment is suggested if aphid counts exceed 150 per linear foot of row throughout the majority of the field and a low degree of beneficial insect activity is present. The greenbug can be the most destructive because of the toxic substances it secretes during feeding, so maintain close surveillance of fields if this aphid is the predominate species. One exception to the treatment threshold applies to wheat under intensive-management practices grown in Virginia, where the transmission of virus diseases by aphids is more prevalent. Treatment of intensive management wheat in Virginia is suggested based on the following threshold table:

Table 4.34 - Aphid Numbers

Time of year	Suggested number needed to treat
Fall	
Plant until spring growth begins	15-25/row-foot and yellowing areas scattered throughout the field.
Spring	
After spring growth resumes until hard-dough stage	100/row-foot, plants 3-6 inches tall 200/row-foot, plants 7-10 inches tall 300/row-foot, plants 11+ inches tall
Heading	20-25/grain head

Grain Aphids During the Grain Head Stage

Sampling

To determine aphid activity after the grain heads form, count the number of aphids on 100 heads throughout the field. Do not bias sampling by checking a few heads along the field margins where infestations usually are higher. Check for natural enemies at the same time that aphids are being counted. Aphids usually are clustered as colonies among bracts of the grain head and may move slightly when disturbed. Anything that actively moves when disturbed is probably a predator. Make a note of the ratio of predators to aphids.

Decision Making

The need for treatment depends primarily on the number of aphids, plant maturity, and the presence of natural enemies. Treatment during the grain head stage is generally considered when aphid numbers exceed more than 25 per head, especially if the crop is late, when cool weather is forecast and the natural enemy complex is lacking. Control is not advised if the crop is approaching the hard dough stage where there is good predator/parasite activity. Ratios of one or more predators to every 50 to 100 aphids are sufficient to achieve biological control.

Table 4.35 - Recommended Insecticides for Aphid Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
Seed Treatments				
imidacloprid (Gaucho XT) + metalaxyl + tebuconazole	0.43 oz 0.03 oz 0.02 oz	3.4 oz/cwt – –	N/A – –	For wheat and barley. Do not graze or feed livestock on treated areas for 45 days after planting.
thiamethoxam (Cruiser 5FS)	0.47-0.83 oz	0.75-1.33 oz/cwt	N/A	For wheat and barley. 120-day plantback restriction on certain non-labeled crops.
Foliar Treatments				
beta-cyfluthrin (Baythroid XL)	0.014-0.019	1.8-2.4 oz	30	Do not graze or forage within 7 days.
chlorantraniliprole + lambda-cyhalothrin (Besiege)	0.058-0.098 lb	6.0-10.0 oz	30	**RESTRICTED USE.**
dimethoate (Dimethoate 4EC) (Dimethoate 2.67EC)	0.25-0.38 lb 0.25-0.33 lb	0.5-0.75 pt 0.75-1.0 pt	35 35	May not give acceptable control below 60°F. Do not apply within 14 days of grazing. Labeled for use on wheat only. Do not make more than 2 applications/season.
flupyradifurone (Sivanto)	0.09-0.137 lb	7.0-10.5 oz	21	
lambda-cyhalothrin (Karate Z) (Warrior T)	0.02-0.03 lb 0.02-0.03 lb	1.28-1.92 oz 2.56-3.84 oz	30 30	**RESTRICTED USE.** Do not apply more than 7.68 oz per acre per season.
lambda-cyhalothrin + thiamethoxam (Endigo ZC)	0.023+0.03 lb - 0.031+0.04 lb	3.5-4.5 oz	30	**RESTRICTED USE.** Barley only. Do not allow livestock to graze in treated areas or harvest treated forage as feed for meat or dairy animals within 30 days after treatment.
Malathion 57 EC	1.0 lb	1.5 pt	7	Barley and wheat.
zeta-cypermethrin (Mustang Max)	0.02-0.025 lb	3.2-4.0 oz	14	**RESTRICTED USE.** Wheat and triticale only. Aids in control.

Cereal Leaf Beetle

Sampling

In many areas of the mid-Atlantic states, cereal leaf beetle eggs are heavily parasitized; thus, the larval stage is the best indicator of the potential yield loss. Once a week, make field inspections of wheat starting in early May and of spring oats starting by mid-May. Examine the flag leaf of wheat or the entire tiller of oats on 5 plants at each of 10 locations in the field. Count the number of larvae per flag leaf or tiller and note any defoliation.

Decision Making

A number of introduced parasites have been instrumental in keeping cereal leaf beetle populations below economic damage levels. Also, favorable planting dates may help suppress populations. Wheat planted early in the fall immediately after the Hessian fly-free date will be more advanced in growth the next spring than late-planted small grains. These early plantings will be less attractive to and more tolerant of the beetles when they peak in the spring. Cereal leaf beetle infestations on spring-planted oats cannot be avoided by means of planting date. Generally, barley is more advanced in maturity and thus less attractive when beetles are active.

Cereal leaf beetle infestations have become more widespread in the last few years. Adults move into small grain in late February and early March and deposit eggs which hatch into larvae. Larvae feed on grain stripping leaves of valuable photosynthetic tissue. New research indicated that damage to both flag and stem leaves reduces yield. New research showed that the best control is achieved if treatments are applied when larvae are small. Treatment should be considered if 25, total, eggs and small larvae are found on 100 stems. Of that 25, at least 1/2 should be larvae. Once wheat reaches the hard dough stage, beetle damage has little effect on yield and controls are not needed.

Table 4.36 - Recommended Insecticides for Cereal Leaf Beetle Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.008-0.014 lb	1.0-1.8 oz	30	Do not graze or forage within 7 days.
carbaryl				Apply to wheat only. No time limits on use as pasture or forage.
(Sevin XLR PLUS)	1.0 lb	2.0 pt	21	
(Sevin 80S)	1.25 lb	1.0 lb	21	
(Sevin 4F)	1.0 lb	2.0 pt	21	
chlorantraniliprole + lambda-cyhalothrin (Besiege)	0.058-0.098 lb	6.0-10.0 oz	30	**RESTRICTED USE.**
lambda-cyhalothrin + thiamethoxam (Endigo ZC)	0.023+0.03 lb - 0.031+0.04 lb	3.5-4.5 oz	30	**RESTRICTED USE.** Barley only. Do not allow livestock to graze in treated areas or harvest treated forage as feed for meat or dairy animals within 30 days after treatment.
lambda-cyhalothrin				**RESTRICTED USE.**
(Karate Z)	0.02-0.03 lb	1.28-1.92 oz	30	Do not apply more than 7.68 oz per acre per season.
(Warrior T)	0.02-0.03 lb	2.56-3.84 oz	30	
Malathion 57EC	1.0 lb	1.5 pt	7	Barley and wheat.
methomyl				**RESTRICTED USE.**
(Lannate LV)	0.225-0.45 lb	0.75-1.5 pt	7	Do not graze or feed treated forage or hay to livestock within 10 days of last treatment.
(Lannate SP)	0.225-0.45 lb	0.25-0.5 lb	7	
spinetoram (Radiant SC)	0.016-0.047 lb	2.0-6.0 oz	21	Do not apply within 21 days of grain or straw harvest or within 3 days of forage, fodder, or hay harvest.
zeta-cypermethrin (Mustang Max)	0.011-0.025 lb	1.76-4.0 oz	14	**RESTRICTED USE.** Wheat and triticale only.

Hessian Fly

The Hessian fly is not a major pest in the mid-Atlantic states because small grains normally are planted after the adult flies occur ("fly-safe" date). There are no insecticidal control measures that can be applied once the field becomes infested. Control is based entirely upon prevention. The important components of preventative fly management include: planting wheat only after the fly-safe planting date; destroying volunteer wheat plants by tillage methods; and planting resistant varieties, especially when planting very early. Check the following tables for the fly-safe dates in your area and contact your local Extension agent for information on resistant varieties. In Virginia, it is generally thought that the fly-safe date is around Oct. 20. However, flies can infest fields planted after that date by moving from volunteer grain plants in or from nearby fields.

Table 4.37 - Safe Planting Dates

Maryland counties					
Anne Arundel	Oct. 7	Dorchester	Oct. 9	Queen Anne's	Oct. 7
Allegany	Sept. 27	Frederick	Oct. 2	St. Mary's	Oct. 9
Baltimore	Oct. 2	Garrett	Sept. 20	Somerset	Oct. 10
Calvert	Oct. 8	Harford	Oct. 1	Talbot	Oct. 8
Caroline	Oct. 7	Howard	Oct. 2	Washington	Oct. 1
Carroll	Sept. 28	Kent	Oct. 6	Wicomico	Oct. 10
Cecil	Oct. 3	Montgomery	Oct. 4	Worcester	Oct. 11
Charles	Oct. 8	Prince George's	Oct. 7		
Delaware counties					
New Castle	Oct. 3	Kent	Oct. 8	Sussex	Oct. 10

Sorghum

Curt Laub, Research Associate, Virginia Tech

Greenbug Aphid

Sampling/Decision Making

A minimum of 40 randomly selected plants per field should be examined each week. Aphids are seldom evenly distributed across a field, so examine plants from all parts of the field. Avoid examining only field borders. Examine a greater number of plants in fields larger than 80 acres or if making a control decision is difficult.

Consider these factors when making a control decision: the estimates for aphids per plant, leaf damage, percentage parasitized aphids (mummies), and appropriate number of greenbug predators per plant.

Table 4.38 - Greenbug Aphid Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
malathion (Malathion 5EC = 57% EC)	0.94 lb	1.5 pt	7	
dimethoate (Dimethoate 4E)	0.25-0.5 lb	0.5-1.0 pt	28	48 hour restricted entry interval. Do not feed or graze within 28 days of last application. Make no more than 3 applications/ season. Do not apply after heading. **Ground application**: use 25 to 40 gal water/A. **Aerial application**: use ≥1 gal water/A.
chlorpyrifos (Lorsban 4E)	0.25-1 lb	0.5-2.0 pt	30	**RESTRICTED USE.** 24 hour restricted entry interval. Do not apply to sweet sorghum. To minimize chemical injury, do not apply Lorsban 4E to drought stressed grain sorghum within 3 days following irrigation or rain except where the product is applied in irrigation water.

Table 4.39 - Greenbug, English Grain Aphid, Bird Cherry-Oat Aphid Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
clothianidin (Poncho 600) Seed treatment	–	5.1-6.4 oz/100 lbs seed	–	Apply prior to planting to provide early season protection of seedlings. Avoid breathing dust and contact with skin and eyes. Poncho aids in control of greenbug, yellow sugarcane aphid, corn leaf aphid, English grain aphid, chinch bugs, white grubs, and wireworms.
thiamethoxam (Cruiser 5FS) Seed treatment	–	5.1-7.6 oz/100 lbs seed	–	Apply prior to planting to provide early season protection of seedlings. Avoid breathing dust and contact with skin and eyes. Cruiser aids in control of greenbug, yellow sugarcane aphid, corn leaf aphid, chinch bugs, fire ants, seedcorn maggot, and wireworms.
zeta-cypermethrin (Mustang Max)	0.02-0.025 lb	3.2-4.0 oz	14 grain and stover 45 forage	**RESTRICTED USE.** Minimum 10 days between applications. Do not apply >0.125 lb active ingredient/A/ season.

Table 4.40 - Treatment Thresholds for Greenbug Aphids

Plant size	When to treat
Emergence to about 6 in	Visible damage (plants beginning to yellow) with colonies of greenbugs on plants.
Larger plant to boot	Aphid colonies causing red spotting or yellowing of leaves. Before any entire leaves are killed.
Boot to heading	Before the death of one functional leaf.
Heading to hard-dough	When aphid numbers cause death of two normal-sized leaves.

If more than 20% of the greenbugs appear brown and swollen from being parasitized, and lady bird beetles, lacewing larvae, and syrphid fly larvae are active, then treatment generally is not necessary

Fall Armyworm (in Whorls)

Table 4.41 - Fall Armyworm (in Whorls) Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.010-0.022 lb	1.3-2.8 oz	14	**RESTRICTED USE.** Effective against first and second instars only. Maximum allowed per 10-day interval: 2.8 oz/a. Maximum allowed per crop season: 8.4 oz/a. Minimum application volume (water) is 10 GPA by ground and 2 GPA by air.
methomyl (Lannate LV) (Lannate SP)	 0.225-0.45 lb 0.225-0.45 lb	 0.75-1.5 pt 0.25-0.5 lb	 14 14	**RESTRICTED USE.** Fall armyworm can be difficult to control. Use ground application or application from helicopter only with high volume. Direct spray into whorls. Treat at 80% infestation (one worm/plant) or 40% infestation (multiple worms/plant). Treat when caterpillars are small.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	30	**RESTRICTED USE.** For control of first and second instars only. Apply as required by scouting, usually at intervals of 5 or more days. Apply by ground or air using sufficient water for full coverage. **Aerial application**: use ≥2 gal water/A. Do not apply >0.32 pt/A per season. In soft dough stage, do not apply >0.08 pt/A per season

Corn Earworm and Fall Armyworm

Sampling/Decision Making

Pre-headed sorghum: ragged shothole damage may be evident and at times 40-60% of plant will have dramatic heavy leaf damage, but worm control in the whorl stage is rarely justified. Late-whorl heading: begin to sample heads soon after flowering and continue until the soft dough stage is reached. Sample minimum of 200 plants at 20 sites within a small field of 10 acres or less. Treat only when larvae damage the head or the developing growing point and worms average 2 or more per head. Open-headed hybrids are damaged less than the compact or closed-headed types.

Sorghum Webworm Sampling

Decision Making

Make frequent head inspections when sorghum is beginning to flower and continue at 5-day intervals until hard dough. To examine heads for sorghum webworm, beat heads on a piece of paper or white handkerchief. Small larvae (less than 1/8-inch long) commonly overlooked during head inspections, will be detected with this method.

Application of an approved insecticide is suggested when five or more small larvae are found per head.

Table 4.42 - Corn Earworm, Fall Armyworm, and Sorghum Webworm (in Seed Heads)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.010-0.022 lb	1.3-2.8 oz	14	**RESTRICTED USE.** For fall armyworm, product is only effective against first and second instars. Maximum allowed per 10-day interval: 2.8 oz/a. Maximum allowed per crop season: 8.4 oz/a. Minimum application volume (water) is 10 GPA by ground and 2 GPA by air.
carbaryl				Direct spray into forming heads for optimum insect control.
(Sevin XLR Plus)	1.0-2.0 lb	2.0-4.0 pt	21 grain, 14 grazing or silage	
(Sevin 4F)	1.0-2.0 lb	2.0-4.0 pt		
(Sevin 80 Solpak)	1.0-2.0 lb	1.25-2.5 lb		
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	30	**RESTRICTED USE.** Apply as required by scouting, usually at intervals of 5 or more days. Apply by ground or air, using sufficient water for full coverage. **Aerial application**: use ≥2 gal water/A Do not apply >0.32 pt/A per season. In soft dough stage, do not apply >0.08 pt/A per season.
methomyl				**RESTRICTED USE.**
(Lannate LV)	0.225-0.45 lb	0.75-1.5 pt	14	48 hour restricted entry interval. Methomyl is product of choice for fall armyworm control. Apply at 50% bloom and 3 to 5 days later if needed. Use higher rates for serious infestations and for aerial applications. Threshold is 1 medium-to-large earworm or armyworm/head or 3 webworms/head.
(Lannate SP)	0.225-0.45 lb	0.25-0.5 lb	14	
zeta-cypermethrin (Mustang Max)	0.011-0.025 lb	1.76-4.0 oz	14 grain and fodder 21 forage/ silage	**RESTRICTED USE.** Minimum 10 days between applications. Do not apply >0.125 lb active ingredient/A/season.

Sorghum Midge Sampling

Decision Making

Adult midges do not damage sorghum, but midge larvae feed on and destroy developing seeds during the bloom period. To determine the presence of sorghum midge, fields should be inspected during midmorning until shortly after noon when midges are most active. During the sorghum bloom period, inspect fields daily or every other day to detect sorghum midges. Midge adults can be detected crawling on or flying about flowering grain heads. Use of a clear plastic bag as a trapping device quickly slipped over sorghum heads is helpful in detecting and counting midge adults. Windy weather conditions make midges more difficult to locate and sample accurately.

To determine the need for chemical control, an assessment of crop development, yield potential and midge density is required. Daily evaluation of these factors is encouraged during flowering.

Midge resistant sorghum hybrids are available commercially and, within limits, provide an additional management tool. At similar infestation levels of ovipositing midge females, resistant hybrids generally suffer one-third the damage that susceptible sorghum hybrids suffer. The antibiosis resistance increases the economic threshold level to five adults per head during flowering compared with one midge per head for susceptible hybrids. When adult midge densities exceed five per panicle during flowering in resistant hybrids, insecticide applications at 5-day intervals are required.

Table 4.43 - Sorghum Midge Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.008-0.01 lb	1.0-1.3 oz	14	**RESTRICTED USE.** Maximum number of applications per season is 6. Minimum application volume (water) is 10 GPA by ground and 2 GPA by air.
lambda-cyhalothrin (Karate [2.08EC]) (Warrior II [2.08EC])	0.015-0.02 lb	0.96-1.28 oz	30	**RESTRICTED USE.** Apply as required by scouting, usually at intervals of 5 or more days. Apply by ground or air, using sufficient water for full coverage. **Aerial Application**: Use ≥2 gal water/A. Do not apply >0.32 pt/A/season. In soft dough stage, do not apply >0.08 pt/A per season.
chlorpyrifos (Lorsban 4E)	0.25 lb	0.5 pt	30	**RESTRICTED USE.** 24 hour restricted entry interval. Apply when 30 to 50% of the seed heads are in bloom, repeat at 3-day intervals if needed. Do not apply to sweet sorghum. To minimize chemical injury, do not apply Lorsban 4E to drought stressed grain sorghum within 3 days following irrigation or rain except where the product is applied in irrigation water.
dimethoate (Dimethoate 4E)	0.125-0.25 lb	0.25-0.5 pt	28	48 hour restricted entry interval. Do not feed or graze within 28 days of last application. Make no more than 3 applications/ season. Do not apply after heading. **Ground application**: use 25 to 40 gal water/A. **Aerial application**: use ≥1 gal water/A.
methomyl (Lannate LV) (Lannate SP)	 0.225-0.45 lb 0.225-0.45 lb	 0.75-1.5 pt 0.25-0.5 lb	 14 14	**RESTRICTED USE.** 48 hour restricted entry interval. Apply at 50% bloom and 3 to 5 days later if needed.
zeta-cypermethrin (Mustang Max)	0.008-0.025 lb	1.28-4.0 oz	14 grain and fodder 21 forage/ silage	**RESTRICTED USE.** Minimum 10 days between applications. Do not apply >0.125 lb active ingredient/A/ season.

Soybeans

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Essentials of a Good Soybean Insect Pest Management Program

Know Soybean Insect Pests

It is very important that you know how to identify common soybean insect pests, and when they are most likely to occur. Different pest species have different economic thresholds and can require different insecticides for effective control. Various Virginia Cooperative Extension publications are available that can be useful in identifying insect pests. Also, consult your local Extension agent.

Know Pest Economic Thresholds

An economic threshold is the number of a particular insect pest that must be controlled to prevent economic loss to the crop. Thresholds have been established through many scientific studies. A treatment before a pest has reached its economic threshold usually will not pay and may cause an increase in other pests, requiring a second insecticide treatment.

Know What Crop Growth Stages Are Most Susceptible to Insect Attack

Leaf feeding insects can attack soybeans at almost any time during the season. Usually leaf feeding occurs continually throughout the season resulting in cumulative leaf damage. New research is showing that full-season and double-crop planting systems may react differently to this leaf damage. Soybean yield appears to be highly related to total leaf area, as measured by LAI (leaf area index). To achieve maximum yield potential, soybeans must develop an LAI of 3.5 to 4.0 or above. An easy way to visualize LAI is to think of a field with an LAI of 4 and having 4 acres of leaf area for every acre of ground. Any leaf canopy above that can be removed (for example: by insect leaf feeders) without reducing the yield potential. Most full-season plantings achieve larger leaf canopies and LAIs, regardless of the climatic conditions (temperature, cloud cover, or rainfall) during the season and are much more tolerant of leaf feeding. However, double-crop plantings do not always achieve as large a leaf canopy and therefore can be more sensitive to defoliation by insects. Until our research is completed, we feel that the "traditional" percent defoliation thresholds (40% prior to bloom, 15% from flowering to pod fill, 35% after pod fill) should only be applied to full-season plantings, or double-crop plantings that, because of good growing conditions, achieve large canopies. Be more conservative with double-crop plantings that do not achieve large canopies due to very late planting, dry conditions, poor soil, or other factors that result in less than optimal growth. With these plantings, allow lower levels of leaf loss before making insecticide treatments. Suggested thresholds for poor growth double-crop plantings are: 20% prior to bloom, 10% from flowering to pod fill, 15% after pod fill.

Know What Conditions Predispose Soybeans to Insect Injury

Corn earworm damage is typically most severe in fields with open leaf canopies, ones having flowers or young pods, or fields under some degree of drought or nematode stress. Therefore, soybeans planted late after small grain or planted in fields affected by drought or nematodes should be watched more closely. In dry seasons, all fields should be watched more closely.

Stay Informed of Current Pest Status

A corn earworm advisory is issued weekly to Virginia Cooperative Extension agents and to some local newspapers from August through September when most soybeans in Virginia are in stages susceptible to corn earworm attack. These advisories summarize current moth activity as monitored by a system of blacklight and pheromone traps. Earworm infestations, if they occur, will most likely follow peak moth activity periods by 8 to 10 days. Stay informed about the moth situation in your area and intensify your scouting efforts during critical periods.

Scout Field Regularly

Scouting (described below) is an essential part of successful economic management of insect pests. You must know what kind and how many insects are in your fields before making treatment decisions. **Do not apply insecticides unless you have confirmed that a real problem exists in your fields.**

Mexican Bean Beetle, Green Cloverworm, Bean Leaf Beetle

Sampling

Check for overwintered Mexican bean beetles as soon as the plants emerge, and first examine the field margins next to overwintering areas. Determine the extent of the infestation because feeding injury usually is not evenly distributed during the early season. Count the number of beetles over a 3-foot section of row in at least five locations in the infested area. Estimate the level of stand reduction if seedlings are killed, or estimate the percentage of defoliation on older plants. Bean leaf beetles also may cause damage to young soybean plants. These insects prefer tender plant tissue and leave rounded holes on leaves. This type of leaf injury is distinguishable from the lacelike injury caused by Mexican bean beetles.

Mexican bean beetle and green cloverworm infestations usually do not reach economic levels before August. Early-planted, full-season soybeans usually attract more colonizing beetles than do later fields. However, double-crop fields may become infested with adults that are moving out of maturing fields late in the season in search of more succulent foliage. Start scouting for both insect pests at least weekly during late July through September. Examine the entire field because larval populations may be localized. Check the undersides of leaves on plants and keep a tally of the number of egg masses, young larvae, older larvae, pupae, and adults. When possible, use a drop cloth to determine numbers in fields with wide rows. Estimate defoliation to the nearest 10 percent on 20 to 30 plants selected throughout the field. Each plant should be pulled up to examine the total leaf area; not just the upper canopy leaves.

When sampling, remember to check for diseased or parasitized larvae because the natural enemies play an important role in controlling these pests. Mexican bean beetles may be suppressed if you release parasitic wasps. The State Departments of Agriculture and grower cooperatives sponsor parasite release programs in several states in the mid-Atlantic area. These tiny parasites, released at carefully managed nursery plots each year, attack the older larvae and help to keep Mexican bean beetle populations below damaging levels. Clover worms are killed by a fungal disease which causes larvae to become hard, mummified, and covered with powdery white to light green spores. The presence of diseased worms usually signals the decline of the pest population.

Decision Making

Spray only when Mexican bean beetles and/or leaf-feeding caterpillars are actively feeding. At seedling, spray when defoliation reaches 40 percent with 2 to 3 beetles per plant throughout the field. At prebloom, spray when defoliation exceeds 30 percent, with 20 or more adults and/or larvae per 3-foot row. At bloom and podset, spray when defoliation exceeds 15 percent, with 16 or more adults and/or larvae per 3-foot of row. Consider the relative size and age composition of the population. If eggs and pupae of the Mexican bean beetle are the predominant stages it is advisable to wait until egg hatch or adult emergence before treating. Also consider the presence of natural controls, such as cloverworms infected with fungal disease or parasitized Mexican bean beetle larvae (mummies).

Table 4.44 - Recommended Insecticides for Mexican Bean Beetle, Green Cloverworm, and Bean Leaf Beetle Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97)	0.73-0.97 lb	0.75-1.0 lb	14	
beta-cyfluthrin (Baythroid XL) (Mexican bean and bean leaf beetle)	0.0125-0.022 lb	1.6-2.8 oz	45	**RESTRICTED USE.** Green forage may be fed 15 days after last application.
(green cloverworm)	0.0065-0.0125 lb	0.8-1.6 oz		
beta-cyfluthrin + imidacloprid (Leverage 360)	0.02-0.04 lb	2.8 oz	45	**RESTRICTED USE.**
bifenthrin (Brigade 2EC)	0.033-0.1 lb	2.1-6.4 oz	18	**RESTRICTED USE.**

Table 4.44 - Recommended Insecticides for Mexican Bean Beetle, Green Cloverworm, and Bean Leaf Beetle Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
chlorantraniliprole (Prevathon)	0.047-0.066 lb	14.0-20.0 oz	21	
chlorpyrifos (Lorsban 4E) (bean leaf beetle) (green cloverworm) (Mexican bean beetle)	 0.5-1.0 lb 0.25-0.5 lb 0.5-0.75 lb	 1.0-2.0 pt 0.5-1.0 pt 1.0-1.5 pt	28	Do not feed or graze livestock on treated plants.
chlorpyrifos + lambda-cyhalothrin (Cobalt Advanced) (green cloverworm) (Mexican bean beetle and bean leaf beetle)	 0.12 + 0.006 – 0.25 + 0.013 lb 0.31 + 0.016 – 0.74 + 0.038 lb	 6.0-13.0 oz 16.0-38.0 oz	30	**RESTRICTED USE.**
esfenvalerate (Asana XL) (bean leaf beetle)	 0.015-0.03 lb 0.03-0.05 lb	 2.9-5.8 oz 5.8-9.6 oz	21	**RESTRICTED USE.** Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai per acre per season. Extremely toxic to fish.
flubendiamide (Belt SC) (green cloverworm)	0.0625 lb	2.0 oz	14	
indoxacarb (Steward EC) (green cloverworm)	0.045-0.11 lb	4.6-11.3 oz	21	
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.016 +0.033lb-0.026 + 0.052 lb	5.0-8.0 oz	30	**RESTRICTED USE**
lambda-cyhalothrin (Karate Z) (Warrior T)	 0.015-0.025 lb 0.015-0.025 lb	 0.96-1.6 oz 1.92-3.2 oz	 45 45	**RESTRICTED USE**. Do not apply more than 7.68 oz per acre per season. Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
Malathion 57EC	1.9 lb	3.0 pt	0	

Table 4.44 - Recommended Insecticides for Mexican Bean Beetle, Green Cloverworm, and Bean Leaf Beetle Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
methomyl (Lannate LV) (green cloverworm and Mexican bean beetle)	0.12-0.225 lb	0.4-0.75 pt	14	**RESTRICTED USE.** Wait 3 days to feed or graze as forage or 7 days for hay. Up to 2 applications may be used.
(Lannate SP) (green cloverworm and Mexican bean beetle)	0.11-0.225 lb	0.125-0.25 lb	14	
(Lannate LV) (bean leaf beetle)	0.225-0.3 lb	0.75-1.0 pt	14	
(Lannate SP) (bean leaf beetle)	0.225-0.34 lb	0.25-0.375 lb	14	
methoxyfenozide (Intrepid 2F) (green cloverworm)	0.06-0.12 lb	4.0-8.0 oz	7 (hay/forage) 14 (seed)	
spinetoram (Radiant SC)	0.15-0.31 lb	2.0-4.0 oz	28	
spinosyn (Blackhawk) (green cloverworm)	0.025-0.05 lb	1.1-2.2 lb	28	Do not feed treated forage or hay to meat or dairy animals.
thiamethoxam + lambda-cyhalothrin (Endigo ZC) (bean leaf beetle)	0.064-0.072 lb	4.0-4.5 oz	30	**RESTRICTED USE.** Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
zeta-cypermethrin (Mustang Max)	0.0175-0.025 lb	2.8-4.0 oz	21	**RESTRICTED USE.** Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

Thrips

Sampling/Decision Making

Thrips rarely require treatment; however, early season injury to drought-stressed plants may occasionally reduce yields. Both nymphs and adults feed on the undersides of the leaves, causing small, silvery streaks and whitish or yellowish discoloration. Treatment may be required when injury appears on drought-stressed plants and more than eight thrips per leaflet are found. Treatment is not recommended in non-stressed fields because soybeans can tolerate thrips injury.

Table 4.45 - Recommended Insecticides for Thrips Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97)	0.24-0.49 lb	0.25-0.5 lb	14	
beta-cyfluthrin (Baythroid XL)	0.0065-0.0125 lb	0.8-1.6 oz	45	**RESTRICTED USE.** Green forage may be fed 15 days after last application.
bifenthrin (Brigade 2EC)	0.033-0.1 lb	2.1-6.4 oz	18	**RESTRICTED USE.**
chlorpyrifos + lambda-cyhalothrin (Cobalt Advanced)	0.31 + 0.016 – 0.74 + 0.038 lb	16.0-38.0 oz	30	**RESTRICTED USE.**
clothianidin + ipconazole + metalaxyl (Inovate - Nipsit Inside + Rancona Xxtra)	—	4.78 oz/cwt		Seed treatment. Do not graze or feed soybean forage and hay to livestock.
imidacloprid (Gaucho 600)	1.0 oz/cwt	1.6 oz/cwt	N/A	Seed treatment.
methomyl (Lannate LV) (Lannate SP)	0.225-0.3 lb 0.225-0.34 lb	0.75-1.0 pt 0.25-0.375 lb	14 14	**RESTRICTED USE.** Wait 3 days to feed or graze as forage or 7 days for hay. Up to two applications may be used per season.
thiamethoxam (Cruiser 5FS)	0.8 oz/cwt	1.28 oz/cwt	N/A	Seed treatment.
zeta-cypermethrin (Mustang Max)	0.02-0.025 lb	3.2-4.0 oz	21	**RESTRICTED USE.** Aids in control. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

Potato Leafhopper

Sampling/Decision Making

Leafhoppers attack soybeans during late June through July but rarely reach population levels that affect yields. Using a standard 15-in sweep net, take five sweeps in each of five locations in the field. Count the number of leafhoppers and empty the net before proceeding to the next location. A single sweep consists of a swath of the net along the row in the top one-third of the plant in one direction only.

The symptoms of leafhopper injury include localized stippling, curling, and yellowing of leaf margins. Treatment is suggested when injury appears and infestations exceed four leafhoppers per sweep in stressed beans or eight leafhoppers per sweep in normal growing fields. Dense pubescent varieties are less susceptible.

Table 4.46 - Recommended Insecticides for Potato Leafhopper Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97)	0.49-0.97 lb	0.5-1.0 lb	14	
beta-cyfluthrin (Baythroid XL)	0.0065-0.0125 lb	0.8-1.6 oz	45	**RESTRICTED USE.** Green forage may be fed 15 days after last application.
bifenthrin (Brigade 2EC)	0.033-0.1 lb	2.1-6.4 oz	18	**RESTRICTED USE.**
chlorpyrifos + lambda-cyhalothrin (Cobalt Advanced)	0.31 + 0.016 – 0.74 + 0.038 lb	16.0-38.0 oz	30	**RESTRICTED USE.**
esfenvalerate (Asana XL)	0.015-0.03 lb	2.9-5.8 oz	21	**RESTRICTED USE.** Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai per acre per season. Extremely toxic to fish.
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.016 + 0.033 lb – 0.026 + 0.052 lb	5.0-8.0 oz	30	**RESTRICTED USE.**
lambda-cyhalothrin (Karate Z) (Warrior T)	0.015-0.025 lb 0.015-0.025 lb	0.96-1.6 oz 1.92-3.2 oz	45 45	**RESTRICTED USE**. Do not apply more than 7.68 oz per acre per season. Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
thiamethozam + lambda-cyhalothrin (Endigo ZC)	0.056-0.064 lb	3.5-4.0 oz	30	**RESTRICTED USE.** Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
zeta-cypermethrin (Mustang Max)	0.0175-0.025 lb	2.8-4.0 oz	21	**RESTRICTED USE.** Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

Spider Mites

Sampling/Decision Making

Mite outbreaks usually are associated with hot, dry weather, which accelerates reproduction and development. During periods of high humidity and field moisture, a fungal disease can reduce populations but high temperatures can nullify these effects. Outbreaks also are associated with the application of certain insecticides that kill natural enemies and/or seem to make the soybean plant more nutritionally suitable for mites.

Check weekly for mites, starting in early July through August, especially during a hot, dry season. Concentrate on the field borders and look for the early signs of white stippling at the bases of the leaves. Do not confuse mite damage with dry weather injury, mineral deficiencies, and herbicide injury. If feeding injury is evident, press the undersides of a few damaged leaves on white paper to reveal any crushed mites. Determine the extent of the infestation and assess the level of injury by examining 20 to 30 plants in the infested area. Field infestations often show defoliated or injured plants at some localized point, with injury becoming less evident and extending in a widening arc into the field.

If isolated spots of mite activity are confined to the perimeter of the field, spot-treatment using ground equipment is recommended to prevent further spread of mites into the field. If the infestation is distributed throughout the interior of the field, treatment of the entire field is suggested if live mites are numerous (20 to 30 per leaflet) and more than 50 percent of the plants show stippling, yellowing, or defoliation over more than one-third of the leaves. If rains come, mite development and survival will decrease but may not drop to economic levels if heavy populations are developing under high temperatures.

Table 4.47 - Recommended Insecticides for Spider Mite Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
bifenthrin (Brigade 2EC)	0.08-0.1 lb	5.12-6.4 oz	18	**RESTRICTED USE.**
chlorpyrifos (Lorsban 4E)	0.25-0.5 lb	0.5-1.0 pt	28	**RESTRICTED USE**. May need second spray 4 to 5 days after initial treatment to control newly hatched mites. Do not graze or feed forage within 14 days after application. Use of vegetable oil as an adjuvant may improve control during hot weather.
dimethoate (Dimethoate 2.67EC) (Dimethoate 4EC)	 0.5 lb 0.5 lb	 1.5 pt 1.0 pt	 21 21	Do not feed or graze within 5 days of the last application. Do not store above 90° F or below 32° F.

Corn Earworm

Sampling

Outbreaks often follow a midsummer drought, which causes the corn to ripen earlier and become less attractive to the moths. Female moths prefer to lay eggs in open-canopied, late-blooming soybean fields. Drought conditions also delay soybean maturity and prevent normal canopy growth, so peak moth activity is more coincidental with blooming of open-canopied fields.

Sampling for corn earworm should be done on a weekly basis from mid-August through September. If row spacing is 30 inches or greater any of the techniques described below can be used to sample for insects. Narrow-row beans, 21 inches or less, are best sampled with either the sweep net or rigid beat cloth. Concentrate on high-risk fields, such as ones that have open canopies, are late flowering, or were previously treated with insecticides.

Standard Beat or Ground Cloth

For each sample, place a standard 3-foot ground cloth on the ground between rows and shake the plants bordering both sides vigorously. The number of insects shaken onto the cloth will be the number per 6 feet of row, so divide by 6 to get the number per row-foot. About ten samples should be taken in each 40 acre area. Thresholds are based on number or earworms per row-foot.

Rigid Beat Cloth

The RBC works on the same principle as a standard beat cloth but the RBC is not flexible. Samples are taken by placing the sampler on its side between two rows of plants (plants cannot be seriously lodged) and beating or vigorously shaking adjacent plants into the sampler while it is leaned away from those plants at about a 45° angle. Two 7-inch rows are beaten and one 14-inch or 21-inch row is beaten per sample. Thresholds are based on the number of earworms ***per sample***.

Sweep Net

Each sample should consist of 15 net sweeps with a 15-inch diameter sweep net done continuously one after the other. Each sweep consists of swinging the net in one direction through the foliage so that the top of the net passes 2 or 3 inches below the tops of plants. Fifteen consecutive sweeps are done from one side to the other while walking down a middle row. Swing the net with enough force to dislodge insects into the net. If some leaves are not broken off and in the net after the sample, the sampler is not using enough force. Each swing should pass through the tops of 5, 3, or 2 rows in 7-inch, 14-inch, or 21-inch row-space plantings, respectively. After each sample, stop and count how many earworms are in the net. Thresholds are based on the number of earworms **per sample**.

Decision Making

Treatment is suggested if sample counts exceed economic thresholds. Thresholds are presented at the end of this chapter. Visit the website *http://soybeans.ces.ncsu.edu/thresholds/* for access to the new threshold calculator.

Table 4.48 - Recommended Insecticides for Corn Earworm Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
Bacillus thuringiensis (DiPel ES)	8.0-16.0 BCLUs	1.2 pts	0	For pyrethroid resistant corn earworms when tank-mixed with a pyrethroid at a labeled rate.
beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	1.6-2.8 oz	45	**RESTRICTED USE.** Green forage may be fed 15 days after last application.
beta-cyfluthrin + imidacloprid (Leverage 360)	0.02 + 0.04 lb	2.8 oz	45	**RESTRICTED USE.**
bifenthrin (Brigade 2EC)	0.033-1.0 lb	2.1-6.4 oz	18	**RESTRICTED USE.**
chlorantraniliprole (Prevathon)	0.047-0.066 lb	14.0-20.0 oz	21	
chlorpyrifos (Lorsban 4E)	0.5-1.0 lb	1.0-2.0 pt	28	**RESTRICTED USE.** Do not feed or graze livestock on treated plants.
chlorpyrifos + lambda-cyhalothrin (Cobalt Advanced)	0.31 + 0.016 – 0.74 + 0.038 lb	16.0-38.0 oz	30	**RESTRICTED USE.**
esfenvalerate (Asana XL)	0.02-0.03 lb	5.8-9.6 oz	21	**RESTRICTED USE.** Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb per acre per season. Extremely toxic to fish.
flubendiamide (Belt SC)	0.0625-0.09375 lb	2.0-3.0 oz	14	
indoxacarb (Steward EC)	0.045-0.11 lb	4.6-11.3 oz	21	
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.016 + 0.033 lb –0.026 + 0.052lb	5.0-8.0 oz	30	**RESTRICTED USE.**
lambda-cyhalothrin (Karate Z) (Warrior T)	 0.015-0.025 lb 0.015-0.025 lb	 0.96-1.6 oz 1.92-3.2 oz	 45 45	**RESTRICTED USE**. Do not apply more than 7.68 oz per acre per season Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
methomyl (Lannate LV) (Lannate SP)	 0.12-0.225 lb 0.11-0.225 lb	 0.4-0.75 pt 0.125-0.25 lb	 14 14	**RESTRICTED USE.** Wait 3 days to feed or graze as forage or 7 days for hay. Up to two applications may be used/season.
spinetoram (Radiant SC)	0.15-0.31 lb	2.0-4.0 oz	28	
spinosyn (Blackhawk)	0.038-0.05 lb	1.7-2.2 oz	0	Do not feed treated forage or hay to meat or dairy animals.

Table 4.48 - Recommended Insecticides for Corn Earworm Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
thiamethozam + lambda-cyhalothrin (Endigo ZC)		3.5-4.0 oz	30	**RESTRICTED USE.** Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
zeta-cypermethrin (Mustang Max)	0.0175-0.025 lb	2.1-6.4 oz	18	**RESTRICTED USE.** Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

Grasshopper

Table 4.49 - Recommended Insecticides for Grasshopper Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97)	0.24-0.49 lb	0.25-0.5 lb	14	
beta-cyfluthrin (Baythroid XL)	0.0155-0.022 lb	2.0-2.8 oz	45	**RESTRICTED USE.** Green forage may be fed 15 days after last application.
beta-cyfluthrin + imidacloprid (Leverage 360)	0.02 + 0.04 lb	2.8 oz	45	**RESTRICTED USE.**
bifenthrin (Brigade 2EC)	0.033-1.0 lb	2.1-6.4 oz	18	**RESTRICTED USE.**
chlorpyrifos (Lorsban 4E)	0.25-0.5 lb	0.5-1.0 pt	28	**RESTRICTED USE**. Do not feed or graze livestock on treated plants.
chlorpyrifos + lambda-cyhalothrin (Cobalt Advanced)	0.12 + 0.006 – 0.25 + 0.013 lb	6.0-13.0 oz		**RESTRICTED USE.**
dimethoate (Dimethoate 2.67EC) (Dimethoate 4EC)	0.5 lb 0.5 lb	1.5 pt 1.0 pt	21 21	**RESTRICTED USE**. Do not feed or graze within 5 days of the last application. Do not store above 90°F or below 32°F.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	**RESTRICTED USE.** Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai per acre per season. Extremely toxic to fish.
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.026 + 0.052 lb – 0.033 + 0.065 lb	8.0-10.0 oz	30	**RESTRICTED USE.**
lambda-cyhalothrin (Karate Z) (Warrior T)	0.025-0.03 lb 0.025-0.03 lb	1.6-1.92 oz 3.2-3.84 oz	45 45	**RESTRICTED USE.** Do not apply more than 7.68 oz per acre per season. Do not graze or harvest treated soybean forage, straw or hay for livestock feed.

Table 4.49 - Recommended Insecticides for Grasshopper Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
zeta-cypermethrin (Mustang Max)	0.02-0.025 lb	3.2-4.0 oz	21	**RESTRICTED USE.** Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

Armyworms

Table 4.50 - Recommended Insecticides for Fall, Yellowstriped, and Beet Armyworm

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97) (except beet)	0.73-0.97 lb	0.75-1.0 lb	14	
beta-cyfluthrin (Baythroid XL) (fall armyworm and beet armyworm - 1st and 2nd instars only)	0.0125-0.022 lb	1.6-2.8 oz	45	**RESTRICTED USE.** Green forage may be fed 15 days after last application.
bifenthrin (Brigade 2EC)	0.033-0.10 lb	2.1-6.4 oz	18	**RESTRICTED USE.**
chlorantraniliprole (Prevathon)	0.047-0.066 lb	14.0-20.0 oz	21	
chlorpyrifos + lambda-cyhalothrin (Cobalt Advanced) (beet) (yellowstriped)	0.43 + 0.022 lb – 0.74 + 0.038 lb 0.215 + 0.01 – 0.51 + 0.026 lb	22.0-38.0 oz 11.0-26.0 oz		**RESTRICTED USE.**
flubendiamide (Belt SC)	0.0625-0.09375 lb	2.0-3.0 oz	14	
indoxacarb (Steward 1.25SC)	0.045-0.11 lb	4.6-11.3 oz	21	
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.026 + 0.052 lb 0.033 + 0.065 lb	8.0-10.0 oz	30	**RESTRICTED USE.**
methomyl (Lannate LV) (Lannate SP)	0.225-0.3 lb 0.225-0.34 lb	0.75-1.0 pt 0.25-0.375 lb	14 14	**RESTRICTED USE.** Wait 3 days to feed or graze as forage or 7 days for hay. Up to two applications may be used per season.
methoxyfenozide (Intrepid 2F)	0.06-0.12 lb	4.0-8.0 oz	7 (hay/forage) 14 (seed)	
spinetoram (Radiant SC)	0.15-0.31 lb	2.0-4.0 oz	28	
spinosyn (Blackhawk)	0.038-0.05 lb	1.7-2.2 oz	28	Do not feed treated forage or hay to meat or dairy animals.

Table 4.50 - Recommended Insecticides for Fall, Yellowstriped, and Beet Armyworm (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
thiamethozam + lambda-cyhalothrin (Endigo ZC) (bean leaf beetle)	0.064-0.072 lb	4.0-4.5 oz	30	**RESTRICTED USE.** Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
zeta-cypermethrin (Mustang Max) (beet and fall) (yellowstriped)	0.02-0.025 lb 0.0175-0.025 lb	3.2-4.0 oz 2.8-4.0 oz	21	**RESTRICTED USE.** Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

Stinkbugs

Table 4.51 - Recommended Insecticides for Stinkbug Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97)	0.49-0.97 lb	0.5-1.0 lb	14	
beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	1.6-2.8 oz	45	**RESTRICTED USE.** Green forage may be fed 15 days after last application.
beta-cyfluthrin + imidacloprid (Leverage 360)	0.02 + 0.04 lb	2.8 oz	45	**RESTRICTED USE.**
bifenthrin (Brigade 2EC)	0.033-0.1 lb	2.1-6.4 oz	18	**RESTRICTED USE.**
chlorpyrifos (Lorsban 4E)	1.0 lb	2.0 pt	28	**RESTRICTED USE.** Do not feed or graze livestock on treated plants.
chlorpyrifos + lambda-cyhalothrin (Cobalt Advanced)	0.31 + 0.016 – 0.74 + 0.038 lb	16.0-38.0 oz	30	**RESTRICTED USE.**
clothianidin (Belay)	0.05-0.067 lb	3.0-4.0 oz	21	Do not graze or feed soybean forage and hay to livestock.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	**RESTRICTED USE.** Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai/A/season. Extremely toxic to fish.
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.026 + 0.052 lb – 0.033 + 0.065 lb	8.0-10.0 oz	30	**RESTRICTED USE.**
lambda-cyhalothrin (Karate Z) (Warrior T)	 0.025-0.03 lb 0.025-0.03 lb	 1.6-1.92 oz 3.2-3.84 oz	 45 45	**RESTRICTED USE**. Do not apply more than 7.68 oz/A per season. Do not graze or harvest treated soybean forage, straw or hay for livestock feed.

Table 4.51 - Recommended Insecticides for Stinkbug Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
thiamethozam + lambda-cyhalothrin (Endigo ZC) (bean leaf beetle)	0.064.0.072 lb	4.0-4.5 oz	30	**RESTRICTED USE.** Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
zeta-cypermethrin (Mustang Max)	0.02-0.025 lb	3.2-4.0 oz	21	**RESTRICTED USE.** Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

Soybean Looper

Table 4.52 - Recommended Insecticides for Soybean Looper Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
chlorantraniliprole (Prevathon)	0.047-0.066 lb	14.0-20.0 oz	21	
flubendiamide (Belt)	0.06-0.09 lb	2.0-3.0 oz	14	
indoxacarb (Steward 1.25SC)	0.055-0.11 lb	5.6-11.3 oz	21	
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.033 + 0.065 lb	10.0 oz	30	
methoxyfenozide (Intrepid 2F)	0.06-0.12 lb	4.0-8.0 oz	7 (hay/forage) 14(seed)	
spinetoram (Radiant SC)	0.15-0.31 lb	2.0-4.0 oz	28	
spinosyn (Blackhawk)	0.025-0.05 lb	1.1-2.2 oz	28	Do not feed treated forage or hay to meat or dairy animals.

Soybean Aphid

Table 4.53 - Recommended Insecticides for Soybean Aphid Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 90S) (Orthene 97)	0.5 -1.0 lb 0.73-0.97 lb	0.56-1.1 lb 0.75-1.0 lb	14 14	Do not graze or cut vines for hay or forage.
bifenthrin (Brigade 2EC)	0.033-0.1 lb	2.1-6.4 oz	18	**RESTRICTED USE.**
chlorpyrifos (Lorsban 4E)	0.5-1.0 lb	1.0-2.0 pt	28	**RESTRICTED USE.** Do not feed or graze livestock on treated plants.

Table 4.53 - Recommended Insecticides for Soybean Aphid Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
chlorpyrifos + lambda-cyhalothrin (Cobalt Advanced)	0.21 + 0.01 – 0.51 + 0.026 lb	11.0-26.0 oz		**RESTRICTED USE.**
clothianidin (Belay)	0.05-0.067 lb	3.0-4.0 oz	21	Do not graze or feed soybean forage and hay to livestock.
cyfluthrin (Baythroid XL)	0.044 lb	2.0-2.8 oz	45	**RESTRICTED USE.** Green forage may be fed 15 days after last application.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	**RESTRICTED USE.** Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb per acre per season. Extremely toxic to fish.
flupyradifurone (Sivanto)	0.09-0.137 lb	7.0-10.5 oz	21	
imidacloprid (Gaucho 600)	1.0 oz/cwt	1.6 oz/cwt	N/A	Seed treatment.
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.016 + 0.033 lb – 0.026 + 0.052 lb	5.0-8.0 oz	30	**RESTRICTED USE.**
lambda-cyhalothrin (Karate Z) (Warrior T)	0.015-0.025 lb 0.015-0.025 lb	0.96-1.6 oz 1.92-3.2 oz	45 45	**RESTRICTED USE.** Do not apply more than 7.68 oz per acre per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
thiamethoxam (Cruiser 5FS)	0.8 oz/cwt	1.28 oz/cwt	N/A	Seed treatment.
thiamethozam + lambda-cyhalothrin (Endigo ZC)	0.056-0.064 lb	3.5-4.0 oz	30	**RESTRICTED USE.** Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
zeta-cypermethrin (Mustang Max)	0.0175-0.025 lb	2.8-4.0 oz	21	**RESTRICTED USE.** Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

Pest Thresholds

Table 4.54 - Corn Earworm Thresholds in Soybeans[1]

Sampling Tool	Row Width	Rows Sampled	Threshold
Sweep Net[2]	7"	5	2.5
	14"	3	2.4
	21"	2	3.1
	36"	1	3.1
Rigid Beat Cloth[3]	7"	2	0.9
	14"	1	0.7
	21"	1	1.2
Beat Cloth	30"	1 or 2	1.0
Standard or Rigid[4]	36"	1 or 2	1.2

[1] Only count worms 3/8 inch or longer.
[2] Based on a 15-sweep sample.
[3] Number per sample.
[4] Number per row foot rather than number per sample.

The timing strategy is to wait until most of the larvae are three-eights of an inch or more in length and then treat when pod damage is first evident. This allows for most egg laying and hatching to occur before treatment and thus reduces the chances of a second spray being needed later. Some defoliation may occur before it is time to treat and this injury should be evaluated just like that of any defoliator. If other defoliating pests are present when pod damage is first evident, then adjustments should be made in the treatment thresholds for earworms. For example, if green cloverworms are actively feeding and have already caused 15 percent defoliation, then insecticide treatment would be justified at lower earworm infestations, about one-half the normal threshold. Finally, treatment may not be necessary if the majority of worms are infected with the fungus disease. This white to greenish white fungus can have a significant impact on earworm populations. Access the web (*www.ipm.vt.edu/cew*) to calculate thresholds based on your estimated cost of control (product cost plus application cost) and today's bushel value.

Table 4.55 - Other Soybean Insect Pest Thresholds

	# per row-foot row-spacing		# per 15 sweeps row-spacing		
Pest species	**7"-21"**	**above 21"**	**7"-21"**	**above 21"**	**Other comments**
Full-season plantings					
Mexican bean beetle	4	6	24	36	40% defoliation - pre-bloom, 15% defoliation - pod-fill, 35+% defoliation - fully developed seeds.
Spider mite	Damage occurring and live mites present				Live mites on 50% of leaves and 50% leaves showing white spotting or premature leaf drop.
Other defoliators[1]					40% defoliation - pre-bloom, 15% defoliation - pod-fill, 35+% defoliation - fully developed seeds.
Double-crop plantings with poor growth					
Mexican bean beetle	2	4	12	24	20% defoliation - pre-bloom, 15% defoliation - fully developed seeds.

[1]Other defoliators include any combinations of green cloverworm, bean leaf beetle, blister beetle, Japanese beetle, soybean looper, yellowstriped armyworm, grasshoppers, or fall armyworm.

Table 4.55 - Other Soybean Insect Pest Thresholds (cont.)

	# per row-foot row-spacing		# per 15 sweeps row-spacing		
Pest species	**7"-21"**	**above 21"**	**7"-21"**	**above 21"**	**Other comments**
Spider mite	Damage occurring and live mites present				Live mites on 50% of leaves and 50% leaves showing white spotting or premature leaf drop.
Other defoliators[1]					20% defoliation - pre-bloom, 10% defoliation - pod-fill, 15% defoliation - fully developed seeds.

[1]Other defoliators include any combinations of green cloverworm, bean leaf beetle, blister beetle, Japanese beetle, soybean looper, yellowstriped armyworm, grasshoppers, or fall armyworm.

Table 4.56 - Revised Stink Bug Thresholds for Soybean (all stink bug species combined)

	# per row foot		# per 15 sweeps	
Row spacing	7-21” rows	Above 21”	7-21” rows	Above 21”
New (Grain)	1-2	1-2	5	5
New (Seed)	0.5	0.5	2.5	2.5

Apply from R3-4 to R7, double after R7

Soybean aphid

The current economic threshold for aphids is an average of 250 aphids per plant, on two consecutive field visits spaced about 5-7 days apart. This is because aphid populations can “crash” quickly due to heavy pressure by natural enemies like lady beetles, parasitic wasps, and fungal diseases. When scouting, choose a “Z” or “W” shaped pattern to cover the entire field and sample at least 20 to 30 plants per field by examining the entire plant, including stems and upper and lower leaf surfaces. Use the aphid/plant average for determining the need for treatment. The threshold applies to soybeans through the R5 growth stage (3 mm long seed in the pod at one of the four uppermost nodes on the main stem), after which time plants can tolerate 1,000+ aphids with no threat to yield.

Peanuts

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Thrips

Seedling peanut plants are usually attacked by thrips within the first 6-8 weeks after planting, and thrips may complete several generations per season under favorable conditions. These tiny, spindle-shaped insects feed primarily within the developing, unfolded leaflets causing crinkling of the leaflets and stunting of the plants. Blackening of the small leaflets occurs with severe infestations and can be mistaken for chemical injury. Under favorable conditions, plants normally outgrow this injury with no reduction in yield or grade. However, the delay in vine growth from early season thrips injury may retard maturity. This in combination with other injury, such as herbicide burn, can reduce yield.

Thrips can be controlled with either systemic or with foliar-applied insecticides. Systemics can be incorporated in the furrow with the seed at planting. Foliar treatments can be applied as needed after crop emergence. During dry seasons or seasons with excessive rains, the systemic insecticides may not give adequate thrips control due to poor systemic uptake by the plants or leaching of chemicals from the soil. Foliar treatments may be warranted to allow more rapid plant growth to assist in weed control if systemics are ineffective, or if injury appears excessive. Foliar treatment is recommended when 25 percent of the leaves show thrips damage and pest populations are still active.

Table 4.57 - Recommended Insecticides for Thrips Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97) band rate broadcast rate	 3.0-6.0 oz 6.0-12.0 oz	14	Do not feed treated forage or hay to livestock or allow animals to graze treated areas.
	beta-cyfluthrin (Baythroid XL)	2.8 oz	14	**RESTRICTED USE.**
	bifenthrin (Brigade 2EC)	5.12-6.4 oz	14	**RESTRICTED USE.** Do not feed immature plants and peanut hay to livestock.
	methomyl (Lannate LV) (Lannate SP)	 1.5-3.0 pt 0.5-1.0 lb	 21 21	**RESTRICTED USE.** Do not feed treated vines.
On-seed	acephate (Acephate 90SP)	3.5 oz/100 lbs seed	–	Mix in the planter to obtain good coverage of ALL seed by layering seed and product. Fill the planter box 1/3 full of seed with 1/3 of the product,add the next 1/3 of the seed and product, then add the last 1/3 of the seed and product. Gently stir each layer before adding the next. **Caution:** Do not use with seed inoculants. Not recommended for air planters. Do not use treated seed for food or feed purposes, or process for oil.
	thiamethoxam (CruiserMaxx Peanut)	3.0-4.0 oz/100 lbs seed	0	
In-furrow	imidacloprid (Admire Pro)	7.0-10.5 oz	14	Apply as an in-furrow spray during planting directed on or below seed.
	imidacloprid + fluopyram (Velum Total)	18 oz	14	Apply as an in-furrow spray during planting directed on or below seed

Table 4.57 - Recommended Insecticides for Thrips Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
	phorate (Thimet 20G)	5.0 lb	90	**RESTRICTED USE.** Distribute granules evenly in the furrow. Do not graze or feed treated hay or forage to livestock.

Potato Leafhopper

The potato leafhopper is a common "above-ground" pest of peanuts in Virginia. This small, wedge-shaped, light green to yellow insect damages the peanut plant by feeding on the undersides of leaves in a piercing-sucking manner. Injured leaf tips turn yellow first then brown and tend to curve downward. Apparently, during feeding, toxins are also passed into plants at feeding sites. If enough damage is done, toxins can stop vine growth resulting in reductions in yield and grade. Injury may occur at any time from early June until the middle of August or later in some years. It is important to note that although late-season damage appears worse in some years, damage done early in the season probably affects plant vigor and yield more. Systemic insecticides applied at planting time will usually control potato leafhoppers that occur early, but if no pegging-time insecticide is applied, it may be necessary to make one or two foliar applications in July or early August. Pegging time applications of rootworm insecticides will usually control leafhoppers from that time until harvest.

Foliar treatments should be made only on a basis of need. When 25% of the leaves show tip yellowing typical of leafhopper damage, and active adult and immature leafhoppers are seen, treat with an effective chemical. When foliar treatments are required, the first application usually is made about the middle of July, and the second about the first of August (if needed). If scheduled treatments are being made for control of leafspot, insecticides may be tank mixed. Do not include insecticides with all leafspot treatments as a matter of course. Too many insecticide applications, or applications later in the season, could cause spider mite populations to increase, especially in dry years after adjacent corn and weedy areas have been cut. Make leafhopper applications only when problems have been identified.

Table 4.58 - Recommended Insecticides for Potato Leafhopper Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97)	6.0-12.0 oz	14	Do not feed treated forage or hay to livestock or allow animals to graze treated areas.
	beta-cyfluthrin (Baythroid XL)	1.0-1.8 oz	14	**RESTRICTED USE.**
	beta-cyfluthrin + imidacloprid (Leverage 360)	2.8 oz	14	**RESTRICTED USE.**
	bifenthrin (Brigade 2EC)	2.1-6.4 oz	14	**RESTRICTED USE.** Do not feed immature plants and peanut hay to livestock.
	esfenvalerate (Asana XL)	2.9-5.8 oz	21	**RESTRICTED USE.** Do not feed or graze livestock on treated vines. Do not exceed 29 oz/ season.
Foliar (cont.)	fenpropathrin (Danitol 2.4EC)	6.0-10.6 oz	14	**RESTRICTED USE.** Do not graze or feed treated peanut vine forage or dried hay within 14 days of the last application. Do not exceed 2.6 pints total application/A/season.

[1]**General -** Apply pegging treatments in 10- to 18-inch bands on row during the first 2 weeks in July after pegging begins and before vines close in middles. Effectiveness of treatments is increased if insecticides are covered by shallow cultivation to avoid exposure to sunlight and lateral movement with heavy rains.

Table 4.58 - Recommended Insecticides for Potato Leafhopper Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
	lambda-cyhalothrin			**RESTRICTED USE.**
	(Karate EC)	1.92-3.2 oz	14	Do not apply more than 15.36 oz/ A/season.
	(Karate Z)	0.96-1.6 oz	14	Do not graze livestock in treated areas, or use
	(Warrior T)	1.92-3.2 oz	14	treated vines or hay for animal feed.
	methomyl			**RESTRICTED USE.**
	(Lannate LV)	0.75- 3.0 pt	21	Do not feed treated vines.
	(Lannate SP)	0.25- 1.0 lb	21	
	zeta-cypermethrin			**RESTRICTED USE.**
	(Mustang Max)	1.28-4.0 oz	7	Do not graze livestock in treated areas. Do not use treated vines or hay for animal feed.
Pegging[1]	chlorpyrifos (Lorsban 15G)	—	—	Lorsban 15G is not labeled for use against leafhopper but will provide suppression if applied for soil insects.

[1]**General -** Apply pegging treatments in 10- to 18-inch bands on row during the first 2 weeks in July after pegging begins and before vines close in middles. Effectiveness of treatments is increased if insecticides are covered by shallow cultivation to avoid exposure to sunlight and lateral movement with heavy rains.

Southern Corn Rootworm

The southern corn rootworm, which is the immature stage of the spotted cucumber beetle, can cause extensive injury to the Virginia peanut crop. Rootworm larvae develop in the soil and feed directly on pegs and pods. Finding rootworms in the soil is very difficult and injury is often not detected until after peanuts are dug, when it is too late for control measures. A preventive treatment is the best strategy. After an infestation is established, control is difficult and often ineffective. Determining the need to treat for southern corn rootworm should be done on a field-by-field basis. Decisions can be based on both adult populations and past history of peanut fields. Adult beetles can be readily detected in peanut fields. Their presence in moderate to high numbers from mid-July to early August should be a warning that a problem could develop. Adults will lay eggs that could develop into the damaging larval stage. Early detection of adults can thus allow for timely treatment and prevention of injury.

Knowledge of the past history of rootworm injury can also be useful in determining the need for treatment. If injury has ever occurred in a field, it will likely occur in other years. Keep field records on the extent of pod and peg injury noticed at harvest time. Pay particular attention to fields with higher levels of organic matter and clay. Rootworms have a higher survival rate in those soils due to higher moisture holding capacity, and injury will typically be more severe than in "light" soils. Use the "Southern Corn Rootworm Risk Index" to aid you in deciding which fields need insecticide treatment.

If rootworm treatments are necessary, they should be applied as 10-18 inch bands on the row during early pegging. Usually, this period occurs during the first 2 weeks of July. Treatment effectiveness is increased if materials are lightly incorporated using shallow cultivation. If vine growth and pegging are in an advanced stage, do not cultivate, as vine "dirting," which leads to disease development and injury to pegs, may offset the gain from insect control. Carefully calibrate equipment to deliver recommended insecticide rates. Using more than is recommended will not increase effectiveness and using less could result in a complete insecticide failure.

Table 4.59 - Recommended Insecticides for Southern Corn Rootworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Pegging[1]	chlorpyrifos (Lorsban 15G)	13.0 lb	21	Do not apply more than 13.3 lb/ season. Do not feed peanut forage or hay to meat or dairy animals.
	phorate (Thimet 20G[2])	10.0 lb	90	**RESTRICTED USE.** Distribute granules as a band over the fruiting zone at pegging. Work into the top few inches of soil immediately. Do not graze or feed treated hay or forage to livestock.

[1]**General -** Apply pegging treatments in 10-18 inch bands on row during the first 2 weeks in July after pegging begins and before vines close in middles. Effectiveness of treatments is increased if insecticides are covered by shallow cultivation to avoid exposure to sunlight and lateral movement with heavy rains.
[2]Labels stipulate light incorporation.

Corn Earworm

Annual infestations of the corn earworm and fall armyworm occur in most Virginia peanut fields. Usually there is a single generation of each species per season. Worms feed on leaf tissue causing peanuts to look ragged; however, research has shown that one-third of peanut foliage can be lost at the normal time of corn earworm infestations (mid-August to early September) without loss of yield or grade. Scouting fields is the only way to determine if treatment is needed. Scout by reaching halfway across 2 row-feet of plants and shaking foliage vigorously towards the row middle. Repeat on the opposite row. Count the worms on the ground and repeat the sample in several spots in the field. Treatment is recommended if an average of 8 or more worms are found per sample, or 4 per row-foot.

If treatment is necessary, apply sprays using systems that provide good canopy penetration and coverage. If spider mites are already present in the field, use of some insecticides may allow for rapid build-up. Scout fields for treatment effectiveness and for possible increases in spider mite activity soon after applications.

Table 4.60 - Recommended Insecticides for Corn Earworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remark
Foliar[1]	acephate (Orthene 97)	12.0-16.0 oz	14	Do not feed treated forage or hay to livestock or allow animals to graze treated areas.
	Bacillius thuringiensis (DiPel ES)	1.0-2.0 pt	0	For pyrethroid resistant corn earworm when tank mixed with a pyrethroid at a labeled use rate.
	beta-cyfluthrin (Baythroid XL)	1.8-2.4 oz	14	**RESTRICTED USE.**
	beta-cyfluthrin + imidacloprid (Leverage 360)	2.8 oz	14	**RESTRICTED USE.**
	bifenthrin (Brigade 2EC)	2.1-6.4 oz	14	**RESTRICTED USE.** Do not feed immature plants and peanut hay to livestock.
	chlorantraniliprole (Prevathon)	14.0-20.0 oz	1	

[1]**General** - Treat only if foliage loss is heavy (1/3 or more). Earworms are easier to control when they are less than 1/2 inch long.

Table 4.60 - Recommended Insecticides for Corn Earworm Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remark
Foliar[1] (cont.)	esfenvalerate (Asana XL)	2.9-5.8 oz	21	**RESTRICTED USE.** Do not feed or graze livestock on treated vines. Do not exceed 29.0 oz/season.
	fenpropathrin (Danitol 2.4EC)	10.6-16.0 oz	14	**RESTRICTED USE.** Do not graze or feed treated peanut vine forage or dried hay within 14 days of the last application. Do not exceed 2.6 pints total application/A/season.
	flubendiamide (Belt SC)	2.0-4.0 oz	3	
	indoxacarb (Steward EC)	6.7-11.3 oz	14	Do not feed or graze livestock on treated fields.
	lambda-cyhalothrin (Karate EC) (Karate Z) (Warrior T)	2.56-3.84 oz 1.28-1.92 oz 2.56-3.84 oz	14 14 14	**RESTRICTED USE.** Do not apply more than 15.36 oz/A/ season. Do not graze livestock in treated areas, or use treated vines or hay for animal feed.
	methomyl (Lannate LV) (Lannate SP)	0.75-3.0 pt 0.25-1.0 lb	21 21	**RESTRICTED USE.** Do not feed treated vines.
	spinetoram (Radiant SC)	3.0-8.0 oz	3	Do not allow grazing of peanut hay.
	spinosyn (Blackhawk)	1.7-3.3 oz	3	Do not allow grazing of crop residue or harvest of crop residue for hay until 14 days after the last application.
	zeta-cypermethrin (Mustang Max)	3.2-4.0 oz	7	**RESTRICTED USE.** Do not graze livestock in treated areas. Do not use treated vines or hay for animal feed.

[1]**General** - Treat only if foliage loss is heavy (1/3 or more). Earworms are easier to control when they are less than 1/2 inch long.

Table 4.61 - Recommended Insecticides for Fall Armyworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remark
Foliar[1]	acephate (Orthene 97)	12.0-16.0 oz	14	Do not feed treated forage or hay to livestock or allow animals to graze treated areas.
	Bacillius thuringiensis (DiPel ES)	1.0-2.0 pt	0	For pyrethroid resistant corn earworm when tank mixed with a pyrethroid at a labeled use rate.
	beta-cyfluthrin (Baythroid XL)	2.4-2.8 oz	14	**RESTRICTED USE.**
	beta-cyfluthrin + imidacloprid (Leverage 360)	2.8 oz	14	**RESTRICTED USE.**

[1]**General** - Treat only if foliage loss is heavy (1/3 or more). Earworms are easier to control when they are less than 1/2 inch long.

Table 4.61 - Recommended Insecticides for Fall Armyworm Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remark
Foliar[1] (cont.)	bifenthrin (Brigade 2EC)	2.1-6.4 oz	14	**RESTRICTED USE.** Do not feed immature plants and peanut hay to livestock.
	chlorantraniliprole (Prevathon)	14.0-20.0 oz	1	
	esfenvalerate (Asana XL)	9.6 oz	21	**RESTRICTED USE.** Suppression only. Do not feed or graze livestock on treated vines. Do not exceed 29.0 oz/season.
	fenpropathrin (Danitol 2.4EC)	10.6-16.0 oz	14	**RESTRICTED USE.** Do not graze or feed treated peanut vine forage or dried hay within 14 days of the last application. Do not exceed 2.6 pints total application/A/season.
	flubendiamide (Belt SC)	2.0-4.0 oz	3	
	indoxacarb (Steward EC)	9.2-11.3 oz	14	
	lambda-cyhalothrin (Kaiso 24WG)	2.0 oz	14	**RESTRICTED USE.**
	methomyl (Lannate LV) (Lannate SP)	0.75-1.5 pt 0.25-0.5 lb	21 21	**RESTRICTED USE.** Do not feed treated vines. 2 pints may be required for good control.
	methoxyfenozide (Intrepid 2F) (beet armyworm only)	6.0-10.0 oz	7	
	spinetoram (Radiant SC)	3.0-8.0 oz	3	Do not allow grazing of peanut hay.
	spinosyn (Blackhawk)	1.7-3.3 oz	3	Do not allow grazing of crop residue or harvest of crop residue for hay until 14 days after the last application.
	zeta-cypermethrin (Mustang Max)	3.2-4.0 oz	7	**RESTRICTED USE.** Do not graze livestock in treated areas. Do not use treated vines or hay for animal feed.

[1]**General** - Treat only if foliage loss is heavy (1/3 or more). Earworms are easier to control when they are less than 1/2 inch long.

Spider Mite

Mites, which have become more numerous during the past several years, are especially injurious during hot, dry weather. While insecticides are very valuable in controlling leafhoppers, thrips, and worms, they may be responsible for destroying some of the natural enemies of spider mites and thus promoting the build-up of mite populations. Insecticides should be used **only when needed** for insect control. Tank mixes that include both fungicides and insecticides are more likely to allow spider mite build-up than when either material is used separately.

Spider mites feed mainly on the undersides of the leaves. They suck the juice from the foliage and cause the leaves to turn brown and eventually drop off. Heavy infestations usually occur first around the borders of peanut fields; then they spread inward throughout the fields. Avoid harvesting spider mite infested cornfields or mowing weedy areas next to peanut fields until peanuts are harvested. Spider mites will readily move into peanuts when corn dries down or is harvested. Be prepared to treat peanuts if adjacent corn is infested.

Important: If you are going to treat, calibrate your equipment to deliver the right amount of pesticide per acre. Arrange and adjust the nozzles or spouts in a manner that will direct the chemical into the desired area to be treated. Adequate sprayer pressure (40 to 60 psi) will aid in getting chemicals in contact with the undersides of leaves and within denser foliage. Penetration of foliage with 20 to 30 gallons of water per acre is very important for the control of spider mites.

Table 4.62 - Recommended Insecticides for Spider Mite Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	bifenthrin (Brigade 2EC)	5.12-6.4 oz	14	**RESTRICTED USE.** Do not feed immature plants and peanut hay to livestock.
	fenpropathrin (Danitol 2.4EC)	10.6-16.0 oz	14	**RESTRICTED USE.** Do not graze or feed treated peanut vine forage or dried hay within 14 days of the last application. Do not exceed 2.6 pints total application/A/season.
	propargite (Comite 6.5EC) (Omite 30W)	2.0 pt 3.0-5.0 lb	14 14	Use a minimum of 20 gallons/A with ground equipment or 5 gallons by air. Make no more than 2 applications/year (either Comite OR Omite). Do not plant rotational crops within 6 months of last application. Do not feed hay to livestock.

Lesser Cornstalk Borer

Lesser cornstalk borer is typically not a problem in Virginia peanut fields. However, it does thrive under hot dry conditions and can become a problem when those conditions continue for 3-4 weeks. Infestations will be most severe where soils are sandy and in high, well drained areas within fields. Larvae are 0.5 to 0.75 inch long and are banded with alternating brown and blue stripes. They wiggle vigorously when disturbed. Larvae feed by burrowing into main stems, lateral limbs, plant crowns, and pods and can do extensive damage, even kill plants. Larvae produce silk-and-sand web tubes, which are attached to pods or stems at the point of feeding. Evidence of web tubes is a sure sign of borer activity.

If weather conditions become favorable for borers, survey fields for damaged plants and larvae. If damage is obvious and active larvae are still present in 10% or more of the plants, treatment is recommended.

Table 4.63 - Recommended Insecticides for Lesser Cornstalk Borer Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Granular	chlorpyrifos (Lorsban 15G)	6.7-13.3 lb	21	Apply in 10-18 inch band on row at first sign of borer. Do not feed peanut forage or hay to meat or dairy animals. Do not apply more than 13.3 lb/season. 10.0-13.0 lb may be broadcast by air as a rescue treatment.

Grasshopper

Table 4.64 - Recommended Insecticides for Grasshopper Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97)	4.0-8.0 oz	14	Do not feed treated forage or hay to livestock or allow animals to graze treated areas.
	beta-cyfluthrin (Baythroid XL)	1.8-2.4 oz	14	**RESTRICTED USE.**
	bifenthrin (Brigade 2EC)	2.1-6.4 oz	14	**RESTRICTED USE.** Do not feed immature plants and peanut hay to livestock.
	esfenvalerate (Asana XL)	5.8-9.6 oz	21	**RESTRICTED USE.** Do not feed or graze livestock on treated vines. Do not exceed 29.0 oz/season.
	zeta-cypermethrin (Mustang Max)	3.2-4.0 oz	7	**RESTRICTED USE.** Do not graze livestock in treated areas. Do not use treated vines or hay for animal feed.

Pesticide Usage Charts

Many pesticides control more than one pest. The three tables below summarize the effectiveness of some popular pesticides used at time of planting, at time of pegging, or as foliar treatments for the control of major insect pests which attack peanuts.

Table 4.65 - Insecticide Activity of Products Applied at Time of Planting

	Pests			
Chemical	**Thrips**	**Leafhopper**	**Rootworm**	**Spider Mite**
Orthene	E	Early	No	No
Thimet	G	Early	P	No

P=poor control, F=fair control, G=good control, E=excellent control, No=not labeled or no activity expected.

Table 4.66 - Insecticide Activity of Granules Applied at Time of Pegging

	Pests			
Chemical	**Rootworm**	**Leafhopper**	**Spider Mite**	**Corn Earworm**
Lorsban[1]	E	G	No	No
Thimet	G	Aids	No	No

P=poor control, F=fair control, G=good control, E=excellent control, No=not labeled or no activity expected.
[1] **NOT SYSTEMIC.** Do not apply in the furrow.

Table 4.67 - Insecticide Activity of Foliar Treatments Applied when Pests Are Present

		Pest Species Controlled						
Insecticide	**Formulation[1]**	**Thrips**	**Leaf-hopper**	**Root-worm**	**Corn earworm**	**Fall army-worm**	**Lesser corn stalk borer**	**Spider mite**
Asana	Xl	No	E	No	E	G	No	No[2]
Comite, Omite	6.5EC, 30W	No	No	No	No	No	No	E
Danitol	2.4EC	No	E	No	E	G	No	E
Karate	Z	E	E	No	E	G	No	F
Lannate	L	P	G	No	E	G	No	No[2]
Malathion	57% EC	P	G	No	P	P	No	P
Orthene	97	E	E	No	G	F	No	No[2]
Sevin	4F, 80s, XLR Plus	P	E	No	F	F	No	No[2]
Steward	1.25SC	No	No	No	E	E	No	No
Blackhawk		No	No	No	E	E	No	No

P=poor control, F=fair control, G=good control, E=excellent control, No=not labeled or no activity expected.
[1]There are other insecticides and other formulations which have federal registration for use on peanuts.
[2]Use of these insecticides may allow rapid build-up of spider mites. Use with caution during extended periods of dry weather.

Cotton

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Thrips

Insect pests such as aphids, spider mites, cutworms, plant bugs and thrips affect cotton in the early stages of development. At present, only thrips must be controlled annually. These tiny, spindle-shaped insects complete several generations per season under favorable conditions and feed primarily by puncturing and rasping the outer cells of the young leaves and buds. Damage results in ragged looking plants with crinkled or "possum-eared" leaves. The damage associated with thrips feeding can stunt growth resulting in fruiting at higher positions and delayed maturity. Damage is most severe if young cotton is subjected to adverse growing conditions such as cool or dry weather or when alternate thrips hosts such as small grains dry down prematurely forcing large numbers of thrips to seek other hosts. Adverse growing conditions during the early stages of cotton development may reduce the uptake of systemic insecticides, therefore early inspection of the crop is important due to the length of the growing season in most of Virginia.

Orthene 97 in furrow - Orthene 97 can be dribbled or sprayed in furrow during the planting operation. Orthene provides good thrips control for up to five weeks if applied at 12-16 oz of product per acre. Applications are usually made at 5 to 10 gallons per acre and are compatible with several liquid fungicides.

Gaucho and Cruiser seed treatment - Gaucho- and Cruiser-treated seed provide good thrips control. May need foliar treatment to provide season-long control.

There is no formal threshold for thrips based on insect numbers or plant injury. Treatment is thought to be justified if the following conditions are met: 1) thrips injury is common, 2) 10% or more plants show extensive bud damage, 3) immature thrips can be easily found, and 4) plant growth is poor.

Table 4.68 - Recommended Insecticides for Thrips Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
In-furrow or seed	acephate (Orthene 97)	12.0-16.0 oz	21	Apply as a liquid into the seed furrow in 5-10 gal of water/A with a system that insures good seed coverage. Do not feed treated forage or hay to livestock or allow animals to graze treated areas.
	imidacloprid (Admire Pro)	7.4-9.2 oz	—	Apply as an in-furrow spray during planting directed on or below seed. Do not graze treated fields after any application of Admire Pro.
	imidacloprid (Gaucho Grande, Aeris)	0.375 mg ai/ seed	—	—
	imidacloprid + fluopyram (Velum Total)	14-18 oz	30	Apply as an in-furrow spray during planting directed on or below seed
	phorate (Thimet 20G)	6.0-9.0 oz/1,000 row ft	—	**RESTRICTED USE.** Do not graze or feed treated hay or forage to livestock.
	thiamethoxam (Cruiser 5FS, Avicta CP)	0.30-0.375 mg ai/seed	—	—
Foliar	acephate (Orthene 97)	2.5-3.0 oz	21	May be tank mixed with Roundup Ultra or Roundup Ultra Max (for use on Roundup ready cotton), Buctril (for use on BXN cotton), or Staple.

Table 4.68 - Recommended Insecticides for Thrips Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar (cont.)	beta-cyfluthrin (Baythroid XL)	0.8-1.6 oz	0	**RESTRICTED USE**
	bifenthrin (Brigade 2EC)	1.3-6.4 oz	14	**RESTRICTED USE.**
	chlorpyrifos+ lambda-cyhalothrin (Cobalt Advanced)	16.0-38.0 oz	21	**RESTRICTED USE.** Do not allow meat or dairy animals to graze in treated areas. Do not feed gin trash or treated forage to meat or dairy animals.
	spinetoram (Radiant SC)	4.25-8.0 oz	28	1.5-3.0 oz for early season suppression.
	zeta-cypermethrin (Mustang Max)	1.28-1.92 oz	14	**RESTRICTED USE.** Do not graze or feed cotton for forage.

Plant Bugs

Prebloom: Prior to bloom, plant bugs, or Lygus, damage cotton by feeding on tender terminals and small squares causing squares to turn black and abort. Excessive square loss can reduce yields or slow plant maturity. In pre-blooming cotton, Lygus has required treatment on an average of only 6 percent of the cotton acreage in North Carolina over the past 8 years, and on only a few hundred acres in Virginia. The best way to determine the need for pre-bloom plant bug control is to assess square retention rates (percent missing squares). Treatment should be considered if square retention drops below 80% (see threshold table below) and plant bugs are still active.

After blooming: Once blooming begins, plant bugs continue feeding on smaller squares and blooms, both of which can cause 'dirty blooms' (white blooms with brown pollen anthers or brown-streaked petals). The presence of dirty blooms indicates that plant bugs are, or have very recently been, active. Levels at or above 15% dirty bloom indicate a large and active plant bug population and the need for sampling of bolls for damage (see threshold table below).

Boll damage: Once bolls are formed, plant bugs prefer feeding on small bolls up to 3 weeks old. Damage to bolls can range from warts or calluses on the insides of boll walls, to small areas of stain lint, to deformed and rotting fruit that is due to direct feeding on seed. This damage is identical to damage caused by stink bugs. Virginia studies indicate that treatments may be justified if boll damage by plant bugs (and/or stink bugs) exceeds 15% of a random sample of quarter-sized bolls (see threshold table below).

Untreated or minimally treated cotton, such as Bollgard cotton, is most susceptible to plant bug damage. Also, fields treated later in the season are open to invasion for a longer period of time.

Table 4.69 - Sampling for Plant Bugs and Thresholds in Cotton

Prebloom	below 80% square retention and plant bugs active
After blooming	15% dirty blooms indicates the presence of an active population 8 plant bugs per 100 sweeps indicates a large, active population
Boll damage	15% or more damaged quarter-sized bolls (up to 14 days old) and plant bugs active

Table 4.70 - Recommended Insecticides for Plant Bug Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97)	4.0-16.0 oz	21	**General** Treatment not recommended if square retention is in excess of 80%. If square retention is less than 80%, confirmation of threshold levels of plant bugs should be met prior to treatment. Although cotton fields exceeding the treatment threshold for plant bugs are relatively rare, fields adjacent to Irish potatoes, weed fields, and other sources of plant bugs in eastern counties may be at higher risk of plant bug injury.
	acetamiprid (Assail 70WP)	1.1-2.3 oz	28	
	beta-cyfluthrin (Baythroid XL)	1.6-2.6 oz	0	**RESTRICTED USE.**
	bifenthrin (Brigade 2EC)	2.6-6.4 oz	14	**RESTRICTED USE.**
	chlorpyrifos (Lorsban 4EC)	6.1 oz	14	
	chlorpyrifos+ lambda-cyhalothrin (Cobalt Advanced)	16.0-38.0 oz	21	**RESTRICTED USE.** Do not allow meat or dairy animals to graze in treated areas. Do not feed gin trash or treated forage to meat or dairy animals.
	clothianidin (Belay)	3.0-4.0 oz	21	
	dicrotophos (Bidrin XP)	4.0-6.0 oz	30	**RESTRICTED USE.**
	dinotefuran (Venom 20SG)	0.44-0.67 lb	14	
	esfenvalerate (Asana XL 0.66EC)	5.8-9.6 oz	21	**RESTRICTED USE.**
	imidacloprid (Admire Pro)	0.9-1.7 oz	14	
	lambda-cyhalothrin (Karate EC) (Karate Z) (Warrior T)	 2.56-3.84 oz 1.28-1.92 oz 2.56-3.84 oz	 21 21 21	**RESTRICTED USE.**
	lambda-cyhalothrin + thiamethoxam (Endigo ZC)	3.5-5.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	chlorantraniliprole + lambda-cyhalothrin (Besiege)	6.5-12.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	methomyl (Lannate 2.4 LV) (Lannate 90SP)	0.75 pt 0.5 lb	15 15	**RESTRICTED USE.**

Table 4.70 - Recommended Insecticides for Plant Bug Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
	oxamyl (Vydate C-LV)	12.7-17.0 oz	14	**RESTRICTED USE.**
	thiamethoxam (Centric 40WG)	1.25-2.0 oz	21	
	zeta-cypermethrin (Mustang Max)	2.64-3.6 oz	14	**RESTRICTED USE.**

Tobacco Budworm/Cotton Bollworm

Bollworms (corn earworms) occur primarily on field corn during their first two generations. Third generation moths usually emerge in large numbers from mid-July to early August when corn is drying and fly to more attractive blooming cotton.

Regular weekly scouting for the bollworm and its cousin, the tobacco budworm, should begin in early to mid-June. Weekly scouting is adequate until egg laying or light-trap catches increase. Fields should then be scouted twice a week, with the emphasis placed upon finding eggs, until insecticide treatments begin. After that, a 4- to 7-day scouting schedule will usually suffice. A 4- to 5-day scouting schedule is suggested for conventional pyrethroid rates and a 6- to 7-day schedule for high rates. Once the egg threshold has been met and treatments made, the primary focus of scouting shifts toward finding small bollworms feeding on squares and bolls, including those under bloom tags.

Tobacco budworm adults are not readily attracted to blacklight traps and sometimes begin laying eggs on cotton prior to the time at which the bollworm egg threshold has been met; occasional fields may reach a 3 percent larval threshold prior to bollworm treatment initiation. Under these circumstances, tobacco budworm pheromone trap deployment and correct sight identification of adult tobacco budworms can assist in recognition of this situation.

After the upper bolls that will be harvested have become difficult to cut with a pocket knife (approximately three weeks after bloom), they are normally safe from bollworm attack. Bollworm scouting can normally be stopped at that time—usually in late August to early September. Spot scouting for fall armyworms and European corn borers should continue through early September, especially in fields of late maturing cotton or in green areas.

Table 4.71 - Bollworm and Tobacco Budworm Thresholds in Cotton

Cotton Type	Threshold	Remarks
Conventional Cotton		
Prebloom	8 bollworms/100 terminals or 6 bollworms/100 squares	Limiting this treatment to one well-timed pyrethroid application is strongly recommended.
Egg	10+ eggs/100 terminals or 2 eggs/100 fruiting forms	After the onset of the major (third generation) bollworm moth flight.
Post-bloom larval	3 live worms/100 terminals, or 3 percent fresh damage to squares, blooms,or bolls	Usually after the egg threshold has been employed; also used after blooming begins and before major bollworm flight, particularly if tobacco budworms are present.
Bollgard Cotton		
Egg	75 to 100 eggs/100 terminals 15 to 20 eggs/100 blooms or bloom tags	Applies only following a period of high egg deposition. Should not be used within 1 week of an insecticide application.

Table 4.71 - Bollworm and Tobacco Budworm Thresholds in Cotton (cont.)

Cotton Type	Threshold	Remarks
Larval	3 second-stage (1/8 inch or larger) bollworms/100 squares or bolls or 2 second-stage bollworms on 2 consecutive scouting trips or 1 second-stage bollworm on 3 consecutive scouting trips	Use against the major bollworm generation. Pay particular attention to bollworms in or under yellow, pink, or dried blooms, but only sample in proportion to their occurrence.
Damage	3 to 6 percent significantly damaged squares (would cause squares to abort) or bolls	

Table 4.72 - Recommended Insecticides for Bollworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar (pyrethroids)	beta-cyfluthrin (Baythroid XL)	1.6[1]-2.6[2] oz	0	**RESTRICTED USE.**
	bifenthrin (Brigade 2EC)	3.2[1]-6.4[2] oz	14	**RESTRICTED USE.**
	esfenvalerate (Asana XL 0.66EC)	5.8[1]-9.7[2] oz	21	**RESTRICTED USE.**
	fenpropathrin (Danitol 2.4EC)	10.6[1]-16.0[2] oz	21	**RESTRICTED USE.**
	lambda-cyhalothrin (Karate EC) (Karate Z) (Warrior T)	 3.2[1]-5.1[2]oz 1.6[1]-2.56[2] oz 3.2[1]-5.1[2] oz	 21 21 21	**RESTRICTED USE.**
	lambda-cyhalothrin + thiamethoxam (Endigo ZC)	3.5-5.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	chlorantraniliprole + lambda-cyhalothrin (Besiege)	6.5-12.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	zeta-cypermethrin (Mustang Max)	2.64[1]-3.6[2] oz	14	**RESTRICTED USE.**
Foliar (others)	*Bacillus thuringiensis* (DiPel ES)	1.0-2.0 pt	0	For pyrethroid resistant corn earworms (bollworms) when tank mixed with a pyrethroid at a labeled use rate.
	chlorpyrifos + lambda-cyhalothrin (Cobalt Advanced)	16.0-38.0 oz	21	**RESTRICTED USE.** Do not allow meat or dairy animals to graze in treated areas. Do not feed gin trash or treated forage to meat or dairy animals.
	flubendiamide (Belt SC)	2.0-3.0 oz	28	
	indoxacarb (Steward EC)	11.3 oz	14	

[1]Standard rate
[2]High rate

Table 4.72 - Recommended Insecticides for Bollworm Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
	methomyl			**RESTRICTED USE.**
	(Lannate 2.4LV)	1.5 pt	15	
	(Lannate 90SP)	0.5 lb	15	
	rynaxypyr			
	(Coragen)	3.5-7.0 oz	21	
	spinetoram			
	(Radiant SC)		28	
	(prebloom)	2.8-8.0 oz		
	(postbloom)	4.25-8.0 oz		
	spinosyn			
	(Blackhawk)	1.6-3.2 oz	28	For second-generation tobacco budworms, 1.6 oz is adequate; for post-bloom bollworms, use the 3.2 oz rate.
	chlorantraniliprole			
	(Prevathon)	14.0-27.0 oz	21	

[1]Standard rate
[2]High rate

European Corn Borer

European Corn Borer (ECB) larvae damage cotton by feeding on large bolls from early August through mid-September. In rank or late-maturing cotton, this damage can be significant. An earlier tunneling type of damage may occur within stems and leaf petioles, usually in mid-July through late August. Although this damage looks serious, with wilting and eventual death of the tissue above the feeding site, it causes no known economic loss. The major moth flight for the ECB often occurs a few days to three weeks later than the major bollworm flight. The female moths lay egg masses that contain 15-75 eggs each. These small, flat, scale-like masses are deposited on the underside of cotton leaves deep within the canopy. At first, early instars feed within the leaf petioles and stems, but they begin to enter and feed upon large bolls, sometimes within 48 hours, particularly after mid-August. Although the caterpillars of this species generally do not feed as extensively within the bolls as do bollworms, most bolls are destroyed.

Controlling ECB damage presents an unusual problem. The flat egg masses are almost impossible to find, even by the trained scouts searching heavily infested fields. By the time the larvae are found feeding on or within bolls, insecticide treatments are usually ineffective. Thus scouting for this pest benefits the producer little during the present year. However, scouting to detect the caterpillars is advised. If small larvae are present (3 percent or more), treatment may be prescribed if an active flight is confirmed. This situation may indicate a late, rank cotton crop that should be avoided in the future.

No control threshold has been developed since finding the egg masses is virtually impossible, and live caterpillars are spotted too late to achieve effective control. Growers must depend on another observation as a trigger for directing insecticide against the pest. Fortunately, because egg laying of the corn earworm usually occurs somewhat earlier than the ECB flight, employing the egg threshold for bollworm control usually works well for ECB if treatments are extended into the ECB infestation period. An insecticide should be selected that is effective against both insects. If the major part of the ECB flight occurs after the bollworm flight has subsided and spraying has been completed, fields can be particularly susceptible. Under this condition, 3-6 total applications may be required for adequate suppression. This approach is recommended only where late rank growth points toward a high probability of ECB damage. Finding moths of this species in local light or pheromone traps, or flushing the adults from around or within cotton fields can help confirm the need for this extended treatment.

Table 4.73 - Recommended Insecticides for European Corn Borer Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	beta-cyfluthrin (Baythroid XL)	1.6-2.6 oz	0	**RESTRICTED USE.**
	bifenthrin (Brigade 2EC)	1.3-6.4 oz	14	**RESTRICTED USE.**
	chlorpyrifos + lambda-cyhalothrin (Cobalt Advanced)	16.0-38.0 oz	21	**RESTRICTED USE.** Do not allow meat or dairy animals to graze in treated areas. Do not feed gin trash or treated forage to meat or dairy animals.
	flubendiamide (Belt SC)	2.0-3.0 oz	28	
	lambda-cyhalothrin (Karate EC) (Karate Z) (Warrior T)	3.2 oz 1.6 oz 3.2 oz	21 21 21	**RESTRICTED USE.**
	lambda-cyhalothrin + thiamethoxam (Endigo ZC)	3.5-5.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	chlorantraniliprole + lambda-cyhalothrin (Besiege)	6.5-12.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	rynaxypyr (Coragen)	3.5-7.0 oz	21	
	spinetoram (Radiant SC)	2.8-8.0 oz	28	
	zeta-cypermethrin (Mustang Max)	2.64-3.6 oz	14	**RESTRICTED USE.**

Stink Bugs

Stink bugs typically begin invading cotton fields in mid-July and build to damaging levels in August. The insecticide applications for the bollworm usually keep stink bug numbers below damaging levels. Problems with stink bugs usually only develop where the bollworm applications are limited or not applied at all. Stink bugs damage cotton by puncturing the carpal walls of bolls and feeding on the soft developing seeds. If bolls are small when feeding occurs, the boll will dry up, turn brown and either remain on the plant or be shed. Bollrot pathogens are sometimes introduced when feeding is concentrated on medium and larger bolls, resulting in portions of the boll being destroyed, hard-lock, and lower grades. External feeding damage appears as small round purplish depressions about the size of a pencil point. The feeding sites are slightly larger but closely resemble the spots that naturally appear on maturing bolls. Stink bug feeding sites can be confirmed by slicing the bolls open under the depressions. The damaged bolls will have a brown stain (bollrot organisms) in the seed area under these spots.

Stink bugs often occur in a clumped distribution within a cotton field; therefore, at least 10 samples should be taken throughout a field to determine if a problem exists. Both sweep nets and shake cloths can be used to sample for stink bugs, but our research is showing that of the two, shake cloths tend to do a better job. A sweep net sample should consist of 25 hard sweeps using a pendulum-like motion with enough speed and force to end up with some leaves and small bolls in the net. An average of one stink bug per 25 sweeps could indicate a problem. A shake cloth sample should consist of placing a 3-foot long cloth on the ground between the rows, bending the bordering plants on either side (first one side, then the other) and vigorously shaking those plants to dislodge any insects. An average of one plant bug per 6 row feet (one 3-foot long shake cloth sample, both sides of the cloth) could indicate a problem.

Research in the southeast has resulted in a dynamic threshold based on percent of bolls injured by stink bug feeding, that changes with week after first bloom (see below).

Table 4.74 - Sampling for Stink Bugs and Thresholds in Cotton

Indicates presence	an average of 1 per 6 row feet using a 3-foot shake cloth
	an average of 1 per 25 sweeps using a 15-inch diameter sweep net
Boll damage	Week of bloom 1 = 50% internal boll damage; week 2 = 30%; weeks 3, 4 and 5 = 10%; week 6 = 20%; week 7 =30%; week 8 = 50%.

Table 4.75 - Recommended Insecticides for Stink Bug Control

Treatment	Insecticide (Formulation)	Amount per acre product	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97)	8.0-12.0 oz	21	Do not feed treated forage or hay to livestock or allow animals to graze treated areas. For brown and green stink bugs.
	chlorpyrifos + lambda-cyhalothrin (Cobalt Advanced)	22.0-38.0 oz	21	**RESTRICTED USE.** Do not allow meat or dairy animals to graze in treated areas. Do not feed gin trash or treated forage to meat or dairy animals.
	clothianidin (Belay)	3.0-4.0 oz	21	Suppression only
	dicrotophos (Bidrin XP)	4.0-6.0 oz	30	**RESTRICTED USE.** For brown and green stink bugs.
	imidacloprid (Admire Pro)	0.9-1.8 oz	14	Suppression only
	imidacloprid + beta-cyfluthrin (Leverage 360)	3.2 oz	14	**RESTRICTED USE.** Do not graze treated fields after application.
	lambda-cyhalothrin + thiamethoxam (Endigo ZC) (brown stink bug) (green stink bug)	5.5 oz 3.5-5.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	chlorantraniliprole + lambda-cyhalothrin (Besiege)	6.5-12.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	pyrethroids (see product labels)			**RESTRICTED USE.** Pyrethroids, when applied two or more times against bollworms, usually provide adequate suppression of green stink bugs.
	thiamethoxam (Centric 40WG)	2.0 oz	21	

Aphids

A number of beneficial insects and fungal diseases can hold aphid numbers below economic threshold levels. By limiting early season insecticide applications, the grower is allowing beneficial insect populations to build, decreasing the chances of developing resistant aphid populations (observed in North Carolina and Virginia), and possibly reducing or eliminating the need for insecticide applications later in the season. An aphid rating level of four or more just before boll opening, plus the presence of honeydew, is probably a good indicator of the need to treat.

Table 4.76 - Aphid Rating Scale

0	No aphids
1	Occasional plants with low numbers of aphids
2	Plants with low numbers common; heavily infested plants rare; honeydew visible occasionally
3	Most plants with some aphids; occasional plants heavily infested; honeydew easily visible in most areas of the field
4	Heavily infested plants common; aphids clumped on upper leaves
5	Many heavily infested plants

Table 4.77 - Recommended Insecticides for Aphid Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acetamiprid (Assail 70WP)	0.6-1.1 oz	28	
	bifenthrin (Brigade 2EC)	2.6-6.4 oz	14	**RESTRICTED USE.**
	clothianidin (Belay)	3.0-4.0 oz	21	
	dicrotophos (Bidrin 8)	4.0 oz	30	**RESTRICTED USE.**
	flupyradifurone (Sivanto)	7.0-10.5 oz	14	
	imidacloprid (Admire Pro)	0.9-1.7 oz	14	Aphid control with insecticides should be attempted only as a last resort, particularly in early season (before major bollworm moth flight).
	thiamethoxam (Centric 40WG)	1.25-2.0 oz	21	

Table 4.78 - Recommended Insecticides for Aphid/Bollworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	cyfluthrin + imidacloprid (Leverage 2.7)	3.0-3.75 oz	21	**RESTRICTED USE.**
	lambda-cyhalothrin + thiamethoxam (Endigo ZC)	3.5-5.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.

Spider Mites

Spider mites can occur during any time of the season but are favored by dry weather and/or the removal of alternative hosts. Mite damage first appears as a slight yellowing of the leaves, which later changes to a purplish or bronze color and is usually associated with webbing. Damage occurs especially in spots or on field edges but widespread defoliation is not uncommon if favorable conditions persist.

Spider mites can be checked while scouting for other insect pests. Active mite populations should be confirmed before applications are made. Delaying treatment should also be considered if rainy, humid conditions are predicted in the near future. Rainy, humid conditions favor a fungus that preys upon mites and may greatly reduce mite numbers.

Table 4.79 - Recommended Insecticides for Spider Mite Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	bifenthrin (Brigade 2EC)	3.8-6.4 oz	14	**RESTRICTED USE.**
	dicofol (Kelthane MF 4E)	1.5-3.0 pt	30	Do not make more than 2 applications/season. Do not feed cotton stalks or trash to meat or dairy animals.
	etoxazole (Zeal)	0.66-1.0 oz	28	Zeal is predominantly an ovicide (egg activity) and larvicide and should be applied early in the life cycle of mites.
	fenpropathrin (Danitol 2.4EC)	10.6-16.0 oz	21	**RESTRICTED USE.**
	propargite (Comite 6.55EC[1])	1.0-2.0 pt	14	
	spiromesifen (Oberon 4SC)	3.0 oz (early season) 4.0-8.0 oz (mid-late season)	30	

[1]not after bolls begin to open

Loopers

Cabbage and soybean loopers rarely damage cotton because they prefer foliage, are prone to virus attack and occur sporadically. Scouting for this pest, which normally appears late season, is done by observing foliage during scouting for other pests. As a general rule, if defoliation exceeds 30% in cotton with a significant portion (25% or more) of the bolls still immature and filling out, treatment may be needed. Soybean loopers are difficult to control with insecticides. Because foliage feeding typically begins at the bottom of the cotton plant and proceeds upward and outward, foliage feeding may be beneficial in preharvest cotton that has begun to open. The brownish larval frass (droppings) can be plentiful and temporarily stain opening cotton; however, this is not thought to be an economic problem. Since loopers are usually controlled by naturally occurring diseases and chemical controls are sometimes not effective due to resistance, recommendations will be available on a year to year basis through your local extension office.

Fall Armyworms

The presence of fall armyworms (FAW) and their damage is recorded as part of bollworm scouting. Additional samples are unnecessary. FAW migrate into Virginia from the south so numbers are generally highest in the southern part of the state. FAW prefer blooms and bolls of all sizes. These caterpillars can be extremely damaging if present in moderate numbers and can become established late in the season. They can feed on mature bolls normally resistant to bollworm penetration. Because FAW are not always controlled effectively by the same insecticides as bollworms, it is very important that they be identified correctly. Also, because fall armyworms are difficult to control with insecticides, treatments are best applied at an early boll bract feeding stage. Fall armyworms have a more difficult time becoming established under a bollworm spray regime with certain pyrethroids.

Table 4.80 - Recommended Insecticides for Fall Armyworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	chlorpyrifos (Lorsban 4E)	1.0-2.0 pt	14	Various rates and combinations may be recommended for armyworm control, depending upon the phenology and the age distribution and population levels of larvae. Pyrethriods will provide some control of fall armyworms hatching from egg masses. Fall armyworms may have more difficulty becoming established following Karate or Capture treatments used for bollworm control.
	chlorpyrifos + lambda-cyhalothrin (Cobalt Advanced)	16.0-38.0 oz	21	**RESTRICTED USE.** Do not allow meat or dairy animals to graze in treated areas. Do not feed gin trash or treated forage to meat or dairy animals.
	chlorantraniliprole + lambda-cyhalothrin (Besiege)	6.5-12.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	flubendiamide (Belt SC)	2.0-3.0 oz	28	
	indoxacarb (Steward EC)	9.2-11.3 oz	14	Various rates and combinations may be recommended for armyworm control, depending upon the phenology and the age distribution and population levels of larvae. Pyrethriods will provide some control of fall armyworms hatching from egg masses. Fall armyworms may have more difficulty becoming established following Karate or Capture treatments used for bollworm control.
	lambda-cyhalothrin + thiamethoxam (Endigo ZC)	3.5-5.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	methomyl (Lannate 2.4LV) (Lannate 90SP)	1.5 pt 0.5 lb	15 15	Various rates and combinations may be recommended for armyworm control, depending upon the phenology and the age distribution and population levels of larvae. Pyrethriods will provide some control of fall armyworms hatching from egg masses. Fall armyworms may have more difficulty becoming established following Karate or Capture treatments used for bollworm control.
	methoxyfenozide (Intrepid 2F)	4.0-10.0 oz	14	
	rynaxypyr (Coragen)	3.5-7.0 oz	21	
	spinetoram (Radiant SC)	4.25-8.0 oz	28	

Table 4.80 - Recommended Insecticides for Fall Armyworm Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
	spinosyn (Blackhawk)	2.4-3.2 oz	28	Various rates and combinations may be recommended for armyworm control, depending upon the phenology and the age distribution and population levels of larvae. Pyrethriods will provide some control of fall armyworms hatching from egg masses. Fall armyworms may have more difficulty becoming established following Karate or Capture treatments used for bollworm control.
	chlorantraniliprole (Prevathon)	14.0-27.0 oz	21	

Table 4.81 - Recommended Insecticides for Beet Armyworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
	flubendiamide (Belt SC)	2.0-3.0 oz	28	
	indoxacarb (Steward EC)	9.2-11.3 oz	14	
	methoxyfenozide (Intrepid 2F)	4.0-10.0 oz	14	
	rynaxypyr (Coragen)	3.5-7.0 oz	21	
	spinetoram (Radiant SC)	4.25-8.0 oz	28	
	chlorantraniliprole + lambda-cyhalothrin (Besiege)	6.5-12.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	spinosyn (Blackhawk)	2.4-3.2 oz	28	
	chlorantraniliprole (Prevathon)	14.0-27.0 oz	21	

Table 4.82 - Recommended Insecticides for Cutworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97)	12.0 oz	21	Control is most effective when ground application is made in the evenings and sprays are directed toward the base and lower portion of plants.
	beta-cyfluthrin (Baythroid XL)	0.8-1.6 oz	14	**RESTRICTED USE.**
	bifenthrin (Brigade 2EC)	2.6-6.4 oz	14	**RESTRICTED USE.**
	esfenvalerate (Asana XL 0.66EC)	5.8 oz	21	**RESTRICTED USE**.
	fenpropathrin (Danitol 2.4EC)	8.0 oz	21	**RESTRICTED USE.**
	lambda-cyhalothrin (Karate EC) (Karate Z) (Warrior T)	1.92 oz 0.96 oz 1.92 oz	21 21 21	**RESTRICTED USE.**
	zeta-cypermethrin (Mustang Max)	1.28-1.92 oz	14	**RESTRICTED USE.**

Beneficial Insects

About a dozen beneficial insects are common in Virginia cotton. Ambush bugs, big-eyed bugs, minute pirate bugs, green lacewings, two species of ladybird beetles, and several types of spiders are examples. They are of two types: 1) predators that prey upon an insect pest, or 2) parasites that live within the host insect. These insects, particularly the predators, reduce the number of eggs and larvae of bollworms, caterpillars and aphids. Because these allies lessen the impact of pest insects, common sense dictates that producers use them as a management tool. Their presence often means that growers can delay and, on occasion, eliminate some insecticide applications.

Many complex factors are involved in determining just how many of each beneficial insect species are needed to influence a given level of pests. Therefore, it is usually not possible to asses the value of these insects except in a very general way. If relatively high numbers of beneficial insects are eating a large portion of aphids or bollworm eggs and larvae, the treatment threshold will be reached later than would otherwise be the case, reducing the number of insecticide applications needed. However, the rapid increase in pest populations, the third generation of bollworms, will often overwhelm the beneficial population and applications become necessary. The careful observation of sound economic thresholds offers the producer the best odds of balancing beneficial insect numbers against damaging insects.