PB 1690

2018

INSECT
and
PLANT DISEASE CONTROL MANUAL

2018 Insect and Plant Disease Control Manual

Department of Entomology and Plant Pathology

Emergency poison control telephone numbers for Tennessee

Human Pesticide Emergency: Poison Control Center Hotline	800-222-1222
General Pesticide Questions: EPA Pesticide Information	800-858-7378
Pesticide Emergency: National Pesticide Information Center	800-424-9300
Non-Emergency Pesticide Information: Chemtrec Info Line	800-262-8200
Animal Pesticide Emergency: National Animal Pesticide Control Center Note: There may be a charge for this service	888-426-4435

ATTENTION

1. Read the label of any pesticide before applying.
2. Do not rely on pesticides alone; employ all cultural methods of control.
3. Regulations and guidelines concerning use of pesticides are subject to change without notice. Consult the label of the product for usages and rates before applying. If recommendations in this manual conflict with the label, please follow the label instructions.
4. When a range of rates and application intervals are recommended, use the lower rate and longer interval for mild-moderate infestations and the higher rate and shorter interval for moderate-severe infestations.
5. Use of trade or brand names in this manual is for clarity and information. The Tennessee Cooperative Extension Service does not imply approval of the product to the exclusion of others which may be similar, suitable composition, nor does it guarantee or warrant the standard to the product.
6. Please read the label before using a product.

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PSEP Education Materials

Department of Entomology and Plant Pathology Faculty

eppserver.ag.utk.edu

Revised 7/18

Name and Title	Specialty	Location	Area of Responsibility
DeWayne Shoemaker Professor and Department Head Entomologist	Extension Research Teaching	Knoxville	Population and evolutionary genomics of insects
Ernest Bernard Professor Nematologist	Research Teaching	Knoxville	All Taxa Biodiversity Inventory (ATBI) Taxonomy and ecology of Collembola, Protura and nematodes, biological control of root-knot and cyst nematodes
Jerome Grant Professor Entomologist	Research Teaching	Knoxville	Integrated pest management and applied ecology of insects, biological control of insects and biodiversity
Kimberly Gwinn Associate Professor Plant Pathologist	Research Teaching	Knoxville	Use of natural products as pesticide alternatives, secondary metabolism of fungi, physiology of plant diseases
Denita Hadziabdic-Guerry Assistant Professor Plant Pathologist	Research	Knoxville	Forest health and forest pathology, population genetics of fungal pathogens, population biology and genetic diversity of ornamental/native plants, tissue culture of ornamental plants
Reza Hajimorad Associate Professor Plant Virologist	Research Teaching	Knoxville	Virus/host interactions with emphasis on evasion of single dominant resistance gene-mediated recognition; virus identification and characterization; characterization of etiologically unknown diseases of plant for viral origin; development of biotechnology-based diagnosis assays for plant viruses
Frank Hale Professor Entomologist	Extension	Nashville	IPM commercial ornamentals and turf, commercial fruits and vegetables, dark tobacco insects and mites, Diagnostic Clinic
Zachariah Hansen Assistant Professor	Extension	Knoxville	Sustainable disease and Integrated Pest Management systems, specialty crop disease management, pathogen detection and diagnostics
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Heather Kelly Associate Professor Plant Pathologist	Extension Research	Jackson	Diseases of field crops; soybeans, cotton, corn, small grains, grain sorghum, wheat, IPM coordinator for UTIA
Paris Lambdin Professor Entomologist	Research Teaching	Knoxville	Biosystematics, biology and phytogenetics of scale insects, insect biodiversity, biological control of ornamental and forest insects
Kurt Lamour Professor Plant Pathologist	Research Teaching	Knoxville	Functional genomics of plant pathogens in the genus *Phytophthora*, population biology and epidemiology; development of high-throughput tools for genomic discovery
Kevin Moulton Associate Professor Entomologist	Research Teaching	Knoxville	Arthropod systematics evolution and biodiversity
Bode Olukolu Assistant Professor	Research Teaching	Knoxville	Genetics/genomics of plant/plant-pathogen interactions, structural, comparative and functional genomics, quantitative genetics, bioinformatics
Bonnie Ownley Professor Plant Pathologist	Research Teaching	Knoxville	Biology, biocontrol and epidemology of soilborne plant pathogens, ecology and population dynamics of soil microorganisms
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Name and Title	Specialty	Location	Area of Responsibility
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Scott Stewart Professor Entomologist	Extension	Jackson	Insect pest management in cotton, soybeans and other field crops
Robert Trigiano Professor Plant Pathologist	Research Teaching	Knoxville	Fungal diseases of ornamental plants; genetic diversity and population analysis of ornamental plants and pathogens; plant biotechnology of ornamental plants
Becky Trout Fryxell Associate Professor Entomologist	Teaching	Knoxville	Medical and veterinary entomology
Karen Vail Professor Entomologist	Extension	Knoxville	Integrated pest management of pests found in and around structures (ants, bed bugs, termites, etc.), IPM of child-serving facilities
Alan Windham Professor Plant Pathologist	Extension	Nashville	Disease control in woody ornamentals, turf, flowers, forages and fescue endophyte, Diagnostic Clinic
Mark Windham Professor and Distinguished Chair	Research Teaching	Knoxville	Diseases of woody ornamentals and nursery crops. Current interests are diseases of black walnut, hydrangea and roses.

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PB 1768

2018
Insect Control Recommendations for Field Crops

Cotton, Soybean, Field Corn, Sorghum, Wheat and Pasture

Real. Life. Solutions.™

UTEXTENSION
INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

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2018 Insect Control Recommendations for Field Crops
Cotton, Soybean, Field Corn, Sorghum, Wheat and Pasture

Scott Stewart, Professor, Department of Entomology and Plant Pathology
Angela McClure, Associate Professor, Department of Plant Sciences

2018 Cotton Insect Control Recommendations

Integrated Pest Management

An Integrated Pest Management (IPM) program integrates control tactics including cultural practices, variety selection, biological control and insecticides to manage insect pest populations so that economic damage and harmful environmental side effects are minimized. Insecticides should only be used on an as-needed basis; therefore, insect scouting must be conducted regularly throughout the season to determine if an insecticide application is warranted.

Scouting/Monitoring

Insect populations vary from year to year and field to field during the growing season. All fields should be monitored for both insect pests and beneficial populations at least weekly during the season, preferably twice weekly after blooming has begun. In areas of high insect pressure or increasing populations, twice-a-week scouting is recommended. Monitoring plant growth and development is an important aspect of crop management, maximizing yield potential and managing insects

Two basic components of decision making in IPM are the economic injury level (EIL) and the economic threshold (ET). The EIL is defined as the lowest pest population density that will cause economic damage. The EIL is a pre-determined number that will justify the cost of treatment. The ET is defined as the pest population level at which control should be initiated to keep the pest population from reaching economically damaging numbers.

Economic thresholds have been established for specific insect pests. Multiple pest thresholds are not well established. Therefore, it is important to monitor the plant for fruit loss and retention levels to evaluate treatment thresholds, involving either single or multiple pests. When losses from multiple pests are occurring, fixed individual pest thresholds may become dynamic or change. Decisions to apply controls should be based on thorough scouting and identification of pests, cost of insecticide, the price of cotton, yield potential and fruit retention goals. The economic value of each fruiting form changes on each fruiting branch (node); therefore, it is important to know how this value is distributed on the plant. The value and placement of fruit being protected should be considered when making treatment decisions. Monitor fruit retention levels weekly, along with insects. Scheduled insecticide sprays should be avoided. Unnecessary applications of insecticide are not cost effective. Applications of insecticides on an as-needed basis will preserve beneficial insects, reducing the likelihood of secondary pest outbreaks.

Certain production practices can have a significant impact on insect pest infestations. Some practices may increase the risk of insect attack and should be avoided, while others may have some level of control value. A production practice that has a negative impact on insect pests is desirable and is termed a cultural control. Some common cultural control practices include:

- **Pre-plant Vegetation Management**
  Destruction of weeds and/or cover crops by tillage or herbicide three or more weeks prior to planting will reduce the risk of cutworm infestations and some other pests.
- **Field Border Maintenance**
  Plant bugs often build up on flowering plants surrounding cotton fields and move into fields when these preferred hosts dry up or are destroyed. Timely mowing of such vegetation can aid in reducing available hosts for plant bugs.
- **Managing for Earliness**
  Early crop maturity decreases the period of crop susceptibility to yield loss by insects, reduces insect control costs and lowers selection pressure for resistance development to insecticides.

Crop Management Considerations

Insecticide Resistance

Management of tobacco budworm in non-Bt cotton varieties has become more difficult in Tennessee due to the development of pyrethroid-resistant populations. Historically, budworm populations have been higher in the southern part of the state, but high populations can also occur in other areas. In response to tobacco budworm resistance, and the potential for resistance in bollworm and tarnished plant bug populations, a resistance management plan will continue to be recommended.

The goal of the Insecticide Resistance Management Plan is to improve the potential of maintaining effective full-season control of tobacco budworm, bollworm and tarnished plant bug by the use of different classes of chemistry in a logical sequence throughout the season, without placing excessive reliance on any single class of chemistry.

In general, levels of resistance are lowest during the early part of the growing season but increase sharply following repeated exposure to a single class of chemistry. Therefore, repeated use of a single class of chemistry may no longer provide effective control. As a result, there is a potential risk of sustaining economic losses. Following a resistance management plan is a recommended method to reduce the risk.

Because cotton insect pest management is dynamic, these guidelines cannot address all situations. Therefore, these recommendations are not intended to limit the professional judgment of qualified individuals. However, the **maximum benefit of a resistance management strategy can only be realized if all producers in a wide geographic area participate**.

Selection of insecticides should be based on insect pests present in the field, stage of crop development, effects on non-target organisms and the risk of contributing to resistance problems in subsequent generations.

Insecticide selection for bollworm and tobacco budworm control should be made after determining the population mix and size of the infestation within a community, farm or field. When dealing with resistance, this determination can mean a control success or failure. Use all available information and techniques including scouting reports, pheromone trap catches, moth flushing counts and identification of “worms.”

Phase I (Planting through June)

Phase I corresponds to that time between planting and first bloom. The first field generation of tobacco budworm and bollworm generally occurs during this time.

The primary objective in Phase I is to preserve the efficacy of the pyrethroids and organophosphate (OP) insecticides. Use of these insecticides in June will foster resistance in tobacco budworm, bollworm and tarnished plant bug populations. Insecticides should not be applied for control of any insect pests unless scouting techniques suggest economic losses are occurring. Producers should strive for a minimum of 80 percent square retention during Phase I.

Consider multiple pests and adjust treatment thresholds to achieve square retention goals. A goal of 100 percent pre-bloom square retention is not realistic if multiple insecticide applications are required. These additional insecticide sprays may increase cost, flare secondary pests and increase resistance selection pressure. Selection of specific compounds should consider all insect pests in the field to be treated, activity on beneficial insects and risks of contributing to control failures in subsequent generations. Automatic applications are discouraged.

Calculating Percent Square Retention

- Select 20 representative plants within a field.
- Examine each first fruiting position on the top five fruiting branches (nodes).
- Record the total number of missing fruit from 100 possible positions.
- 100 minus number missing = percent square retention.

Phase II (July to end of season)

Phase II includes the blooming and boll development period, during which the second and subsequent field generations of tobacco budworm/bollworm occur. It is during this window that cotton is most susceptible to insect injury, and pyrethroid or other appropriate classes of insecticides should be used whenever pest densities exceed economic thresholds. However, **pyrethroid insecticides should not be used for tobacco budworm.** Pyrethroid resistance in tobacco budworm populations is well established in Tennessee. If a failure occurs with a pyrethroid or pyrethroid tank mixture, a second application with full rates of a non-pyrethroid insecticide should be made immediately. It is not realistic to expect follow-up applications made after an insecticide control failure to totally “clean-up” remaining larvae.

When Unsatisfactory Control with Foliar Insecticide Occurs

All control problems are not related to insecticide resistance, and several factors should be considered in response to these problems. Treatment decisions should consider a variety of factors that influence insecticide efficacy and damage potential: species composition, population density, population age structure, application timing, insecticide dosage, application methods, application carriers, treatment evaluation timing, need for multiple applications, environmental conditions and insecticide resistance levels. Good coverage using labeled rates adjusted to infestation levels is necessary for satisfactory control. Do not expect 100 percent control with any insecticide treatment. Attempts to reduce insect populations to zero damage levels are not cost-effective and result in early field-control failures.

Managing for Earliness

Managing crop maturity is an important component of these guidelines. Cotton producers should plant an early-maturing cotton variety during a 20-day period between April 20 and May 10. At-planting fungicides and insecticides are recommended to promote plant establishment and seedling growth, manage early-season insect pests and accelerate crop maturity.

The goal is to obtain an optimal stand of healthy and actively growing cotton that initiates squaring 35-45 days after planting. Producers should avoid practices that delay crop maturity (some herbicides and excessive nitrogen) and increase the attractiveness of cotton to late-season insect pests. With timely planting and proper insect pest management, most of the harvestable bolls will be set on the plant by early August. Under these conditions, the cotton crop should mature soon enough to avoid severe damage by the August generations of tobacco budworm and bollworm. Early crop maturity will also reduce the probability of economic losses from other late-season insect pests.

Nodes Above White Flower (NAWF) and Terminating Insect Control

NAWF is the number of fruiting branches (nodes) above the uppermost first-position white flower of a plant. Counting from the top, the first node will have an unfolded leaf the size of a quarter or larger. NAWF is a useful measure of plant maturity and can be used to help make insect management decisions. NAWF=5 is referred to as cutout (see below). Average NAWF counts should be recorded weekly for each cotton field once blooming has begun.

The plant physiological stage of “cutout” is when there are five or fewer nodes above the uppermost first-position white flower (i.e., NAWF5). At cutout, cotton starts becoming less attractive and less sensitive to late-season insect pests. Insect treatment thresholds can be adjusted to higher levels after cutout. Insecticide applications for some pests can be terminated once fields have accumulated 350-450 heat units (DD60s) after the cutout date (approximately 18-21 days). Research has shown that accumulating 350 - 450 DD60s after cutout is enough time to mature yield-contributing bolls beyond the point where economic losses from bollworm, tobacco budworm, plant bugs and stink bugs are likely to occur. It may be necessary to control some pests beyond NAWF5 + 350 - 450 DD60s. For example, fall armyworm can damage more mature bolls. Also, because leaves are important to complete boll maturation, treatments for spider mites or loopers may be necessary to prevent excessive defoliation before the crop is fully mature (about NAWF5 + 850 DD60s).

> **Calculating Heat Units (DD60s):** Use the maximum and minimum temperature for a 24-hour period to determine the average temperature for the day. Subtract 60 degrees from the average. The remainder is the number of heat units (DD60s) accumulated for that day. Add these daily units to obtain the accumulated total.

Guidelines to Manage Tobacco Budworm and Bollworm in Non-Bt Cotton

- Promote earliness (plant between April 20 and May 10 with an early maturing variety, use an at-planting fungicide and insecticide, avoid excessive fertilization, control all insect pests when populations exceed thresholds, consider multiple pests and maintain 80 percent or higher square retention prior to bloom).
- Do not apply automatic applications of insecticides.
- Scout fields twice each week if possible.
- Time insecticide applications against eggs and 1- to 2-day-old larvae.
- Two treatments on a 4- to 5-day interval may be needed.
- Multiple applications, at median rates, are often more effective than a single application at a high rate.

- Consider pheromone-trapping data and moth-flushing counts to determine species composition (tobacco budworm vs. bollworm) before choosing an insecticide.
- Pyrethroids are generally not recommended for control of mixed budworm/bollworm populations.
- Only use pyrethroids, or pyrethroids tank mixed with carbamates or organophosphates, if tobacco budworms are a small part of the population (< 25 percent) **and** overall larval **and** egg numbers are < 8-10 per 100 plants.
- Use insecticides from different classes of chemistry if a pyrethroid failure occurs.
- Improve insecticide coverage by use of nozzles producing relatively small droplets while maintaining adequate spray volume.
- Monitor crop maturity and terminate insecticide applications when yield-contributing bolls are no longer susceptible to insect damage.

Bt Cotton Management

Bt cotton varieties, which produce toxins from the bacterium *Bacillus thuringiensis*, are widely used in Tennessee. The use of Bt cotton is recommended in areas with high occurrence of tobacco budworm and bollworm. Bt cotton must be monitored on a regular basis for pests, including bollworm. Tobacco budworm should not cause economic damage to Bt cotton at any time during the season, and damaging infestations of bollworm are uncommon prior to bloom. Prior to bloom, concentrate efforts in Bt cotton on monitoring square retention and scouting for pests such as plant bugs. However, fields should be checked for the presence of surviving larvae if a bollworm egg lay occurs. Larvae must feed on plant tissue to ingest a toxic dose of Bt toxin. This feeding is generally superficial and will not cause economic damage. A larva that is 1/4 inch or greater in length is considered to have survived or "escaped" the toxin.

During the blooming period, bollworms can sometimes cause economic damage to Bt cotton. Twice a week scouting and closer examination within the plant canopy may be necessary to locate and determine bollworm survival before making a treatment decision. The Bt toxin should be given an opportunity to work; therefore, treatment based just on the presence of eggs is not usually recommended. Spray coverage and timing are critical for best control.

Bt Cotton and Resistance Management

Bt cottons — including Bollgard II, Bollgard III, TwinLink, TwinLink Plus, WideStrike and WideStrike 3 technologies — are more effective than the original Bollgard technology, including better activity on bollworm, armyworms and loopers. However, insecticide treatments may still be needed if sufficient pest pressure occurs, particularly for bollworm or fall armyworm. Bt cotton does not control tarnished plant bugs, stink bugs or other non-caterpillar pests.

A refuge is not required for Bt cotton varieties, but planting a refuge is still a potentially valuable resistance management strategy. Planting non-Bt cotton will provide a source of susceptible moths for mating with resistant moths that survive in Bt cotton.

Boll Weevil

The boll weevil has been successfully eradicated from Tennessee. Post-eradication pheromone trapping will continue in order to detect reinfestations that may occur. **Evidence of boll weevil infestations should be reported immediately to boll weevil eradication officials.**

Expected Occurrence of Insect Pests in Cotton

Below is a timetable of when pests are typically encountered in cotton, although conditions vary from season-to-season or farm-to-farm within a season.

Stage of Plant Development	Common Pests	Occasional Pests
Emergence to first square	Thrips	Aphids, Cutworms, Plant bugs, Spider mites
First square to first bloom	Plant bugs	Aphids, Spider mites, Bollworm, Tobacco budworm
After first bloom	Bollworm, Tobacco budworm, Plant bugs, Stink bugs	Aphids, Loopers, Fall and Beet armyworm, Spider mites, Whiteflies

Cutworms

Cutworm damage occurs most frequently following legume cover crops or in reduced tillage systems. Cutworms may become established on existing vegetation and move to emerging cotton once this vegetation has been killed. Destroying all green vegetation 21 days prior to planting reduces the likelihood of cutworm attack.

Treat when cutworms are damaging stand and plant population is less than three plants per row foot. Infestations may be spotty within a field and only require treatment where damage and live cutworms are found. At-planting insecticides applied in a band (no less than 10 inches) may be justified if vegetation has not been burned down at least 21 days prior to planting.

Do not expect Bt cotton to provide adequate control of cutworms, although it provides some protection against small larvae or low infestation levels.

Insecticide (Trade Names) for CUTWORMS	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
acephate 90 (Orthene 90S)	0.72	0.8 lb	1.25
bifenthrin (Brigade 2, Discipline 2, Fanfare 2)	0.04 - 0.1	2.4 - 6.4 oz	53.3 - 20
chlorpyrifos (Lorsban 4, Nufos 4)	0.75 - 1	24 - 32 oz	5.3 - 4
chlorpyrifos (Lorsban Advanced 3.755)	0.75 - 1	25.6 - 34.1 oz	5 - 3.8
cypermethrin 2.5	0.025 - 0.1	1.3 - 5 oz	100 - 25
deltamethrin (Delta Gold 1.5)	0.013 - 0.019	1.11 - 1.62 oz	115 - 79
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	22 - 13
β-cyfluthrin (Baythroid XL 1)	0.0065 - 0.0125	0.8 - 1.6 oz	160 - 80
γ-cyhalothrin (Declare 1.25)	0.0075 - 0.01	0.77 - 1.02 oz	166 - 125
λ-cyhalothrin (Karate 2.08, Warrior II)	0.015 - 0.02	0.96 - 1.28 oz	133 - 100
Z-cypermethrin (Mustang Max 0.8)	0.008 - 0.012	1.28 - 1.92 oz	100 - 67

Thrips

Thrips injury causes foliar deformity (leaves crinkle and cup upward), plant stunting and delays in maturity. Preventative in-furrow or seed treatments are recommended. Under adverse growing conditions, a foliar treatment may be needed even when preventative controls were used. Foliar applications, when needed, typically provide the most benefit when applied before the third true leaf has emerged. Under conditions of slow emergence and seedling growth, consider applying a foliar insecticide at the first or second leaf stage when the emerging leaf shows signs of thrips injury and especially if immature thrips are present. Two foliar insecticide applications are rarely justified if at-planting treatments were used.

Insecticide (Trade Names) for THRIPS	**Lb Active Ingredient per Acre**	**Amount Formulation per Acre**	**Acres Treated per Gal. or Lb of Dry Product**
In-furrow Systemic Sprays:			
acephate 90 (Orthene 90S)	0.9 - 1	1 - 1.1 lb	1 - 0.9
disulfoton (Di-Syston 8)	0.75 - 1	12 - 16 oz	10.7 - 7.8
imidacloprid (Admire Pro 4.6)	0.27 - 0.33	7.4 - 9.2 oz	17.3 - 13.9
imidacloprid (Velum Total 2.17)	0.24 - 0.31	14 - 18 oz	9.1 - 7.1
Foliar Sprays: *			
acephate 90 (Orthene 90S)	0.18	3.2 oz	5
dicrotophos (Bidrin 8)	0.1 - 0.2	1.6 - 3.2 oz	80 - 40
dimethoate 4	0.125 - 0.25	4 - 8 oz	32 - 16
spinetoram (Radiant SC 1), suppression **	0.012 - 0.023	1.5 - 3 oz	42.7 - 21.3
Treated Seed			
imidacloprid (Gaucho 600, Aeris, Acceleron Standard, Acceleron Elite, Avicta Elite Cotton Plus)	0.34 - 0.375 mg active ingredient per seed		
Orthene 97 ST or Acephate 80S *	Acephate can be applied to a seed at 6.4 oz/100 lb seed (Orthene 97 ST) or 8 oz/100 lb seed (Acephate 80 S)		

* Not recommended as a standalone treatment for thrips control.

** Radiant SC is suggested if western flower thrips are present in significant numbers. The use of an adjuvant is recommended when using Radiant SC for control of thrips.

Plant Bugs

The tarnished plant bug and clouded plant bug are the predominant species. Cotton fleahoppers are observed some years. The sweep net is a very effective tool for monitoring adult plant bugs and detecting movement into the field. The ground cloth is a more effective tool for monitoring nymphs. The presence of nymphs indicates reproduction is occurring, and they generally are more common after first bloom. Visual scouting is a less reliable method but may also be used.

Visual sampling should include examining terminals for adults and nymphs, and checking inside squares, blooms and small bolls for nymphs. Boll injury appears as small, dark sunken spots on the outside. Seed and lint damage is usually localized to the lock where feeding occurred.

Distinguishing plant bug damage from stink bug based on external symptoms is difficult. “Dirty blooms” (anthers dark and brown) are a sign of plant bug feeding.

First two weeks of squaring: Treat when plant bugs number **eight** or more per 100 sweeps (standard sweep net) or one or more per drop cloth (0.2 per row foot).

Third week of squaring until first bloom: Treat when plant bugs number **15** or more per 100 sweeps or two or more per drop cloth (0.4 per row foot).

From first square to first bloom: Low or dropping square retention can be a warning of plant bug problems. If square retention drops below **80 percent** and plant bugs are present, treatment should be considered even if numbers are below threshold. The objective is to maintain the square retention goal. Consider if multiple pests are contributing to this square loss before selecting an insecticide.

After first bloom: Treat when plant bugs number **three** or more per drop cloth (0.6 per foot) or 15 or more per 100 sweeps. Count clouded plant bugs as equivalent to 1.5 tarnished plant bugs when determining if populations are above treatment level. Treatment should also be considered if 15 or more plant bugs are observed per 100 plants during visual examination, or 10 percent or more of squares show external evidence of plant bug feeding (i.e., dirty squares). **Consecutive insecticide applications at a 4 to 7 day interval are often required to control high populations of nymphs and adults.**

Insecticide (Trade Names)	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of
PLANT BUGS - PHASE I, PRE-BLOOM WINDOW*			
acetamiprid (Intruder Max 70WP, Strafer Max 70WP)	0.074 – 0.101	1.7 - 2.3 oz	9.4 - 7.0
clothianidin (Belay 2.13)	0.05 - 0.067	3 - 4 oz	42.7 - 32
flonicamid (Carbine 50WG)	0.081 - 0.089	2.6 - 2.8 oz	6.2 - 5.7
imidacloprid 2.0	0.047 - 0.062	3 - 4 oz	42.7 - 32
imidacloprid 4.0 (Couraze Max)	0.047 - 0.062	1.5 - 2 oz	85 - 64
imidacloprid 4.6 (Admire Pro)	0.047 - 0.062	1.3 - 1.7 oz	97.7 - 74.2
thiamethoxam (Centric 40WG)	0.044 - 0.05	1.75 - 2.5 oz	9.1 – 6.4
PLANT BUGS - PHASE II, BLOOMING WINDOW			
acephate 90 (Orthene 90S)	0.45 - 0.675	0.5 - 0.75 lb	2 - 1.3
acephate 97 (Orthene 97SP)	0.49 - 0.73	0.5 - 0.75 lb	2 - 1.3
dicrotophos (Bidrin 8)	0.31 - 0.5	5 - 8 oz	25.6 - 16
dimethoate 4	0.25 – 0.5	8 - 16 oz	16 - 8
malathion 5	1.25	32 oz	4
novaluron (Diamond 0.83, Mayhem 0.83)**	0.058 - 0.078	9 - 12 oz	14.2 - 10.7
oxamyl (Vydate C-LV 3.77)	0.29 - 0.35	10 - 12 oz	12.8 - 10.7
pyrethroids***	See labels (use mid- to high-recommended rates)		

* These products tend to perform better prior to bloom and are primarily recommended in this window. Applications can be banded to reduce costs. Avoiding the use of pyrethroid, organophosphate and carbamate insecticides prior to bloom is suggested as a resistance management tool.
**This product controls only immature plant bugs. Tank mixes with other insecticides are recommended if significant numbers of adults are present.
***Pyrethroid insecticides applied alone will not provide adequate control of tarnished plant bugs. However, tank mixing pyrethroid insecticides with other Phase II recommended insecticides will often improve their performance.

Aphids

Early season
Parasites and predators usually control aphids on seedling cotton. If aphids are present on numerous plants and some leaves are curled along the edges (signs of stress), treatment is suggested, particularly if the crop is already suffering from drought stress. Some in-furrow insecticides and seed treatments used for thrips control can suppress early-season aphid populations.

Mid-late season
Treat when aphids are very numerous, honeydew is present, plants are showing signs of stress, and natural control agents are not reducing aphid populations. Consider the possibility of a fungal epizootic (disease) before treating.

Insecticide (Trade Names) for APHIDS	**Lb Active Ingredient per Acre**	**Amount Formulation per Acre**	**Acres Treated per Gal or Lb of Dry Product**
acetamiprid (Intruder 70WSP, Strafer 70WSP)*	0.026 - 0.048	0.6 - 1.1 oz	26.7 - 14.5
clothianidin (Belay 2.13), suppression*	0.05 - 0.067	3 - 4 oz	42.7 - 32
dicrotophos (Bidrin 8)*	0.25 - 0.5	4 - 8 oz	32 - 16
dimethoate 4*	0.125 - 0.5	4 - 16 oz	32 - 16
flonicamid (Carbine 50 WP)	0.044 - 0.089	1.4 - 2.8 oz	11.4 - 5.7
imidacloprid 2.0*	0.031 - 0.047	2 - 3 oz	64 - 42.7
imidacloprid 4.0 (Couraze Max)*	0.031 - 0.047	1 - 1.5 oz	128 - 85
imidacloprid 4.6 (Admire Pro)*	0.047 - 0.062	0.9 - 1.3 oz	142 - 98.5
thiamethoxam (Centric 40WG)*	0.031 - 0.05	1.25 - 2 oz	12.8 - 8

* Because of resistance, these products may fail or only provide suppression, especially if the same class of insecticide was used previously.

Bollworm/Tobacco Budworm

Non-Bt Cotton
Insecticides are recommended on the basis of knowing which species (bollworm vs. tobacco budworm) and how many are present in the field. **Prior to bloom**, treat when eight or more small larvae are present per 100 plants (or when populations threaten to reduce square retention below 80 percent). **After first bloom**, treat when four or more small larvae per 100 plants are present (or 5 percent or more of the squares are damaged and larvae are present). Insecticide application will often be needed when 10-20 percent or more of plants are infested with eggs.

In both Bt and non-Bt cotton, the treatment threshold should gradually increase after cotton reaches cutout (NAWF5) until NAWF5 + 350 - 450 DD60's at which time insecticide applications for bollworm and budworm are no longer necessary.

Pyrethroid insecticides are NOT recommended against tobacco budworm infestations because of insecticide resistance. Time applications to control newly hatched larvae (< 1/4 inch length). Multiple applications on a 4- to 5-day interval may be needed. Tank-mixing pyrethroids with other insecticides may improve control of pyrethroid-resistant tobacco budworms but are only recommended when the budworm ratio is no more than 25 percent and populations are less than 8-10 larvae per 100 plants. Change insecticide chemistry if a control failure occurs.

Bt Cotton

Recent data indicates bollworm are developing resistance to some Bt toxins. Thus, insecticide applications for bollworm in Bt cotton are more likely and especially for WideStrike, TwinLink, and Bollgard II. Treatment is less likely for WideStrike 3, TwinLink Plus, and Bollgard III varieties. **Prior to bloom**, treat when eight or more surviving larvae (> 1/4 inch or longer) are present per 100 plants, or when populations threaten to reduce square retention below 80 percent. **After first bloom**, treat when four or more surviving larvae (> 1/4 inch or longer) per 100 plants are present. Treatment should also be made if a combination of square and boll sampling shows 6 percent or more injury (e.g., 3 percent square injury and 3 percent boll injury, 4 percent square injury and 2 percent boll injury, etc.). Scouting fields twice per week may be necessary once blooming has begun, especially if heavy egg lays are occurring. Treatments based on eggs alone is not usually recommended, but applications to some Bt technologies should be considered when high numbers of eggs are present. Whole plant examination may be necessary to find eggs and/or surviving larvae within the plant canopy.

Insecticide (Trade Names)	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
BOLLWORM*			
bifenthrin (Brigade 2, Discipline 2, Fanfare 2)	0.05 - 0.1	3.2 - 6.4 oz	40 - 20
cypermethrin 2.5	0.063 - 0.1	3.2 - 5 oz	40 - 26
deltamethrin (Delta Gold 1.5)	0.02 - 0.03	1.7 - 2.56 oz	75 - 50
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	22 - 13
β-cyfluthrin (Baythroid XL 1)	0.0125 - 0.020	1.6 - 2.6 oz	80 - 49
γ-cyhalothrin (Declare 1.25)	0.0125 - 0.02	1.28 - 2.05 oz	100 - 62
λ-cyhalothrin (Karate 2.08, Warrior II)	0.025 - 0.04	1.6 - 2.56 oz	83 - 52
Z-cypermethrin (Mustang Max 0.8)	0.0165 - 0.0225	2.64 - 3.6 oz	48.5 - 35.6
BOLLWORM AND TOBACCO BUDWORM			
acephate 90 (Orthene 90S)	0.9	1 lb	1
chlorantraniliprole (Prevathon 0.43 SC)	0.067 - 0.09	16 - 27 oz	6.4 - 4.7
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	8 - 12.5 oz	16 - 10.25
emamectin benzoate (Denim 0.16)	0.01 - 0.015	8 - 12 oz	16 - 10.7
indoxacarb (Steward 1.25)	0.11	11.3 oz	11.3
methomyl (Lannate LV 2.4)	0.45	24 oz	5.3
spinetoram, methoxyfenozide (Intrepid Edge)	See label	7 - 8 oz	18.3 - 16
spinetoram (Radiant SC 1)	0.033 - 0.0625	4.25 - 8 oz	30.1 - 16
spinosad (Blackhawk 36% WDG)	0.056 - 0.072	2.0 - 3.2 oz	6.4 - 5

* Pyrethroids have often been used when the population is exclusively bollworm, such as would be expected on Bt cotton varieties, but the efficacy of pyrethroid insecticides for the control of bollworm has declined. Thus, alternative chemistries or tank mixes with alternative chemistries may be needed for adequate control.

Stink Bugs

Small, dark spots about 1/16-inch in diameter on the outside of bolls are usually associated with stink bug feeding. Stink bugs have piercing, needle-like mouthparts that can penetrate even more mature bolls. Stink bugs are seed feeders and migrate from other host crops into cotton when bolls begin to develop. Stink bugs are often difficult to detect. Intensively scout for this pest when stink bugs or bolls with dark feeding spots are observed.

Treat when stink bugs number one or more per 6 row feet. Treatment is also recommended if 20 percent or more of 12- to 16-day-old (thumb-sized) bolls have internal feeding warts and/or stained lint indicating stink bug injury.

Insecticide (Trade Names) for STINK BUGS	**Lb Active Ingredient per Acre**	**Amount Formulation per Acre**	**Acres Treated per Gal or Lb of Dry Product**
acephate 90 (Orthene 90S)	0.49 - 0.72	0.54 - 0.8 lb	1.9 - 1.25
acephate 97 (Orthene 97SP)	0.49 - 0.73	0.5 - 0.75 lb	2 - 1.33
bifenthrin (Brigade 2, Discipline 2, Fanfare 2)*	0.05 - 0.1	3.2 - 6.4 oz	60 - 30
dicrotophos (Bidrin 8)	0.33 - 0.5	5.3 - 8 oz	24 - 16
methyl parathion 4 (Methyl 4E)	0.5	16 oz	8
oxamyl (Vydate C-LV 3.77)	0.32 - 0.5	10.9 - 17 oz	11.6 - 7.5

* Most pyrethroid insecticides are labeled and effectively control green and southern green stink bugs. Bifenthrin is the only pyrethroid recommended if brown stink bugs are present in significant numbers.

Spider Mites

Spider mites are found on the underside of leaves, and close examination is required to detect their presence. Reddish or yellow speckling of leaves indicates spider mite activity. Infestations often occur on field edges or in isolated spots and then spread across the field. Treat when 30-50 percent of plants are affected and mites are still present. More than one application on a 4- to 5-day schedule may be required if eggs continue to hatch.

Insecticide (Trade Names) for SPIDER MITES	**Lb Active Ingredient per Acre**	**Amount Formulation per Acre**	**Acres Treated per Gal or Lb of Dry Product**
abamectin (Abba 0.15, Agri-Mek 0.15, Zoro 0.15)	0.0047 - 0.019	4 - 16 oz	32 - 8
(Agri-Mek SC 0.7)	0.0055 - 0.019	1 - 3.5 oz	128 - 36.6
bifenazate (Acramite 4)	0.375 - 0.75	16 - 24 oz	8 - 5.3
bifenthrin (Brigade 2, Discipline 2, Fanfare 2)*	0.06 - 0.1	3.8 - 6.4 oz	33 - 20
dimethoate 4*	0.25 - 0.5	8 - 16 oz	16 - 8
emamectin benzoate (Denim 0.16)*	0.01 - 0.015	8 - 12 oz	16 - 10.7
etoxazole (Zeal 72 WSP)	0.034 - 0.045	0.75 - 1 oz	21.3 - 16
(Zeal SC 2.88)	0.300 - 0.045	1.33 - 2 oz	96.2 - 64
fenpyroximate (Portal 0.4)	0.05 - 0.075	16 - 24 oz	8 - 5.3
propargite (Comite II 6)	0.94 - 1.69	20 - 36 oz	6.4 - 3.6
spiromesifen (Oberon 4)	0.094 - 0.25	3 - 8 oz	42.7 - 16

See label for specific use rates at different times of the season.
* These products may only suppress spider mite populations.

Fall Armyworm

Proper identification of fall armyworm larvae is critical for effective control. Look for an inverted "Y" mark on the head. Treat when four or more larvae are found in 100 blooms and/or bolls or when 10-20 larvae are found per 100 plants. Timing applications to control small larvae is more effective than trying to control larger larvae. Small larvae are often found in white blooms, pink bloom tags or behind the bracts of medium- or large-sized bolls.

Bt cotton provides some control of fall armyworm infestations. Insecticide treatment may still be necessary depending upon pest pressure. It is unlikely that WideStrike, WideStrike III, TwinLink Plus, and Bollgard III varieties will require an insecticide application to control fall armyworm. Insecticide treatments should not be made unless surviving larvae (> 1/4 inch in length) are found at the threshold numbers indicated above.

Insecticide (Trade Names)* for FALL ARMYWORM	**Lb Active Ingredient per Acre**	**Amount Formulation per Acre**	**Acres Treated per Gal or Lb of Dry Product**
acephate 90 (Orthene 90S)	0.9	1.0 lb	1
chlorantraniliprole (Prevathon 0.43 SC)	0.067 - 0.09	20 - 27 oz	6.4 - 4.7
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	8 - 12.5 oz	16 - 10.25
emamectin benzoate (Denim 0.16)	0.01 - 0.015	8 - 12 oz	16 - 10.7
indoxacarb (Steward 1.25)	0.09 - 0.11	9.2 - 11.3 oz	13.9 - 11.3
methomyl (Lannate LV 2.4)	0.45	24 oz	5.3
methoxyfenozide (Intrepid 2)	0.06 - 0.16	4 - 10 oz	32 - 12.8
novaluron (Diamond 0.83, Mayhem 0.83)	0.039 - 0.078	6 -12 oz	21.3 - 10.7
spinetoram (Radiant SC 1)	0.033 - 0.0625	4.25 - 8 oz	30.1 - 16
spinetoram, methoxyfenozide (Intrepid Edge)	See label	6 - 8 oz	21.3 - 16
spinosad (Blackhawk 36% WDG)	0.056 - 0.072	2.4 - 3.2 oz	6.7 - 5

*Most pyrethroid insecticides provide some suppression of fall armyworm infestations, and using the highest labeled rates or a tank mixture with products listed above will often improve control.

Beet Armyworm

Beet armyworms can be recognized by a characteristic small black dot directly above the second true leg. Newer insecticide chemistries have made established beet armyworm populations easier to control. Production of an early crop and preservation of beneficial insects will reduce the risk of a beet armyworm outbreak.

Prior to Aug. 15: Treat for beet armyworm when 5-6 "hits" (active clusters of small larvae) are found per 300 row feet.

After Aug. 15: Treat when 10 or more "hits" are found per 300 row feet.

Bt cottons provide good control of beet armyworm infestations. Supplemental insecticide applications are unlikely unless infestation levels are unusually high.

Insecticide (Trade Names) for BEET ARMYWORM	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
chlorantraniliprole (Prevathon 0.43 SC)	0.067 - 0.09	20 - 27 oz	6.4 - 4.7
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	8 - 12.5 oz	16 - 10.25
emamectin benzoate (Denim 0.16)	0.0075 - 0.01	6 - 8 oz	21.3 - 16
indoxacarb (Steward 1.25)	0.09 - 0.11	9.2 - 11.3 oz	13.9 - 11.3
methoxyfenozide (Intrepid 2)	0.06 - 0.16	4 - 10 oz	32 - 12.8
spinetoram (Radiant SC 1)	0.033 - 0.0625	4.25 - 8 oz	30.1 - 16
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 8 oz	32 - 16
spinosad (Blackhawk 36% WDG)	0.056 - 0.072	2.4 - 3.2 oz	6.7 - 5

Loopers

Two species of loopers (cabbage looper and soybean looper) may occur on cotton. Both are light green and have two pairs of prolegs; however, the soybean looper is more difficult to control with insecticides. Looper populations are often held below damaging levels by natural biological control agents. Treat when loopers cause 25 percent defoliation or populations threaten premature defoliation prior to boll maturity.

Bt cotton provides good control of looper infestations. Supplemental insecticide applications are unlikely unless infestation levels are unusually high.

Insecticide (Trade Names) for LOOPERS	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
chlorantraniliprole (Prevathon 0.43 SC)	0.067 - 0.09	20 - 29 oz	6.4 - 4.4
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	10 - 12.5 oz	12.8 - 10.25
emamectin benzoate (Denim 0.16)	0.01 - 0.015	8 - 12 oz	16 - 10.7
indoxacarb (Steward 1.25)	0.09 - 0.11	9.2 - 11.3 oz	13.9 - 11.3
methoxyfenozide (Intrepid 2)	0.06 - 0.16	4 - 10 oz	32 - 12.8
spinetoram (Radiant SC 1)	0.033 - 0.0625	4.25 - 8 oz	30.1 - 16
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 8 oz	32 - 16
spinosad (Blackhawk 36% WDG)	0.056 - 0.072	2.4 - 3.2 oz	6.7 - 5

Bandedwinged Whitefly

Treat when whiteflies are present on most plants, particularly if honeydew is accumulating on leaves. The adults are small, white, moth-like insects feeding on the underside of leaves and readily fly when disturbed. More than one application on a 4- or 5-day schedule may be required if eggs continue to hatch.

Insecticide (Trade Names) for WHITEFLY	**Lb Active Ingredient per Acre**	**Amount Formulation per Acre**	**Acres Treated per Gal or Lb of Dry Product**
acephate 90 (Orthene 90S)	0.45 - 0.9	0.5 - 1 lb	2 - 1
spiromesifen (Oberon 4)	0.125 - 0.25	4 - 8 oz	32 - 16
thiamethoxam (Centric 40 WG)	0.05	2 - 2.5 oz	8

Premixed Insecticide Products

The following products are available as premixes of two or more insecticides. The use of these premixes may provide suppression or control of multiple pests, and thus, are typically recommended when several pests are present at treatment level. Use of these products is suggested primarily after first bloom.

Trade Name (Insecticides)	**Amount Product per Acre**	**Acres Treated per Gal of Product**	**Primary Target Pests (see label for other pests that may be controlled)**
Athena (bifenthrin, abamectin)	10 - 17 oz	12.8 - 7.5	Spider mites
Besiege (chlorantraniliprole, λ-cyhalothrin)	8 - 12.5 oz	16 - 10.25	Most caterpillar pests, stink bugs
Bidrin XP II (dicrotophos, bifenthrin)*	8 - 12.8 oz	16 - 10	Plant bugs, stink bugs, bollworm
Brigadier (imidacloprid, bifenthrin)	5.1 - 7.7 oz	25.1 - 16.6	Plant bugs, stink bugs, bollworm
Cobalt Advanced (chlorpyrifos, γ-cyhalothrin)	22 - 42 oz	5.8 - 3	Plant bugs, stink bugs, bollworm
Double Take (diflubenzuron, λ-cyhalothrin)	4 oz	32	Stink bugs, bollworm
Endigo ZC (thiamethoxam, λ-cyhalothrin)	4 - 5.5 oz	32 - 23.3	Plant bugs, stink bugs, bollworm
Fyfanon Plus ULV (malathion, γ-cyhalothrin)	10 - 16 oz	12.8 - 8	Plant bugs, stink bugs, bollworm
Hero (bifenthrin, Z-cypermethrin)	5.2 - 10.3 oz	24.6 - 12.4	Stink bugs, bollworm
Intrepid Edge (methoxyfenozide, spinetoram)	4 - 8 oz	32 - 16	Most caterpillar pests
Leverage 360 (imidacloprid, β-cyfluthrin)	2.8 - 3.2 oz	45 - 40	Plant bugs, stink bugs, bollworm
Stallion (chlorpyrifos, Z-cypermethrin)	9.25 - 11.75 oz	13.8 - 10.9	Plant bugs, stink bugs, bollworm
Triple Crown (Z-cypermethrin, bifenthrin, imidacloprid)	4.5 - 6.4 oz	28.4 - 20	Plant bugs, stink bugs, bollworm

* Bidrin XP II may only be used prior to squaring or after flowering has begun.

Introduction

Many different insects can be found on soybeans in Tennessee. Some are detrimental, while others are beneficial. The most economical and effective insect control program must begin with scouting, proper insect identification and a determination of possible economic damage.

Serious reductions in yield and quality may result if an outbreak of an insect pest occurs and is not controlled. Some of these pests feed on leaves and stems; others are primarily pod feeders. Many times insecticides are not needed for control, but in some cases, damaging localized populations are not noticed until serious damage has occurred. Soybean fields should be scouted weekly, paying special attention during the time of early bloom (R1) to full seed (R6).

Insect Identification

Foliage Feeders

Loopers: Loopers are often the most common "worms" on soybeans. They are light green and have two pairs of abdominal prolegs (excluding the pair on the last abdominal segment). The body is thickest at the rear and tapers to the head. These insects form the characteristic hump or "loop" when crawling. When populations are heavy, loopers eat much of the leaf surface, causing plants to look very ragged. Populations are often held in check by beneficial insects and diseases. Note: Although many pyrethroid insecticides are labeled for soybean looper control, they are not recommended because resistance is well documented.

Green Cloverworm: This species is commonly found in Tennessee soybean fields. The green cloverworm is a slender green caterpillar with three pairs of abdominal prolegs. It becomes very active and falls to the ground when disturbed. The feeding damage produced by the green cloverworm is similar to that of loopers. Although they are present most of the growing season, they are damaging only at high populations or in combination with other defoliators.

Japanese Beetle: Japanese beetle adults are metallic green or greenish-bronze beetles, ½ inch long, with reddish wing covers. They have white spots near the tip of the abdomen and on the sides. As they feed on soybean foliage, Japanese beetles skeletonize the leaves. This pest rarely occurs at economically damaging levels.

Bean Leaf Beetle: The bean leaf beetle feeds on leaves and sometimes on small pods. The beetles may feed through the pod and eat the beans, leaving damage that resembles bollworm feeding. The adults can cause severe damage on small plants. The larvae feed on roots and nodules and underground portions of the stems. Adults are reddish to tan, usually with four dark spots on each wing.

Mexican Bean Beetle: Mexican bean beetles damage plants by feeding on the underside of the leaf surface, resulting in a skeletonized appearance. Both adults and larvae feed in a similar manner. Adults are copper brown with 16 black spots on the back. Larvae are yellow to brown with many spines on the back and sides. Both adults and larvae are about ¼ inch long. This pest rarely occurs at economically damaging levels.

Blister Beetles: Blister beetles are elongated, soft-winged beetles that feed on leaves. One species, the striped blister beetle, has alternating dark brown and yellow stripes running the length of the body. Another species, the margined blister beetle, is black with a gray stripe along margins of the wing covers. These insects usually feed in groups in one or several areas of the field.

Soybean Aphid: Also called Chinese aphid, this is a relatively new pest for Tennessee, discovered first in Middle Tennessee. Its distribution probably includes all soybean growing areas in Tennessee, but pest numbers are generally low and scattered at this time. Aphids pierce leaf tissue during feeding in order to suck sap from soybean leaves. Soybean mosaic virus and other viral diseases are sometimes transmitted by aphids during feeding.

Pod Feeders

Fall Armyworm: The fall armyworm is a multicolored, striped caterpillar with an inverted "Y" on the head and four pairs of abdominal prolegs. Armyworms may feed on leaves, stems, pods and beans. They may appear in large numbers and quick control is important.

Corn Earworm: The corn earworm, also called the bollworm or podworm, can seriously reduce yields since it feeds directly on beans by eating a hole in the pod and

consuming the seed. Large caterpillars may be green, brown or yellow. The body is stocky and the head is usually pale brown or orange. Light and dark stripes run the length of the body. The larva has four pairs of abdominal prolegs. Young blooms and tender leaves are sometimes eaten. Beans should be checked during flowering and early pod set.

Stink Bugs: Stink bugs suck the juices from immature soybean seeds. This feeding introduces disease organisms into developing seeds, reduces germination and lowers milling quality. Damaged beans appear wrinkled and are smaller than normal. Adults are shield-shaped, either green or brown and are about ½ inch long.

Stem Feeders

Threecornered Alfalfa Hopper: The adult threecornered alfalfa hopper is a green, wedge-shaped insect about ¼-inch long. Adults and nymphs feed by inserting their piercing-sucking mouthparts into the stem a few inches above the soil line. This feeding around the stem girdles the plant, often causing it to lodge later in the season. It is primarily a problem in reduced tillage fields. Maintaining a clean field border helps to reduce population numbers.

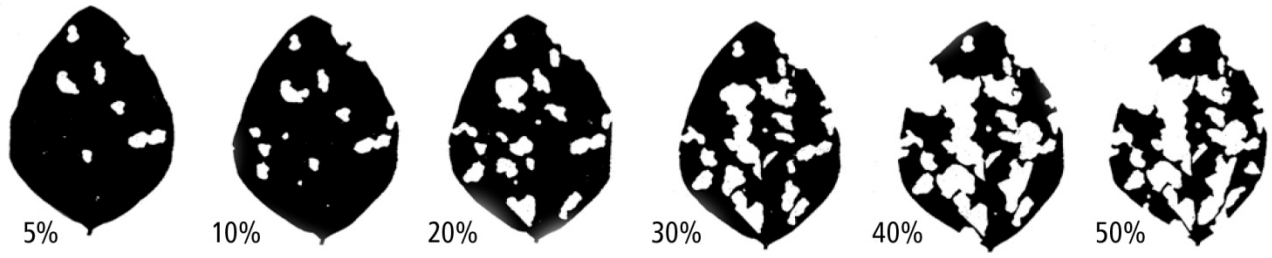
Kudzu Bug: Infestations of kudzu bug on kudzu and soybean have been reported from most soybean producing areas of Tennessee, and this invasive insect is spreading rapidly through the state. Adult kudzu bugs are about the same size as adult lady beetles. They are approximately ¼-inch long, almost square-appearing in shape with a brown to olive-green hue. The immature stages are similarly shaped but smaller and "hairy." Eggs of kudzu bugs are light-colored, barrel-shaped, and usually placed on plant leaves in two rows. Infestations often occur first and most heavily on field edges, and treatment decisions should be made based on thorough scouting of entire fields.

Scouting Procedures

A good sampling plan is to check 6 feet of row at 5 locations or take 25 sweeps at 4 locations in average sized fields (about 50 acres). Increase sampling points proportionately with the acreage in a field. Make sure sample points are scattered over the entire field.
Look for:

- **Seedling/Stem Feeding:** Check seedlings very closely until the plants are about 12 inches tall. The stems become woody and severe damage from seedling pests becomes less likely at this time. Look for insects that may be on the plant (threecornered alfalfa hopper) or in the soil around the base of the plants (lesser corn stalk borer, cutworms). Evaluate stand loss (percentage of dead or dying plants) and try to determine if future stand loss is probable (insects easily found and actively damaging plants). Kudzu bug infestations often occur later, once plants start blooming.
- **Foliage Feeders:** Determine what insects are eating the foliage and estimate percent defoliation. Use a sweep net or a drop cloth (shake sheet) to sample for insect pests. At each sample point, estimate percent foliage loss so that an average can be calculated for the field. For soybean aphids, begin scouting in early July. Look for aphids on the undersides of upper leaves in vegetative and flowering soybeans. Estimate aphid density per plant at 5-10 locations throughout the field.
- **Pod-Feeders:** After full bloom, when pods are forming, look closely for any pod-feeding caterpillars (corn earworms and fall armyworms) and stink bugs which are dislodged onto the shake cloth or into the sweep net. Count these carefully.

Figure 1 – Percent Defoliation



Expected Occurrence of Insect Pests in Soybean

Below is a timetable of when common pests are typically encountered in soybean, although conditions vary from season to season or farm to farm within a season.

Stage of Plant Development	Common Pests	Occasional Pests
Seedling	Threecornered alfalfa hopper	Thrips, grasshoppers, bean leaf beetle, cutworms, grape colaspis, white grubs
V5 - R1 (Early flowering)	---	Threecornered alfalfa hopper
R1 - R5 (Early flowering to early podfill)	Stink bugs, green cloverworm	Threecornered alfalfa hopper, blister beetles, corn earworm, fall armyworm, loopers, soybean aphid, kudzu bug
R5 + (mid to late podfill)	Stink bugs, loopers, green cloverworm	Blister beetles, fall armyworm, loopers, soybean aphid, kudzu bug

Insecticide Seed Treatments

Insecticide seed treatments such as thiamethoxam (e.g., Cruiser), imidacloprid (e.g., Gaucho, Acceleron I), and clothianidin (e.g., NipsIt Inside) are available from seed companies or local distributors. Seed treatments will help control some seed and seedling pests such as thrips, bean leaf beetle, grape colaspis, threecornered alfalfa hopper, wireworms and white grubs. Data indicates that insecticide seed treatments provide an average yield increase of 1-2 bushels per acre in Tennessee. Insecticide seed treatments are recommended when cover crops are planted and persist in fields within 3 to 4 weeks of planting, particularly if the cover crop includes a legume species such as vetch or winter peas.

When to Treat	
Threecornered Alfalfa Hopper	Treat if 10 percent of young plants (up to 10-12 inches) are infested with adults or nymphs. Bend small plants over to check for girdling and consider treatment if 50 percent or more of plants are girdled. Treatment is not generally recommended for plants greater than 12 inches tall.
Defoliating Pests (bean leaf beetles, green cloverworm, blister beetles, loopers, grasshoppers, Japanese beetles, etc.)	Treat at 30 percent defoliation until bloom (R1), 20 percent from bloom to full seed (R1-R6), and 30 percent after R6 to R6 plus 7-10 days. <u>Alternatives to defoliation thresholds during pod filling (R1-R6):</u> Bean leaf beetle – 50 beetles per 25 sweeps Green cloverworm – 38 larvae per 25 sweeps Loopers – 19 larvae per 25 sweeps
Stink Bugs	From beginning bloom (R1) to full seed (R6), treat when an average of 9 or more stink bugs is found per 25 sweeps (or 1 stink bug is found per foot of row). From R6 to R7, treat when an average of 18 or more stink bugs is found per 25 sweeps. *
Corn Earworm	See tables below for treatment threshold based on sweep net sampling, or consider treatment once blooming has begun if an average of 1 or more larvae is found per foot of row.
Fall Armyworm	Once blooming has begun, treat when an average of 9 or more larvae is found per 25 sweeps (or 1 or more larvae is found per foot of row). Fall armyworm may also feed on foliage, and severe infestations may originate on weedy grasses. Treatment can be based on the percent defoliation thresholds above under these circumstances.

When to Treat	
Soybean Aphid	Treat when an average of 250 aphids or more is found per plant from early bloom (R1) until early pod fill (R5). Treatment after R5 is less likely to increase yield.
Kudzu Bug	Treat between emergence and R1 when 5 or more kudzu bugs are found per plant. From R1 to R7, treat when an average of 1 or more immature kudzu bug is present per sweep (25 per 25 sweeps).

* In soybeans planted on 36-inch or wider rows, sweep only one row. In narrow-row soybeans, allow the normal arch of a sweep net to continue through the adjacent rows.

Corn Earworm: The suggested treatment threshold for corn earworm based on sweep-net sampling is below. To determine the treatment level, estimate the potential value of the crop and the cost of the insecticide application. For example; if the crop value is $8/bushel and the cost of control is $14/acre, including application costs, the sweep-net threshold would be 8.6 larvae per 25 sweeps.

Crop Value ($/bu)	Number of Corn Earworm Larvae/25 Sweeps						
	Control Costs ($/acre) Including Application						
	8	**10**	**12**	**14**	**16**	**18**	**20**
6	6.5	8.2	9.8	11.4	13.1	14.7	16.3
7	5.6	7.0	8.4	9.8	11.2	12.6	14.0
8	5.0	6.1	7.4	8.6	9.8	11.0	12.3
9	5.0	5.4	6.5	7.6	8.7	9.8	10.9
10	5.0	5.0	5.9	6.9	7.8	8.8	9.8
12	5.0	5.0	5.0	5.7	6.5	7.4	8.2
13	5.0	5.0	5.0	5.3	6.0	6.8	7.5
15	5.0	5.0	5.0	5.0	5.2	5.9	6.5

Suggestions for Chemical Control of Soybean Insects

Insects and Chemicals (Trade Names)	Lbs Active Ingredient Per Acre	Amount Formulation Per Acre	Acres a Gallon Will Cover
CUTWORMS			
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.047 - 0.10	3 - 6.4 oz	42.7 - 20
carbaryl (Sevin 80S) (Sevin XLR Plus)	1.0 - 1.5 1.0 - 1.5	1.25 - 1.875 lb 32 - 48 oz	--- 4 - 2.7
chlorpyrifos (Lorsban 4E, Nufos 4E) (Lorsban Advanced 3.755)	0.5 - 1.0 0.5 - 0.94	16 - 32 oz 17 - 32 oz	8 - 4 7.5 - 4
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	22 - 13
permethrin (Pounce 3.2E)	0.05 - 0.10	2 - 4 oz	64 - 32
β-cyfluthrin (Baythroid XL 1)	0.065 - 0.0125	0.8 - 1.6 oz	160 - 80
γ-cyhalothrin (Declare 1.25)	0.0075 - 0.0125	0.77 - 1.28 oz	166 - 126
λ-cyhalothrin (Karate 2.08, Warrior II)	0.015 - 0.025	0.96 - 1.60 oz	133 - 80
Z-cypermethrin (Mustang Max 0.8E)	0.008 - 0.025	1.28 - 4 oz	100 - 32
THREECORNERED ALFALFA HOPPER			
acephate 90 (Orthene 90S)	0.75 - 0.99	0.83 - 1.10 lb	---
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.05 - 0.10	3.2 - 6.4 oz	40 - 20
carbaryl (Sevin 80S) (Sevin XLR Plus)	1.0 1.0	1.25 lb 32 oz	--- 4
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	22 - 13
β-cyfluthrin (Baythroid XL 1)	0.025 - 0.044	1.6 - 2.8 oz	80 - 45
γ-cyhalothrin (Declare 1.25)	0.0075 - 0.0125	0.77 - 1.28 oz	166 - 126
λ-cyhalothrin (Karate 2.08, Warrior II)	0.015 - 0.025	0.96 - 1.6 oz	133 - 80
Z-cypermethrin (Mustang Max 0.8E)	0.0175 - 0.025	2.8 - 4 oz	45 - 32
BEAN LEAF BEETLE			
acephate 90 (Orthene 90S)	0.75 - 0.99	0.83 - 1.10 lb	---
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	32 - 20
carbaryl (Sevin 80S) (Sevin XLR Plus)	0.5 - 1.0 0.5 - 1.0	0.67 - 1.25 lb 16 - 32 oz	--- 8 - 4
chlorpyrifos (Lorsban 4E, Nufos 4E) (Lorsban Advanced 3.755)	0.5 - 1.0 0.5 - 0.94	16 - 32 oz 17 - 32 oz	8 - 4 7.5 - 4
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	22 - 13
methomyl (Lannate LV 2.4)	0.23 - 0.45	12 - 24 oz	10.4 - 5.3
methyl parathion 4 (Methyl 4E)	1.0	32 oz	4
permethrin (Pounce 3.2E)	0.05 - 0.1	2 - 4 oz	64 - 32
β-cyfluthrin (Baythroid XL 1)	0.0125 - 0.022	1.6 - 2.8 oz	80 - 45
γ-cyhalothrin (Declare 1.25)	0.0075 - 0.0125	0.77 - 1.28 oz	166 - 100
λ-cyhalothrin (Karate 2.08, Warrior II)	0.015 - 0.025	0.96 - 1.6 oz	133 - 80
Z-cypermethrin (Mustang Max 0.8E)	0.0175 - 0.025	2.8 - 4 oz	45 - 32

Insects and Chemicals (Trade Names)	Lbs Active Ingredient Per Acre	Amount Formulation Per Acre	Acres a Gallon Will Cover
GRASSHOPPERS			
acephate 90 (Orthene 90S)	0.30 - 0.50	0.33 - 0.56 lb	---
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	32 - 20
carbaryl (Sevin 80S)	0.5 - 1.5	0.67 - 1.875 lb	---
(Sevin XLR Plus)	0.5 - 1.5	16 - 48 oz	8 - 2.7
chlorpyrifos (Lorsban 4E, Nufos 4E)	0.25 - 0.50	8 - 16 oz	16 - 8
(Lorsban Advanced 3.755)	0.25 - 0.47	8.5 - 16 oz	15.1 - 8
diflubenzuron (Dimilin 2L), for immatures	0.031	2 oz	64
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	22 - 13
methyl parathion 4 (Methyl 4E)	1.0	32 oz	4
β-cyfluthrin (Baythroid XL 1)	0.0155 - 0.022	2.1 - 2.8 oz	60 - 45
γ-cyhalothrin (Declare 1.25)	0.0125 - 0.015	1.28 - 1.54 oz	100 - 83
λ-cyhalothrin (Karate 2.08, Warrior II)	0.025 - 0.030	1.6 - 1.9 oz	80 - 67
Z-cypermethrin (Mustang Max 0.8E)	0.020 - 0.025	3.2 - 4 oz	40 -32
MEXICAN BEAN BEETLE			
acephate 90 (Orthene 90S)	0.75 - 0.99	0.83 - 1.10 lb	---
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	32 - 20
carbaryl (Sevin 80S)	0.5 - 1.0	0.67 - 1.25 lb	---
(Sevin XLR Plus)	0.5 - 1.0	16 - 32 oz	8 - 4
chlorpyrifos (Lorsban 4E, Nufos 4E)	0.5 - 0.75	16 - 24 oz	8 - 5.3
(Lorsban Advanced 3.755)	0.5 - 0.75	17 - 25.6 oz	7.5 - 5
dimethoate 4	0.5	16 oz	8
esfenvalerate (Asana XL 0.66E)	0.015 - 0.03	2.9 - 5.8 oz	44 - 22
methomyl (Lannate LV 2.4)	0.23 - 0.45	12 - 24 oz	10.4 - 5.3
methyl parathion 4 (Methyl 4E)	0.5	16 oz	8
permethrin (Pounce 3.2E)	0.05 - 0.1	2 - 4 oz	64 - 32
β-cyfluthrin (Baythroid XL 1)	0.0125 - 0.022	1.6 - 2.8 oz	80 - 45
γ-cyhalothrin (Declare 1.25)	0.0075 - 0.0125	0.77 - 1.28 oz	166 - 100
λ-cyhalothrin (Karate 2.08, Warrior II)	0.015 - 0.025	0.96 - 1.6 oz	133 - 80
Z-cypermethrin (Mustang Max 0.8E)	0.0175 - 0.025	2.8 - 4 oz	45 - 32
BLISTER BEETLE			
carbaryl (Sevin 80S)	0.5 - 1.0	0.67 - 1.25 lb	---
(Sevin XLR Plus)	0.5 - 1.0	16 - 32 oz	8 - 4
methyl parathion 4 (Methyl 4E)	0.5	16 oz	8
β-cyfluthrin (Baythroid XL 1)	0.0125 - 0.022	1.6 - 2.8 oz	80 - 45
γ-cyhalothrin (Declare 1.25)	0.0125 - 0.015	1.28 - 1.54 oz	100 - 83
λ-cyhalothrin (Karate 2.08, Warrior II)	0.025 - 0.03	1.6 - 1.9 oz	80 - 67
Z-cypermethrin (Mustang Max 0.8E)	0.0175 - 0.025	2.8 - 4 oz	45 - 32

Insects and Chemicals (Trade Names)	Lbs Active Ingredient Per Acre	Amount Formulation Per Acre	Acres a Gallon Will Cover
JAPANESE BEETLE			
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	32 - 20
carbaryl (Sevin 80S)	1.0	1.25 lb	---
(Sevin XLR Plus)	0.5 - 1.0	16 - 32 oz	8 - 4
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	22 - 13.3
permethrin (Pounce 3.2E)	0.05 - 0.10	2 - 4 oz	64 - 32
β-cyfluthrin (Baythroid XL 1)	0.0125 - 0.022	1.6 - 2.8 oz	80 - 45
γ-cyhalothrin (Declare 1.25)	0.0125 -0 .015	1.28 - 1.54 oz	100 - 83
λ-cyhalothrin (Karate 2.08, Warrior II)	0.025 - 0.03	1.6 - 1.9 oz	80 - 67
Z-cypermethrin (Mustang Max 0.8E)	0.0175 - 0.025	2.8 - 4 oz	45 - 32
GREEN CLOVERWORM			
acephate 90 (Orthene 90S)	0.75 - 0.99	0.83 - 1.10 lb	---
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	32 - 20
carbaryl (Sevin 80S)	0.5 - 1.0	0.67 - 1.25 lb	---
(Sevin XLR Plus)	0.5 - 1.0	16 - 32 oz	8 - 4
chlorantraniliprole (Prevathon 0.43 SC)	0.047 -0.067	14 - 20 oz	9.1 - 6.4
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	6 - 8 oz	21.3 - 16
chlorpyrifos (Lorsban 4E, Nufos 4E)	0.25 - 0.5	8 - 16 oz	16 - 8
(Lorsban Advanced 3.755)	0.25 - 0.47	8.5 - 16 oz	15.1 - 8
diflubenzuron (Dimilin 2)	0.031 – 0.063	2 - 4 oz	64 - 32
esfenvalerate (Asana XL 0.66E)	0.015 - 0.03	2.9 - 5.8 oz	44 - 22
indoxacarb (Steward 1.25)	0.055 - 0.11	5.6 - 11.2 oz	22.8 - 11.5
methomyl (Lannate LV 2.4)	0.23 - 0.45	12 - 24 oz	10.7 - 5.3
methoxyfenozide (Intrepid 2)	0.063 - 0.125	4 - 8 oz	32 - 16
methyl parathion 4 (Methyl 4E)	0.375 - 0.50	12 - 16 oz	10.6 - 8
permethrin (Pounce 3.2E)	0.05 - 0.1	2 - 4 oz	64 - 32
spinetoram (Radiant SC 1)	0.016 - 0.031	2 - 4 oz	64 - 32
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 6.4 oz	32 - 20
spinosad (Blackhawk 36% WDG)	0.034 - 0.05	1.1 - 2.2 oz	14.5 - 7.3
β-cyfluthrin (Baythroid XL 1)	0.025 - 0.044	1.6 - 2.8 oz	80 - 45
γ-cyhalothrin (Declare 1.25)	0.0075 - 0.0125	0.77 - 1.28 oz	166 - 100
λ-cyhalothrin (Karate 2.08, Warrior II)	0.015 - 0.025	0.96 - 1.6 oz	133 - 80
Z-cypermethrin (Mustang Max 0.8E)	0.0175 - 0.025	2.8 - 4 oz	45 - 32
SOYBEAN LOOPER			
chlorantraniliprole (Prevathon 0.43 SC)	0.047 -0.067	14 - 20 oz	9.1 - 6.4
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	10 oz	12.8
indoxacarb (Steward 1.25)	0.055 - 0.11	5.6 - 11.3 oz	22.8 - 11.5

Insects and Chemicals (Trade Names)	Lbs Active Ingredient Per Acre	Amount Formulation Per Acre	Acres a Gallon Will Cover
methoxyfenozide (Intrepid 2)	0.063 - 0.125	4 - 8 oz	32 - 16
spinetoram (Radiant SC 1)	0.016 - 0.031	2 - 4 oz	64 - 32
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 6.4 oz	32 - 20
spinosad (Blackhawk 36% WDG)	0.034 - 0.05	1.1 - 2.2 oz	14.5 - 7.3
CORN EARWORM			
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	32 - 20
carbaryl (Sevin 80S) (Sevin XLR Plus)	0.5 - 1.5 0.5 - 1.5	0.67 - 1.25 lb 16 - 48 oz	--- 8 - 2.7
chlorantraniliprole (Prevathon 0.43 SC)	0.047 - 0.067	14 - 20 oz	9.1 - 6.4
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	6 - 8 oz	21.3 - 16
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	22 - 13
indoxacarb (Steward 1.25)	0.055 - 0.11	5.6 - 11.3 oz	22.8 - 11.5
methomyl (Lannate LV 2.4)	0.23 - 0.45	12 - 24 oz	10.7 - 5.3
NPV virus (Heligen)	----	1.0 - 1.6 oz	128 - 80
permethrin (Pounce 3.2E)	0.1 - 0.2	4 - 8 oz	32 - 16
spinetoram (Radiant SC 1)	0.031	4 oz	32
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 6.4 oz	32 - 20
spinosad (Blackhawk 36% WDG)	0.038 - 0.05	1.7 - 2.2 oz	9.4 - 7.3
β-cyfluthrin (Baythroid XL 1)	0.0125 - 0.022	1.6 - 2.8 oz	80 - 46
γ-cyhalothrin (Declare 1.25)	0.0098 - 0.0125	1 - 1.28 oz	128 - 100
λ-cyhalothrin (Karate 2.08, Warrior II)	0.015 - 0.025	0.96 - 1.6 oz	133 - 80
Z-cypermethrin (Mustang Max 0.8E)	0.0175 - 0.025	2.8 - 4 oz	45 - 32
FALL ARMYWORM			
acephate 90 (Orthene 90S)	0.75 - 0.99	0.83 - 1.10 lb	---
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	32 - 20
carbaryl (Sevin 80S) (Sevin XLR Plus)	1.0 - 1.5 1.0 - 1.5	1.25 - 1.875 lb 32 - 48 oz	--- 4 - 2.7
chlorantraniliprole (Prevathon 0.43 SC)	0.047 -0.067	14 - 20 oz	9.1 - 6.4
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	8 - 10 oz	16 – 12.8
indoxacarb (Steward 1.25)	0.055 - 0.11	5.6 - 11.3 oz	22.8 - 11.5
methomyl (Lannate LV 2.4)	0.23 - 0.45	12 - 24 oz	10.7 - 5.3
methoxyfenozide (Intrepid 2)	0.063 - 0.125	4 - 8 oz	32 - 16
spinetoram (Radiant SC 1)	0.031	4 oz	32
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 6.4 oz	32 - 20
spinosad (Blackhawk 36% WDG)	0.038 - 0.05	1.7 - 2.2 oz	9.4 - 7.3
β-cyfluthrin (Baythroid XL 1)	0.0125 - 0.022	1.6 - 2.8 oz	80 - 45
γ-cyhalothrin (Declare 1.25)	0.065 - 0.075	1.28 - 1.54 oz	100 - 83
λ-cyhalothrin (Karate 2.08, Warrior II)	0.025 - 0.03	1.6 - 1.92 oz	80 - 67

Insects and Chemicals (Trade Names)	Lbs Active Ingredient Per Acre	Amount Formulation Per Acre	Acres a Gallon Will Cover
Z-cypermethrin (Mustang Max 0.8E)	0.020 - 0.025	3.2 - 4 oz	40 - 32
STINK BUGS			
acephate 90 (Orthene 90S)	0.50 - 0.99	0.56 - 1.10 lb	---
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	32 - 20
methyl parathion 4 (Methyl 4E)	0.3 - 1.0	12 - 32 oz	10.6 - 4
β-cyfluthrin (Baythroid XL 1)	0.025 - 0.044	1.6 - 2.8 oz	80 - 45
γ-cyhalothrin (Declare 1.25)	0.0125-0.015	1.28-1.54 oz	100 - 80
λ-cyhalothrin (Karate 2.08, Warrior II)	0.025 - 0.030	1.6 - 1.9 oz	80 - 67
Z-cypermethrin (Mustang Max 0.8E)	0.020 - 0.025	3.2 - 4 oz	40 - 32
SPIDER MITES			
abamectin (Agri-Mek SC 0.7)	0.01 - 0.019	1.75 - 3.5 oz	73 - 36.6
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E) *	0.063 - 0.10	4 - 6.4 oz	32 - 20
chlorpyrifos (Lorsban 4E, Nufos 4E) *	0.25 - 0.5	8 - 16 oz	16 - 8
(Lorsban Advanced 3.755) *	0.25 - 0.47	8.5 - 16 oz	15.1 - 8
dimethoate 4 *	0.5	16 oz	8
etoxazole (Zeal SC 2.88)	0.045 - 0.135	2 - 6 oz	64 - 21.3
SOYBEAN APHID			
acephate 90 (Orthene 90S)	0.75 - 0.99	0.83 - 1.10 lb	---
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	32 - 20
chlorpyrifos (Lorsban 4E, Nufos 4E)	0.50 - 1.0	16 - 32 oz	8 - 4
(Lorsban Advanced 3.755)	0.50 - 0.94	17 - 32 oz	7.5 - 4
γ-cyhalothrin (Declare 1.25)	0.010 - 0.0125	1.0 - 1.28 oz	125 - 100
λ-cyhalothrin (Karate 2.08, Warrior II)	0.025 - 0.030	1.6 - 1.9 oz	80 - 67
Z-cypermethrin (Mustang Max 0.8E)	0.0175 - 0.025	2.8 - 4 oz	45 - 32
KUDZU BUG			
acephate 90 (Orthene 90S)	0.75 - 0.99	0.83 - 1.10 lb	---
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.078 - 0.10	5 - 6.4 oz	25.6 - 20
γ-cyhalothrin (Declare 1.25)	0.0125 - 0.015	1.28 - 1.54 oz	100 - 83
λ-cyhalothrin (Karate 2.08, Warrior II)	0.031	1.92 oz	67
Z-cypermethrin (Mustang Max 0.8E)	0.025	4 oz	32

* May only provide suppression of spider mites.

** NPV virus (Heligen) will only control corn earworm. Applications should be made when larvae are small. Do not apply if most larvae are large or if infestations are well above treatment threshold.

Premixed Insecticide Products

The following products are available as premixes of two or more insecticides. The use of premixes may provide suppression or control of multiple pests, and thus are typically recommended when several pests are present at treatment level.

Trade Name (Insecticides)	Amount Product per Acre	Acres Treated per Gal of Product	Primary Target Pests (see label for other pests that may be controlled)
Besiege (chlorantraniliprole, λ-cyhalothrin)	5 - 10 oz	25.6 - 12.8	Caterpillars, stink bugs, threecornered alfalfa hopper, kudzu bug
Brigadier (imidacloprid, bifenthrin)	4 - 6.1 oz	32 - 21	Corn earworm, green cloverworm, stink bugs, kudzu bug
Cobalt Advanced (chlorpyrifos, γ-cyhalothrin)	22 - 38 oz	5.8 - 3.3	Stink bugs, corn earworm, green cloverworm, threecornered alfalfa hopper
Double Take (diflubenzuron, λ-cyhalothrin)	2 - 4 oz	64 - 32	Green cloverworm, stink bugs, threecornered alfalfa hoppers, kudzu bug, grasshoppers
Endigo ZC (thiamethoxam, λ-cyhalothrin)	3.5 - 4.5 oz	36.6 - 28.4	Stink bugs, corn earworm, green cloverworm, threecornered alfalfa hopper, kudzu bug
Hero (bifenthrin, Z-cypermethrin)	4 - 10.3 oz	32 - 12.4	Stink bugs, corn earworm, green cloverworm, threecornered alfalfa hopper, kudzu bug
Intrepid Edge (methoxyfenozide, spinetoram)	4 - 6.4 oz	32 - 20	Most caterpillar pests
Justice (acetamiprid, bifenthrin)	3 - 5 oz	32 - 25.6	Bean leaf beetle, aphids, armyworms, kudzu bugs
Leverage 360 (imidacloprid, β-cyfluthrin)	2.8 oz	45.7	Stink bugs, corn earworm, green cloverworm, threecornered alfalfa hopper
Stallion (chlorpyrifos, Z-cypermethrin)	9.25 - 11.75 oz	13.8 - 10.9	Stink bugs, corn earworm, green cloverworm, threecornered alfalfa hopper
Triple Crown (Z-cypermethrin, bifenthrin, imidacloprid)	3.5 - 4.8 oz	36.6 - 26.7	Stink bugs, corn earworm, green cloverworm, threecornered alfalfa hopper, kudzu bug

Insects rob Tennessee corn producers of about five percent of their potential yields on an annual basis. However, severe pest infestations can cause complete crop loss. While pesticides play an important role in crop protection, they should be used only when there is the potential for damage severe enough to cause economic loss. There are several cultural practices that can be used to reduce insect problems and minimize pesticide use. Scouting fields for insect infestations and monitoring pest populations with pheromone traps can provide an estimate of insect pressure in a field, and thus, help to guide any treatment decisions.

Prevention

Early Planting: Planting field corn early, during the recommended planting window, will reduce the chances of crop damage from several insect species. For example, corn borers and fall armyworm are frequent pests of late-planted corn in Tennessee.

Weed Control: Certain insects carry (or transmit) virus diseases in corn. By controlling weeds such as Johnsongrass early in the season, the chances of leafhoppers and aphids transmitting viruses to corn are reduced. When planting corn in fields known to be heavily infested with Johnsongrass, choose a hybrid with good tolerance to the Maize Dwarf Mosaic Virus (MDMV) complex.

Tillage: No-tillage production can increase soil insect pest problems in many cases. Cutworms, wireworms, white grubs, seedcorn maggots and lesser cornstalk borers may build up in grass sod or where previous crop residue has been left on the soil surface at planting. Burndown with herbicides well in advance of planting (3-4 weeks) can reduce the risks of infestation. Look for white grubs, wireworms and any other insects that may be exposed during land preparation.

Seed and At-Planting Insecticide Treatments: Almost all seed corn comes treated with insecticide. These insecticides will control or suppress a number of seed and seedling insect pests. Insecticide seed treatments, specifically Poncho and Cruiser, have largely replaced the use of in-furrow or banded insecticides which were often applied at planting. However, at-planting insecticides can still be used for supplemental control of seed and seedling pests, or higher than standard insecticide seed treatment rates can sometimes be requested (see tables below).

Consider using higher labeled insecticide seed treatment rates or supplemental at-planting insecticides when:

- You have a known soil insect problem.
- Planting in a field that was fallow, pasture, sod, or a cover crop was planted and not terminated at least 3-4 weeks before planting.

Relative Efficacy of Selected Insecticide Seed Treatments on Seed and Seedling Insect Pests

Trade Names*	Active Ingredients and Rates*	Billbugs	White grubs	Wire-worms	Seedcorn maggot	Cutworms	Sugarcane beetle**	Stink bugs	Chinch bugs	Southern corn rootworm	Western corn rootworm
Poncho 250, Acceleron, NipsIt Inside	clothianidin, 0.25 mg ai/kernel	NL	F	G	E	P - F	F	F	G	E	P, NL
Poncho 500, Acceleron with Poncho Votivo, NipsIt Inside	clothianidin, 0.50 mg ai/kernel	F	E	G	E	P - F	G	F - G	G - E	E	P
Poncho 1250, Acceleron with Poncho Votivo 1250, PPST + Poncho 1250/Votivo, NipsIt Inside	clothianidin, 1.25 mg ai/kernel	G	E	E	E	F - G	G	G	E	E	G
Cruiser Maxx 250, PPST 250	thiamethoxam, 0.25 mg ai/kernel	NL	F	G	E	P	P	P	F	G - E, NL	P, NL
Cruiser Maxx Corn 500, Avicta Complete Corn 500	thiamethoxam, 0.50 mg ai/kernel	NL	G	G	E	P	F?	F	F	E	P, NL
Cruiser Maxx Corn 1250, Avicta Complete Corn 1250	thiamethoxam, 1.25 mg ai/kernel	G	E	E	E	F	F?	G	G	E	P
PPST 250 plus Lumivia	thiamethoxam, 0.25 mg ai/kernel; chlorantraniliprole, 0.25 mg ai/kernel	E	G?	VG?	E	G?	P	P	F	G - E, NL	NL
Gaucho 600, Dynashield, Imidacloprid 5, Nitro Shield, Senator 600, etc.	imidacloprid, 0.60 mg ai/kernel (mid labeled rate)	P, NL	G	G	E	P, NL	P, NL	P, NL	F	G, NL	P, NL
Latitude	imidacloprid, 3.5 oz/100 lb seed	P, NL	F, NL	G	G	P, NL	P, NL	P, NL	F, NL	G, NL	P, NL
Concur	imidacloprid, 1.5 oz/42 lb seed	P, NL	F	G	G	P, NL	P, NL	P, NL	F, NL	G, NL	P, NL

E = excellent, G = good, F = fair, P = poor or no activity, ? = insufficient data to provide confident ranking, NL = pest not listed on label. Some ratings are based on incomplete data and are only meant to provide a general guideline of relative efficacy to the best knowledge of the author. Parts of this table are courtesy of Auburn University's corn insect, disease, nematode, and weed control recommendations for 2017.

* Formulated product may also include fungicidal and/or nematicidal ingredients that are not listed.

** Efficacy of seed treatments on sugarcane beetle is dependent upon the timing of infestation. Expect less control if infestations occur several weeks after emergence.

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Examples of At-Planting Treatments for Seed and Seedling Insect Pests

Insecticide (Trade Names)	Rates	Common Pests Controlled or Suppressed
chlorpyrifos (Lorsban 15G)*	8 - 12 oz/1000 row ft	Seedcorn maggot, Southern corn rootworm, Wireworms, White grubs, Cutworms
terbufos (Counter 20G)*	5 - 6 oz/1000 row ft	Seedcorn maggot, Southern corn rootworm, Wireworms, White grubs
cyfluthrin, tebupirimphos (Aztec 2.1G)*	6.7 oz/1000 row ft	Seedcorn maggots, Southern corn rootworm, Wireworms, White grubs, Cutworms
tefluthrin (Force 3G)	4 - 5 oz/1000 row ft	Seedcorn maggots, Southern corn rootworm, Wireworms, White grubs, Cutworms
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)**	0.15 - 0.3 oz/1000 row ft	Seedcorn maggots, Southern corn rootworm, Wireworms, White grubs
bifenthrin (Capture LFR 1.5)	0.2 - 0.78 oz/1000 row ft	Seedcorn maggots, Southern corn rootworm, Wireworms, White grubs, Cutworms, Sugarcane beetle
λ-cyhalothrin (Ballista LFC 1)	0.66 oz/1000 row ft	Seedcorn maggots, Southern corn rootworm, Wireworms, White grubs, Cutworms

See the insecticide label for specific use instructions.
* Caution: When using organophosphate insecticides such as Aztec, Counter or Lorsban with herbicides such as Accent, Callisto, Capreno, Halex GT, Steadfast, Option or Resolve, the possibility for plant injury exists. See herbicide label for restrictions.
** Many other pyrethroid insecticides are labeled for at-planting control of cutworms and some other pests. These include Asana XL, Baythroid XL, Declare, Mustang Max and Pounce. Please see their labels for specific use instructions.

Scouting Corn

Seedling Corn: Check twice weekly for cutworms, seedcorn maggots, armyworms, white grubs and other pests of seedling corn. Walk in a zigzag pattern through the field, checking at least 10 places in the field. Count the number of damaged plants in 10 feet of row. Check at least 100 plants. Look for silken tubes at the bases of plants for lesser corn stalk borers. Plants less than 12 inches tall are most susceptible to injury.

Whorl-Feeding Insects: Corn fields should be checked at least weekly until the crop is mature to determine the presence of insect pests or their damage. Walk in a U-shaped pattern over the field. Sample 10 plants in 10 locations on a weekly basis, but fewer plants can often be checked depending upon pest density. To check for live larvae, cut open at least two (or more) plants in each sample and record the number of larvae.

Look on the undersides of leaves for fall armyworm or corn borer egg masses. Southwestern and European corn borers lay their eggs in an overlapping pattern that appears like small fish scales. However, southwestern corn borer egg masses are usually smaller (2-8 eggs) than those of European corn borer (10 or more eggs). Fall armyworms lay their eggs in clusters of 50 to several hundred on corn leaves and other vegetation.

Silking/Tasseling Stages: Examine plants for European and southwestern corn borers. Look for egg masses or small larvae feeding on the leaves. Corn borers lay their egg masses on the middle third of the plant near the ear zone. Check on the undersides of leaves for these egg masses. Small larvae may be found between ear husks or behind leaf collars. It is important to correctly identify larvae which are found because corn borers, corn earworm and fall armyworm may all be present. Treatment for insect pests during this stage will be more difficult. Insecticidal control for corn borers in tasseling corn is generally not as efficient as for plants in the whorl stage. Small larvae are more easily controlled than larger worms.

Black Light and Pheromone Traps: Black light traps can be used to monitor movement of adult insects. Pheromone (sex-attractant) traps are also used to monitor various insect flights, such as southwestern corn borers. Light or pheromone traps can be used to complement an effective scouting program. Traps can be used in each county or on individual farms to provide producers with advance warnings of insect infestations.

Bt Corn Traits: Bt corn for the control of corn borers is typically recommended on at least part of a grower's acreage and particularly in late planted fields. The table below is intended to provide growers with the information needed to help them select among the various Bt trait packages offered by seed distributors. Some trait packages may also express Bt proteins that control western and northern corn rootworm. These are uncommon pests in Tennessee, and Bt traits for corn rootworm control are seldom needed. However, continuous corn production in the same field increases the likelihood of western corn rootworm infestations. **Resistance management guidelines for Bt corn require a producer to plant a refuge of non-Bt corn.** Some newer trait packages require a smaller refuge of non-Bt corn. Please refer to the grower licensing agreement and refuge guidelines provided by the company for complete details.

Relative Efficacy and Refuge Requirements of Selected, Commercially Available Bt Corn Products

Traits / Brands	Corn borers	Cutworm	Corn earworm	Fall armyworm	Western corn rootworm
Agrisure GT/CB/LL, Agrisure Artesian [1]	Excellent	Poor	Fair	Fair	None
Agrisure 3011 GT [1]	Excellent	Poor	Fair	Fair	Good
Agrisure Viptera 3110 [2]	Excellent	Good	Excellent	Excellent	None
Agrisure Viptera 3111 [2]	Excellent	Good	Excellent	Excellent	Good
Genuity VT Triple Pro (GENVT3P) [2]	Excellent	Poor	Good	Very Good	Excellent
Genuity VT Double Pro (GENVT2P) [3]	Excellent	Poor	Good	Very Good	None
Genuity SmartStax or SmartStax (GENSS or SSX) [3]	Excellent	Good	Good	Very Good	Excellent
Herculex I (HX1 or HR) [1]	Excellent	Good	Poor	Good	None
Optimum Intrasect (YHR) [3]	Excellent	Good	Fair	Very Good	None
Optimum Intrasect Xtra (YXR) [2]	Excellent	Good	Fair	Very Good	Excellent
Optimum Intrasect XTreme [3]	Excellent	Good	Fair	Very Good	Excellent
Optimum Leptra (VYHR) [3]	Excellent	Good	Excellent	Excellent	None
Optimum TRIsect [1]	Excellent	Good	Poor	Good	Excellent
Genuity Trecepta [3]	Excellent	Good	Excellent	Excellent	None
YieldGard Corn Borer (YGCB) [1]	Excellent	Poor	Fair	Fair	None
YieldGard VT Triple (VT3) [1]	Excellent	Poor	Fair	Fair	Excellent
Below are RIB Systems (Non-Bt Refuge Seed Included in Each Bag of Seed), For Non-Cotton Growing Areas Only *					
Agrisure Viptera 3220 [4]	Excellent	Good	Excellent	Excellent	None
Agrisure Viptera 3122 [4]	Excellent	Good	Excellent	Excellent	Excellent
Genuity VT Double Pro RIB (GENVT2P RIB) [4]	Excellent	Poor	Good	Very Good	None
Genuity SmartStax or SmartStax RIB (GENSS or SSX) [4]	Excellent	Good	Good	Very Good	Excellent
Optimum AcreMax [4]	Excellent	Good	Fair	Very Good	None
Optimum AcreMax Xtra [5]	Excellent	Good	Fair	Very Good	Excellent
Optimum AcreMax XTreme [4]	Excellent	Good	Fair	Very Good	Excellent
PowerCore [4]	Excellent	Good	Good	Very Good	None
Genuity Trecepta RIB [4]	Excellent	Good	Excellent	Excellent	None

[1] 50% and 20% non-Bt corn refuge requirement in cotton and corn areas, respectively.
[2] 20% non-Bt corn refuge is required in cotton and corn areas.
[3] 20% and 5% refuge requirement in cotton and corn areas, respectively.
[4] 5% refuge in bag system in non-cotton areas; a separate 20% non-Bt refuge is required in cotton growing areas.
[5]10% refuge in bag system in non-cotton areas; a separate 20% non-Bt refuge is required in cotton growing areas.
***Designated "Cotton Areas" in Tennessee:** The counties of Carroll, Chester, Crockett, Dyer, Fayette, Franklin, Gibson, Hardeman, Hardin, Haywood, Lake, Lauderdale, Lincoln, Madison, Obion, Rutherford, Shelby and Tipton. Refer to the licensing agreement for specific details on refuge requirements for selected Bt corn hybrids.

When to Treat

Seedling Plants

- **Seed or Root Feeding Insects:** Only at-planting insecticide treatments or seed treatments are effective in controlling infestations of seedcorn maggots, wireworms, white grubs and southern corn rootworms. Fields with prior infestations or no-till or minimum-till plantings are more likely to benefit from an at-planting insecticide for the prevention of these insect pests. This is strongly recommended for fields that were in pasture, CRP or fallow the previous year. Bt corn with rootworm resistance will provide effective control of western corn rootworm but has no effect on other seed or root feeding insects.
- **Armyworm (True):** Treatment may be necessary when one worm is found on 25 percent of the plants checked.
- **Fall Armyworm:** Treat when 50 percent of the plants have one or more larvae per plant.
- **Flea Beetles:** Treat when 75 percent of the plants show obvious scarring by beetles on stems and leaves.
- **Cutworms:** Treat when larvae are present and 5 percent or more of plants are damaged or when two larvae per 100 plants are present.
- **Sugarcane Beetles:** The sugarcane beetle is an occasional pest of seedling corn, feeding on roots and reducing plant stands. Although few insecticides are labeled for this pest in field corn, some at-planting insecticides and seed treatments can suppress damage caused by sugarcane beetles. Rescue treatments of chlorpyrifos (e.g., Lorsban) or pyrethroid insecticides may provide some control and are recommended when 10 percent of the stand is lost or badly damaged.
- **Stink Bugs:** The growing point of small plants can be damaged by stink bug feeding resulting in irregular growth. Treat corn less than 24 inches tall if 10 percent or more of plants are infested with stink bugs. Some at-planting insecticides and seed treatments may suppress stink bug feeding on seedling corn.

Whorl-Stage or Larger Plants

- **Fall Armyworm and Corn Earworm:** These are two "budworms" commonly found in Tennessee field corn. Controls should be initiated when 75 percent of whorls have larvae present. Control of larvae in ears is not economically practical in field corn.
- **European Corn Borer:** Bt hybrids with corn borer protection provide a high level of control for this pest. For non-Bt corn, treat when 50 percent of the plants are infested or when one egg mass is found per plant. Use at least 20 gallons of water per acre for treating whorl-feeding insects. Direct the coarse spray down into the whorls for most effective control.
- **Southwestern Corn Borer:** Bt hybrids with corn borer protection provide a high level of control for this pest. For non-Bt corn, treat prior to tasseling when 5 percent or more of plants are found with egg masses or live larvae or 7 to 10 days after pheromone traps catch an average of 50 or more moths on a seven-day catch. Beginning at tasseling (VT) and through the milk stage (R3), treat when 10 percent or more of plants are found with egg masses or live larvae or 7 to 10 days after pheromone traps catch an average of 100 or more moths on a seven-day catch. Treatment is generally not recommended once the dough stage (R4) is reached.
- **Japanese Beetles:** Infestations are usually worse along field margins. Treat when three or more beetles are present per ear during the first week of silking.
- **Stink Bugs:** Before silking, small developing ears (1/2 – 3/4 inches long) can be damaged by stink bug feeding resulting in malformed ear development. Treat corn if 10 percent or more of plants are infested with stink bugs at or shortly before ear shoots appear (about V15). Treating for stink bugs is generally not recommended once silking has begun.

Suggestions for Chemical Control of Corn Insects			
Insect	**Insecticide (Trade Names)**	**Product Rate/Acre (Unless Specified)**	**Pre-Harvest Interval (Days) And Comments**
Cutworms	bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	2.1 - 6.4 oz	Foliar application, 30
	carbaryl (Sevin XLR Plus 4)	64 oz	0
	chlorpyrifos (Lorsban 4E, Nufos 4E, Lorsban Advanced 3.755)*	24 - 32 oz	21
	esfenvalerate (Asana XL 0.66E)	5.8 - 9.6 oz	21
	permethrin (Pounce 3.2E)	4 - 8 oz	30
	β-cyfluthrin (Baythroid XL 1)	0.8 - 1.6 oz	21
	γ-cyhalothrin (Declare 1.25)	0.77 - 1.28 oz	21
	λ-cyhalothrin (Karate 2.08, Warrior II)	0.96 - 1.6 oz	21
	Z-cypermethrin (Mustang Max 0.8E)	1.28 - 2.8 oz	30 grain, 60 forage
Fall Armyworm**	bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	4 - 6.4 oz	30
	carbaryl (Sevin XLR Plus 4)	32 - 64 oz	0
	chlorpyrifos (Lorsban 4E, Nufos 4E, Lorsban Advanced 3.755)*	24 - 32 oz	21
	chlorantraniliprole (Prevathon 0.43 SC)	14 - 20 oz	14
	chlorantraniliprole, λ-cyhalothrin (Besiege)	6 - 10 oz	21
	methomyl (Lannate LV 2.4)*	12 - 16 oz	3
	methoxyfenozide (Intrepid 2F)	4 - 8 oz	21
	methyl parathion 4 (Methyl 4E)	8 oz	12
	permethrin (Pounce 3.2E)	4 - 8 oz	30
	spinetoram (Radiant SC 1)	3 - 6 oz	28 grain, 3 forage
	spinosad (Blackhawk 36% WDG)	1.7 - 3.3 oz	1 grain, 7 forage
	β-cyfluthrin (Baythroid XL 1)	2.8 oz	21
	γ-cyhalothrin (Declare 1.25)	1.02 - 1.54 oz	21
	λ-cyhalothrin (Karate 2.08, Warrior II)	1.28 - 1.92 oz	21
	Z-cypermethrin (Mustang Max 0.8E)	3.2 - 4 oz	30 grain, 60 forage
Corn Earworm	bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	4 - 6.4 oz	30
	carbaryl (Sevin XLR Plus 4)	32 - 64 oz	0
	chlorantraniliprole (Prevathon 0.43 SC)	14 - 20 oz	14
	chlorantraniliprole, λ-cyhalothrin (Besiege)	6 - 10 oz	21
	esfenvalerate (Asana XL 0.66E)	5.8 - 9.6 oz	21
	methomyl (Lannate LV 2.4)*	12 - 16 oz	3
	permethrin (Pounce 3.2E)	4 - 8 oz	30

Suggestions for Chemical Control of Corn Insects			
	spinetoram (Radiant SC 1)	3 - 6 oz	28 grain, 3 forage
	spinosad (Blackhawk 36% WDG)	2.2 - 3.3 oz	1 grain, 7 forage
	β-cyfluthrin (Baythroid XL 1)	1.6 - 2.8 oz	21
	γ-cyhalothrin (Declare 1.25)	0.77 - 1.28 oz	21
	λ-cyhalothrin (Karate 2.08, Warrior II)	0.96 - 1.6 oz	21
	Z-cypermethrin (Mustang Max 0.8E)	2 - 4 oz	30 grain, 60 forage
Southwestern and European Corn Borer	bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	4 - 6.4 oz	30
	carbaryl (Sevin XLR Plus 4)	48 - 64 oz	0
	chlorantraniliprole (Prevathon 0.43 SC)	14 - 20 oz	14
	chlorantraniliprole, λ-cyhalothrin (Besiege)	6 - 10 oz	21
	esfenvalerate (Asana XL 0.66E)	7.8 - 9.6 oz	21
	methoxyfenozide (Intrepid 2F)	4 - 8 oz	21
	permethrin (Pounce 3.2E)	4 - 8 oz	30
	spinetoram (Radiant SC 1)	3 - 6 oz	28 grain, 3 forage
	spinosad (Blackhawk 36% WDG)	2.2 - 3.3 oz	1 grain, 7 forage
	β-cyfluthrin (Baythroid XL 1)	1.6 - 2.8 oz	21
	γ-cyhalothrin (Declare 1.25)	1.02 - 1.54 oz	21
	λ-cyhalothrin (Karate 2.08, Warrior II)	1.28 - 1.92 oz	21
	Z-cypermethrin (Mustang Max 0.8E)	2.75 - 4 oz	30 grain, 60 forage
Flea Beetles	bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	3 - 6.4 oz	30
	carbaryl (Sevin XLR Plus 4)	32 - 64 oz	0
	chlorpyrifos (Lorsban 4E, Nufos 4E, Lorsban Advanced 3.755)*	32 oz	21
	esfenvalerate (Asana XL 0.66E)	5.8 - 9.6 oz	21
	permethrin (Pounce 3.2E)	4 - 8 oz	30
	β-cyfluthrin (Baythroid XL 1)	0.8 - 1.6 oz	21
	γ-cyhalothrin (Declare 1.25)	1.02 - 1.54 oz	21
	λ-cyhalothrin (Karate 2.08, Warrior II)	1.28 - 1.92 oz	21
	Z-cypermethrin (Mustang Max 0.8E)	2.75 - 4 oz	30 grain, 60 forage
Stink Bugs	bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	3 - 6.4 oz	30
	carbaryl (Sevin XLR Plus 4)	32 - 64 oz	0
	methyl parathion 4 (Methyl 4E)	8 - 16 oz	12
	β-cyfluthrin (Baythroid XL 1)	1.6 - 2.8 oz	21

Suggestions for Chemical Control of Corn Insects			
	γ-cyhalothrin (Declare 1.25)	1.02 - 1.54 oz	21
	λ-cyhalothrin (Karate 2.08, Warrior II)	1.28 - 1.92 oz	21
	Z-cypermethrin (Mustang Max 0.8E)	2.75 - 4 oz	30 grain, 60 forage
Japanese Beetle	bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	3 - 6.4 oz	30
	carbaryl (Sevin XLR Plus 4)	32 - 64 oz	0
	β-cyfluthrin (Baythroid XL 1)	1.6 - 2.8 oz	21
	γ-cyhalothrin (Declare 1.25)	1.02 - 1.54 oz	21
	λ-cyhalothrin (Karate 2.08, Warrior II)	1.28 - 1.92 oz	21
	Z-cypermethrin (Mustang Max 0.8E)	2.75 - 4 oz	30 grain, 60 forage
Grasshoppers	bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	3 - 6.4 oz	30
	chlorpyrifos (Lorsban 4E, Nufos 4E, Lorsban Advanced 3.755)*	8 - 16 oz	21
	esfenvalerate (Asana XL 0.66E)	5.8 - 9.6 oz	21
	β-cyfluthrin (Baythroid XL 1)	2.1 - 2.8 oz	21
	γ-cyhalothrin (Declare 1.25)	1.02 - 1.54 oz	21
	λ-cyhalothrin (Karate 2.08, Warrior II)	1.28 - 1.92 oz	21
	Z-cypermethrin (Mustang Max 0.8E)	2.75 - 4 oz	30 grain, 60 forage

* Caution: When using organophosphate insecticides such as Lorsban or Lannate with ALS herbicides such as Accent, Capreno, Halex GT, Steadfast, Lightning, Option or Resolve, the possibility for plant injury exists. See herbicide label for restrictions.
** Insecticides recommended for fall armyworm should generally provide control of true armyworm (see label).

Premixed Insecticide Products

The following products are available as premixes of two or more insecticides. The use of these premixes may provide suppression or control of multiple pests, and thus, are typically recommended when several pests are present at treatment level.

Trade Name (Insecticides)	Amount Product per Acre	Comments and Primary Target Pests (see label for other pests that may be controlled)
Besiege (chlorantraniliprole, λ-cyhalothrin)	6 - 10 oz	Corn borers, corn earworm, stink bugs; Pre-harvest interval - 21 days
Cobalt Advanced (chlorpyrifos, γ-cyhalothrin)	See label	Foliar applications: Corn borers, corn earworm, stink bugs; Pre-harvest interval - 21 days grain, 14 days forage
Hero 1.24 (bifenthrin, Z-cypermethrin)	4 - 10.3 oz	Corn borers, corn earworm, stink bugs, corn earworm; Pre-harvest interval - 30 days grain, 60 days forage
Stallion (chlorpyrifos, Z-cypermethrin)	See label	Foliar applications: Corn borers, corn earworm, stink bugs; Pre-harvest interval - 30 days grain, 60 days forage

*Caution: When using Cobalt Advanced with ALS herbicides such as Accent, Capreno, Halex GT, Steadfast, Lightning, Option or Resolve, the possibility for plant injury exists. See herbicide label for restrictions.

2018 Sorghum Insect Control Recommendations

Introduction

Grain sorghum is an important minor rotational crop in Tennessee. Sorghum is more drought-tolerant than either corn or soybeans, and provides another non-host crop for managing soybean cyst nematode populations. Grain sorghum can be used in a double-crop system following wheat or as a late-planted grain crop.

Several insect pests may reduce yields. By planting grain sorghum on the recommended dates, some insect problems can be reduced or avoided. Infestations of the sorghum midge, corn earworm, fall armyworm and sorghum webworm will cause more damage to late-planted sorghum. Fortunately, there are many insecticides that will control economically damaging populations of sorghum insect pests.

Sap-feeding Insects

Different types of aphids may be found on grain sorghum early in the season. These insects are found on top and underneath the leaves and whorls of sorghum plants, where they cause damage by sucking juices from the plant. The most common aphids found in grain sorghum are the greenbug and the corn leaf aphid. The greenbug injects plant tissue with toxic saliva and both types of aphids can transmit viral diseases like Maize Dwarf Mosaic Virus.

Insects Feeding on Grain Heads and Seed Kernels

The sorghum midge and sorghum webworm feed on the ripening grain kernels. Sorghum webworms feed on the ripening kernels by devouring the inside and leaving the hollow kernel shell. Corn earworms and fall armyworms usually consume the entire kernel as they feed.

Insects Feeding on Leaf Tissue

Corn earworms and fall armyworms feed in the whorls of young grain sorghum plants. Severe feeding injury to the growing point or intercalary meristem may destroy the emerging grain head.

Recommended Planting Dates

Grain sorghum should be planted from May 1 to June 1 for highest yields. Planting before mid-May will avoid some insect damage from sorghum midge, fall armyworm, sorghum webworm and corn earworm.

Scouting Procedures and When to Treat

Greenbug: A small, light green aphid with a dark green stripe down the back. It is approximately 1/16 inch long. Reproductive potential is very high compared to other aphids. Early-planted sorghum is more susceptible to attack from greenbug. Look on the undersides of leaves for these small green aphids. Treat when one or two greenbugs are on a majority of the plants in the seedling stage and leaves are showing damage. The greenbug has a toxic substance in its saliva that causes red spots on leaves where it has fed. In larger plants, treat when one or two leaves per plant are dying.

Yellow Sugarcane Aphid: A small aphid that is yellow to light green in color, although usually yellow in sorghum. They have two double rows of dusky colored spots down the top of the abdomen, and rows of spots are also present along the lateral margins of the abdomen. The body is covered with short, stiff hairs. The cornicles (tail-pipes at the end of the abdomen) are reduced to slightly elevated pores. Like the greenbug, the yellow sugarcane aphid injects a toxin while feeding that causes red spots on leaves where it has fed. Use the same treatment threshold as for greenbug.

Corn Leaf Aphid: The cornicles, legs and antennae of this species are black. The body is bluish-green in color and about 1/16 inch long. Aphids are usually found feeding in the whorl of the sorghum plant. Check primarily in the whorls of sorghum plants for this insect. The corn leaf aphid does not inject a toxic saliva into the leaves, as do greenbugs, but can transmit viral diseases if Johnsongrass is present in the field. Sorghum plants can tolerate a large number of these insects, so treatments are usually unnecessary.

Sugarcane Aphid: This invasive insect was first found in Tennessee in 2014. It is small and white to yellow in color. Populations can build rapidly and may kill leaves or entire plants in some circumstances. The accumulation of honeydew on heads may also reduce harvest efficiency. Because this is a new pest, treatment thresholds have not been fully defined. Infestations are often initially concentrated on field edges. Current recommendations are to treat when aphids are present on 30 percent or more of plants and occasional leaves have 100 or more aphids present.

Treatment should also be considered if honeydew is present in multiple spots throughout a field and aphid populations are increasing. Intensify scouting efforts when sugarcane aphids are detected because populations can build rapidly and outbreaks can result in devastating yield losses.

Sorghum Midge: This small, gnat-like insect is reddish-orange and about 1/10 inch long. Female sorghum midges lay eggs in spikelets and seed husks during the bloom stage of sorghum. The larvae feed on the developing seeds, causing them to dry up and die. Check grain heads from emergence through bloom stage twice per week. Place a clear plastic bag over the head and shake, allowing the bag to remain over the head, and observe any midges that may light on the bag walls. Treat when an average of one midge per grain head is found.

Sorghum Webworm: This is a small, hairy caterpillar with four reddish-brown stripes down its back. Full-grown larvae are about 1/2 inch long. They are usually associated with a sticky webbing in the area of their feeding. Check inside grain heads for larvae and on the leaves under grain heads for white fecal droppings from these insects. Close examination is necessary. Treat when an average of three to four or more larvae is found per grain head.

Corn Earworm: This larva has alternating light and dark stripes down its body. The skin is set with tiny spines and the color varies from green to pink. The head capsule is a creamy-yellow. Full grown larvae are about 1½ inches long. Corn earworms feed in the whorls of young plants, and can devour entire grain kernels. Check in the whorls of young plants and inside the grain heads of older plants. Treat when an average of one or more larvae is found per head.

Fall Armyworm: Larvae have a dark head capsule and a more prominent inverted Y on the front of the head. The body color is greenish to brownish, with brownish to black stripes on the sides of the body. Check in the whorls of young late-planted sorghum plants and inside the grain heads of more mature plants. Treat when an average of one or more larvae is found per head.

Insecticide Seed Treatments

Insecticidal seed treatments (e.g., Cruiser, Gaucho, Poncho) are available from seed companies. Seed treatments will help control some seed and seedling pests such as chinch bug, greenbug, wireworms and white grubs. However, there has been little testing of these treatments in Tennessee. Recent data indicates that these insecticide seed treatments may reduce infestations of sugarcane aphid, which may be especially important on late-planted sorghum.

Suggestions for Chemical Control of Sorghum Insects

Insect Pest	Insecticide	Rate Product Per Acre	Pre-Harvest Days (Grain) *
Aphids, except	chlorpyrifos (Lorsban 4, Nufos 4, Lorsban Advanced 3.775)	8 - 32 oz	30 - 60, see label
sugarcane aphid **	chlorpyrifos, γ-cyhalothrin (Cobalt Advanced)	11 - 38 oz	30
	dimethoate 4	8 - 16 oz	See label
Sugarcane Aphid	flupyradifurone (Sivanto Prime)	4 - 7 oz	21
	Contact a UT Extension agent to determine if additional insecticides have been approved to control this pest.		
Sorghum Midge	chlorpyrifos (Lorsban 4, Nufos 4, Lorsban Advanced 3.775)	8 oz	30
	chlorpyrifos, γ-cyhalothrin (Cobalt Advanced)	6 - 13 oz	30
	chlorpyrifos, Z-cypermethrin (Stallion)	3.75 - 11.75 oz	30
	methomyl (Lannate LV 2.4)	12 - 24 oz	14
	esfenvalerate (Asana XL 0.66)	2.9 - 5.8 oz	21

Suggestions for Chemical Control of Sorghum Insects			
Insect Pest	**Insecticide**	**Rate Product Per Acre**	**Pre-Harvest Days (Grain) ***
Sorghum Midge	spinosad (Blackhawk 36% WDG), suppression	1.5 - 3.3 oz	21
	β-cyfluthrin (Baythroid XL 1)	1 - 1.3 oz	14
	γ-cyhalothrin (Declare 1.25)	0.77 - 1.02 oz	21
	λ-cyhalothrin (Karate 2.08, Warrior II)	0.92 - 1.23 oz	30
	Z-cypermethrin (Mustang Max 0.8)	1.28 - 4 oz	14
Corn Earworms	carbaryl (Sevin 80S)	1.25 - 2.5 lb	21
	carbaryl (Sevin XLR 4)	16 - 32 oz	21
	chlorantraniliprole (Prevathon 0.43 SC)	14 - 20 oz	14
	chlorantraniliprole, λ-cyhalothrin (Besiege)	6 - 10 oz	30
	chlorpyrifos (Lorsban 4, Nufos 4, Lorsban Advanced 3.775)	32 oz	60
	chlorpyrifos, γ-cyhalothrin (Cobalt Advanced)	16 - 38 oz	See label
	chlorpyrifos, Z-cypermethrin (Stallion)	5 - 11.75 oz	30
	methomyl (Lannate LV 2.4)	24 oz	14
	NPV virus (Heligen) ***	1 - 1.4 oz	0
	spinosad (Blackhawk 36% WDG)	1.7 - 3.3 oz	21
	esfenvalerate (Asana XL 0.66) ****	2.9 - 5.8 oz	21
	β-cyfluthrin (Baythroid XL 1) ****	1.3 - 2.8 oz	14
	γ-cyhalothrin (Declare 1.25) ****	1.02 - 1.54 oz	21
	λ-cyhalothrin (Karate 2.08, Warrior II) ****	1.23 - 1.85 oz	30
	Z-cypermethrin (Mustang Max 0.8) ****	1.76 - 4 oz	14
Sorghum Webworm	carbaryl (Sevin 80S)	1.25 - 2.5 lb	21
	carbaryl (Sevin XLR 4)	16 - 32 oz	21
	chlorantraniliprole (Prevathon 0.43 SC)	14 - 20 oz	14
	chlorantraniliprole, λ-cyhalothrin (Besiege)	6 - 10 oz	30
	chlorpyrifos (Lorsban 4, Nufos 4, Lorsban Advanced 3.775)	16 - 32 oz	30-60, see label
	chlorpyrifos, γ-cyhalothrin (Cobalt Advanced)	16 - 38 oz	See label
	chlorpyrifos, Z-cypermethrin (Stallion)	5 - 11.75 oz	30

Suggestions for Chemical Control of Sorghum Insects			
Insect Pest	**Insecticide**	**Rate Product Per Acre**	**Pre-Harvest Days (Grain) ***
Sorghum Webworm	methomyl (Lannate LV 2.4)	24 oz	14
	spinosad (Blackhawk 36% WDG)	1.7 - 3.3 oz	21
Fall Armyworm	carbaryl (Sevin 80S)	1.25 - 2.5 lb	21
	carbaryl (Sevin XLR 4)	32 - 64 oz	21
	chlorantraniliprole (Prevathon 0.43 SC)	14 - 20 oz	14
	chlorantraniliprole, λ-cyhalothrin (Besiege)	6 - 10 oz	30
	chlorpyrifos (Lorsban 4, Nufos 4, Lorsban Advanced 3.775)	16 - 32 oz	30-60, see label
	chlorpyrifos, γ-cyhalothrin (Cobalt Advanced)	24 - 38 oz	See label
	chlorpyrifos, Z-cypermethrin (Stallion), suppression	9.25 - 11.75 oz	30
	methomyl (Lannate LV 2.4)	12 - 24 oz	14
	methoxyfenozide (Intrepid 2F)	8 - 10 oz	21
	spinosad (Blackhawk 36% WDG)	1.7 - 3.3 oz	21
	β-cyfluthrin (Baythroid XL 1) ****	1.3 - 2.8 oz	14
	γ-cyhalothrin (Declare 1.25) ****	1.02 - 1.54 oz	21
	λ-cyhalothrin (Karate 2.08, Warrior II) ****	1.23 - 1.85 oz	30
	Z-cypermethrin (Mustang Max 0.8) ****	1.76 - 4 oz	14
Stink Bugs	carbaryl (Sevin 80S)	1.5 - 2.5 lb	21
	carbaryl (Sevin XLR 4)	38 - 64 oz	21
	chlorpyrifos, γ-cyhalothrin (Cobalt)	16 - 38 oz	See label
	chlorpyrifos, Z-cypermethrin (Stallion)	5 - 11.75 oz	30
	β-cyfluthrin (Baythroid XL 1)	1.3 - 2.8 oz	14
	γ-cyhalothrin (Declare 1.25)	1.02 - 1.54 oz	21
	λ-cyhalothrin (Karate 2.08, Warrior II)	1.23 - 1.85 oz	30
	Z-cypermethrin (Mustang Max 0.8)	1.76 - 4 oz	14

* Waiting period from insecticide application until grain harvest.
** Controls are usually unnecessary for corn leaf aphids.
*** NPV virus (Heligen) will only control corn earworm. Applications should be made when larvae are small. Do not apply if most larvae are large or if infestations are well above treatment threshold.
**** Pyrethroid insecticides may not provide adequate control of corn earworm or fall armyworm and are not recommended if infestations are well above the treatment threshold.

Many farmers in Tennessee use wheat as a double-crop with soybeans. As with any crop, wheat has several insect pests that may reduce yields if not effectively controlled in the field. Yields can be improved if more producers take time to inspect their fields during the growing season for insect pests. This publication is designed to acquaint the producer with the major insect pests of wheat, the damage they cause and measures used to control the pests.

Aphids: Several aphids feed on the leaves and grain heads of wheat. These pests are significant in that they are capable of transmitting diseases to the plant such as barley yellow dwarf virus in addition to the damage inflicted by their feeding habits. Adult aphids are only about 1/8 inch long, and adults may or may not have two pairs of nearly transparent wings.

Oat-Bird Cherry Aphid is dark green in color and is the primary species responsible for transmission of the barley yellow dwarf virus. This and the English grain aphid are usually the most common species observed in wheat.
English Grain Aphid is pale green in color with black antennae and black cornicles, and the cornicles and antennae are longer than other aphid species normally observed in wheat.
Greenbug is pale green, having a dark green stripe down the back of the wingless forms. The tips of the legs and cornicles are black, and the antennae are mostly black.
Corn Leaf Aphid is bluish-green and all of the legs, cornicles and antennae are black.
Rice Root Aphid occurs on the roots of wheat and has been known to transmit barley yellow dwarf virus.

Armyworms: Armyworms can be serious pests of wheat when populations reach large numbers. Armyworms get their name from their migrating habit, as they sometimes start at one portion of the field and devour everything in their path.

True Armyworm: Damaging infestations of true armyworm normally occur in the spring. Mature larvae are smooth, almost without any hairs, greenish-brown to reddish-brown, with a dark stripe along each side. A broad dorsal stripe runs down the length of the back. This species differs from the fall armyworm by having a dark lateral band on the outer portion of each proleg. Besides feeding on foliage, larvae will sometimes cut the heads of maturing wheat plants.

Fall Armyworm: As the name implies, the fall armyworm is normally a pest of early planted seedling wheat. These insects can completely defoliate a wheat field when populations are very large. This insect differs from the true armyworm by having a prominent inverted Y on the front of the head and no dark bands on the outer portion of the prolegs.

Hessian Fly: These small insects have been responsible for tremendous wheat losses in the past. Hessian fly larvae feed on stems at the base of plants, hidden behind the leaf sheaths. Larvae are reddish at first emergence and turn white or greenish white; they are shiny and without legs. Larvae are legless, resembling small grains of rice, and are approximately 1/4 inch long when full grown. The pupae, or flax seed stage, are brown in color but are otherwise similar to the larvae. Tennessee typically does not have significant problems with this pest. However, early planted wheat is susceptible to infestation. Planting after Oct. 15 (i.e., the “fly free date”) will greatly reduce the likelihood of serious Hessian fly infestations. Also, avoid planting wheat as a cover crop prior to the fly free date. Volunteer wheat is a good fall host for this pest, and any volunteer wheat should be destroyed before September. Plowing under wheat stubble after harvest may help reduce subsequent infestations in the fall. Although some varieties are available with resistance to Hessian flies, there are no varieties with adequate resistance to the fly biotype most common in Tennessee (Biotype L).

Cereal Leaf Beetle: The cereal leaf beetle is a pest of wheat, oats, barley and other cereal crops. It has been found in most all counties in Tennessee, and may be present from April to June. The larvae are pale yellow and soft-bodied, but they are normally covered with their fecal material giving them a dark gooey, shiny appearance. Adults are shiny, black beetles with red legs and thorax and are approximately 3/16 inch long. Adults and larvae skeletonize the leaf tissue between the veins.

When to Treat

Aphids: One of the most consistent management approaches of preventing aphid infestations and infection with barley yellow dwarf viruses is to plant during the recommended planting window. Early planted wheat is more likely to be infested by aphids during the fall and often results in higher infection with virus during the seedling stage. Consequently, planting is not recommended until October 15 or later, which also helps avoid infestations from Hessian fly.

Insecticide seed treatments such as Gaucho (imidacloprid), Cruiser (thiamethoxam) and NipsIt Inside (clothianidin) also can reduce transmission of barley yellow dwarf (BYD). Early planted wheat is most likely to benefit from use of a seed treatment. If a seed treatment is not used, a foliar insecticide application for aphid control during the fall (e.g., approximately 30 days after planting) and/or late winter (prior to March) may also reduce BYD. Insecticide applications should be made before aphid populations exceed 6-8 per linear foot of row; otherwise, any virus transmission may have already occurred. However, infection with BYD becomes less damaging as plants grow, and applications after jointing are less likely to increase yield.

Greenbug: This aphid injects a toxin while feeding. Treatment should be made when aphids are killing three or more leaves per plant. For wheat less than 6 inches tall, treatment should also be considered if greenbugs number 50 or more per linear foot. Treatment should also be made if greenbugs number 200 or more per foot in wheat 6-10 inches tall.

Armyworms: Treatment for fall armyworm during the fall should be considered when four or more larvae are present per square foot. For true armyworm infestations that occur during the spring, use a threshold of 6-8 larvae per square foot if wheat is still in the milk stage. Once past the milk stage, wheat can tolerate higher populations and treatment is not usually recommended unless larvae are cutting wheat heads.

Hessian Fly: Foliar insecticide applications for this pest are difficult to time, and thus only marginally effective. Plant after the fly free date (October 15) and use resistant varieties if they are available. Insecticide seed treatments will provide some protection against fall infestations of Hessian fly, especially when used at the highest labeled rates.

Cereal Leaf Beetle: Check 10 plants per sample site for larvae and adults. Treatment is necessary if 25 or more larvae are present per 100 tillers and wheat is still in the milk stage.

Suggestions for Chemical Control of Wheat Insects

Insect	Insecticide (Trade Names)	Rate Product Per Acre
Aphids	**Seed Treatments**	
	clothianidin (NipsIt Inside 5)	0.75 - 1.79 oz per 100 lb seed
	imidacloprid (Gaucho 600)	0.8 - 2.4 oz per 100 lb seed
	thiamethoxam (Cruiser 5)	0.75 - 1.33 oz per 100 lb seed
(see label for suggested insecticide rates for different species)	**Foliar Treatments**	
	dimethoate 4*	8 - 12 oz
	methomyl (Lannate LV 2.4)*	12 - 24 oz
	methyl parathion 4 (Methyl 4)*	8 - 24 oz
	β-cyfluthrin (Baythroid XL 1)	1.8 - 2.4 oz
	γ-cyhalothrin (Declare 1.25)	1.54 oz
	λ-cyhalothrin (Karate 2.08, Warrior II)	1.28 - 1.92 oz
	Z-cypermethrin (Mustang Max 0.8)	3.2 - 4 oz
Armyworms (True & Fall)	carbaryl (Sevin XLR Plus 4)	32 - 48 oz
	chlorantraniliprole (Prevathon 0.43 SC)	14 - 20 oz
	chlorantraniliprole, λ-cyhalothrin (Besiege)	6 - 10 oz
	methyl parathion 4 (Methyl 4)*	24 oz
	methomyl (Lannate LV 2.4)*	12 - 24 oz
	spinetoram (Radiant SC 1)	3 - 6 oz
	spinosad (Blackhawk 36% WDG)	1.7 - 3.3 oz
	β-cyfluthrin (Baythroid XL 1)	1.8 - 2.4 oz
	γ-cyhalothrin (Declare 1.25)	1.02 - 1.54 oz
	λ-cyhalothrin (Karate 2.08, Warrior II)	1.28 - 1.92 oz
	Z-cypermethrin (Mustang Max 0.8)	3.2 - 4 oz
Cereal Leaf Beetle	carbaryl (Sevin XLR Plus 4)	32 oz
	methomyl (Lannate LV, 2.4)*	12 - 24 oz
	spinosad (Blackhawk 36% WDG)	1.1 - 3.3 oz
	β-cyfluthrin (Baythroid XL 1)	1 - 1.8 oz
	γ-cyhalothrin (Declare 1.25)	1.02 - 1.54 oz
	λ-cyhalothrin (Karate 2.08, Warrior II)	1.28 - 1.92 oz
	Z-cypermethrin (Mustang Max 0.8)	1.76 - 4 oz

*Use extra caution when handling these insecticides.

When to Treat

Armyworms: Treatment should be considered when populations exceed three to four larvae per square foot. If fields are ready or near ready for cutting, harvesting is suggested rather than applying insecticide.

Grasshoppers: Treatment thresholds have not been established.

Bermudagrass Stem Maggot: This invasive fly has recently become established in Tennessee. The larval (maggot) stage feeds within Bermudagrass stems, causing shoot tips to turn light brown or white, giving infested fields a frosted appearance. Infestations are typically worse later in the summer. Infested fields should be harvested if they are within seven days of the normal harvest stage. Heavily infested fields should be harvested earlier, and any baled grass should be removed. Current recommendations are to treat infested, recently harvested fields with a foliar-applied insecticide within a few days after the previous harvest. A second application five to seven days later may be justified in cases of severe infestations. Relatively low rates of pyrethroid insecticides will provide effective control of adults, helping to prevent reinfestation.

Suggestions for Chemical Control of Pasture Insects

Insects	Insecticide (Trade Names)	Rate per Acre	Restrictions/Comments*
Armyworms or Grasshoppers	carbaryl (Sevin XLR Plus 4)	32 - 48 oz	Must remove cattle. Do not apply within 14 days of harvest or grazing. Other Sevin formulations are also available.
Armyworms	chlorantraniliprole (Prevathon 0.43 SC)	10 - 13 oz	0 day application restriction for forage or hay.
Armyworms, Bermudagrass Stem Maggot, Grasshoppers	chlorantraniliprole, λ-cyhalothrin (Besiege, premix)	6 - 10 oz	0 day application restriction for forage or hay.
Grasshoppers	diflubenzuron (Dimilin 2L)	2 oz	Allow 1 day after treatment before cutting for hay. Apply when grasshoppers are small.
Armyworms or Grasshoppers	malathion (malathion 57E)	32 oz	Must remove cattle. Allow spray to dry before harvest or grazing.
Armyworms	methomyl (Lannate 2.4LV)	12 - 24 oz	Bermudagrass only. Must remove cattle. Do not apply within 3 days of harvest or 7 days of grazing.
Armyworms	methoxyfenozide (Intrepid 2F)	4 - 8 oz	Do not apply within 7 days of harvest; 0 day application restriction for grazing.
Armyworms or Grasshoppers	methyl parathion (Methyl 4E)	24 oz	Must remove cattle. Do not apply within 15 days of harvest or grazing.
Armyworms	spinosad (Blackhawk 36% WDG)	1.1 - 2.2 oz	Do not apply within 3 days of harvest; 0 day restriction for grazing.

Suggestions for Chemical Control of Pasture Insects			
Insects	**Insecticide (Trade Names)**	**Rate per Acre**	**Restrictions/Comments***
Armyworms, Bermudagrass Stem Maggot, Grasshoppers	β-cyfluthrin (Baythroid XL 1)	1.6 - 1.9 oz	Use highest rate for grasshoppers; Do not apply within 7 days of harvest; 0 day application restriction for grazing.
Armyworms, Bermudagrass Stem Maggot, Grasshoppers	λ-cyhalothrin (Karate 2.08, Warrior II)	1.3 - 1.9 oz	Do not apply within 7 days of harvest; 0 day restriction for grazing.
Armyworms, Bermudagrass Stem Maggot, Grasshoppers	Z-cypermethrin (Mustang Max 0.8)	2.8 - 4 oz	0 day application restriction for forage or hay.

* See insecticide labels for complete list of pests controlled, restrictions and comments

Insecticide Classes, Modes of Action and EPA Registration Numbers

It is important to know the classes of insecticides being used. Rotating insecticide classes or using mixes of insecticides with two or more modes of action is often recommended to help prevent resistance. Producers are also required to keep records, including EPA product registration numbers, of all insecticides applied to fields. Product registration numbers for products not listed below are provided on the insecticide labels.

Insecticide (IRAC Class)*	EPA Product Registration Number**
Acramite	400-514
Admire Pro (4A)	264-827
Agri-Mek (6)	100-898
Capture LFR (3A)	279-3302
Cypermethrin (3A)	279-3027-5905
Asana XL (3A)	352-515
Baythroid XL (3A)	264-840
Belay (4A)	59639-150
Besiege (3A, 28)	100-1402
Bidrin (1B)	5481-448
Bidrin XP II (3A, 1B)	5481-9024
Blackhawk (5)	62719-523
Brigade (3A)	279-3313
Brigadier (3A,4A)	279-3332
Carbine (9C)	71512-9-279
Centric (4A)	100-1147
Cobalt Advanced (3A,1B)	62719-615
Comite II (12C)	400-154
Counter (1B)	5481-545
Couraze Max (4A)	264-783-67760
Cruiser (4A)	100-941
Delta Gold (3A)	264-1011-1381
Declare (3A)	67760-96
Denim (6)	100 - 903
Diamond (15)	66222-35-400
Dimethoate (1B)	See label
Dimilin (15)	400-461
Di-Syston (1B)	264-734
Discipline (3A)	5481-517
Endigo ZC (3A,4A)	100-1276

Insecticide (IRAC Class)*	EPA Product Registration Number**
Fanfare (3A)	66222-99
Force (3A)	100-1075
Fyfanon Plus ULV (1B,3A)	67760-108
Gaucho (4A)	264-968
Hero (3A)	279-3315
Intrepid (18)	62719-442
Intrepid Edge (5, 18)	62719-666
Intruder (4A)	8033-24-10163
Karate (3A)	100-1097
Lannate (1A)	352-384
Leverage 360 (3A,4A)	264-1104
Lorsban Advanced (1B)	62719-591
Malathion (1B)	See label
Methyl parathion (1B)	See label
Mustang Max (3A)	279 - 3249
Oberon (23)	264-850
Orthene 90S (1B)	59639-33
Poncho (4A)	264-789
Pounce 25WP (3A)	279-3051
Portal (21A)	71711-19
Prevathon (28)	352-844
Radiant (5)	62719-545
Sevin XLR Plus (1A)	264-333
Sevin 80S (1A)	264-316
Sivanto Prime (4D)	264-1141
Steward (22A)	352-638
Transform WG (4C)	62719-625
Vydate CL-V (1A)	352-532
Warrior II (3A)	100-1295
Zeal (10B)	59639-123

* Insecticide mode of actions class as identified by Insecticide Resistance Action Committee: 1A, carbamates; 1B, organophosphates; 3A, pyrethroids; 4A-4D, neonicotinoid subclasses; 5, spinosyns; 6, avermectins; 9C, flonicamid; 10B, etoxazole; 12C, organosulfurs; 15, benzolureas; 18, diacylhydrazines; 21A, METI acaricides; 22A, oxadiazines; 23 = spiromesifen; 28, diamides; UN = unknown. ** Registration numbers change with company brands, although the product name or active ingredient may be the same. Check the label to be sure.

Additional Brand Names of Commonly Used Active Ingredients (Generic Insecticides)

Active Ingredients (Common Brand Names)	Additional Brands with Same or Similar Active Ingredient*
abamectin (Abba, Agri-Mek, Agri-Mek SC, Zoro)	Abamex, Epi-Mek, Reaper
acephate (Orthene 90, Orthene 97)	Acephate 90, Acephate 97, Livid 90WDG, Livid 97 Prill
bifenthrin (Brigade, Discipline, Fanfare)	Bifenthrin, Bifenture, Capture LFR, Reveal, Sniper, Tundra
bifenthrin + chlorpyrifos	Match-Up, Tundra Supreme
bifenthrin + imidacloprid (Brigadier)	Avenger Bold, Skyraider, Swagger, Tempestbri
chlorpyrifos (Lorsban Advanced, Nufos)	Chlorpyrifos, Govern, Lorsban, Warhawk, Vesper, Yuma
chlorpyrifos + λ-cyhalothrin (Cobalt Advanced)	Lambdafos
cypermethrin	Battery, Cypermethrin, Holster, Up-Cyde
dicrotophos (Bidrin 8E)	Dicromax 8
diflubenzuron (Dimilin 2L)	Cavalier 2L
esfenvalerate (Asana XL)	S-FenvalorStar, Zyrate
imidacloprid (Admire Pro, Couraze Max)	Advise Four, Alias, Imida, Imidacloprid, Nuprid, Pasada, Provoke, Wrangler
methoxyfenozide (Intrepid 2F)	Troubadour 2F
methyl parathion (Methyl 4E)	Methyl Parathion 4E, Penncap-M 2E
permethrin (Pounce 3.2E)	Ambush 2E, Arctic, Permastar AG, Permethrin 3.2, Perm-Up
spinosad (Blackhawk 36% WDG)	Success 2F
β-cyfluthrin (Baythroid XL)	Tombstone (= cyfluthrin)
γ-cyhalothrin (Declare)	Proaxis
λ-cyhalothrin (Karate, Warrior II)	Grizzly, Grizzly Too, Grizzly Z, Kendo, Lambda, Lambda-Cy, LambdaStar, Ravage, Silencer
Z-cypermethrin (Mustang Max)	Holster, Respect

* Read the insecticide label before making application. Although active ingredients are the same or very similar, brands often have different formulations, different labeled uses, and different use rates. This information is provided for educational purposes, and some of the additional brands listed above have not been independently evaluated by the University of Tennessee.

Protection of Honeybees and Other Pollinators

Pollinators, including honeybees, are a vital component of the ecosystem. Beekeepers are having difficulty maintaining the health of honeybee colonies. The careful use of pesticides, and insecticides in particular, can help prevent additional stresses on honeybee health. Many insecticide labels indicate that applications to field crops cannot be made when bees are foraging in fields unless pest populations exceed economic thresholds. However, there are additional steps that should be taken to mitigate the potential negative effects of pesticides on pollinators.

- Beekeepers, growers and pesticide applicators should communicate so that all parties know the location of beehives near agricultural fields. Apiaries should be clearly marked with the beekeeper's contact information.
- The beekeeper should try to select apiary locations that have natural barriers, such as tree lines, to mitigate exposure to insecticide drift.
- The beekeepers should avoid placing hives directly adjacent to agricultural fields that are likely to be sprayed with insecticides.
- If hives are close to field edges, the entrances should be directed away from the field when possible.
- In high-risk areas, growers or pesticide applicators should notify beekeepers when insecticides that are toxic to bees are likely to be applied.
- Pesticide applications should not be made in conditions where drift towards bee hives or natural foraging habitats is likely to occur.
- When possible, avoid aerial application in high-risk areas where beehives or naturally occurring pollinator habitat is near agricultural fields.
- Make applications when bees are not active (i.e., early in the morning or especially late in the day) in sensitive areas or when many pollinators are observed foraging within a field.

The following table is a list of commonly used insecticides and the potential risk they pose to honeybees and other pollinators.

Relative Toxicity of Commonly Used Insecticides to Adult Honeybees*

Trade Name	Common Name	Hazards to Adult Bees
Acramite	bifenazate	moderate
Admire Pro	imidacloprid	high (3.5 days)
Agri-Mek, Abba	abamectin	moderate (0.5 day)
Asana	esfenvalerate	high (<1 day)
Baythroid XL, Tombstone	β–cyfluthrin, cyfluthrin	high (>1 day)
Besiege	chlorantraniliprole + λ-cyhalothrin	high
Blackhawk, Success	spinosad	moderate (<2 hours)
Brigade, Sniper, Fanfare	bifenthrin	high (1 day)
Carbine	flonicamid	low
Centric	thiamethoxam	moderate to high
Comite	propargite	none
Cruiser	thiamethoxam (seed treatment)	none to very low
Cypermethrin	cypermethrin	high (<1 day)
Diamond	novaluron	high
Dimethoate	dimethoate	high (3.5 days)
Dimilin	diflubenzuron	none
Endigo	thiamethoxam + λ-cyhalothrin	high
Gaucho	imidacloprid (seed treatment)	none to very low
Intrepid	methoxyfenozide	none
Intruder, Strafer	acetamiprid	none
Karate, Warrior, etc.	λ-cyhalothrin	high
Leverage 360	imidacloprid + cyfluthrin	high (3.5 days)
Lorsban	chlorpyrifos	high (3.5 days)
Malathion	malathion	high (2 days)
Mustang Max	zeta-cypermethrin	high (<1 day)
Oberon	spiromesifen	unknown
Orthene, Acephate	acephate (foliar)	high (2.5 days)
Portal	fenpyroximate	unknown
Prevathon	chlorantraniliprole	moderate ?
Radiant	spinetoram	moderate (<2 hours)
Steward	indoxacarb	high
Vydate C-LV	oxamyl	high (4 days)
Zeal	etoxazole	low

*Modified from UC Davis, http://www.ipm.ucdavis.edu/PMG/r114900911.html#REFERENCE.

Restricted Entry Intervals and Insecticide Performance Charts

The restricted entry interval (or re-entry interval) is the time period required by federal law between application of pesticides to crops and the entrance of workers into those crops without protective clothing. Re-entry intervals serve to protect workers from possible pesticide poisonings. Growers, scouts and other farm laborers must effectively communicate when and where pesticides have been applied. Reentry periods vary by product. Scouts should not enter fields without the required personal protective equipment (PPE) until all reentry intervals have expired.

Disclaimer: The following ratings are based on a general consensus from multiple efficacy trials across the Midsouth. Insecticides with a higher numerical rating are expected to give the best control of the target pest. Insecticide performance is often dependent upon the timing of an application. Some ratings are based on limited data, and local performance may vary depending on insecticide resistance levels and previous use of insecticides. **Ratings are shown for standard use rates and not all products rated for a pest are listed on the insecticide label. Please refer to the label before spraying any insecticide.**

Grain Sorghum Insecticide Performance Ratings

Insecticide	Restricted Entry Interval (hours)	Restricted use (R)	Chinch Bug	Sorghum Webworm	Corn Earworm	Fall Army-worm	Greenbug (Aphid)	Sugar-cane Aphid	Sorghum Midge	Stink Bug
Asana XL	12	X	7	3	6	5	8	0	8	7
Baythroid XL	12	X	7	3	6	5	8	0	8	7
Besiege	24	X	7	9	9	9	8	0	8	7
Blackhawk	4		0	9	6	8	0	0	5?	0
Declare	24	X	7	3	6	5	8	0	8	7
Diamond	12		0	9	4	9	0	0	4?	4
Dimethoate	48		5	5	0	5	8	3	8	5
Intrepid	4		0	5?	4	8	0	0	0	0
Lannate	48	X	5	7	7	8	7	3?	6	5
Lorsban	24	X	7	7	5	7	8	5	6	5
Mustang Max	12	X	8	3	6	5	8	0	8	7
Prevathon	4		0	9	9	9	0	0	0	0
Sevin	12		7	7	5	7	5	0	6	5
Transform	24		0	0	0	0	8?	7	0	4
Sivanto prime	4		0?	0	0	0	9	9	0	0
Warrior	24	X	7	3	6	5	8	0	8	7

Rating Scale: 0 = no control, 10 = excellent. The performance ratings in the chart are for comparison purposes only and are not necessarily a measure of percent control.

Field Corn Insecticide Performance Rating

Insecticide	Restricted Entry Interval (hours)	Restricted Use (R)	Chinch Bug	Corn Earworm, Fall Armyworm	Cutworm	European or South-western Corn Borer	Flea Beetle	Grass-hopper	Green Stink Bug	Brown Stink Bug
Ambush / Pounce	12	X	7	5	8	5		7	4	3
Asana XL	12	X	7	6	8	6		7	8	4
Baythroid XL	12	X	7	6	8	6	6	8	8	4
Besiege	24	X	7	9	8?	9	6	8	8	4
Blackhawk	4		0	7	7	5	0	1	0	0
Brigade	12	X	7	6	8	7	6	8	8	7
Cobalt Adv.	24	X	7	7	8	7	6	8	8	5
Declare	24	X	7	6	8	6	6	8	8	4
Hero	12	X	7	6	8	7	6	8	8	7
Intrepid	4		0	3,7	7	8		0	0	0
Lannate	48	X	3	7	5	1		4	5	5
Lorsban	24	X	7	4	7	5		6	4	4
Malathion	12		1	2	0	1		5	7	7
Mustang Max	12	X	7	6	8	6	6	8	8	4
Prevathon	4		0	9	8?	9		6?	0	0
Sevin	12	X	3	4	5	2	8	5	4	4
Warrior	24	X	7	6	8	6	6	8	8	4

Rating Scale: 0 = no control, 10 = excellent. The performance ratings in the chart are for comparison purposes only and are not necessarily a measure of percent control.

Cotton Insecticide Performance Ratings

Insecticide	Restricted Entry Interval (hours)	Restricted Use (R)	Fall Armyworm	Beet Armyworm	Aphid**	Thrips	Western Flower Thrips	Cutworm	Grasshopper	Bollworm	Tobacco Budworm	Cabbage Looper	Soybean Looper	Saltmarsh Caterpillar	Plant Bug	Spider Mite**	Green Stink Bug	Brown Stink Bug	Whitefly
Admire Pro (imidacloprid)	12		0	0	4	3	1	0	2	0	0	0	0	0	5	0	2	2	3
Agri-Mek (abamectin)	12	X	0	0	0	0	0	0	0	0	0	0	0	0	3	7	0	0	0
Asana XL	12	X	5	2	0	4	3	8	6	7	2	8	2	5	2	0	8	4	2
Bacillus thuringiensis	4		1	1	0	0	0	0	0	4	5	6	6	2	0	0	0	0	0
Baythroid XL	12	X	5	2	0	4	2	8	7	7	2	8	2	5	3	0	8	4	4
Belay	12		0	0	5	3		2	2	0	0	0	0	0	7	0	7	6	5?
Besiege	24	X	9	9?	0	4	2	8?	7?	9	9	9	9	9?	3	0	8	4	2
Bidrin	144	X	0	0	6	8	5	0	7	0	0	0	0	1	7	0	9	9	3
Bidrin XP II	144	X	5	2	6	8	5	8	7	7	2	8	2	5	8	5	9	9	3
Blackhawk	4		7	9	0	1	1	7	2	7	8	9	9	3	0	0	0	0	0
Brigade	12	X	5	2	0	4	2	6	8	7	2	8	2	5	4	5	8	7	4
Brigadier	12	X	5	2	4	5	5	8	7	7	2	8	2	5	6	5	8	7	6
Carbine	12		0	0	8	5	1	0	2	0	0	0	0	0	5	0	2	2	0
Centric	12		0	0	5	3	4	0	2	0	0	0	0	0	7	0	6	4	7
Comite	168		0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0
Confirm	4		8	8	0	0	0	2	0	4	4	7	7	8	0	0	0	0	0
Cypermethrin	12	X	5	1	0	4	3	8	6	7	1	6	1	5	2	0	8	4	1
Declare	24	X	5	2	0	4	2	8	7	7	2	8	2	5	2	0	8	4	2
Denim	12		8	9	0	1	1	7	2	7	7	9	9	3	2	5	0	0	0
Diamond	12		8	5?	0	1	1	1		4	4	6	6		7*	0	4*	4*	4*
Dimethoate	48		0	0	5	7	2	0	6	0	0	0	0	1	6	3	6	4	3
Endigo	24	X	5	2	5	6	4	8	7	7	2	8	2	5	7	0	8	7	8
Intrepid	4		8	9	0	0	0	5	0	5	6	9	9	9	0	0	0	0	0
Intrepid Edge	4		9	9	0	0	0	8	0	7	8	9	8	9	0	0	0	0	0
Intruder, Strafer	12		0	0	8	6	0	0	0	0	0	0	0	0	3	0	1	1	6
Lannate	72	X	7	4	5	1	0	5	6	4	4	7	7	4	3	0	5	3	0
Leverage 360	12	X	5	2	5	6	2	8	7	7	2	8	2	5	6	0	8	6	5
Lorsban	24	X	5	2	4?	4?		7	7	6	4	4	2		4	2	6	5	
Mustang Max	12	X	5	3	0	6	3	8	7	7	2	8	2	5	3	0	8	7	2
Oberon	12		0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	8?
Orthene (acephate)	24		5	3	3	8	5	6	8	5	5	7	4	3	9	0	6	9	7
Portal	12		0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	7?
Prevathon	4		9	9?	0	0	0	8?	7?	9	9	9	8	9?	2	0	0	0	0
Radiant	4		7	9	0	8	7	7?	2	7	8	9?	8?	9	0	0	0	0	0
Steward	12		8	9	0	0	0	5	0	7	8	9	9	5	3	0	3	3	0?
Transform	24		0	0	9			0	0	0	0	0	0	0	9	0	5	3?	7?
Vydate C-LV	48	X	0	0	0	4	1	0	6	0	0	0	0	0	6	0	8	7	0
Warrior	24	X	5	2	0	4	2	8	7	7	2	8	2	5	3	0	8	4	2
Zeal	12		0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0

Rating Scale: 0 = no control, 10 = excellent. The performance ratings in the chart are for comparison purposes only and are not necessarily a measure of percent control.

*Effective on nymphs only.

**Cotton aphids and spider mite populations can be flared by use of broad spectrum insecticides such as pyrethroids or OPs.

Soybean Insecticide Performance Ratings

Insecticide	Restricted Entry Interval (hours)	Restricted Use (R)	Stem Feeders			Defoliators								Defoliators and Pod Feeders				Pod Feeders	
			Cutworm	Kudzu Bug	Threecornered Alfalfa Hopper	Blister Beetle	Garden Webworm	Grasshopper	Green Cloverworm	Saltmarsh Caterpillar	Cabbage Looper	Soybean Looper	Spider Mite	Bean Leaf Beetle	Beet Armyworm	Yellowstriped and Fall Armyworm	Corn Earworm	Green Stink Bug	Brown Stink Bug
Agri-Mek SC	12	X	0	0	0	0		0		0	0		8	0			0	0	0
Ambush / Pounce	12	X		5	7	6	7	6	8	6	6	2	0	6	3	7	5	5	3
Asana XL	12	X	8	6	8	7	8	7	9	6	7	3	0	4	3	7	6	7	5
Bacillus thuringiensis	4		0	0	0	0	5	0	8	3	6	6	0	0	2	0	2	0	0
Baythroid XL	12	X	8	5	8	7	8	7	9	6	7	3	0	4	3	7	6	8	5
Belay	12		0	5	7?			3?		0	0	0	0	7?	0	0	0	7	7
Besiege	24	X	8?	8?	8	7	9?	7	9	9	9	8	0	7	9?	9?	9	8	5
Blackhawk	4		7	5	0	0	8	2	9	9	9	8	0	3	8	7	7	0	0
Brigade	12	X	9	9	9	7	7	7	9	6	7	3	6	7	0	8	6	9	8
Declare	24	X	8	8	8	7	8	7	9	5	7	3	0	6	3	7	6	7	5
Dimethoate	48		0	8	6	5	5	7	3	1	2	2	4	6	2	4	2	8	6
Endigo	24	X	8	9	8	7	8	7	9	6	7	3	0	8	3	7	6	8	7
Hero	12	X	9	9	9	7	7	7	9	6	7	3	6	7	0	8	6	9	8
Intrepid	4		7?		0	0	8	0	8	8	9	8	0	0	8	8	4	0	0
Intrepid Edge	4		8	0	0	0	8	0	9	9	9	9	0	0	9	9	8	0	0
Lannate 2.4 LV	48	X	2	4	5	5	8	6	9	5	7	7	0	4	7	7	7	7	5
Leverage 360	12	X	8	5	8	7	8	7	9	6	7	3	0	7	3	7	6	8	6
Lorsban	24	X	7	7	5		5?	7	8	2?	4	2	4	5?	2	3?	6	6	5
Mustang Max	12	X	8	8	8	7	8	7	9	5	7	3	0	7	3	7	6	8	5
Orthene (acephate)	24		4?	8	8			8	8	2?	7	6	0	6	0	2?	6	8	9
Prevathon	4		8?		0	0?	9?	7?	9	9	9	8	0	4?	9?	9?	9	0	0
Sevin	12		5	8	3	8	3	7	8	5	1	1	0	8	3	6	6	5	4
Steward	12		9	2	0	0	8	0	9	6	9	8	0	7	8	8	8	3	2
Warrior	24	X	8	8	8	7	8	7	9	6	7	3	0	7	3	7	6	8	5
Zeal SC	12		0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0

Rating Scale: 0 = no control, 10 = excellent. The performance ratings in the chart are for comparison purposes only and are not necessarily a measure of percent control.

Small Grains Insecticide Performance Ratings (Wheat, Barley, Oats, Rye)

Insecticide	Restricted Entry Interval (hours)	Restricted use (R)	Armyworm	Greenbug (Aphids)	Grasshopper	Cereal Leaf Beetle
Baythroid XL	12	X	8	8	7	7
Besiege	24	X	9	8	8	7?
Blackhawk	4		8	0	2	7?
Declare	24	X	8	8	7	7
Dimethoate	48		0	7	6	4?
Lannate	48	X	7	7	3	8
Malathion	12		3	6	6	8
Mustang Max	12	X	8	8	7	7
Prevathon	4		9	0	7?	0?
Sevin	12		6	0	4	7
Warrior	24	X	8	8	7	7

Rating Scale: 0 = no control, 10 = excellent. The performance ratings in the chart are for comparison purposes only and are not necessarily a measure of percent control.

Insecticide Safety Considerations

Communication and safety are important considerations to avoid accidental insecticide poisoning. Scouts should be familiar with commonly used insecticides. Talk frequently with growers, co-workers and employers. Know when and what insecticide applications have been made to a field. Someone should know your approximate whereabouts and schedule in case of accident or emergency. Cellphones or two-way radios are suggested as a means of emergency communication.

Know Your Insecticides

Insecticides vary widely in their toxicity to people. Never enter a field immediately after an insecticide application. This is especially dangerous for highly toxic insecticides. Insecticide labels provide information on minimum restricted entry intervals following an insecticide application, treatment information in the case of poisoning, and other information. The table below provides a relative index of acute toxicity for some common insecticides. This is primarily for dermal (skin) exposure. Many relatively safe insecticides can be very dangerous if ingested because even insecticides with low toxicity are often mixed with chemicals that are dangerous if ingested. Always seek immediate medical attention if any insecticide is swallowed.

Relative Insecticide Toxicity of Some Representative Insecticides

Insecticide (common name)	**Risk level***	**Insecticide (common name)**	**Risk level***
Admire Pro or Gaucho (imidacloprid)	L	Intrepid (methoxyfenozide)	L
Asana XL (esfenvalerate)	L-M	Intruder, Strafer (acetamiprid)	L
Bacillus thuringiensis (Bt)	L	Lannate (methomyl)	**H**
Baythroid XL (β-cyfluthrin)	L-M	Lorsban (chlorpyrifos)	M
Bidrin (dicrotophos)	H	Malathion	L
Blackhawk (spinosad)	L	Methyl parathion	**H**
Brigade (bifenthrin)	L-M	Mustang Max (Z-cypermethrin)	L-M
Centric or Cruiser (thiamethoxam)	L	Orthene (acephate)	L-M
Comite (propargite)	M	Prevathon (chlorantraniliprole)	L
Counter (terbufos)	H	Sevin (carbaryl)	L
Cypermethrin	L-M	Sivanto Prime (flupyradifurone)	L
Delta Gold (deltamethrin)	L-M	Steward (indoxacarb)	L
Denim (emamectin benzoate)	L-M	Transform (sulfoxaflor)	L
Diamond (novaluron)	L	Vydate C-LV (oxamyl)	**H**
Dimethoate	M-**H**	Warrior (λ-cyhalothrin)	L-M

* L = Low, M = Moderate, H = High

Insecticide Poisoning

Symptoms may include eye tearing, blurred vision, salivation, unusual sweating, coughing, vomiting, and frequent bowel movements and urination. Breathing may become difficult, and muscles may twitch and become weak. It is rare, but death can occur. Symptoms last hours to days after exposure to carbamate insecticides but can last for weeks after exposure to organophosphate insecticides. Pyrethroid insecticides can cause sneezing, eye tearing, coughing, and occasional difficulty breathing. Serious symptoms rarely develop.

Treatment for suspected insecticide poisoning should be immediate. Insecticide labels contain treatment instructions for physicians. Remove clothing and wash any skin which was exposed to insecticide.

Other Safety Considerations

Besides the risk of pesticide poisonings, and more common, scouts may suffer heat stroke. Symptoms of heat stroke include weakness, dizziness, rapid pulse, reddish tinge to skin, nausea and/or vomiting, unconsciousness, and high body temperature.

Safety Tips:

- Always follow label instructions concerning re-entry intervals and protective clothing requirements following an insecticide application.
- To avoid heat stroke, drink plenty of water, wear a wide-brimmed hat, and take breaks in the shade.
- Pants, rather than shorts are recommended to reduce wear and tear on your legs. They also keep your skin from contacting any insecticide residue on plants.
- Bring a change of clothes, particularly later in the year when early morning dew will soak your clothing. Not only will you be more comfortable, dry clothes are a better barrier to any insecticide residue that may be present on plants.
- Wash your hands before eating or drinking.
- If possible, schedule your hardest work during cooler times of the day.
- You are more likely to get in an automobile or four-wheeler accident than to be poisoned by pesticides, so drive carefully!

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Precautionary Statement

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

Disclaimer

This publication contains pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. The label always takes precedence over the recommendations found in this publication.

Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others that may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product. The author(s), the University of Tennessee Institute of Agriculture and University of Tennessee Extension assume no liability resulting from the use of these recommendations.

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Diagnosis and Management of Foliar Diseases of Cotton in the United States

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Ascochyta Blight (West Weather Blight)

Caused by: *Ascochyta gossypii* (*Phoma exigua*)

Foliar Symptoms: Ascochyta Blight forms lesions on cotyledons, leaves, stems and bolls. Lesions on the cotyledons and leaves approach 2 mm (<0.1 in) in diameter, are white to light brown and circular in shape. Elongated cankers on the stem are reddish-purple to black or ash gray in color. Small, black fruiting structures are likely to be embedded in symptomatic tissue.

Left: *Symptoms of Asochyta Blight on cotton leaf. Note dark border and also small, embedded fruiting structures in the spots.*
Right: *Early-season symptoms of Ascochyta Blight on cotyledons of cotton. (Photo credit: S.M. Brown)*

Management: Use fungicide-treated seed, avoid planting in cool, wet weather, and incorporate cotton residue to encourage decomposition, which helps in fields with a history of Ascochyta Blight.

Diagnostic Note: Margins of necrotic regions on leaves and cotyledons will have dark borders. Spots may have a target-like appearance. However, Ascochyta Blight typically occurs early in the season and small, black fruiting structures are observed in the lesions.

Range and Yield Loss: Ascochyta Blight has been reported in most major cotton-producing regions. Yield loss is rarely reported, but is possible under conditions such as prolonged cloudy weather with cooler temperatures and rainfall.

Bacterial Blight (Angular Leaf Spot, Black Arm)

Caused by: *Xanthomonas citri* pv *malvacearum*

Foliar Symptoms: Symptoms of Bacterial Blight start as tiny water-soaked spots and progress into characteristically angular shapes due to leaf veins limiting bacterial movement. Lesions appear on the upper side of the leaf, turn black as they expand, and defoliation may occur. Systemic infections follow the main veins as black streaks; symptoms on the bolls are characteristically sunken, water-soaked lesions.

Sunken lesions resulting from Bacterial Blight.

Note angular shape and dark brown color of lesions and petiole damage of Bacterial Blight.

Management: Resistant cultivars are the most economical option to minimize yield loss. Incorporation of infected residue into the soil will help with decomposition of infected debris and reduce inoculum in the soil.

Diagnostic Note: Lesions are typically dark brown (darker than many other pathogens) and can be "shot-hole" in appearance when necrotic tissue falls away. Observe the underside of the leaf for water-soaking around the lesions.

Close-up of lesions of Angular Leaf Spot. (Photo credit: Tom Allen)

Range and Yield Loss: Bacterial Blight is a major disease of cotton. Since acid delinting of cottonseed in the U.S., Bacterial Blight has been rare, except in OK and TX; however, there is a recent resurgence in additional states. Yield loss can be severe, up to 20 percent, depending on variety and pathogen race.

Target Spot

Caused by: *Corynespora cassiicola*

Foliar Symptoms: Characteristic symptoms of Target Spot include brown lesions, sometimes approaching 2 cm (~1 inch) in diameter, exhibiting a series of concentric rings. Unlike Stemphylium and Alternaria Leaf Spot, the spots are typically not bordered by a dark band. Leaf spots and premature defoliation are generally confined to the interior canopy (unlike that found in Stemphylium and Alternaria diseases.)

Interior defoliation commonly observed with Target Spot.

Typical symptomatic lesion of Target Spot.

Management: Management of Target Spot with fungicides is made difficult by the dense canopy which obstructs placement of fungicides in the interior of the canopy. Greatest success in managing Target Spot has been achieved by applying fungicides during the first and third weeks of bloom.

Typical spores of Corynespora cassiicola, *causal agent of Target Spot.*

Diagnostic Note: Target Spot can be quickly differentiated from Stemphylium Leaf Spot by its location in the canopy. Also, defoliation from Target Spot typically begins at the bottom of the plant and progresses upwards. Lesions may occur in the upper canopy, but defoliation of the upper 20 percent has not been observed.

Range and Yield Loss: Target Spot has become progressively more widespread in the Southeast and Mid-South regions of the Cotton Belt, but is most severe in Florida, Alabama and Georgia. In severe cases, yield losses exceeding 200 lbs lint/A have been documented.

Cercospora Leaf Spot

Caused by: *Cercospora gossypina, Mycosphaerella gossypina*

Foliar Symptoms: Reddish lesions will occur during the early stages. As the disease progresses, the lesions enlarge and turn white to light brown in the center. The lesions are circular and vary in size. Concentric zones are often present with a red color at the margins.

Management: Maintaining plant vigor by having proper fertility and preventing drought stress through irrigation helps delay primary infections and reduce the severity of disease outbreaks.

Diagnostic Note: In the field it is often difficult to differentiate Cercospora Leaf Spot from other foliar diseases. The spots appear concentric, like those of Target Spot, and the general distribution of spots on the plant may be the same as Stemphylium and Alternaria Leaf Spot. Correct diagnosis often requires viewing the long, thin whiplike, septate spores. Caution should be taken as *C. cassiicola* spores can appear similar to Target Spot, but typically are broader and may have a basal scar.

Foliar symptoms of Cercospora Leaf Spot. (Photo credit: J. Brock)

Tapered cylindrical spores of Cercospora gossypina.

Cercospora lesions on cotton leaf.

Range and Yield Loss: Cercospora Leaf Spot occurs in all cotton producing areas within the U.S. When Cercospora Leaf Spot occurs while plants are under stress, or in a disease complex with Alternaria or Stemphylim Leaf Spot, premature defoliation, reduced yield and lower fiber quality have been documented.

Alternaria Leaf Spot

Cotton field in Texas severely affected by Alternaria Leaf Spot. (Photo credit: J.E. Woodward)

Caused by: *A. macrospora, A. alternata*

Foliar Symptoms: Alternaria Leaf Spot forms lesions on senescing leaves that are brown with purple margins. As lesions expand they typically exhibit concentric zonation, and the necrotic tissue will overlap with other lesions. As the disease progresses, the lesions will become gray and dry with some of the necrotic tissue falling out, giving it a "shot-hole" appearance.

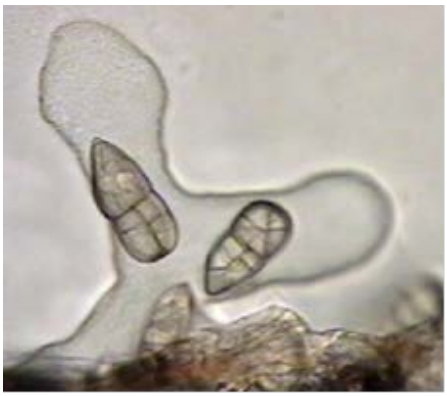
Foliar symptoms of Alternaria leaf spot. (Photo credit: J.E. Woodward)

Management: Reducing plant stress and insuring proper soil fertility, especially with potassium, can reduce disease severity.

Diagnostic Note: Symptoms of Alternaria and Stemphylium Leaf Spot are similar; however, Alternaria Leaf Spot is more commonly observed in Texas and the Mid-South and Stemphylium Leaf Spot in the Southeast. Lesions with concentric rings may appear similar to Target Spot; however, spots from Alernaria Leaf Spot will occur throughout the canopy and are also associated with reddening and yellowing leaves.

Range and Yield Loss: Alternaria is one of the most common cotton diseases and is associated with late-season cotton development. (Note: Alternaria and Stemphylium Leaf Spot are similar in that both are most severe when cotton plants have insufficient potassium, either from inadequate fertilization or during periods of drought.) Yield loss is not considered a problem with Alternaria Leaf Spot if symptoms and defoliation occur late in the season.

Stemphylium Leaf Spot



Spores of Stemphylium solani*, causal agent of Stemphylium leaf spot. (Photo credit: Rome Ethredge)*

Caused by: *Stemphylium solani*

Foliar Symptoms: Stemphylium Leaf Spot lesions are 2 cm in diameter (~1 inch), circular in shape, and brown in color with concentric zones. As lesions mature they will develop a whitish center that may crack and fall out, producing a "shot-hole" appearance. The lesions normally form on the upper leaves in the canopy and start at the leaf margin and move inward. Fields where Stemphylium Leaf Spot is severe also typically demonstrate symptoms of nutrient deficiency.

General defoliation associated with Stemphylium Leaf Spot.

Management: Managing vigorous crop growth by irrigating to avoid drought stress, proper fertilization, and reducing pest pressure will help reduce the incidence of disease outbreaks. Fungicides are available, but are not normally economical for the control of Stempyhlium Leaf Spot.

Diagnostic Note: Stemphylium Leaf Spot can be differentiated from Target Spot by position on the plant (Stemphylium typically is found at the top of the plant first; Target Spot is within the canopy). Also, leaves affected by Stemphylium Leaf Spot often show nutrient deficiencies (yellow and red), whereas leaves affected by Target Spot often appear green, unless approaching senescence.

Range and Yield Loss: Stemphylium Leaf Spot has been found in all the cotton producing areas of the U.S. Since this disease is normally associated with other plant stress factors (drought, nutrient deficiencies, nematode and insect pressure), yield loss can be severe from the stress complex.

Foliar symptoms of Stemphylium Leaf Spot. Note the "ashy" centers of the spots and the reddening of the leaf associated with stress on the plant.

Areolate Mildew

Caused by: *Ramularia gossypii*

Foliar Symptoms: Small lesions appear on leaves in the lower canopy late in the growing season. The lesions, 3-4 mm (~0.15 in) wide and restricted by a major leaf vein, are slightly chlorotic on the upper leaf surface with a white mildew growth on the lower surface. Lesions may become necrotic and resemble bacterial blight. In severe cases, premature defoliation will occur.

Symptoms of Areolate Mildew. Note brown necrotic lesions and powdery white sporulation on underside of leaf. (Appling County, GA)

Management: Use of resistant varieties is the best control strategy for Areolate Mildew. Incorporating crop residue and crop rotation will help reduce inoculum for next season. Fungicides (e.g., azoxystrobin and pyraclostrobin) were effective in managing this disease in Georgia.

Premature defoliation from Areolate Mildew in Appling County, GA. Plant on left was not treated. Plant on right was treated twice with a strobilurin funaicide.

Diagnostic Note: No other cotton disease commonly observed will have the white, powdery growth on the underside of the leaf.

Range and Yield Loss: Areolate Mildew is observed in most countries where cotton is produced, but not commonly observed in the U.S. In Georgia, the disease is typically restricted to the extreme southeastern counties. This disease normally appears late in the season and usually causes little yield loss.

Key to Differentiating Spots in the Cotton Fields

1A. Borders of spots often defined by leaf veins, creating angular or geometric appearance: **Go to 2**

1B. Border of spots not defined by leaf veins and approximately circular in shape: **Go to 3**

2A. Typically observed late in season; often a white sporulation is found on the underside of spots: Areolate Mildew.

2B. Spots dark in color, may appear early in the season and often have a "water-soaked" appearance: Bacterial Blight/Angular Leaf Spot.

3A. Spots affect foliage throughout the plant, especially on upper leaves. Spots typically associated with plants affected by nutrient deficiencies or stress: Stemphylium, Alternaria or Cercospora Leaf Spots. Submit to disease diagnostic clinic for further diagnosis.

3B. Spots often with concentric rings and not associated with symptoms of nutrient deficiencies or stress: **Go to 4**

4A. Spots found typically on young plants and with dark, pepper grainlike sunken structures: Ascochyta Leaf Spot or possibly herbicide injury.

4B. Spots with concentric rings on older plants: **Go to 5**

5A. Spots with concentric rings, typically found on leaves within the canopy of foliage: Target Spot.

5B. Spots with concentric rings possibly surrounded by a yellow halo: Identification requires additional diagnosis and a sample should be submitted to a plant disease diagnostic lab for confirmation.

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Management of Soybean Diseases
Foliar Fungicide Efficacy for Control of Foliar Soybean Diseases — July 2018

Heather M. Kelly
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Department of Entomology and Plant Pathology

The North Central Regional Committee on Soybean Diseases (NCERA-137) has developed the following information on foliar fungicide efficacy for control of major foliar soybean diseases in the United States. Efficacy ratings for each fungicide listed in the table were determined by field testing the materials over multiple years and locations by the members of the committee. Efficacy ratings are based upon level of disease control achieved by product and are not necessarily reflective of yield increases obtained from product application. Efficacy depends upon proper application timing, rate and application method to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. **Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table, unless otherwise noted. Table includes systemic fungicides available that have been tested over multiple years and locations. The table is not intended to be a list of all labeled products[1].** *Efficacy categories: NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent; NL = Not Labeled for use against this disease; U = Unknown efficacy or insufficient data to rank product efficacy.*

Fungicide(s)											
Class	Active ingredient (%)	Product/Trade name	Rate/A (fl oz)	Anthracnose	Brown spot	Cercospora leaf blight[2]	Frogeye leaf spot[3]	Soybean rust	*Phomopsis/Diaporthe (Pod and stem light)*	Target Spot	Harvest restriction[4]
Qol Strobilurins Group 11	Azoxystrobin 22.9%	Quadris 2.08 SC Multiple Generics[5]	6.0 - 15.5	VG	G	P	P	G-VG	U	P-F	14 days
	Fluoxastrobin 40.3%	Aftershock 480 SC Evito 480 SC	2.0 - 5.7	G	G	P	P	U	U	U	R5 (beginning seed) 30 days
	Picoxystrobin 22.5%	Aproach 2.08 SC	6.0 - 12.0	G	G	P	P	G	U	U	14 days
	Pyraclostrobin 23.6%	Headline 2.09 EC/SC	6.0 - 12.0	VG	G	P	P	VG	U	P-F	21 days
DMI Triazoles Group 3	Cyproconazole 8.9%	Alto 100 SL	2.75 - 5.5	U	VG	F	F	VG	U	U	30 days
	Flutriafol 11.8%	Topguard 1.04 SC	7.0 - 14.0	VG	VG	P-G	VG	VG-E	U	P	21 days
	Propiconazole 41.8%	Tilt 3.6 EC Multiple Generics[5]	2.0 - 4.0	VG	G	NL	F	VG	NL	U	R5 (beginning seed)
	Prothioconazole 41.0%	Proline 480 SC	5.0 - 5.7	NL	U	NL	G-VG	VG	NL	U	21 days
	Tetraconazole 20.5%	Domark 230 ME	4.0 - 5.0	VG	VG	P-G	G-VG	VG-E	U	P	R5 (beginning seed)
MBC Thiophanates Group 1	Thiophanate-methyl 45.0%	Topsin-M Multiple Generics[5]	10.0 - 20.0	U	U	F	VG	G	U	U	21 days
SDHI Carboximides Group 7	Boscalid 70%	Endura 0.7 DF	3.5 - 11.0	NL	VG	U	P	NL	NL	U	21 days

Fungicide(s)				Anthracnose	Brown spot	Cercospora leaf blight	Frogeye leaf spot	Soybean rust	*Phomopsis/Diaporthe (Pod and stem light)*	Target Spot	Harvest restriction
Class	**Active ingredient (%)**	**Product/Trade name**	**Rate/A (fl oz)**								
Mixed mode of action	**Azoxystrobin 25.3% Flutriafol 18.63%**	**Topguard EQ 4.29 SC**	**5.0 – 7.0**	U	U	U	F-G	U	U	P	21 days
	Azoxystrobin 18.2% Difenoconazole 11.4%	**Quadris Top 2.72 SC**	**8.0 - 14.0**	U	G-VG	P-G	VG	VG	U	P	14 days
	Azoxystrobin 19.8% Difenoconazole 19.8%	**Quadris Top SBX 3.76 SC**	**7.0-7.5**	U	U	U	G-VG	U	F-G	F-G	14 days
	Azoxystrobin 7.0% Propiconazole 11.7%	**Quilt 1.66 SC Multiple Generics[5]**	**14.0 - 20.5**	U	G	F	F	VG	U	U	21 days
	Azoxystrobin 13.5% Propiconazole 11.7%	**Quilt Xcel 2.2 SE**	**10.5 - 21.0**	VG	G	F	F	VG	U	P	R6
	Bensovindiflupyr 10.27% Azoxystrobin 13.5% Propiconazole 11.7%	**Trivapro**	**13.7-20.7**	U	VG	U	VG	U	G	U	14 days R6
	Tetraconazole 7.48% Azoxystrobin 9.35%	**Affiance 1.5 SC**	**10.0-14.0**	VG	VG	F	G	U	U	U	R5 14 days
	Cyproconazole 7.17% Picoxystrobin 17.94%	**Aproach Prima 2.34 SC**	**5.0 - 6.8**	U	VG	P-G	G	U	U	F-G	14 days
	Fluoxastrobin 18.0% Tebuconazole 25.0%	**Evito T 3.99 F**	**4.0 - 6.0**	F	VG	P-F	F	U	U	U	30 days
	Flutriafol 19.3% Fluoxastrobin 14.84%	**Fortix SC Preemptor SC**	**4.0 - 6.0**	U	G	U	G	U	U	P	R5 (beginning seed)
	Pyraclostrobin 28.58% Fluxapyroxad 14.33%	**Priaxor 4.17 SC**	**4.0 - 8.0**	VG	E	P-G	P-F	VG	U	F-G	21 days
	Pyraclostrobin 28.58% Fluxapyroxad 14.33% Tetraconazole 20.50%	**Priaxor D 4.17 SC 1.9 SC**	**4.0 (each component)**	U	VG	U	G-VG	U	G	U	21 days R5 (beginning seed)
	Trifloxystrobin 32.3% Prothioconazole 10.8%	**Stratego YLD 4.18 SC**	**4.0 - 4.65**	VG	VG	F	F-VG	VG	U	P	21 days
	Tebuconazole 7.5% Thiophanate-methyl 37.5%	**Topsin XRT Multiple Generics[5]**	**20**	U	U	U	G-VG	U	**U**	**F-G**	21 days
	Tetraconazole 4.2% Thiophanate-methyl 21.3%	**Acropolis**	**20.0-23.0**	U	U	U	VG-E	VG-E	U	U	R5 14 days

[1]Multiple fungicides are labeled for soybean rust only, powdery mildew, and Alternaria leaf spot, including tebuconazole (multiple products) and Laredo (myclobutanil). Contact fungicides such as chlorothalonil may also be labeled for use.

[2] Cercospora leaf blight efficacy relies on accurate application timing, and standard R3 application timings may not provide adequate disease control. Fungicide efficacy may improve with earlier or later applications; however, efficacy has been inconsistent with some products. Fungicides with a solo or mixed QoI or MBC mode of action may not be effective in areas where QoI or MBC resistance has been detected in the fungal population that causes Cercospora leaf blight.

[3] In areas where QoI-fungicide resistant isolates of the frogeye leaf spot pathogen are ***not*** present*, QoI fungicides may be more effective than indicated in this table.*

[4]Harvest restrictions are listed for soybean harvested for grain. Restrictions may vary for other types of soybean (edamame, etc.) and soybean for other uses such as forage or fodder.

[5]Multiple generic products containing this mode of action may also be labeled in some states.

Many products have specific use restrictions about the amount of active ingredient that can be applied within a period of time or the amount of sequential applications that can occur. Please read and follow all specific use restrictions prior to fungicide use. This information is provided only as a guide. It is the responsibility of the pesticide applicator by law to read and follow all current label directions. Reference to products in this publication is not intended to be an endorsement to the exclusion of others that may be similar. Persons using such products assume responsibility for their use in accordance with current directions of the manufacturer. Members or participants in the NCERA-212 or NCERA- 208 group assume no liability resulting from the use of these products.

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Management of Soybean Seedling Diseases
Fungicide Efficacy for Control of Soybean Seedling Diseases — July 2018

Heather M. Kelly, Associate Professor and Extension Specialist
Department of Entomology and Plant Pathology

The members of the Identification and Biology of Seedling Pathogens of Soybean project funded by the North Central Soybean Research Program and plant pathologists across the United States have developed the following ratings for how well soybean fungicide seed treatments control seedling diseases. Efficacy ratings for each fungicide active ingredient were determined by field testing the materials over multiple years and locations by the members of this group and include ratings summarized from national fungicide trials published in Plant Disease Management Reports (formerly Fungicide and Nematicide Tests) by the American Phytopathological Society at apsnet.org. Each rating is based on the fungicide's level of disease control and does not necessarily reflect efficacy of fungicide active ingredient combinations and/or yield increases obtained from applying the active ingredient. The list includes many of the most widely marketed products available, but is not intended to be a list of all labeled active ingredients and products. Additional active ingredients may be available, but may not have been evaluated in a manner allowing a rating. Some products may contain additional active ingredients for insect and nematode control; however, only active ingredients for pathogen control are listed and rated.

Many active ingredients and their products have specific use restrictions. Read and follow all use restrictions before applying any fungicide to seed or before handling any fungicide-treated seed. This information is provided only as a guide. It is the applicator's and user's legal responsibility to read and follow all current label directions. Reference in this publication to any specific commercial product, process or service, or the use of any trade, firm or corporation name is for general informational purposes only and does not constitute an endorsement, recommendation or certification of any kind by members of the group or by the North Central Soybean Research Program. Individuals using such products assume responsibility for their use in accordance with current directions of the manufacturer. Efficacy categories: E = Excellent; VG = Very Good; G = Good; F = Fair; P = Poor; NR = Not Recommended; NS = Not Specified on product label; U = Unknown efficacy or insufficient data to rank product. Please note: Efficacy ratings may be dependent on the rate of the fungicide product on seed. Contact your local Extension plant pathologist for recommended fungicide product rate information for your area.

Fungicide active ingredient	FRAC Code	*Pythium* sp.[1.]	Phytophthora root rot	*Rhizoctonia* sp.	*Fusarium* sp.[1,3]	Sudden death syndrome (SDS) (*Fusarium virguliforme*)	*Phomopsis* sp.
Azoxystrobin	11	P-G	NS	VG	F-G	NR	P
Carboxin	7	U	U	G	U	NR	U
Chloroneb	14	U	P	E	P	NR	P
Ethaboxam	22	E	E	U	U	U	U
Fludioxonil	12	NR	NR	G	F-VG	NR	G
Fluopyram	7	NR	NR	NR	NR	VG	NR
Fluxapyroxad	7	U	U	E	G	NR	G
Ipconazole	3	P	NR	F-G	F-E	NR	G
Mefenoxam	4	E[2]	E	NR	NR	NR	NR
Metalaxyl	4	E[2]	E	NR	NR	NR	NR
Oxathiapiprolin	49	P-G	E	NR	NR	NR	NR
PCNB	14	NR	NR	G	U	NR	G
Penflufen	7	NR	NR	G	G	NR	G
Prothioconazole	3	NR	NR	G	G	NR	G
Pyraclostrobin	11	P-G	NR	F	F	NR	G
Sedaxane	7	NS	NS	E	NS	NR	G
Thiabendazole	1	NS	NS	NS	NS	P	U
Trifloxystrobin	11	P	P	F-E	F-G	NR	P-F

[1.] Products may vary in efficacy against different *Fusarium* and *Pythium* species.
[2.] Areas with mefenoxam or metalaxyl insensitive populations may see less efficacy with these products.
[3.] Listed seed treatments do not have efficacy against Fusarium virguliforme, causal agent of sudden death syndrome.

Fungicide(s)

Product/Trade name	Company[1]	Active ingredient
Acceleron	Monsanto Company	Fluxapyroxad (DX-612) Metalaxyl (DX-309) Pyraclostrobin (DX-109)
Allegiance FL	Bayer CropScience	Metalaxyl
Allegiance LS	Bayer CropScience	Metalaxyl
Apron XL LS	Syngenta Crop Protection	Mefenoxam
ApronMaxx RFC	Syngenta Crop Protection	Fludioxonil Mefenoxam
ApronMaxx RTA	Syngenta Crop Protection	Fludioxonil Mefenoxam
Catapult XL	Agriliance	Chloroneb Mefenoxam
CruiserMaxx	Syngenta Crop Protection	Fludioxonil Mefenoxam
CruiserMaxx Advanced or Cruiser Maxx Plus	Syngenta Crop Protection	Fludioxonil Mefenoxam
CruiserMaxx Advanced Vibrance	Syngenta Crop Protection	Fludioxonil Mefenoxam Sedaxane
Dynasty	Syngenta Crop Protection	Azoxystrobin
EverGol Energy SB	Bayer CropScience	Metalaxyl Penflufen Prothioconazole
ILeVO	Bayer CropScience	Fluopyram
Inovate Pro	Valent U.S.A. Corporation	Ipconazole Metalaxyl
Intego	Valent U.S.A. Corporation	Ethaboxam
Lumisena	DuPont Crop Protection	Oxathiopiprolin Metalaxyl
Maxim 4FS	Syngenta Crop Protection	Fludioxonil
Mertect 340 F	Syngenta Crop Protection	Thiabendazole
Prevail	Chemtura Corporation	Carboxin Metalaxyl PCNB
Trilex 2000	Bayer CropScience	Metalaxyl Trifloxystrobin
Vibrance	Syngenta Crop Protection	Sedaxane
Warden CX	Winfield Solutions	Fludioxonil Mefenoxam Sedaxane
Warden RTA	Winfield Solutions	Fludioxonil Mefenoxam

[1.] Other companies may offer same or similar products/options. This is not an endorsement for any company or product

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Management of Small Grain Diseases
Fungicide Efficacy for Control of Wheat Diseases 2018

Heather M. Kelly, *Associate Professor and Extension Specialist*
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The North Central Regional Committee on Management of Small Grain Diseases (NCERA-184) has developed the following information on fungicide efficacy for control of certain foliar diseases of wheat for use by the grain production industry in the U.S. Efficacy ratings for each fungicide listed in the table were determined by field testing the materials over multiple years and locations by the members of the committee. Efficacy is based on proper application timing to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table. Table includes most widely marketed products, and is not intended to be a list of all labeled products. ***See next page for table footnotes.***

Efficacy of fungicides for wheat disease control based on appropriate application timing.

Fungicide(s)				Powdery mildew	Stagonospora leaf/glume blotch	Septoria leaf blotch	Tan spot	Stripe rust	Leaf rust	Stem rust	Head scab	Harvest Restriction
Class	Active ingredient	Product	Rate/A (fl. oz)									
Strobilurin	Picoxystrobin 22.5%	Aproach SC	6.0 - 12	G[1]	VG	VG[2]	VG	E[3]	VG	VG	NL	Feekes 10.5
	Fluoxastrobin 40.3%	Evito 480 SC	2.0 - 4.0	G	--	--	VG	--	VG	--	NL	Feekes 10.5 and 40 days
	Pyraclostrobin 23.6%	Headline SC	6.0 - 9.0	G	VG[2]	VG[2]	E	E[3]	E	G	NL	Feekes 10.5
Triazole	Metconazole 8.6%	Caramba 0.75 SL	10.0 - 17.0	VG	VG	--	VG	E	E	E	G	30 days
	Tebuconazole 38.7%	Folicur 3.6 F[5]	4.0	NL	NL	NL	NL	E	E	E	F	30 days
	Prothioconazole 41%	Proline 480 SC	5.0 - 5.7	--	VG	VG	VG	VG	VG	VG	G	30 days
	Prothioconazole19% Tebuconazole 19%	Prosaro 421 SC	6.5 - 8.2	G	VG	VG	VG	E	E	E	G	30 days
	Propiconazole 41.8%	Tilt 3.6 EC[4,5]	4.0	VG	VG	VG	VG	VG	VG	VG	P	Feekes 10.5
Mixed modes of action[6]	Tebuconazole 22.6% Trifloxystrobin 22.6%	Absolute Maxx SC	5.0	G	VG	VG	VG	VG	E	VG	NL	35 days
	Cyproconazole 7.17% Picoxystrobin 17.94%	Aproach Prima SC	3.4 - 6.8	VG	VG	VG	VG	E	VG	--	NR	45 days
	Prothioconazole 16.0% Trifloxystrobin 13.7%	Delaro 325 SC	8.0	G	VG	VG	VG	VG	VG	VG	NL	Feekes 10.5 35 days
	Fluoxastrobin 14.8% Flutriafol 19.3%	Fortix Preemptor SC	4.0 - 6.0	--	--	VG	VG	E	VG	--	NL	Feekes 10.5 and 40 days
	Fluapyroxad 2.8% Pyraclostrobin 18.7% Propiconazole 11.7%	Nexicor EC	7.0 - 13.0	G	VG	VG	E	E	E	VG	NL	Feekes 10.5
	Fluxapyroxad 14.3% Pyraclostrobin 28.6%	Priaxor	4.0 - 8.0	G	VG	VG	E	VG	VG	G	NL	Feekes 10.5
	Propiconazole 11.7% Azoxystrobin 13.5%	Quilt Xcel 2.2 SE[5]	10.5 - 14.0	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5
	Prothioconazole 10.8% Trifloxystrobin 32.3%	Stratego YLD	4.0	G	VG	VG	VG	VG	VG	VG	NL	Feekes 10.5 35 days
	Benzovindiflupyr 10.3% Propiconazole 11.7% Azoxystrobin 13.5%	Trivapro SE	9.4 – 13.7	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5.4
	Metconazole 7.4% Pyraclostrobin 12%	TwinLine 1.75 EC	7.0 – 9.0	G	VG	VG	E	E	E	VG	NL	Feekes 10.5

Footnotes

[1]Efficacy categories: NL = Not Labeled; NR = Not Recommended; P = Poor; F = Fair; G = Good; VG = Very Good; E = Excellent; -- = Insufficient data to make statement about efficacy of this product.

[2] Product efficacy may be reduced in areas with fungal populations that are resistant to strobilurin fungicides.

[3]Efficacy may be significantly reduced if solo strobilurin products are applied after stripe rust infection has occurred.

[4]Application of products containing strobilurin active ingredients may result in elevated levels of the mycotoxin Deoxynivalenol (DON) in grain damaged by head scab.

[5]Multiple generic products containing the same active ingredients also may be labeled in some states.

[6]Products with mixed modes of action generally combine triazole and strobilurin active ingredients. Nexicor, Priaxor and the Trivapro include carboxamide active ingredients.

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Management of Corn Diseases: Fungicide Efficacy for Control of Corn Diseases — July 2018

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The Corn Disease Working Group (CDWG) has developed the following information on fungicide efficacy for control of major corn diseases in the United States. Efficacy ratings for each fungicide listed in the table were determined by field testing the materials over multiple years and locations by the members of the committee. Efficacy ratings are based upon level of disease control achieved by product, and are not necessarily reflective of yield increases obtained from product application. Efficacy depends upon proper application timing, rate, and application method to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. **Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a *single application* of the labeled rate as listed in the table. Table includes systemic fungicides available that have been tested over multiple years and locations. The table is not intended to be a list of all labeled products**[1]. *Efficacy categories: NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent; NL = Not Labeled for use against this disease; U = Unknown efficacy or insufficient data to rank product. Table footnotes on second page.*

Fungicide(s)				Anthracnose leaf blight	Common rust	Eyespot	Gray leaf spot	Northern leaf blight	Southern rust	Harvest Restriction[2]
Class	Active ingredient (%)	Product/Trade name	Rate/A (fl oz)							
QoI Strobilurins Group 11	Azoxystrobin 22.9%	Quadris 2.08 SC Multiple Generics	6.0 - 15.5	VG	E	VG	E	G	G	7 days
	Pyraclostrobin 23.6%	Headline 2.09 EC/SC	6.0 - 12.0	VG	E	E	E	VG	VG	7 days
	Picoxystrobin 22.5%	Aproach 2.08 SC	3.0 – 12.0	VG	VG-E	VG	F-VG	VG	G	7 days
DMI Triazoles Group 3	Propiconazole 41.8%	Tilt 3.6 EC Multiple Generics	2.0 - 4.0	NL	VG	E	G	G	F-G	30 days
	Prothioconazole 41.0%	Proline 480 SC	5.7	U	VG	E	U	VG	G	14 days
	Tebuconazole 38.7%	Folicur 3.6 F Multiple Generics	4.0 - 6.0	NL	U	NL	U	VG	F-G	36 days
	Tetraconazole 20.5%	Domark 230 ME Multiple Generics	4.0 – 6.0	U	U	U	E	VG	G	R3 (milk)
Mixed models of action	Azoxystrobin 13.5% Propiconazole 11.7%	Quilt Xcel 2.2 SE Multiple Generics	10.5 - 14.0	VG	VG-E	VG-E	E	VG	VG	30 days
	Bensovindiflupyr 10.27% Azoxystrobin 13.5% Propiconazole 11.7%	Trivapro	13.7	U	U	U	E	VG	E	30 days
	Cyproconazole 7.17% Picoxystrobin 17.94%	Aproach Prima 2.34 SC	3.4 – 6.8	U	U	U	E	VG	G-VG	30 days
	Flutriafol 19.3% Fluoxastrobin 14.84%	Fortix 3.22 SC Preemptor 3.22 SC	4.0 -6.0	U	U	U	E	VG-E	VG	R4 (dough)

Table Continued

Fungicide(s)				Anthracnose leaf blight	Common rust	Eyespot	Gray leaf spot	Northern leaf blight	Southern rust	Harvest Restriction[2]
Class	Active ingredient (%)	Product/Trade name	Rate/ A (fl							
Mixed models of action	Pyraclostrobin 13.6% Metconazole 5.1%	Headline AMP 1.68 SC	10.0 - 14.4	U	E	E	E	VG	G-VG	20 days
	Pyraclostrobin 28.58% Fluxapyroxad 14.33%	Priaxor 4.17 SC	4.0 – 8.0	U	VG	U	VG	VG-E	G	21 days
	Trifloxystrobin 32.3% Prothioconazole 10.8%	Stratego YLD 4.18 SC	4.0 - 5.0	VG	E	VG	E	VG	G-VG	14 days
	Tetraconazole 7.48% Azoxystrobin 9.35%	Affiance 1.5 SC	10.0-14.0	U	U	U	F-VG	U	G	7 days

Footnotes:

[1]*Additional fungicides are labeled for disease on corn, including contact fungicides such as chlorothalonil. Certain fungicides may be available for diseases not listed in the table, including Gibberella and Fusarium ear rot. Applications of Proline 480 SC for use on ear rots requires a FIFRA Section 2(ee) and is only approved for use in Illinois, Indiana, Iowa, Louisiana, Maryland, Michigan, Mississippi, North Dakota, Ohio, Pennsylvania and Virginia.*

[2]*Harvest restrictions are listed for field corn harvested for grain. Restrictions may vary for other types of corn (sweet, seed or popcorn, etc.), and corn for other uses such as forage or fodder.*

Many products have specific use restrictions about the amount of active ingredient that can be applied within a period of time or the amount of sequential applications that can occur. Please read and follow all specific use restrictions prior to fungicide use. This information is provided only as a guide. It is the responsibility of the pesticide applicator by law to read and follow all current label directions. Reference to products in this publication is not intended to be an endorsement to the exclusion of others that may be similar. Persons using such products assume responsibility for their use in accordance with current directions of the manufacturer. Members or participants in the CDWG assume no liability resulting from the use of these products.

Disclaimer

This publication contains pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. The label always takes precedence over the recommendations found in this publication.

Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others that may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product. The author(s), the University of Tennessee Institute of Agriculture and University of Tennessee Extension assume no liability resulting from the use of these recommendations.

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Fungal Wheat Disease Identification

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Leaf Blotch (*Septoria tritici*)

- **Conditions for disease development** include temperatures between 59 to 77 F and periods of rainy or humid weather that last for more than one day. Disease outbreaks occur more commonly on lower leaves in the early spring after **cool, wet conditions**. The pathogen will start to decline as temperatures increase.

- **Symptoms** usually develop on winter wheat in early spring on the **lowest overwintered leaves** and will develop on higher leaves if cool, wet conditions persist. Lesions have tan to brown centers surrounded by yellow areas that are laterally restricted. Lesions may have small, black specks (pycnidia) in the necrotic areas of lesions. Lesions can be scattered over the leaf blade and may coalesce to cover large portions of the leaf blade.

- **Management** options include reducing risk of infection by growing wheat at 2-year intervals, implementing wide row spacing, planting resistant varieties, and making timely fungicide treatments (see UT Extension publication W 341 Wheat Fungicide Table).

Leaf blotch on wheat leaves and enlarged lesion with black pycnidia in the center of lesion.

Glume Blotch (*Stagonospora nodorum*)

- **Conditions for disease development** are more prevalent **in dense foliage** and **areas of heavy fertilization.** Risks of disease are higher in reduced-tillage fields or short-rotation wheat production. Disease outbreaks are promoted by **wet, warm** weather. Optimal temperature for symptom development is between 68 and 80 F.

- **Symptoms** are often first noted in the spring on the **lowest overwintered leaves** and will develop on higher leaves if warm, wet conditions persist. Foliar lesions begin as yellow flecks, becoming brown or grayish brown, elongated, and often lens- shaped. Stem infections are also common, especially at nodes. Glume infections result in purple brown or grayish brown streaks and blotches starting at the glume tips.

- **Management** options include reducing risk of infection by growing wheat at 2-year intervals, maintaining balanced fertilizer rates, implementing wide row spacing, planting resistant varieties, and making timely fungicide treatments (see UT Extension publication W 341 Wheat Fungicide Table).

Leaf blotch and glume blotch may occur in different combinations within a field and on individual plants.

Glume blotch on a wheat leaf and head *(APS Compendium of Wheat Diseases and Pests, courtesy R. L. Bowden)*

Stripe Rust/Yellow Rust (*Puccinia striiformis*)

- **Conditions for disease development** are optimal during **50 to 64 F with intermittent rain or dew**. High levels of disease can occur in years with cool and wet springs, cool summers, and mild winters, which allow spores to survive from season to season. Stripe rust can overwinter on leaf tissue, volunteer wheat and other grass hosts at temperatures as low as 23 F. The spores rapidly decline at temperatures above 59 F.

- **Symptoms** first appear as yellow, chlorotic patches on leaves. **Tiny, yellow to orange raised pustules** develop in these areas with thousands of yellow orange spores. **Distinct stripes** of pustules develop on upper leaves after stem elongation but not on seedling leaves. Depending on temperature and the resistance of the cultivar, yellow to tan spots or stripes of various sizes can develop with or without spores.

- **Management** options include growing resistant cultivars, destroying volunteer wheat, avoiding excessive water and fertilizer, and making timely fungicide applications (see UT Extension publication W 341 Wheat Fungicide Table). Resistant cultivar usually contain adult plant resistance, meaning the resistance occurs at later growth stages such as jointing/elongation or flag leaf emergence.

Stripe rust on wheat. Stripe pattern of raised pustules on leaves.

Leaf Rust (*Puccinia triticina*)

- **Conditions for disease development** include temperatures between **64 and 77 F with high humidity or moisture**. After spores land on leaves, infection is completed in 6 to 8 hours and disease symptoms can develop within 7 days.

- **Symptoms** include **small, round or oblong, raised pustules that are orange red** in color. Leaf rust pustules are more scattered and larger in size compared to stripe rust.

- **Management** options include growing resistant cultivars, destruction of volunteer wheat, avoiding excessive water and fertilizer, and making timely fungicide applications (see UT Extension publication W 341 Wheat Fungicide Table).

Leaf rust infected wheat leaves (*from ars.usda.gov*).

Powdery Mildew (*Blumeria graminis* syn. *Erysiphe graminis*)

- **Conditions for disease development** are optimal between **59 and 72 F with high humidity** and are more prevalent in dense foliage and **areas of heavy fertilization.** The pathogen can survive on volunteer wheat, and powdery mildew symptoms typically appear in the spring when wheat growth resumes.

- **Symptoms** will usually appear in the lower canopy on older leaves and are more prevalent on the upper surfaces of the leaf. Stems also can become infected and show the same symptoms as leaves. Symptoms include **patches of white, cottony growth** (colonies) on the surface of the plant that can turn a dull gray brown. As wheat and the powdery mildew mature, distinct brown black dots (the sexual fruiting structures, or cleistothecia) within aging colonies may be seen. Symptoms can occur at any time after seedlings emerge.

- **Management** options include growing resistant varieties, destruction of volunteer wheat, balanced fertilization rates, wide row spacing, and making timely fungicide applications (see UT Extension publication W 341 Wheat Fungicide Table).

Powdery mildew on lower leaves and stems and enlarged patches of white, cottony colonies on wheat.

Fusarium Head Blight/Scab (*Fusarium* species)

- **Conditions for disease development** are more prevalent in wheat planted behind corn and when warm, wet conditions occur during flowering. Although wheat can become infected from head emergence until harvest, infections initiated at and soon after flowering have the greatest destructive potential.

- **Symptoms** include bleaching of spikelets or entire heads of wheat. Superficial, often pink or orange masses of spores may be seen on and especially at the base of diseased spikelets. Small, dark (blue-black) fruiting structures will often be seen some time after the initial infection. Seed formed from infected heads is often shriveled or discolored. The fungus also may produce mycotoxins in the wheat. The most frequently associated mycotoxin is deoxynivalenol (vomitoxin, also referred to as DON), which can cause grain to be rejected if too much is present.

- **Management** options include crop rotation with at least a 1-year break from a host crop (corn, wheat, barley and other cereals), plowing to bury crop residues, using a less susceptible variety (research is ongoing to develop a commercial variety with improved resistance), and timely fungicide applications (see UT Extension publication W 341 Wheat Fungicide Table and Fusarium Head Blight Prediction Center at www.wheatscab.psu.edu).

Bleached spikelets infected with fusarium.
Feekes 10.5.1, mid bloom is the best time for fungicide application for scab.

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Wheat Disease Management

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For a disease to develop, have significant effect on yield, and become a significant **PEST**, four major factors must align:

- Pathogen presence — Influenced by field history.
- Environment — The right conditions for disease to develop.
- Susceptible host — A variety that is susceptible to disease.
- Time — Regarding the growth stage of the plant and when the disease develops.

Wheat diseases that occur in Tennessee include glume (stagonospora) blotch, septoria (Leaf) blotch, leaf rust, stripe rust, powdery mildew and fusarium head blight (scab). Short descriptions of fungal wheat diseases which include conditions for disease development, symptoms and specific management options can be found along with images at UTCrops.com (Fungal Wheat Disease Identification).

Disease Scouting and Important Growth Stages

The last leaf (flag leaf) to emerge from the whorl is very significant because it makes up approximately 75 percent of the effective leaf area that contributes to grain fill. Hence, the amount of disease on the flag leaf correlates to yield loss and timing a ***fungicide application to protect the flag leaf can be critical***. Leaves in the lower canopy of wheat contribute little to yield, and thus, disease on lower canopy leaves has very little impact on yield. Therefore, ***disease scouting is very important from the time just before the flag leaf emergence until the end of flowering.***

To determine if the flag leaf has emerged, split the stem above the highest node. The flag leaf is confirmed if no additional leaves and the head are found inside. If the fungicide application is made too early, the flag leaf will not be protected, and if too late, disease may develop to the point that a fungicide application would not prevent yield loss.

Another potentially critical time for fungicide application is during early to mid-bloom (Feekes 10.5.1 - 10.5.2) to protect wheat from fusarium head blight/ head scab. Head scab can be more severe in wheat planted behind corn that has received large applications of N fertilizers. Rain events and warm temperatures during flowering are necessary for head scab to occur, and while Tennessee doesn't regularly experience substantial scab infestations, the risk varies from year to year. A disease risk forecasting tool is available at www.wheatscab.psu.edu.

Growth Stage	Disease Management Considerations
Feekes 1 - Feekes 8 Emergence through jointing and stem elongation	Scout for disease but fungicide applications are usually unnecessary.
Feekes 9 - Feekes 10.5 Flag leaf through head emergence	Apply fungicides to protect flag leaf from foliar diseases as needed.
Feekes 10.5.1 - Feekes 10.5.2 Early to mid-flowering	Check risk for fusarium head blight (scab) at www.wheatscab.psu.edu. Apply fungicides if warm and wet weather are expected.

To Spray or Not to Spray

The decision to apply a fungicide to wheat should be based upon multiple factors including: 1) disease presence or risk, 2) fertility and yield potential, 3) weather conditions, and 4) cropping history. For example, a fungicide application would be warranted if:

- Disease is present or moderate to high risk is predicted.
- Nitrogen (N) has been applied and the wheat has good yield potential.
- Weather conditions favor disease development (dependent on the disease, but most are favored by wet, humid conditions).
- Wheat has been planted in the field in the past 2 years or behind corn.

A detailed foliar fungicide point system can be found at UTCrops.com (Wheat Foliar Fungicide Point System) that can be used as a guide to determine the need for a fungicide application.

Fungicide Selection

There are multiple fungicides labeled for wheat and for the control of different diseases. The North Central Regional Committee on Management of Small Grain Diseases (NCERA-184) has developed information on fungicide efficacy for control of certain wheat diseases. This information can be found at UTCrops.com and in UT Extension publication W 341 Wheat Fungicide Table. Application coverage is also important and applications should be made in at least 5 gallons of water per acre by airplane or 15 gallons of water per acre by ground application.

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WHEAT FOLIAR FUNGICIDE POINT SYSTEM

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This point system should be used only as a guide to determine the need for application of fungicides. It does not guarantee an economical return. If a "zero" is indicated in category I or III, then the field ***should not*** be sprayed.

			Points
I.	**Yield Potential** (immediately prior to application)		
	1. 40 Bu/A or above	= 150	
	2. 30-39 Bu/A	= 50	
	3. Below 30 Bu/A	= 0	I._____
II.	**Cropping History**		
	1. Wheat in field last year	= 100	
	2. Wheat in field two years ago	= 50	
	3. First time in wheat three years or longer	= 25	II._____
III.	**Fertility** (fertilizer Nitrogen [N] applied)		
	1. Applied 90-120 lb N/ac	= 100	
	2. Applied only 60-90 lb N/ac	= 50	
	3. Applied no N	= 0	III._____
IV.	**Seeding rate** (assuming 80% plus germination)		
	1. Planted 2 or more bu/ac	= 75	
	2. Planted 1.5-2.0 bu/ac	= 50	
	3. Planted less than 1.5 bu/ac	= 25	IV._____
V.	**Disease**		
	1. Severe (disease apparent on flag leaf)	= 100	
	2. Moderate (bottom & middle leaves diseased)	= 75	
	3. Light (disease found on lower leaves)	= 50	
	4. No foliar disease present	= 25	V._____
VI.	**Seasonal rainfall** prior to first application		
	1. Above normal	= 100	
	2. Normal	= 75	
	3. Below normal	= 25	VI._____
VII.	**Traditional Disease Pressure**		
	1. Heavy	= 125	
	2. Moderate	= 75	
	3. Light	= 25	VII._____

Total Points _____

After inspection of each field, producers should total the number of points to determine the probability of a yield increase.

Total Field Points	**Chances of Yield Increase**
750-1000	Excellent
500-749	Fair
Below 500	Poor

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W 648

2018 Fire Ant Management in Pastures and Rangeland

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Imported fire ants have been present in the United States for 100 years. The black imported fire ant, *Solenopsis richteri*, was accidentally introduced into Mobile, AL, around 1918, and the red imported fire ant, *Solenopsis invicta*, followed a few decades later. A viable hybrid of these two species was first identified in 1985. Imported fire ants (IFA) did not become established in Tennessee until 1987. They spread from their original introduction point through mating flights and unintentional human assistance. Today, IFA infest about 367 million acres in 14 mostly southern states, Puerto Rico, and 66 counties in Tennessee (Figure 1). Fire ants present a stinging hazard, and complying with the federal IFA quarantine affects the movement of nursery plants, hay, straw, earth-moving equipment and other items which may harbor IFA.

Tennessee areas under the IFA quarantine have expanded during the last three decades and in 2017 covered more than 17.8 million acres or slightly more than 67% of Tennessee's land area. About 4.7 million Tennesseans, or 70% of the state's population, live in infested counties and are affected by these pests. The hybrid has extended its range westward into traditionally black IFA-infested areas and now dominates in East and Middle Tennessee with the black most common in the west (Figure 2). We expect the hybrid, which is more cold tolerant than the red or black species, to eventually dominate the Tennessee IFA distribution. Although the red IFA is found throughout the southeastern U.S., it is rare in Tennessee. The largest red IFA population is found in an isolated pocket in Williamson/Davidson County.

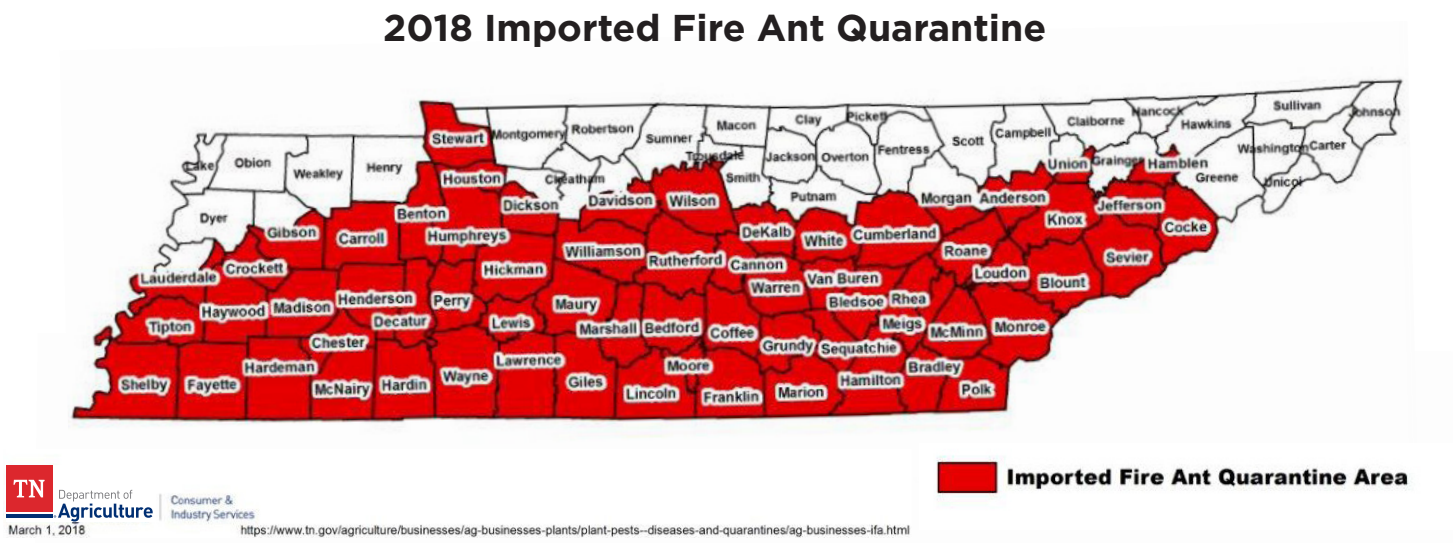

Figure 1. The Tennessee areas quarantined for imported fire ants in 2018 are indicated in red. A list of quarantined areas by county can be found at fireants.utk.edu/resources/updates.html.

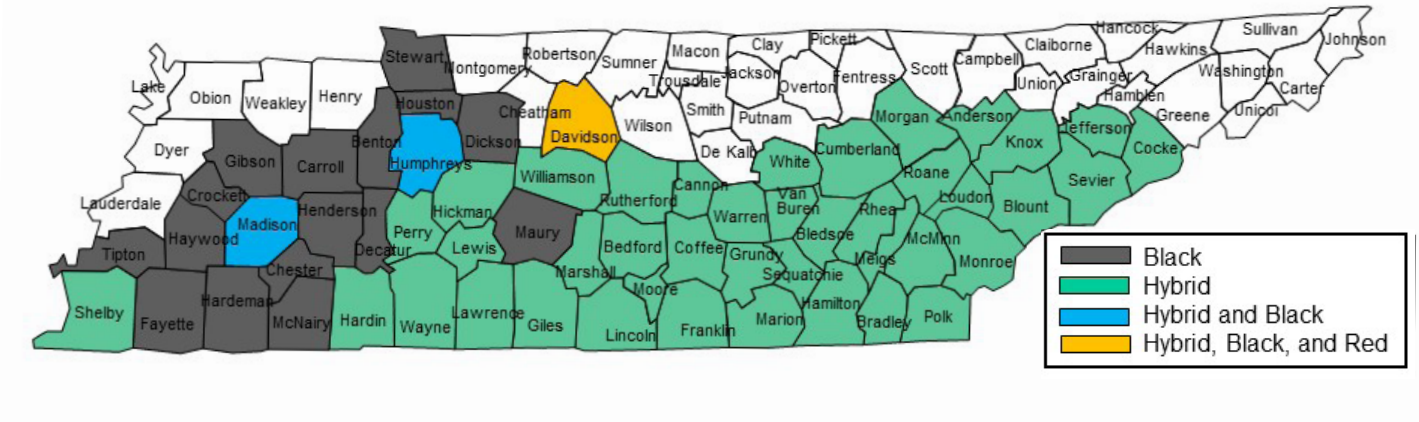

Figure 2. The predominant fire ants in each Tennessee county as determined by a Tennessee State University survey.

Imported fire ants are predators and scavengers and feed on a wide variety of foods. Their mounds are a familiar sight in southern Tennessee pastures and roadsides. The impact of IFA in pastures is hard to document because they affect different areas of the livestock operation. They injure both cattle and humans, and they also damage hay cutting and baling equipment, electrical equipment and livestock feed. Insecticide-based management strategies have been quite effective for home lawns, golf courses and other public areas. Managing IFA in livestock pastures, however, is more difficult because of the extensive land area involved, the high cost of insecticides, livestock safety concerns and potential contamination of food animal products.

A Texas survey indicated that it may be economically feasible to treat calving pastures and hayfields, but it may not be feasible to treat all pastures and rangeland. Worksheets to determine losses due to IFA can be found on the UT website "Imported Fire Ants in Tennessee" at *fireants.utk.edu/management/agricuture.html* or at the eXtension website *http://articles.extension.org/pages/9755/management-of-imported-fire-ants-inlivestock-production-systems*. As an example, losses due to livestock injury or death in Texas pastures averaged 7 cents per acre. The cost of treatment averaged $10 to $20 per acre. However, IFA are a distinct nuisance to humans, and their mounds cause equipment damage and lost work time due to that damage. Therefore, the decision to treat or not treat for IFA mounds will probably be based more on human factors than on actual injury to livestock.

Fire ant colonies are initiated by individual winged queens, which after mating, dig chambers and begin to lay eggs. Flights of winged queens occur throughout the year, but are most common in late spring/early summer. As the colony develops, the typical IFA mound usually appears. Single-queen IFA colonies are territorial and tend to discourage new colonizers. Therefore, the single-queen IFA mounds usually stabilize at a density around 80 - 100 mounds per acre and are typically found 10 to 20 feet apart. Unfortunately, there is a reproductive form of IFA that is not as territorial. This form has many queens per colony, and mound densities can reach up to 800 per acre. These multi-queen colonies have been detected throughout the fire ant range in Tennessee, but are still less common than single-queen colonies likely due to their slow rate of spread.

Hay Shipments. In Tennessee, shipments of hay outside the quarantine must be inspected, determined to be free of IFA and accompanied by a permit prior to movement. Hay must have been stored off the ground to be shipped. If hay was stacked, as long as it was not the bottom tier of hay, it would be considered as stacked off the ground. Contact your Tennessee Department of Agriculture Plant Certification Inspector for regulations pertaining to the IFA quarantine. Regardless of whether or not the hay is accompanied by a permit, hay imported from IFA-infested areas into uninfested areas should be inspected prior to acceptance into the uninfested area. TDA personnel will help with this inspection. Hay being moved from quarantined areas without proper permits should not be purchased. See "Questions and Answers: Moving Baled Hay From Areas Under Quarantine for Imported Fire Ant" located at *https://www.aphis.usda.gov/aphis/newsroom/factsheets/baled-hay* for more information on importing hay.

Cultural Practices. Currently, both cultural and chemical management options are used for IFA control in pastures and hayfields. In hayfields, frequent mowing discourages the building of large mounds even though IFA will still be present. Disc mowers are more practical than conventional sickle-bar mowers because they are less likely to break. In pastures on heavy soils, it is a good idea to clip with a rotary mower two to three times a year to reduce the height of the IFA mounds. UT Extension recommends spreading manure throughout a pasture during the winter months to better distribute nutrients as a best management practice. Dragging pastures to spread manure prior to an extreme cold weather event could disturb fire ant mounds, allow the cold to penetrate deeper, and cause greater fire ant mortality.

Chemical Control Options. Chemical treatment for IFA is probably not economical in most pasture situations. It may be prudent to treat pastures in which heavy calving activity will occur between March and September when IFA are most active. It may also be prudent to treat hayfields and areas around equipment sheds. As previously mentioned, most IFA are territorial, and defensive actions tend to limit the number of mounds per acre. When insecticides eliminate existing colonies at a site, future populations of IFA may actually increase for a short period because there are no established colonies to discourage re-colonization.. Therefore, chemical treatment for IFA has to be a continuous process. Treatments control what is already there, but cannot prevent reinfestation by incoming flights of queens.

Currently, the most economical treatment for pastures is to broadcast an insecticide-laced bait that will be picked up by the foraging ants and carried back to each colony. Broadcast applications of baits are better than individual mound treatments for pastures because the visible mounds are only the tip of the iceberg. There are other colonies that have not yet built mounds. Mound treatments may be useful follow ups a few weeks after bait has been applied. See the UT or eXtension IFA website for more information on bait applications.

When a bait is broadcast, it will be picked up and carried back to all of the colonies, no matter how large or how small they are. The baits are carefully designed to be slow-acting so that they will be spread by the foraging ants to their nestmates before the foraging ants die. Because of this, death may take several days to two weeks. Baits must be attractive so that the ants will pick them up. They must be placed where the foraging ants will find them and recognize them as food.

Because baits must be carried back to the nest, they must be applied when ants are actually foraging. Winter applications will not be effective. Morning or late afternoon treatments (70 to 90 F) are best because of high foraging activity in warm weather. Few ants forage during the heat of the day. When in doubt whether fire ants are actively foraging, place a few pieces of hot dogs or greasy chips in the planned application area. If after 30 minutes the test food is covered in fire ants, you know fire ants are actively foraging and your bait application should be successful. Baits should be applied when the foliage is dry. Rain immediately following application will reduce efficacy. Unfortunately, there is often a conflict between late afternoon applications to dry foliage and frequent late afternoon thundershowers. In such weather, it is best to wait until after the shower is over and the foliage has begun to dry. Do not apply baits immediately before or after cutting or mowing because mound disturbance can result in a temporary reduction in fire ant foraging. Baits are most effective when applied between May and September. Individual mound treatments may be useful after baits have been applied. However, it is important to wait a few days after applying bait before treating the mound so that the active ingredient in the bait will be distributed through the colony to the queen.

There are two kinds of IFA baits used in pastures: those containing a metabolic inhibitor, such as AmdroPro, and those containing an insect growth regulator, such as Esteem or Extinguish. Metabolic inhibitor baits act within two to four weeks, but the effect wears off fairly quickly (four to eight months) depending on re-invasion pressure. Insect growth regulator baits take longer to work (four to eight weeks), but tend to give longer lasting control (eight to 12 months). Trials in Texas showed that mixing 0.75 pound of a metabolic inhibitor bait with 0.75 pound of an insect growth regulator bait worked faster than an insect growth regulator alone. It also lasted longer than a metabolic inhibitor alone. Extinguish Plus bait contains both a metabolic inhibitor and an insect growth regulator.

Before applying bait or insecticide products to a pasture or rangeland, ensure these sites are listed on the pesticide label. Many home-use products labeled for lawns are not labeled for pasture. The table below lists products registered for IFA management in Tennessee's pastures and rangeland along with rates and other remarks. Always read the pesticide label before application, since sites and other use requirements may change. It is the user's responsibility by law to follow all the proper pesticide label directions and requirements.

Insect	Material	Rate/Acre	Precautions & Remarks
Imported Fire Ants See "Fire Ants in Tennessee" website at fireants.utk.edu or the eXtension website at extension.org/fire_ants for a more thorough discussion of IFA management in pastures.	Amdro Pro Fire Ant Bait (hydramethylnon)	Broadcast 1 to 1½ lbs.	Broadcast bait uniformly. Treat when ants are foraging and when rain is not forecast for 24 hours. Or treat the mound by applying 2 to 5 level tablespoons per mound, distributing material 3 to 4 feet around the mound. Do not exceed 8 lbs per acre per year. Do not apply more than 4 times per year at 9- day intervals. Do not cut or bale hay from rangeland or pasture until 7 days after the treatment. Cutting restrictions do not apply if only companion animals that are not to be used for food or feed are supported by this area. 12 hour REI cdms.net/LDat/ld3GJ013.pdf
	Extinguish Professional Fire Ant Bait (methoprene)	Broadcast 1 to 1½ lbs.	Extinguish is labeled for use in all forages. Apply as a broadcast treatment when ants are foraging and when rain is not forecast for 24 hours. Or apply as a mound treatment by sprinkling 3 to 5 tablespoons around each mound, distributing material 4 feet around the mound. Extinguish is an insect growth regulator. It may take several months to see noticeable results. No withdrawal or grazing restrictions are necessary on treated areas. 4 hour REI zoecon.com/-/media/files/zoecon-na/us/product%20labels/specimen/extinguish%20professional%20fire%20ant%20bait%20specimen%20label.pdf
	Esteem Ant Bait (pyriproxyfen)	Broadcast 1½ to 2 lbs.	Apply uniformly when ants are looking for food. Avoid application if rain is expected within 4 to 6 hours. Or apply as a mound treatment by sprinkling 2 to 4 level tablespoons around the mound. Noticeable results may take 4 to 8 weeks. There are no preharvest intervals or grazing restrictions for this product. 12 hour REI . Do not plant any other crop other than those with registered pyriproxyfen uses in treated areas sooner than 30 days after the last application. Do not exceed 26.67 lbs Esteem bait (i.e., 0.134 lb pyriproxyfen) per acre per season. valent.com/agriculture/products/esteemant/label-msds.cfm
	Extinguish Plus (methoprene and hydramethylnon)	Broadcast 1½ lbs	Do not exceed 8 pounds bait per acre per year or more than 4 applications a year, with a minimum re-treatment interval of 90 days. Do not bale and cut treated pastures and rangelands for 7 days following application. These cutting and baling hay restrictions for pasture and rangeland do not apply when the treated pasture and rangeland is used solely to support COMPANION ANIMALS (e.g., horses, llamas, etc.). Companion animals grazed on treated areas cannot be used for food or feed. Extinguish® Plus may be used on uncultivated, agricultural, nonfood crop and nonagricultural land. zoecon.com/-/media/files/zoecon-na/us/product%20labels/specimen/extinguish%20plus%20fire%20ant%20control%20specimen%20label.pdf
	Hopper Blend of Extinguish Fire Ant Bait and AmdroPro	Broadcast 3/4 lb. Extinguish mixed with 3/4 lb. AmdroPro	Mix Extinguish Professional Fire Ant Bait in a 50:50 mix with a hydramethylnon ant bait. Broadcast or treat the mound by applying 3 to 5 tablespoons per mound, distributing material 4 feet around the mound. See individual bait listings above for use restrictions.

Insect	Material	Rate/Acre	Precautions & Remarks
	*Advion Fire Ant Bait (Indoxacarb)	Broadcast 1 ½ lbs	***Advion Fire Ant Bait may be applied to control imported fire ants in fenced pastures if grazed only by horses or companion animals (i.e., animals not raised for production of meat or milk).** Up to 4 applications of Advion Fire Ant Bait may be applied per year, generally at 12-16 week intervals. Broadcast or treat mound by applying 4 level tablespoons uniformly 3-4 feet around the mound. Do not disturb the mound. Do not apply to tops of mound when treating mounds individually.
	Sevin (carbaryl) Sevin XLR Plus cdms.net/ldat/ldAK3029.pdf Sevin 4F cdms.net/ldat/ldAK2009.pdf Carbaryl 4L cdms.net/ldat/ld27Q009.pdf http://www.cdms.net/ldat/ld0TS005.pdf	Drench — individual mound treatment 3/4 fl. oz. per gallon of water 3/4 fl. oz. per gallon of water 3/4 fl. oz. per gallon of water	Apply a total of 2 gallons of the diluted solution over each mound or at least 1 quart per 6 inches of mound diameter, using a bucket or watering can. Thoroughly wet mound and surrounding area, distributing material 4 feet around the mound. Do not disturb the mound prior to treatment. Pour solution from a height of about 3 feet to give sufficient force to break the mound open and flow into tunnels. For best results, apply when the temperature is between 65 and 80 F. Repeat application if mound activity resumes after 30 days. Pressurized sprays may reduce the effectiveness of the treatment by disturbing the ants and causing migration.

Modified from "Pastures and Forage Crops: Insect and Weed Control," *2016 Alabama Pest Management Handbook*, Volume 1, pages 157-58.

PRECAUTIONARY STATEMENT

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store, or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

DISCLAIMER

This publication contains pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. The label takes precedence over the recommendations found in this publication. Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others which may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product. The author(s), The University of Tennessee Institute of Agriculture, the University of Tennessee Extension and Tennessee State University assume no liability resulting from the use of these recommendations.

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2018 Fire Ant Products for Tennessee's Schools
By Formulation, Active Ingredient, Application Method and Use Site

Intended as a supplement to UT Extension publication, “PB 1788 Managing Fire Ants in and Around Schools”
extension.tennessee.edu/publications/Documents/PB1788.pdf

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Department of Entomology and Plant Pathology

One of the most efficient ways to manage fire ants on school grounds is to broadcast a fire ant bait. Treating individual mounds can be expensive and requires more time and effort to scout for all the mounds, and often the smaller mounds are overlooked. If baits are broadcasted twice a year, often other treatments are not needed. Please refer to PB 1788 for a full discussion of fire ant management around schools. In this publication you'll find a list of fire ant baits, the application methods (individual mound treatments or broadcast), and other use sites for which they are labeled. This information is also provided for granules, liquids and dusts should these be deemed necessary as suggested in PB 1788. In addition, products labeled for electrical equipment and utility housing are provided. The speed and mode of action of active ingredients in fire ant products found in the last table will help with the product selection process.

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Bait Fire Ant Products Labeled for Schools

Bait Active ingredient	Trade Name	EPA Reg #	Broadcast	Individual Mounds	Interior[1]
Abamectin	Award® II Fire Ant Bait	100-1452	X	X	
Abamectin B_1	Abathor Fire Ant Bait	83923-7	X	X	X
Abamectin B_1	Prescription Treat. Ascend Fire Ant Bait Formula 1	499-370	X	X	X
Fipronil	Maxforce FC Fire Ant Bait	432-1433	X	X	
Hydramethylnon	Amdro Pro Fire Ant Bait	241-322	X	X	
Hydramethylnon	Probait Formulation For Professionals	73342-1-2724	X	X	
Hydramethylnon + methoprene (IGR)	Extinguish Plus	2724-496	X	X	X
Indoxacarb	Advion Fire Ant Bait	100-1481	X	X	
Metaflumizone	Siesta Insecticide Fire Ant Bait	7969-232	X	X	
Methoprene (IGR)	Extinguish	2724-475	X	X	X
Pyriproxyfen (IGR)	Distance Fire Ant Bait	1021-1728-59639	X	X	
Spinosad	Ferti-lome Come and Get It	62719-329-7401	X	X	

[1] Interior treatments should be applied as crack and crevice and only when children are not present unless the label states otherwise. Apply to cracks and crevices where insects may enter the building such as around doors, windows, pipes, vents, weep holes, under siding and in wall voids.

Granular Fire Ant Products Labeled for Schools

Granular Active Ingredient	Trade Name	EPA Reg #	Broadcast	Individual Mounds	Perimeter
Bifenthrin	Bifen L/P Insecticide Granules	53883-124	X	X	X
Bifenthrin	Howard Johnsons PL Bifenthrin Granular	53883-124-32802	X	X	X
Bifenthrin	Southern Ag Lawnstar Insecticide Granules	70506-73-829	X	X	
Bifenthrin	Talstar PL	279-3168	X	X	X
Bifenthrin	Wisdom EZ or Lawn Granular	5481-521	X	X	X
Deltamethrin	DeltaGard G Insectcide Granule	432-836	X	X	
Fipronil	TopChoice Insecticide [1]	432-1217	X		
Hexa-Hydroxyl	EcoExempt G Granular Insecticide[2]		X	X	X
Zeta-cypermethrin & Bifenthrin	Talstar XTRA	279-3343	X	X	

[1] Restricted use pesticide must be applied by a certified applicator.

[2] Exempt from EPA registration according to FIFRA 25B

Liquid Fire Ant Products Labeled for Schools

Liquid Active Ingredient	Trade Name	EPA Reg #	Broadcast	Individual Mounds	Interior[1]	Perimeter
Bifenthrin	Bifen I/T	53883-118	X	X		
Bifenthrin	Masterline Bifenthrin 7.9 Termiticide/Insecticide	73748-7	X	X		
Bifenthrin	Menace 7.9% Flowable	228-451	X	X		X
Bifenthrin	Talstar P	279-3206	X	X		
Bifenthrin	Wisdom TC Flowable	5481-520	X	X		
β-Cyfluthrin	Tempo SC Ultra	432-1363		X		X
Cyfluthrin	Cy-Kick CS	499-304			X	
Deltamethrin	Suspend SC	432-763		X	X	X
Deltamethrin	Suspend Polyzone	432-1514		X		X
Dinotefuran	Alpine Pressurized Insecticide	499-531			X	X
Gamma-Cyhalothrin	Optimate CS	67760-104-53883	X	X		
Lambda-Cyhalothrin	Cyzmic CS	53883-261	X	X		
Lambda-Cyhalothrin	Demand CS	100-1066	X	X		
Lambda-Cyhalothrin	Scimitar CS	100-1078	X	X		
Permethrin	Astro Insecticide	279-3141	X	X		X
Permethrin	Martin's Permethrin SFR Termiticide/Insectide	70506-6-53883		X		
Permethrin	Permethrin CS	53883-282		X	X	X
Thiamethoxam	Optigard Flex	100-1306		X		

[1] Interior treatments should be applied as crack and crevice and only when children are not present unless the label states otherwise. Apply to cracks and crevices where insects may enter the building such as around doors, windows, pipes, vents, weep holes, under siding and in wall voids.

Dust Fire Ant Products Labeled for Schools

Dust Active Ingredient	Trade Name	EPA Reg #	Individual Mounds	Interior[1]	Perimeter
Deltamethrin	DeltaDust Insecticide	432-772	X		
Cyfluthrin	Tempo 1 % Dust Insecticde RTU	432-1373	X		
Pyrethrins, PBO, Silicon Dioxide	Bombs Away	10088-93-1553	X	X	
Pyrethrins, PBO, Silicon Dioxide	Demise Fire Ant & Insect Dehydrator	10088-93-68562	X	X	
Pyrethrins, PBO, Silicon Dioxide	WildFire Fire Ant and Insect Dehydrator	10088-93-11547	X	X	
Zeta-Cypermethrin	Cynoff Dust Insecticide	279-3259		X	X

[1] Interior treatments should be applied as crack and crevice and only when and where children are not present unless the label states otherwise. Apply to cracks and crevices where insects may enter the building such as around doors, windows, pipes, vents, weep holes, under siding and in wall voids.

Fire Ant Products Labeled for Electrical Equipment and Utility Housings

Dust Active Ingredient	Trade Name	EPA Reg #	Individual Mounds	Interior[1]	Peri-meter	Motor housings, switch boxes, junction boxes, conduits[2]	Above ground transformers, in-ground utility boxes[2]	Pad-mounted utilities[2]
Pyrethrins, PBO, Silicon Dioxide	Bombs Away	10088-93-1553	X	X		X		
Pyrethrins, PBO, Silicon Dioxide	Demise Fire Ant & Insect Dehydrator	10088-93-68562	X	X		X		
Pyrethrins, PBO, Silicon Dioxide	WildFire Fire Ant and Insect Dehydrator	10088-93-11547	X	X		X		
Cynoff Insecticide	Zeta-Cypermethrin, PBO	279-3259		X	X	X		
Bait Active Ingredient								
Abamectin B1	Abathor Fire Ant Bait	83923-7	X	X	X		X	
Abamectin B1	Prescription Treat. Ascend Fire Ant Bait Formula 1	499-370	X	X	X		X	
Granular Active Ingredient								
Bifenthrin	Bifen L/P	53883-124	X		X			X
Bifenthrin	Howard Johnson's Bifenthrin PL Granular	53883-124-32802	X		X			X
Bifenthrin	Talstar PL	279-3168	X		X			X
Bifenthrin	Wisdom EZ & Lawn Granular	5481-521	X		X			X

[1] Interior treatments should be applied as crack and crevice and only when children are not present unless the label states otherwise. Apply to cracks and crevices where insects may enter the building such as around doors, windows, pipes, vents, weep holes, under siding and in wall voids.

[2] For safety reasons, only electricians or licensed pest control operators should treat electrical equipment. Specialized products and training are necessary to treat these sites safely and effectively.

Speed and Mode of Action of Active Ingredients in Fire Ant Products

Common name of active ingredients	Signal Word[1]	Speed of control	Mode of action or how it works
(S)-methoprene	Caution	3 to 6 months bait	stops production of new fire ants (igr)
(S)-methoprene, hydramethylnon	Caution	2 to 4 weeks	mix of two types of baits (see (S)-methoprene and hydramethylnon)
abamectin B1	Caution	2 to 8 weeks bait	kills workers as well as queens
acephate	Caution	1 to 2 days	contact insecticide
beta-cyfluthrin	Caution	1 to 2 days	contact insecticide
bifenthrin	Caution	1 to 2 days	contact insecticide
carbaryl	Caution	1 to 2 days	contact insecticide
cypermethrin	Caution to Warning	1 to 2 days	contact insecticide
D-limonene	Caution	1 to 2 days	contact insecticide
deltamethrin	Caution	1 to 2 days	contact insecticide
fipronil	Caution	3 to 4 weeks	slow-acting insecticide
gamma-cyhalothrin	Caution	1 to 2 days	contact insecticide
hexa-hydroxyl (clove oil, thyme oil)[2]		1 to 2 days	contact insecticide
hydramethylnon	Caution	2 to 6 weeks	bait kills workers as well as queens
indoxacarb	Caution	3 to 7 days	bait kills workers as well as queens
lambda-cyhalothrin	Caution	1 to 2 days	contact insecticide
permethrin	Caution	1 to 2 days	contact insecticide
2 phenylethyl propionate[2]		1 to 2 days	contact insecticide
pyrethrins	Caution	1 to 2 days	contact insecticide
pyriproxyfen	Caution	2 to 6 months	stops production of new fire ants (igr)
spinosad	Caution	2 to 4 weeks	bait kills workers as well as queens
thiamethoxam	Caution	3 to 7 days	contact insecticide
thyme oil[2]		1 to 2 days	contact insecticide

[1] Signal Words describe the acute (short-term) toxicity of the formulated pesticide product and are based on the results of six acute toxicity studies. The acute oral, dermal and inhalation studies evaluate systemic toxicity by those routes of entry. The primary eye and skin irritation studies measure irritation or corrosion, while the dermal sensitization study evaluates the potential for allergic contact dermatitis. See the following link for more information: edis.ifas.ufl.edu/PI137

The Signal Word is determined by the most severe toxicity category assigned to the acute toxicity studies with some exceptions. The Signal Words and associated toxicity categories are as follows: Toxicity Category I (most toxic) = DANGER/POISON Skull and Crossbones; Toxicity Category II (moderately toxic) = WARNING; Toxicity Category III (less toxic) = CAUTION; Toxicity Category IV (least toxic) = No Signal Word required.

Modified from previous Extension publications.

[2] Exempt from EPA registration according to FIFRA 25B, no Signal Word required.

If you find a fire ant product in a Tennessee store and it is labeled for schools, but not listed here, please contact kvail@utk.edu with the product information.

Precautionary Statement

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

Disclaimer

This publication contains pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. The label always takes precedence over the recommendations found in this publication. Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others that may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product. The author(s), the University of Tennessee Institute of Agriculture and University of Tennessee Extension assume no liability resulting from the use of these recommendations.

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2018 Fire Ant Products for the General Public Sorted by Formulation, Product Name and Use Site

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Department of Entomology and Plant Pathology

This publication is intended as an update to UT Extension fire ant publications, such as "SP 419 The Two-Step Method: Managing Fire Ants Around Homes and In Neighborhoods" (extension.tennessee.edu/publications/Documents/SP419.pdf) and "PB 1739 Managing Fıre Ants in Urban Areas" (extension.tennessee.edu/publications/Documents/PB1739.pdf). While many copies of the printed version are in circulation, they may contain outdated pesticide suggestions. Thus, the following tables list current products to be used with the printed and web publications. A pesticide can only be applied to a site listed on the label. Formulations (bait, dust, granular and liquids) are provided in separate tables, and application sites for each product are indicated to help select a product for the needed site and to prevent misapplications to unlisted sites. Most products listed are for the general public with a few exceptions. The products listed under electrical equipment and utility housing are meant to be applied by professionals, and the products listed in the Quarantine tables are for nursery and sod producers in the federal quarantine expecting to ship outside the quarantine.

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Bait Name	Active Ingredient	EPA reg #	Home Lawn/ Ornamentals		Peri-meter	Rec. Areas		Right of Ways		Pasture[1]		Poultry Houses		Crop Area 2 & 3		Other Ag. Fence Rows, Ditches, Out Bldgs., etc.		Sod		Nursery Container 2 & 3		Nursery B&B[3]		Inter-ior[4]
			B	IMT	P	B	IMT	B	IMT	B	IMT	P	IN	B	IMT	B	IMT	B	IMT	B	IMT	B	IMT	IN
Abathor Fire Ant Bait	Abamectin B1	83923-7	X	X	X	X	X																	X
Advion Fire Ant Bait	Indoxacarb	100-1481	X	X		X	X	X	X	X[5]	X[5]							X	X	X	X			
Amdro Ant Block	Hydramethylnon	73342-2		X	X		X					X												
Amdro Fire Ant Bait	Hydramethylnon	73342-1	X	X		X	X					X												
Amdro Yard Treatment Bait	Hydramethylnon + (s) methoprene (IGR)	73342-6	X			X						X												
Amdro Pro Fire Ant Bait	Hydramethylnon	241-322	X	X		X	X	X	X	X	X	X						X	X	X	X	X	X	X
Award® II Fire Ant Bait	Abamectin	100-1452	X	X		X	X													X				
Clinch Ant Bait	Abamectin	100-894										X		X	X	X	X							
Distance Fire Ant Bait	Pyriproxyfen (IGR)	1021-1728-59639	X	X		X	X	X	X	X[6]	X[6]							X	X	X	X	X	X	
Ortho Fire Ant Killer Mound Bait	Indoxacarb	239-2722		X	X																			
Esteem Ant Bait	Pyriproxyfen (IGR)	59639-114								X	X			X	X	X	X							
Extinguish Plus	Methoprene (IGR) + Hydramethylnonn	2724-496	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X	X
Extinguish Professional Fire Ant Bait	Methoprene	2724-475	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Ferti-Lome Come And Get It! Fire Ant Killer	Spinosad	62719-329-7401	X	X		X	X							X										
Maxforce FC Fire Ant Bait	Fipronil	432-1433	X	X		X	X											X	X					
Prescription Treat. Advance 375 A Select Granular Ant Bait	Abamectin B1	499-370	X	X	X	X	X																	X
Prescription Treat. Ascend Fire Ant Bait Formula 1	Abamectin B1	499-370	X	X		X	X																	X
Probait Formulation For Professionals	Hydramethylnon	73342-1-2724	X	X		X	X	X	X			X												
Siesta Insecticide Fire Ant Bait	Metaflumizone	7969-232	X	X	X	X	X	X	X			X				X	X	X	X	X	X			
Southern Ag Payback Fire Ant Bait	Spinosad	62719-304-829	X	X	X																			

Key
B = Broadcast
IMT = Individual Mound Treatment
P = Perimeter
IN = Interior
(IGR) = Insect Growth Regulator

1. Check label for restrictions on applying the product in areas grazed by livestock or other domestic animals or on feeding treated sod clippings to them.
2. Check label to see which crops may be treated.
3. Check label for restrictions on harvesting after application to soil around non-bearing fruit and nut nursery stock.
4. Check label for sites where the product may be applied.
5. May be applied to pastures and rangeland if used ONLY for COMPANION ANIMALS (horses, llamas, etc.). Companion animals grazed on treated areas cannot be used for food or feed.
6. May be used on nongrazed pasture.

Dust Name	Active Ingredient	EPA reg #	Home Lawn/ Ornamentals		Peri-meter	Rec. Areas		Rights of Way		Other Ag. (Fence Rows, Field Borders, etc.)		Interior[1]	Motor housings junction boxes, switch boxes, conduits[2]
			B	IMT	P	B	IMT	B	IMT	B	IMT	IN	
Bayer Advanced Fire Ant Killer Ready-To-Use Dust	β-Cyfluthrin	72155-32		X									
Bengal Ultradust 2X Fire Ant Killer	Deltamethrin	68543-26		X									
Bombs Away	Pyrethrins, Piperonyl Butoxide, Silicon Dioxide	10088-93-1553		X								X	X
Delta Dust Insecticide	Deltamethrin	432-772		X									
Demise Fire Ant & Insect Dehydrator	Pyrethrins, Piperonyl Butoxide, Silicon Dioxide	10088-93-68562		X								X	X
Eagles-7 Fire Ant Destroyer	Deltamethrin	3487-29		X	X								
Hi-Yield Fire Ant Killer with Acephate	Acephate	70506-1-7401		X			X				X		
Hi-Yield Multi-Use Dust	Deltamethrin	7401-452		X									
Martin's Surrender Fire Ant Killer Insecticide	Acephate	53883-133		X			X		X		X		
Ortho Orthene Fire Ant Killer 1	Acephate	239-2632		X									
Tempo 1 % Dust	Cyfluthrin	432-1373		X									
Terro Ant Dust	Deltamethrin	149-12		X									
WildFire Fire Ant and Insect Dehydrator	Pyrethrins, Piperonyl Butoxide, Silicon Dioxide	10088-93-11547		X								X	X

Key

B = Broadcast

IMT = Individual Mound Treatment

P = Perimeter

IN = Interior

1. Check label for sites where the product may be applied.
2. For safety reasons, only electricians or licensed pest control operators should treat electrical equipment. Specialized products and training are necessary to treat these sites safely and effectively.

Granular Name	Active Ingredient	EPA reg #	Home Lawn/ Ornamentals		Perimeter	Rec. areas		Sod	
			B	IMT	P	B	IMT	B	IMT
Allectus G Insecticide	Imidacloprid & Bifenthrin	432-1407	X	X		X	X		
Bayer Advanced Insect Killer for Lawns Ready-To-Spread Granules	β-Cyfluthrin	72155-35		X					
Bifen L/P	Bifenthrin	53883-124	X	X	X	X	X		
Bonide Ant Killer Granules	Permethrin	4-425		X					
Bonide Eight Insect Control Flower & Vegetable Above & Below Soil Insect Granules	Bifenthrin	53883-194-4	X	X	X				
Chipco Choice Insecticide	Fipronil	432-896	X			X		X	
DeltaGard G Insecticide Granule	Deltamethrin	432-836	X	X	X	X	X		
Eco Exempt G Granular Insecticide	Hexa-Hydroxyl	N/A		X			X		
Garden Tech Sevin Lawn Insect Granules	Carbaryl	432-1212-71004		X					
Garden Tech Advanced Over'N Out! Fire Ant Killer	Zeta-cypermethrin & Bifenthrin	279-3344-71004	X	X	X				
Hi-Yield Bug Blaster II Turf Insect Control Granules	Bifenthrin	228-498-7401	X	X		X	X		
Hi-Yield Imported Fire Ant Control Granules Containing Deltamethrin	Deltamethrin	7401-454	X	X	X				
Hi-Yield Kill-a-Bug II Lawn Granules	Permethrin	7401-453		X					
Hi-Yield Turf Ranger Insect Control Granules	Deltamethrin	7401-454	X	X	X				
Howard Johnsons Bifenthrin PL Granular	Bifenthrin	53883-124-32802	X	X	X				
Howard Johnsons Permethrin 0.25 G	Permethrin	53883-39-32802		X					
Knockout Ant, Flea & Tick Killer II Granules	Bifenthrin	228-494-59144	X	X	X				
Knockout Fire Ant Killer Plus Granules II	Bifenthrin	228-494-59144	X	X	X				
Lesco Crosscheck EZ Granular Insecticide	Bifenthrin	279-3168-10404	X	X	X	X	X		
Ortho Fire Ant Killer Mound Treatment 1	Bifenthrin	239-2738		X					
Ortho Max Fire Ant Killer Broadcast Granules	Bifenthrin	239-2681	X	X					
Southern Ag Lawnstar Insecticide Granules	Bifenthrin	70506-73-829	X	X		X	X		
Southern Ag Permetrol Lawn Insecticide Granules	Permethrin	829-296		X					

Key
B = Broadcast
IMT = Individual Mound Treatment
P = Perimeter

Granular Name Continued	Active Ingredient	EPA reg #	Home Lawn/ Ornamentals		Perimeter	Rec. areas		Sod	
			B	IMT	P	B	IMT	B	IMT
Spectracide Fire Ant Shield Mound Destroyer Granules	Lambda-Cyhalothrin	9688-174-8845		X					
Spectracide Fire Ant Shield Yard Protection	Lambda--Cyhalothrin	9688-232-8845	X	X	X				
Spectracide Triazicide Insect Killer for lawns Granules	Gamma-Cyhalothrin	9688-250-8845	X	X	X				
Talstar XTRA	Zeta-cypermethrin & Bifenthrin	279-9552	X	X	X	X	X		
Talstar PL	Bifenthrin	279-3168	X	X	X	X	X		
Terro Ant Killer Plus Multi-Purpose Insect Control 2	Lambda--Cyhalothrin	53883-195-149		X	X				
TopChoice Insecticide	Fipronil	432-1217	X			X		X	
Up-Star Gold Granular Insecticide	Bifenthrin	70506-73	X	X		X	X		
Wisdom EZ & Lawn Granular	Bifenthrin	5481-521	X	X	X	X	X		

Key
B = Broadcast
IMT = Individual Mound Treatment
P = Perimeter

Liquid Name	Active Ingredient	EPA reg #	Home Lawn/ Ornamentals		Perimeter	Rec. Areas		Crop Areas[1]	Turf	Interior[2]
			B	IMT	P	B	IMT	IMT	IMT	IN
Astro	Permethrin	279-3141	X	X	X	X	X			
Bayer Advanced Carpenter Ant & Termite Killer Plus Concentrate	β-Cyfluthrin	72155-58		X						
Bayer Advanced Home Pest Control Indoor & Outdoor Insect Killer RTU	β-Cyfluthrin	72155-27		X	X					
Bifen I/T	Bifenthrin	53883-118	X	X	X	X	X			
Bull's-Eye Bioinsecticide	Spinosad	62719-314-56872		X						
Bonide Captain Jack's DeadBug Brew Concentrate	Spinosad	4-471		X						
Bonide Colorado Potato Beetle Beater Conc.	Spinosad	62719-314-4		X				X		
Cyonara Lawn & Garden Insect Control	Lambda-Cyhalothrin	53883-197		X						
Cyzmic CS	Lambda-Cyhalothrin	53883-261	X	X		X	X			
Demand CS	Lambda-Cyhalothrin	100-1066	X	X		X	X			
Entrust	Spinosad	62719-282		X			X		X	
Natural Guard by Ferti-lome Bagworm, Tent Caterpillar and Chewing Insect Control Spray	Spinosad	62719-314-7401		X						
Hi-Yield Bug Blaster Bifenthrin 2.4	Bifenthrin	228-459-7401		X						
Hi-Yield Indoor/Outdoor Broad Use Insecticide	Permethrin	7401-455		X			X			
Hi-Yield 38 Plus Turf, Termite & OrnamentaL Insect Control	Permethrin	7401-466		X						
Martin's Permethrin SFR Termiticide/Insectide	Permethrin	70506-6-53883		X						X
Masterline Bifenthrin 7.9% T/I	Bifenthrin	73748-7	X	X	X	X	X			
Mavrik Perimeter	Tau-Flauvalinate	2724-478		X	X					
Menace 7.9% Flowable	Bifenthrin	228-451	X	X	X	X	X			
Monterey Garden Insect Spray	Spinosad	62719-314-54705		X						
Optigard Flex Liquid	Thiamethoxam	100-1306		X						
Optimate CS	Gamma-Cyhalothrin	279-3612-53883	X	X	X					X
Orange Guard Fire Ant Control	D-Limonene	61887-2-AA		X	X					X

Key
B = Broadcast
IMT = Individual Mound Treatment
P = Perimeter
IN = Interior

1. Check label to see which crops may be treated.
2. Check label for sites where the product may be applied.

Liquid Name Continued	Active Ingredient	EPA reg #	Home Lawn/ Ornamentals		Perimeter	Rec. Areas		Crop Areas[1]	Turf	Interior[2]
			B	IMT	P	B	IMT	IMT	IMT	IN
Orthene TTO WSP	Acephate	5481-8971		X			X		X	
Patrol	Lambda-Cyhalothrin	100-1066		X	X		X			X
Permethrin CS	Permethrin	53883-282		X	X				X	X
Quali-Pro® Bifen I/T 7.9 F	Bifenthrin	66222-190	X	X		X	X			
Scimitar CS	Lambda-Cyhalothrin	100-1078	X	X		X	X			
Southern Ag Conserve Naturalyte Insect Control	Spinosad	62719-314-829		X						
Stormtrooper Fire Ant Killer	Tetramethrin & Permethrin	44446-64		X	X					X
Suspend Polyzone	Deltamethrin	432-1514		X	X					
Suspend SC	Deltamethrin	432-763		X	X		X			X
Talstar P	Bifenthrin	279-3206	X	X	X	X	X			
Tempo SC Ultra	β-Cyfluthrin	432-1363		X	X		X			
Tempo Ultra WP	β-Cyfluthrin	432-1304	X	X	X	X	X			
Termite & Carpenter Ant Killer Concentrate	Permethrin	4-349		X						
Wisdom TC Flowable	Bifenthrin	5481-520	X	X	X	X	X			

Key
B = Broadcast
IMT = Individual Mound Treatment
P = Perimeter
IN = Interior

1. Check label to see which crops may be treated.
2. Check label for sites where the product may be applied.

Fire Ant Products Labeled for Electrical Equipment and Utility Housing

Dust Trade Name	Active Ingredient	EPA Reg #	Individual Mounds	Interior[1]	Perimeter	Motor housings, switch boxes, junction boxes[2]	Above ground transformers, in ground Utility boxes[2]	Pad-mounted utilities[2]
Bombs Away	Pyrethrins, PBO, Silicon Dioxide	10088-93-1553	X	X		X		
Demise Fire Ant & Insect Dehydrator	Pyrethrins, PBO, Silicon Dioxide	10088-93-68562	X	X		X		
WildFire Fire Ant and Insect Dehydrator	Pyrethrins, PBO, Silicon Dioxide	10088-93-11547	X	X		X		
Cynoff Insecticide	Zeta-Cypermethrin, PBO	279-3259		X	X	X		

Bait

Trade Name								
Abathor Fire Ant Bait	Abamectin B1	83923-7	X	X	X		X	
Prescription Treat. Ascend Fire Ant Bait Formula 1	Abamectin B1	499-370	X	X	X		X	

Granular

Trade Name								
Bifen L/P	Bifenthrin	53883-124	X		X			X
Hi-Yield Bug Blaster II Turf Insect Control Granules	Bifenthrin	228-498-7401	X		X			X
Howard Johnson's Bifenthrin PL Granular	Bifenthrin	53883-124-32802	X		X			X
Lesco Crosscheck EZ & PL Granular Insecticide	Bifenthrin	279-3168-10404	X		X			X
Talstar PL	Bifenthrin	279-3168	X		X			X
Wisdom EZ & Lawn Granular	Bifenthrin	5481-521	X		X			X

1 Interior treatments should be applied as crack and crevice and only when children are not present unless the label states otherwise.

2. For safety reasons, only electricians or licensed pest control operators should treat electrical equipment. Specialized products and training are necessary to treat these sites safely and effectively.

Labels Available for Use in IFA Quarantine (January 2017)

Labels located online as of January 2017 – others may be available. Availability determined by manufacturer website and/or National Pesticide Information Center-Sate Pesticide Regulatory Agencies website link: npic.orst.edu/reg/state_agencies.html and/or cdms.net. Pesticide products information not available specifically for Puerto Rico in some cases.

Chemical	Product label	Manufacturer/Distributor	Use in Quarantine	Availability in IFA states
Abamectin	Award® II Fire Ant Bait	Syngenta	field grown/IFA-free[1]	all including PR
Bifenthrin	Talstar® Nursery Granular Insecticide	FMC Corp	Containers	all, unknown PR
	Bifenthrin Nursery Granular Insecticide	Southern Agricultural Insecticides, Inc.	Containers	FL, GA, NC, TN
	Broadcide™ NG	Regal Chemical Co	Containers	GA only
	Up-Star® Nursery Granular Insecticide	United Phosphorus, Inc.	Containers	all except PR
	Wisdom™ Nursery Granular Insecticide	Amvac Chemical Corp	Containers	all, including PR
	Talstar® S Select Insecticide	FMC Corp.	Containers/B&B/sod	all, unknown PR
	OnyxPro® Insecticide	FMC Corp.	Containers/B&B/Sod	all, unknown PR
	Avalon™ Golf & Nursery Insecticide	Prokoz	Containers/B&B/Sod	all except CA and PR
	Bifen G/N 7.9 Select	Prime Source LLC	Containers	all except CA, unknown PR
	Menace™ GC 7.9% Flowable	Nufarm Americas, Inc.	Containers	all except PR
	Quali-Pro® Bifenthrin Golf &Nursery 7.9F	Quali-Pro Professional T&O Products	Containers	all, unknown PR
	Up-Star® SC Lawn & Nursery Insecticide	United Phosphorus, Inc.	Containers	all including PR
	Wisdom™ Flowable	Amvac Chemical Corp	Containers	all including PR
Chlorpyrifos[2]	Chlorpyrifos AG 4E	Makhteshim Agan/Adama USA	B&B/Containers	all except PR
	Chlopryrifos 4E-AG	Drexel Chemical Co.	B&B/Containers	all including PR
	Chlorpyrifos SPC 2	Nufarm	B&B/Containers	all except CA, unknown PR

[1] Field-grown nursery stock requires bait + contact insecticide treatment; as of 1/23/17 no labels were available for the contact insecticide portion of the treatment. Therefore the only IFA quarantine use for bait as of 1/23/17 is within the IFA-free nursery program.

[2] All the chlorpyrifos labels were on the companies' websites as of 1/23/17; not all may be available throughout 2017 but existing supplies of any chlorpyrifos EC label with IFA quarantine use patterns may be used up.

Labels Available for Use in IFA Quarantine (January 2017) - Continued

Labels located online as of January 2017 – others may be available Availability determined by manufacturer website and/or
National Pesticide Information Center-Sate Pesticide Regulatory Agencies website link: npic.orst.edu/reg/state_agencies.html and/or cdms.net.
Pesticide products information not available specifically for Puerto Rico in some cases.

Chemical	Product label	Manufacturer/Distributor	Use in Quarantine	Availability in IFA states
Chlorpyrifos[2]	Chlorpyrifos SPC 4	Nufarm	B&B/Containers	all except CA, unknown PR
	CPF 4E	Direct Ag Source	B&B/Containers	all except AL, OK, unknown PR
	Quali-Pro® Chlorpyrifos 4E	Quali-Pro Professional T&O Products	B&B/Containers	all, unknown PR
	Vulcan®	Makhteshim Agan/Adama	B&B/Containers	all except PR
Diazinon	Contact your local state regulatory official to determine whether your state has a FIFRA section 24(c) exemption to use this product – Diazinon AG500, Diazinon 50W.			
Fenoxycarb	Award® Fire Ant Bait	Syngenta	field grown/IFA-free[1]	discontinued
	Syngenta has discontinued Award with fenoxycarb, but existing supplies may be used			
Fipronil	Chipco® Choice™	Bayer	sod	all including PR
	TopChoice™	Bayer	sod	all including PR
	Fipronil 0.0143G Broadcast	Quali-Pro	sod	all except CA, VA, unknown PR
	Fipronil 0.1G	Quali-Pro	sod	all except CA, VA, unknown PR
	Taurus® Trio G	Control Solutions, Inc	sod	all except CA, unknown PR
Hydramethylnon	Amdro®Pro Fire Ant Bait	BASF Corp	field grown/IFA-free[1]	all including PR
Hydramethylnon plus Methoprene	Extinguish® Plus Bait	Wellmark International	field grown/IFA-free[1]	all including PR
Metaflumizone	Siesta™ Fire Ant Bait	BASF Corp	field grown/IFA-free[1]	all including PR
Methoprene	Extinguish® Fire Ant Bait	Wellmark International	field grown/IFA-free[1]	all including PR
Pyriproxyfen	Distance® Fire Ant Bait	Valent	field grown/IFA-free[1]	all including PR
Tefluthrin	no nursery labels currently available			

Most of the products listed are available to homeowners, many othe products are available to pest management professionals. If you find a fire ant product in a Tennessee store and it is not listed here, please contact kvail@utk.edu with the information.

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Precautionary Statement

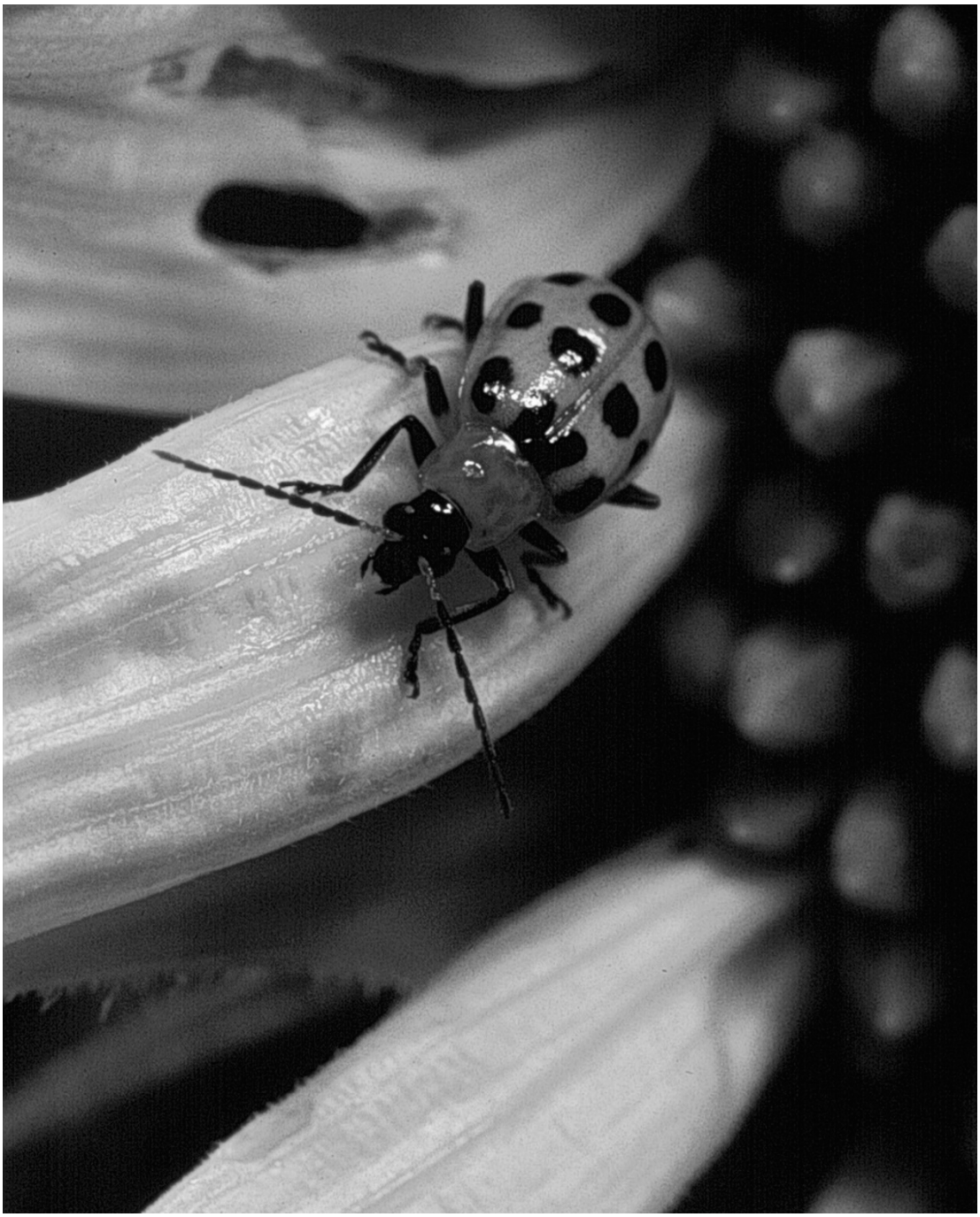
To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

Disclaimer

This publication contains pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. The label always takes precedence over the recommendations found in this publication. Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others that may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product. The author(s), the University of Tennessee Institute of Agriculture and University of Tennessee Extension assume no liability resulting from the use of these recommendations.

PB 595

You Can Control Garden Insects
2018



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Helpful website ipm.ncsu.edu/AG295/html/index.html

Insect and Related Pests of Vegetables
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Prepared by Cathy Cameron Carter and K. Sorenson with collaboration by D. Stephan
North Carolina Cooperative Extension Service

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Cover photo by Frank Hale

You Can Control Garden Insects

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Insect Infestations

Insect infestations reduce yields and lower the quality of harvested garden vegetables. Three to seven generations of many insect pests attack garden vegetables during the growing season. All plant parts may be injured by insects. Some insects bore into roots, seeds or stems. Many suck large quantities of plant sap. Others destroy crops by chewing on the succulent foliage, stems or fruits. Plant diseases are carried by certain insects.

Safe, effective and economical control measures can minimize the loss from insects. Control can be maintained all season by a combination of cultural practices, mechanical control, biological control and chemical applications. To maintain control, follow these practices, as they apply to the vegetables in your garden:

- Anticipate insect pest problems.
- Remove other vegetation and debris that harbor insects from vegetable garden beds.
- Turn under spent plants when the vegetables have been harvested.
- Inspect plants regularly for insect infestations and spray when needed.
- Apply sprays when the young, most vulnerable stages of insect pests are beginning to hatch or emerge.
- Observe use restrictions and avoid applying insecticide on garden vegetables within the minimum number of days between last application and harvest.
- Select insecticides that take a short time to control insects during the harvest period.

Insect Reproduction, Growth and Development

How Insects Grow

Most insects develop from an egg and, upon hatching, have a form different from that of the adult. The series of form changes as an insect develops from egg to adult is called **metamorphosis**. The young insect is covered with a more or less firm skin called the **exoskeleton**. As the insect feeds, it grows inside this skin, but it cannot increase in volume because it is restricted by its exoskeleton. A new elastic exoskeleton then forms under the old rigid exoskeleton. The old exoskeleton splits along the back and the insect crawls out of its old skin and expands to its new size. After exposure to air for a short time, the new exoskeleton becomes hardened and the insect is ready to resume activity and grow some more. The process of shedding the old skin is called **molting**. Molting occurs several times over varying periods of time until the final stage is reached.

With each molt insects change their form to varying degrees, depending on the kind of metamorphosis that insects may have. Most vegetable garden insect pests have either gradual (Figure 1) or complete metamorphosis (Figure 2). Examples of gradual or incomplete metamorphosis, in which the very young resemble the adults, include plantbugs, grasshoppers, stink bugs, squash bugs, aphids and leafhoppers. Examples of pests with complete metamorphosis are Mexican bean beetles, cabbage loopers, hornworms, flies, June beetles, cutworms and armyworms.

Gradual metamorphosis (Figure 1). Generally these young insects resemble the adults. In proportion to the rest of the body, the legs and head become relatively smaller in each instar. This is because the head and legs do not grow as fast as the rest of the body. In insects that are winged, there is also a gradual development of the wings with each molt. There are no more molts after the fully developed, winged, adult emerges. Not all of these insects develop wings. The young are called nymphs. Nymphs and adults inhabit the same places and eat the same kind of food.

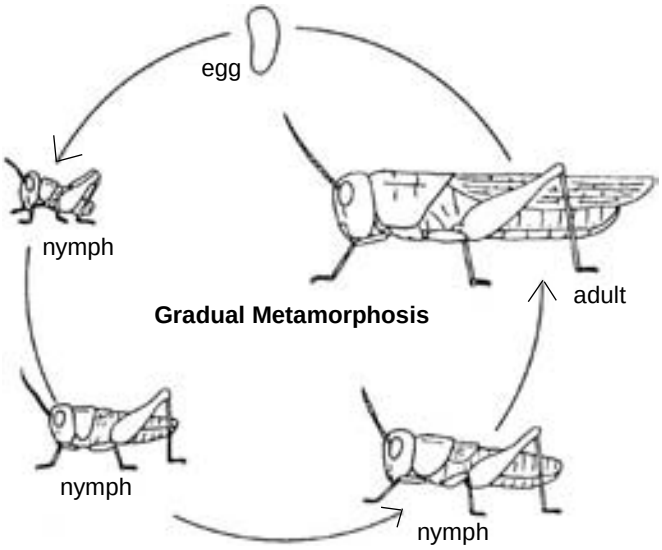


Figure 1

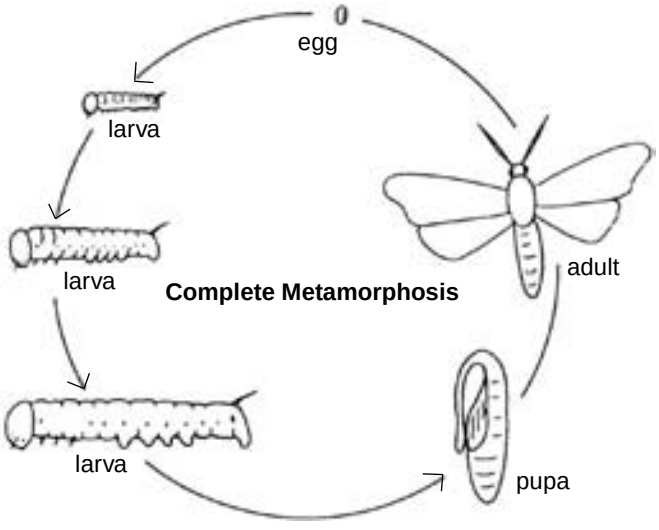


Figure 2

Complete metamorphosis (Figure 2). All four stages of development — egg, larva, pupa and adult — are present. All increases in size occur during the larval stage. Some people erroneously think that small flies will grow to be big flies. At the end of the larval stage, the insect transforms into a pupa, which does not feed or move about. It is sometimes called a resting stage, but inside the pupal skin drastic changes are taking place. More alteration of form is going on during the pupal stage than during any other period of the insect's development. Out of the pupa emerges the fully formed adult, complete with wings. No further molts occur. The larvae and adults of these insects may live in different habitats, eat different food, have different kinds of mouthparts and have many other differences. The larval stage of some orders of insects are called maggots, grubs or caterpillars.

Soil Insects

Many garden insect pests live in the soil during one or more stages of their life cycle. These insects are adapted to feeding in or on the planted seeds, roots or lower stems of plants.

The length of time the individual insect lives in the soil varies from two to three weeks for some flies, to three years for some wireworm species.

These insects may either occur as large numbers of newly hatched larvae or as partially grown over-wintered larvae with a ravenous appetite at the time you plant your garden. The plants can be severely damaged or even killed overnight following planting.

Anticipate problems with soil insects. Inspect the plant bed soil thoroughly as you cultivate the bed.

Seed Corn Maggot

Description: Small, white maggots without legs or a distinct head, about 1/3 inch long, that feed externally and internally on roots and seeds.

Damage: Death of small plants may result from maggots feeding on roots.

What to do: Avoid planting spring turnips and radishes in soil that is high in partially decomposed organic matter. Do not plant in wet soil.

Onion Maggot

Description: Small white maggots without legs or distinct head, about 1/3 inch long, that bore through underground stems and bulbs.

Damage: Thinning of stands often results from plant death caused by the maggots tunneling in small bulbs. Even if they are not totally destroyed in the garden, damaged bulbs will rot in storage.

What to do: Avoid planting onions in an area high in partially decomposed organic matter. Cull onions should be removed from the garden after harvest.

Cabbage Maggot

Description: Yellowish white; legless larva; blunt at the rear end and pointed at the front; about 1/4 to 1/3 inch long. The adult fly lays eggs in the soil around the base of the plant, and the eggs hatch into maggots that burrow down to adjacent roots.

Damage: The maggots are destructive in seed beds and in young transplants. They feed on the roots and stems just below the surface; seedlings wilt, turn yellow and die. Infested cabbage rarely produces a head. Maggots are also reported to introduce a fungus causing blackleg and to spread bacterial soft rot.

What to do: Protect seedlings from egg-laying adults with a square of tar paper laid flat on the ground around the stem or cover with mesh or screening to exclude the fly. Don't plant in cold, damp soil. In the spring, wait until the soil warms up and is sufficiently dry. Add organic matter to the soil in the fall to reduce soil's attractiveness to egg-laying spring cabbage maggot flies.

Wireworm

Description: Shiny, slick, reddish-brown, tough, 6-legged worms up to 1 ½ inches long.

Damage: The wireworm tunnels through tubers, making deep, more or less cylindrical burrows.

What to do: Avoid planting potatoes in an area that has been in sod for the past two or three years.

White Grub

Description: Several species. White or light yellow; hard brown heads; curved; ½ inch to 1 ½ inches long when full grown. White grubs live in soil and are larvae of May and June beetles. They require three years to mature. Adult lays eggs in grassy areas.

Potato Tuberworm

Description: White caterpillars up to 3/4 inch long with a pinkish or greenish tinge and brown at both ends.

Damage: Larvae burrow into stems and petioles and mine the leaves of plants. The tubers of potatoes in the field and in storage are riddled with slender, dirty-looking, silk-lined burrows.

What to do: Keep potatoes well cultivated and deeply buried in hills during growth. Infested vines should be removed before digging to avoid larval movement to tubers.

Early-Season Insect Pests

Early-season insect pests infest and damage seedling plants early in the growing season. They feed on leaves and stems of young seedling plants.

Cutworm

Description: Plump, smooth-skinned, greasy-looking caterpillars up to 1 inch long often found curled up at base of plants.

Damage: Young transplants may be cut down at ground level, or branches may be removed from larger plants. Some damage to small tomato fruit may occur on older plants.

What to do: Physical barriers, such as aluminum foil wrapped around a 4-inch length of stem between leaves and roots, may be used to protect newly set transplants. Baits, sprays or recommended insecticides may be needed. Avoid planting tomatoes in soil recently in grass or sod.

Thrips

Description: Adult — extremely small (1/25 inch long), yellow or brown winged insects; very active. Nymph — similar to adult but smaller and wingless. Thrips often feed on weeds in and around the garden.

Damage: Adults and larvae suck plant juices and cause whitish blotches. Tips of leaves may become distorted and die. Entire plants may wither and fall over with severe infestations.

What to do: Set onions should not be grown near seed onions. Weeds in and around the garden should be removed to reduce buildup of thrips. Beginning when thrips are numerous enough to cause scarring of leaves, two or three applications of a recommended insecticide should be made at weekly intervals or as directed by label. Certain varieties of sweet Spanish onions possess considerable resistance to injury.

Flea Beetle

Description: Adult — many species; very small, black or striped shiny beetles 1/16 to 1/8 inch long that jump readily when disturbed. Adults overwinter under leaves, grass and trash in and around the garden.

Damage: Adults chew tiny holes in the leaves.

What to do: Removal of weed hosts will reduce flea beetle populations. When extremely heavy populations are observed on weeds surrounding the garden, insecticide treatment of garden margins may prevent entry by the pest. When beetles and damage are seen on eggplant or beets, apply a recommended insecticide before serious damage results.

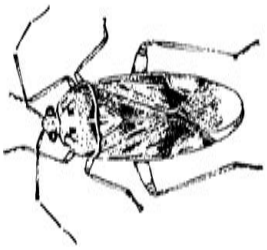
Aphids

Description: Adult and nymphs — small, soft-bodied, yellow, pale green or powdery grey; about 1/8 inch long with two "tail pipes." Usually occur in colonies or clusters on the undersides of leaves and in broccoli heads.

Damage: Adults and nymphs suck plant juices, leaves thicken, wrinkle, and turn yellow or brown; small plants may be severely weakened. Broccoli is very sensitive to aphids, which are difficult to remove from the heads in preparation for eating.

What to do: Observe small plants closely after rapid growth begins in the spring. Wash the aphids from the plants daily with a forceful stream of water until the population is no longer a problem or apply a recommended insecticide when colonies are found in the absence of enemies such as lady beetles.

Lygus Bugs



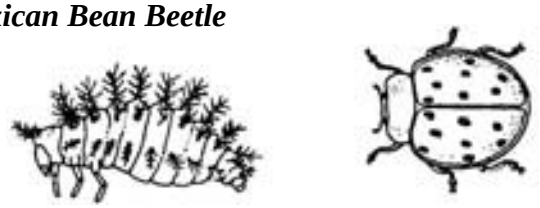
Description: Several related species including tarnished plant bug are included in this group. They are flat, oval, mottled with white, yellow and black splotches that give it a tarnished appearance; 1/4 inch long. When disturbed, these active insects fly or move to opposite side of stems; they are seldom seen.

Damage: Adults and nymphs pierce and suck juices from the pods, stems and blossoms. This feeding causes blossoms and young pods to drop from the plants. Feeding on the older pods causes the pods and seed to be pitted and undesirable for food. The pods may also be deformed.

What to do: Dust or spray with an insecticide labeled for the specific crop. Clean up and destroy weeds and trash in the fall to prevent overwintering.

Insect Pests Infesting Plant Foliage, Pods and Fruits. These Pests Continue Feeding on Garden Plants Throughout the Season.

Mexican Bean Beetle

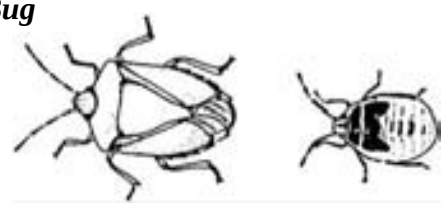


Description: Adult — coppery-brown rounded beetles; about 1/4 inch long, with 16 black spots on the back. Adult spends the winter in rubbish and weeds. Larva — yellowish, soft-bodied and fuzzy. Clusters of yellow eggs are laid under the leaves.

Damage: Leaves appear lacy from adults and larvae chewing on the undersides.

What to do: Apply a recommended insecticide or hand pick adults and larva and crush the eggs. Clean up plant debris after harvest to reduce overwintering adults. Plant early and pick mature pods promptly.

Stink Bug



Description: Adult is shield-shaped, flat, bright green or brown, 5/8 inch long with wings and a narrow head; bad-smelling when crushed. The nymph resembles adult in shape, but is somewhat more rounded than shield-shaped, wingless, and green, orange and black. Adults overwinter in weeds.

Damage: Adults and nymphs suck juices and cause pods to fall and cause distortion of seeds. Brown spots form on the pods from the feeding.

What to do: Apply a recommended insecticide; keep the weeds down both in and around the garden.

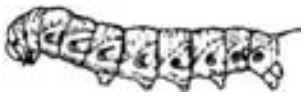
Whitefly

Description: Adults — very small sucking insects with two pairs of broadly rounded wings covered with a snow white waxy powder. They look like tiny moths and fly out in a cloud when disturbed. Larvae are very small flat, scale-like insects, difficult to see. All stages feed on the undersides of leaves and excrete honeydew.

Damage: The flies suck plant juices, causing leaf discoloration, leaf drop and stunting of plants. A sooty mold grows on the honeydew, causing a black unsightly appearance on the leaves.

What to do: Use a recommended insecticide.

Hornworms (Tobacco and Tomato)

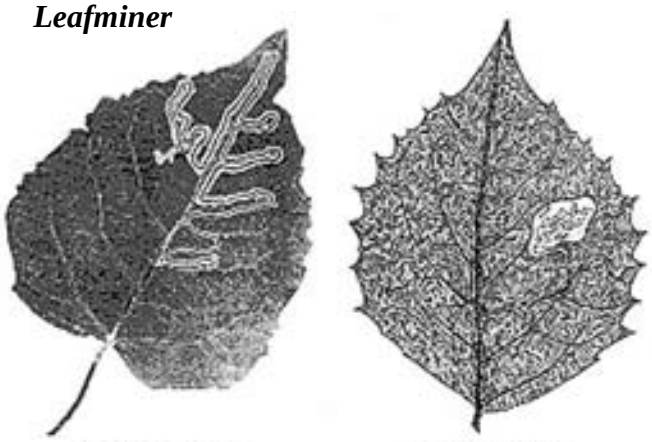


Description: Large, green caterpillars with white bars; up to 3 or 4 inches long with a slender horn projecting from near the rear end.

Damage: Hornworms feeds on leaves, consuming large amount of foliage. Leaf loss may result in stunting and fruit scald.

What to do: Handpicking and destruction are often easily accomplished because of size. If large numbers of hornworms or plants are involved, use a recommended insecticide.

Leafminer

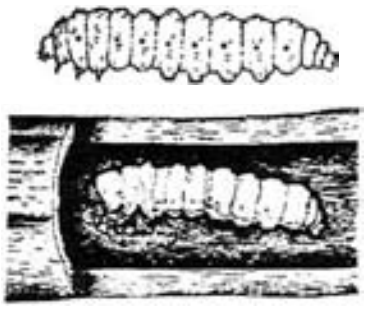


Description: Winding white trails or broad white spots appear on leaves, made by small white or yellow legless maggots feeding between upper and lower surfaces of the leaf.

Damage: The leaves may be weakened, and the mines or tunnels may serve as points where disease and decay may start.

What to do: Handpick infested leaves, if practical, before the larvae pupate and begin another generation, or use a recommended insecticide when large numbers of mines are found.

Squash Vine Borer



Description: Thick, white, wrinkled, brown-headed caterpillars, up to 1 inch long. Produces yellowish, sawdust-like excrement from holes in the vines.

Damage: Infested vines are often completely girdled and usually become rotten and die beyond the point of attack. Late in the season, some tunneling in and damage to fruit may occur.

What to do: Plant as early as the weather will allow. With few infested plants, stems can be split and larvae removed. A spade-full of moist soil should be placed over damaged stems to encourage new root growth. Apply a recommended insecticide weekly or as directed by label during the fruiting period.

Stalk Borer

Description: Slender, up to 1 ½ inches long. Young borer: creamy white, dark purple band around the body, several brown or purple stripes running lengthwise down the body. Full-grown borer: creamy white to light purple without band and stripes.

Damage: Eats tunnel in stem, causing plant to wither and die. Tunnel usually has opening up to 1/4 inch in diameter at its lower end. Attacks pepper, corn, potato and rhubarb.

Distribution: East of Rocky Mountains.

What to do: Remove and destroy weeds; the insect breeds in weeds, especially dock and ragweed. Plant may be saved by puncturing the insect. To locate the borer, split the stems lengthwise above opening to tunnel. Bind split stem and keep plant watered.

Blister Beetle

Description: Soft, slender beetles with long legs; 1 ½ - 1 3/4 inches long; either black, grayish or black with narrow gray or yellow stripes on margins of the wing covers.

Damage: Leaf removal from large members of beetles feeding on the foliage may cause fruit injury by sun (sun scald).

What to do: Apply a recommended insecticide.

Harlequin Bug

Description: Adult — red and black, shiny, flat, shield-shaped; about 3/8 inch long. Nymph — red and black, oval, no wings. Eggs — white with black rings, barrel-shaped; laid in double rows under the leaves. Adults overwinter around trash and old plants in and around the garden. This bug has a disagreeable odor.

Damage: Sucking adults and nymphs cause yellow splotches; leaves wilt, turn brown and die.

What to do: Handpick bugs and crush their eggs as they appear; if necessary, apply a recommended insecticide; keep weeds and trash down in and around the garden to reduce overwintering adults.

Squash Bug

Description: Adult — the winged adult is dingy gray-black and nearly an inch long with a narrow head. Adults and nymphs have a very disagreeable odor when crushed. Nymph resembles adult in general shape. Newly hatched nymphs have reddish heads and legs and green bodies. Later they become darker, the head and legs turning black and the body light to dark gray.

Damage: Adults and nymphs suck plant juices. Young plants can be severely weakened or killed. Older plants often have one or more runners damaged. Leaves on damaged runners wilt and become crisp and dark brown.

What to do: If only a few vines are involved, the easiest control method is hand collection of eggs and bugs. The eggs are 1/6 inch long, elliptical, yellowish-brown to bronze, and usually in clusters on the underside of leaves. Garden sanitation reduces overwintering populations. Apply a recommended insecticide to control the young nymphs, because the adults are very difficult to control with insecticides.

Colorado Potato Beetle

Description: Adult — yellow and black striped, hard-shelled beetle about 3/8 inch long. Larva — brick-red, humpbacked, soft-bodied larva with rows of black spots along each side of the body. Eggs — orange, elongated eggs laid on the leaves.

Damage: Adults and larvae eat holes in leaves, especially damaging to small plants.

What to do: The Colorado potato beetle is notorious for its ability to develop resistance to insecticides. Applying a recommended insecticide as soon as adult beetles are observed may provide control. If the initial application is made before egg-laying, repeat treatments may be unnecessary. Adults, larvae and the eggs may be hand-picked from plants and destroyed.

Leafhopper

Description: Small, very active, greenish, slender, wedge-shaped jumping insects up to 1/8 inch long.

Damage: The leafhopper sucks sap from undersides of leaves causing leaf tops to turn brown, followed by the browning and curling of entire leaf margins.

What to do: Apply a recommended insecticide.

European Corn Borer

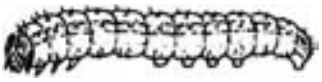
Description: Flesh-colored; rows of small, round, dark-brown spots; dark-brown head; up to 1 inch long. Overwinters as a caterpillar in the stalk.

Damage: Larvae bore into the stems of plants and cause breakage. Heaviest damage occurs late in the season. In addition, larvae may enter the fruit by boring under the calyx (small green leaves under the flower). Larvae feed in tassels and young leaves in the

whorl, soon moving to tunnel in the stalks and the ear; may enter the ear at the base, side or tip. Broken tassels and stalks, shredded leaves, sawdust castings outside small holes in the stalk and ear are signs of the borer. Tunneling in fruit often causes premature fruit drop.

What to do: Plant as early as the weather permits; apply a recommended insecticide when larvae are first found. Apply a recommended insecticide when the corn borers are first seen in the whorl and before they enter the stalk and ear. Remove old plants after harvest to reduce borer numbers.

Fall Armyworm



Description: Light green to black, striped; black head with inverted white Y on the front of the head; about 1 ½ inches long. Feeds at night.

Damage: Attacks the young emerging corn leaves in the whorl and the ear in a manner similar to the corn earworm. Fall armyworms will chew through the husks to attack the kernels, whereas corn earworms enter the tip. Often several fall armyworms are found in an ear.

What to do: Apply a recommended insecticide. Plant early.

Corn Earworm or Tomato Fruitworm

Description: Fully grown larvae are up to 1 3/4 inches long; variable in color from light green to pink to brown to nearly black, marked with alternating light to dark stripes running lengthwise on the body. The head is yellow and unspotted, and the legs are dark or nearly black. The skin of the larvae is coarse with short black hairs (like on a two-day old beard).

Damage: Earworms chew buds and leaves in the whorl resulting in large ragged holes as the leaves unfold and may cause plants to be stunted; they later feed on the silk and the kernels from the tip of the ear downward; seldom more than one corn earworm per ear. Chewed-off silk prevents pollination; various mold fungi are introduced into the ear. Holes are eaten in tomatoes, causing them to rot.

What to do: Plant as early as the weather permits; apply a recommended insecticide when larvae are first noticed, or when damage is first observed.

Cowpea Curculio

Description: Adult — black, hump-backed, hard-shelled beetle, nearly 1/4 inch long, with a slender snout and prominent round punctures (dimples) on the back. Larva — whitish, legless grub inside the pods.

Damage: Adults cause black wart-like stings on surface of pods by feeding and egg-laying activities. Larvae develop from eggs deposited inside pods. Larvae feed on one or more peas during their course of development.

What to do: Where feasible, remove broomsedge and bluestem from garden edge to reduce overwintering sites.

Cucumber Beetles — Spotted Cucumber Beetle

Description: Adult — greenish-yellow, 12 black spots on wings, black heads, slender, about 1/4 inch long. Adult overwinters at the base of plants, which are not entirely killed down by the frost.

Damage: The beetles eat holes in the leaves and flowers and carry bacterial wilt. May attack young seedlings even before they emerge. Larvae tunnel roots and stems of beans, corn and grasses.

What to do: Protect young plants by cone-shaped netting or screen protectors until runners develop; apply a recommended insecticide; clean up weeds to reduce overwintering adults.

Cucumber Beetles — Striped Cucumber Beetle

Description: Adult — pale yellow to orange, three black stripes on wings, black heads, about 1/4 inch long. Larvae — white, brownish at the ends; slender.

Damage: Adults feed on the leaves, stems, and fruit and transmit bacterial wilt. Larvae sometimes feed on underground stems and roots of cucumbers and related plants.

What to do: Cover seedlings with netting or cone-shaped screens until runners form; or apply a recommended insecticide.

Cabbage Looper

Description: Pale green, smooth-skinned worms up to 1 1/4 inches long, which make a loop in the middle portion of the body as they move along the plant. Brown pupae are attached to one side of a plant leaf during the growing season.

Damage: Large holes are eaten in leaves. So much leaf tissue may be consumed that plant growth is interfered with. Larvae may be present in the heads and go unnoticed until cooking.

What to do: It is very important to control these larvae while small, as the larger ones are quite difficult to control. Conventional chemical insecticides often fail. Applications of *Bacillus thuringiensis* (Dipel or Thuricide) are usually effective in keeping populations under control.

Diamondback Moth Caterpillar

Description: Greenish-yellow with black hairs; slightly pointed at both ends; wiggles rapidly when disturbed and hangs from a silk thread; about 1/3 inch long. Overwinters as a pupa in the leaves of the host plant.

Damage: Larvae chew holes in all parts of the plant, but prefer areas around the bud. Larvae may be present in the heads and go unnoticed until cooking.

What to do: Apply a recommended insecticide. Clean up old plants after harvest to remove pupae.

Imported Cabbageworm

Description: Velvety green with a narrow orange stripe down the middle of the back and a broken yellowish stripe along each side; about 1 1/4 inches long. Overwinters as pupae in the leaves of the host plant or other objects nearby.

Damage: The larvae chew holes in the leaves and are more likely to feed near the center of the plant. Larvae may be present in the head and go unnoticed until cooking.

What to do: Apply a recommended insecticide. Clean up old plants after harvest to remove pupae.

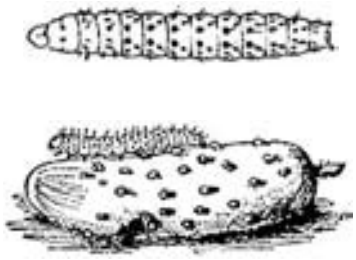
Spider Mites

Description: Tiny (barely visible) red, orange, yellow or green mites that suck juice from the undersides of leaves. Fine webs on the leaves.

Damage: Yellow spots on leaves; leaves turn yellowish brown and drop; plants are stunted.

What to do: Frequent high pressure syringing with water will tend to reduce populations; wait for natural predators to reduce the mites if the population doesn't get too high or apply a recommended miticide.

Pickleworm



Description: Yellowish-white caterpillar with dark spots when young; old larvae are greenish or coppery; up to 3/4 inch long. Overwinters in south Florida and spreads northward each year.

Damage: Burrow into buds, blossoms, vines and fruits. The larvae push out small masses of green, sawdust-like excrement from holes in the fruit, causing rotting and loss of fruit.

What to do: Plant as early as the weather will allow. Apply a recommended insecticide during the fruiting period.

Nonchemical Control of Insects

Chemical dusts and sprays offer the most consistent, most effective and easiest method of controlling insects. However, they do have disadvantages: they kill both the bad and good insects; chemicals used previously may no longer be effective (the insects are said to be resistant to this chemical or group of chemicals); they are toxic and must be handled and stored carefully; they may leave excessive pesticide residues on the food unless label instructions are carefully followed; and they are often expensive.

There are many excellent cultural, mechanical and biological control methods that can be used for insect control. Most gardeners will find that a combination of nonchemical and chemical methods work best.

Garden Site Selection

Where possible, avoid planting your vegetable garden in ground that was in sod within two to three years. Soil insects are more likely to be numerous in this situation. Digging or plowing the garden as described below will help.

Soil Preparation

Several species of soil insects (wireworms and white grubs) feed on the roots and seeds of garden vegetables. Many of these pests are harbored on weeds or grasses in the garden before vegetables are planted. The garden should be dug or plowed in the fall and again in the spring, at least three weeks before planting. This practice not only eliminates weeds supporting these pests, but also exposes many pests to drying, cold weather and predators. Rotating crops to new locations in the garden also aids in reducing insects.

Vigorous Plants

Healthy plants are better able to tolerate pest damage than weak sickly ones. Use only the plant varieties best suited for your part of Tennessee and use the correct amounts of fertilizer, lime and water. You can obtain a soil test through your county Extension office.

Plant Early

The number of insects successfully overwintering is actually quite low, but because of their reproductive capacity, large populations develop by late summer. If corn, cucurbits, tomatoes, peppers, eggplant and cole crops are planted as early as weather permits, many of these vegetables will be mature and harvested before heavy insect pressure occurs.

Diversified Planting

Many insects attack plants belonging to a certain species or family and reject unrelated ones. For example, striped cucumber beetles enjoy cucumber, squash and melons (cucurbit family) and are not a pest of corn or beans. Thus, do not plant all those cucurbits or others of the same group in one place in the garden if you can avoid it. If you have many tomato plants, do not put them all in the same location. Insects that begin to attack a particular vegetable often will spread to similar neighboring plants. You may be able to reduce your losses if you do not put all of one group in the same location. Groups of related vegetables are as follows:

Cole crops	cabbage, cauliflower, collards, brussels sprouts, broccoli
Greens	lettuce, endive, mustard, turnips (tops)
Root/bulb crops	sweet potatoes, onion, garlic radishes, turnips, beets, carrots
Cucurbit crops	cucumbers, gourds, melons, pumpkin, squash
Legumes	beans, peas

Do Not Plant Seed Too Deep

Seed planted deeper than accompanying directions may often rot before they germinate or crack through the soil.

Use Physical Barriers

Transplants such as tomato, pepper and eggplant can be wrapped with a 4-by-4-inch strip of aluminum foil to prevent cutworm damage and contact with the soil-borne southern blight organisms. Wrap the stem area between the roots and leaves with foil and plant so 2 inches of stem are below the soil and 2 inches are above the soil. Do not allow the soil to touch the uncovered stem above the foil.

Companion Planting

There is little data to prove or disprove the value of companion planting, although this arrangement has been used by many gardeners who claim success. Presumably some herbs and other plants repel specific insect pests and planting these in association with a particular vegetable gives some protection. A few common plantings are as follows:

- Interplant beans with rosemary to control Mexican bean beetles.
- Interplant tomatoes with basil to repel the tomato hornworm.
- Interplant eggplant with catnip to repel flea beetles.
- Interplant cucumbers with radish or nasturtiums to control cucumber beetles.
- Interplant cabbage with thyme to control imported cabbageworms.

There are many other combinations found in the literature, but remember there is little definite information available on their effectiveness. The latter four listed have been tested in south Georgia with disappointing results.

Water the Garden

Furrow irrigation is ideal. If overhead sprinklers are used, water after the dew dries in the morning or early in the afternoon so the foliage will dry before night. Do not allow foliage to be wet for more than eight to 10 hours.

Harvest Vegetables

The longer a vegetable is in the garden, the longer it is exposed to insect attack. In addition, overripe vegetables are more attractive to certain insect pests and invite an unwanted invasion.

Weeds in or Around the Garden Area

Some insects are first attracted to weeds and will then move into your vegetable garden. In addition, heavy weed stands increase humidity and subsequent insect severity. Constant weed control is essential, because destruction of a heavy weed stand can cause migration of an insect population to the crop. Mulching is a good way to keep the weeds down in the garden, and it has many other benefits as well.

Use Bacillus thuringiensis

This biological insecticide contains a toxin of a bacterium that is deadly to cabbageworms (and other caterpillar species), but harmless to humans, pets and beneficial insects. It is available under the trade names of Dipel, Thuricide and others.

Handpicking Some Insects

Destroying insects that are large enough to pick and slow enough to capture and destroying egg masses are often quick methods of insect control. Tomato hornworms are often easily controlled by handpicking. Removing Colorado potato beetles by hand is also successful.

Cut Out the Squash Vine Borer

When the squash vine borer is found tunneling in the base and runners of squash, you can split the stem to find the larva, kill or remove it, and place about a shovel full of damp soil over the wound to encourage new roots.

Solarization

Solar heating of moist soil by means of polyethylene mulching, particularly during the summer months, is effective in reduction of soil-inhabiting pests. Soil should be tilled, fairly moist and covered with clear plastic for optimum control of these pests.

Repelling Insect Vectors in Tomatoes and Cucurbits

Thrips and aphids spread several diseases and the only protection against the disease is controlling the insect vector(s). Highly reflective surfaces tend to repel most thrips and aphids. Aluminum foil or plastic painted with a chrome-colored paint may aid in repelling these insects.

Crop Rotation

Crops should be rotated to avoid the buildup of pests associated with that crop.

Resistant Varieties

Resistant varieties are either tolerant of pests, not preferred by pests or negatively affect pests. Resistant varieties should be used whenever possible.

Proper Plant Spacing

Proper plant spacing allows the plant canopy to shade the ground, thereby preventing weeds from growing and decreasing the rate at which the soil dries. Plants spaced too far apart will allow weeds to grow and those spaced too closely could be stressed due to competition for light, nutrients and water.

Clean Up All Plants

Many insects will mature or overwinter in plants they fed on. Removing debris or end-of-season plowing will reduce pest populations.

Heat

Where allowed, burning off old crop residue may reduce soil-inhabiting pests.

Insect Predators, Parasitoids and Disease-Causing Organisms

Outbreaks of insect pests in home gardens often result because the pests have no natural enemies or their natural enemies are lacking. The natural enemies of garden insect pests that play the greatest role in keeping pests in check are predators, parasitoids and disease-causing organisms. These natural enemies are found on a wide variety of crops — they go where the pest is. It is important that you be able to recognize these beneficial organisms, and not mistake them for destructive pests needing control.

Predators

The most common predators in gardens are various beneficial insects and spiders. Predators actively seek, kill and consume a large part of the pest insect. Common predators are lady beetles, ground beetles, lacewings, praying mantids, damsel bugs and spiders.

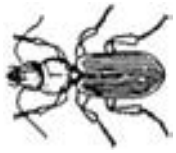
Several mail order businesses advertise predators for sale, particularly lady beetles and praying mantids. Release of these beneficials in a garden rarely leads to pest suppression, because the beneficials quickly disperse in search of additional prey. In addition, there are generally a number of these beneficials already in the garden. Therefore, it is more important that you learn to distinguish the beneficial insects from the destructive ones already in your garden than to buy or import insects.

Lady Beetle

Lady beetle adults are oval-shaped insects that vary in color but usually have black or orange-red spots on their wing covers. Lady beetle larvae are spindle or carrot-shaped with conspicuous warty or

spiny backs. They usually are black, blue and orange with thick, stubby legs. Both the lady beetle adults and larvae feed on small, soft-bodied insects and insect eggs. Lady beetle eggs are yellow to orange and laid in a cluster of five to 20 eggs. They are found standing on end in contact with one another. All stages of lady beetle development are usually found on the foliage of plants.

Ground Beetle



Ground beetle adults are flat, black or brown, long-legged and swift-running insects. Sometimes the colors are brilliant metallic greens, blues or purples, occasionally spotted with iridescent dots or pits of gold. The adults range in length from ½ to 1 ½ inches. Ground beetle larvae are dark-colored, slender, a little flat and slightly tapering to the tail, which terminates in two bristly, hair-like or spine-like structures. Both the adults and larvae feed on small, soft-bodied insects, eggs and worms. Ground beetle adults and larvae are generally found on the soil, acting as ground level predators.

Lacewing

Lacewing adults are insects that have many veins in their wings, giving them a net-like appearance. The wings are held roof-like over the back. The adults are green or brown, and some have characteristic golden-colored eyes. Lacewing larvae are about ½ inch long, spindle-shaped insects with long, sharply pointed mandibles that protrude out from the front of the head. These larvae are tan and white with a warty or spiny appearance. Larvae eat small, soft-bodied insects, eggs and worms.

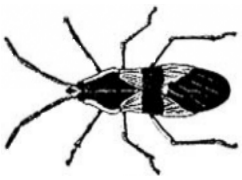
The eggs of the lacewings are small, green to whitish and are always laid at the end of a slender, thread-like stalk.

Praying Mantid

Praying mantids are green or brown with long bodies and papery wings (if they are present). These medium to large insects are readily recognized by the enlarged front legs that are used for grasping its prey.

Eggs are laid in a mass, arranged in a definite pattern of rows and glued together. The egg mass is rather commonly observed glued to branches of trees, fence posts or other objects. The winter is spent in the egg stage. Only one annual generation of this insect has been observed. The praying mantid has often been given too much credit as a predator, perhaps because of its size and menacing looks. Praying mantids are basically lazy and generally wait for the prey to come to them. In addition, they will feed on other beneficial insects.

Damsel Bug



Damsel bug adults are long, slender, cigar-shaped insects. They are tan to brown and about ½ inch long. The wings are light smoky-colored. The front legs are thick and made for grasping and holding their prey. Damsel bug nymphs resemble the adults except they have no wings and appear very fragile. Both the adults and nymphs feed on small, soft-bodied insects, worms and eggs.

Spider

Spiders are not insects, but this group of arthropods is very important as predators of insects in the garden. Many types of spiders are found in the garden and vary greatly in size and color. They will prey on almost any insect that comes within their range.

Parasitoids

Some insects will feed inside the bodies of other insects, eventually killing them. These insects are called parasitoids.

One of the most common parasitoids found in home gardens is a braconid wasp, which lays its eggs in the body of tomato hornworms. The eggs of this parasitoid hatch into larvae that riddle the internal organs of the hornworm during development. As pupation occurs, the parasitoids can be observed in white cocoons on the back of the hornworm. These are often mistaken for hornworm eggs by the gardener and subsequently destroyed. However, effort should be made to preserve these pupae, since the adult parasitoids will emerge from them to continue their beneficial activities.

Diseases

Microorganisms pathogenic to insects occur commonly among protozoa, bacteria, fungi and viruses. The most common natural diseases in garden insect pests are caused by the latter two groups of microorganisms. However, they are usually effective in reducing pest numbers only after pests reach high population levels. Such pest levels are too destructive to vegetables to await the spread of the disease.

Because of the increased interest and research in diseases for controlling pest insects, it is expected that more of these biological control agents will be made available in the future.

Chemical Control Insecticide Precautions

Insecticides used incorrectly can be injurious to you and your garden vegetables. The best insurance against hazards is the careful observance of the insecticide label directions and precautions. Before purchasing an insecticide, and again before using it, you should read the label and make sure you are able to follow all directions and precautions.

Store all insecticides behind locked doors (or at least out of reach of children) in original containers with the labels intact. The storage area should keep the insecticides from freezing temperatures, but do not sacrifice safety by storing near food, clothing or medicines.

Apply insecticides selectively and carefully. Do not apply an insecticide when there is danger of drift to other areas. Generally, the wind is most calm in early morning or late evening hours. Avoid prolonged inhalation of an insecticidal spray or dust. When applying an insecticide, you should wear at least a long-sleeved shirt, long pants, shoes and socks.

After handling an insecticide, do not eat, drink or smoke until you have washed with soap and water. If an insecticide is swallowed or gets in the eyes, follow the first aid treatment given on the label and get prompt medical attention. If an insecticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

The insecticides recommended for home garden use are among the safest available, but should be treated as potentially dangerous poisons. The best way to dispose of an insecticide is to use it in accordance with label directions. When a container is empty, it should be rinsed three times with water, and the rinse water should be added to the spray tank. Empty containers of most homeowner insecticides can be disposed of with household garbage. Wrap in several layers of paper and tie. Follow the directions on the label.

Insecticides vary in their toxicity to humans and domestic animals. The toxicity is measured in milligrams of the insecticide per kilogram of body weight of the test animal that produces a 50 percent mortality rate in tests. Since a milligram is 1/1000 of a gram and a kilogram is 1000 grams or 2.2 pounds, the toxicity is actually expressed in parts per million. As the toxicity rating is based on the amount of the

active ingredient of an insecticide in a mixture, it follows that the diluted spray mixture is a much smaller toxic hazard than a concentrate.

The Insecticide Label

Always read the label carefully on the insecticide container. It will tell you the active ingredient as well as the maximum amount or concentration that can be used safely. Pay particular attention to warning statements and precautions. Always observe recommended intervals between the last application and harvest to avoid harmful residues on the produce. Apply an insecticide product only to those crops that are listed on the label.

- **Highly toxic insecticide labels have** "DANGER POISON" signal words SKULL & CROSSBONES
- **Moderately toxic insecticides have** Warning signal word
- **Slightly toxic insecticides have** Caution signal word

Common Insecticides

Sevin is the trade name of carbaryl, a carbamate insecticide. It is relatively safe, controls many kinds of insects, and is the most common garden insecticide used. However, mites may build up where it is used. Sevin is also very toxic to honey bees. Use it as little as possible when the plants are in bloom and apply it late in the day when bee activity is reduced.

Malathion is an organophosphate insecticide fre- quently used in the home garden because it is relatively safe to apply, and its residues disappear quickly. It effectively controls many pests, including aphids, spider mites and bean beetles.

Pyrethrum is a contact botanical insecticide, not a stomach poison, and provides rapid knockdown of many garden insect pests.

Pyrethroid insecticides (bifenthrin, cyfluthrin, cyhalothrin, permethrin) are similar to pyrethrum, but are synthetic, more photostable and have a longer residual. Pyrethroids are used against a wide variety of insects, including caterpillars, flea beetles and others.

Spinosad is a mixture of spinosyn A and spinosyn D fermentation products derived from the bacterium, *Saccharopolyspora spinosa*. This product is active against caterpillars, leafminers, thrips, Colorado potato beetle and some borers. Spinosad does not impact predatory beneficial insects, beneficial mites and spiders.

Bacillus thuringiensis subspecies *kurstaki* is a bac- terial insecticide that is sold in most home garden stores under various trade names. This product is extremely effective against various caterpillars (particularly cabbageworms). However, good coverage of plants is necessary since the toxins of this bacterium must be eaten by the caterpillars before they become diseased.

Chemical Control of Insects

The severity and type of pest problems on garden vegetables usually vary considerably from year to year. During most growing seasons, consistent production of high-quality vegetables is assured only with the use of pesticides for control of insects and diseases. This is not to suggest that vegetables cannot be grown without pesticides by using nonchemical methods, but it will usually take more effort on the part of the gardener and some damage (sometimes severe) must be accepted.

The pattern of pesticide use (preventive and curative) depends largely on the type of pest. Generally, fungicides are used to prevent the establishment of dis- eases, and insecticides are used after insect infestations are found. However, if you do have an insect pest thatusually causes serious damage, an insecticide should be applied when the infestation first develops. Fungicides should be applied before there is evidence of plant damage. Repeat treatments of both fungicides and insecticides should be made every week or 10 days if disease development or insect infestations continue, or as directed by label. More frequent applications may be needed during moist weather. Whether you use a dust or a spray, only those parts of the plant that are actually coated with the fungicide or insecticide are protected.

Pesticides may be used as a dust or a spray. Dusts are ready to use when purchased; they require no mixing. They can be applied with less expensive equipment than that needed for sprays. Sprays must usually be mixed by the home gardener, but they are frequently more effective. Some sprays are in ready-to-use form, but they are generally more expensive.

Dusts

Home gardeners usually prefer dusts because they are easier to handle and apply. Dusts should be applied while the air is calm, usually in the early morning or late afternoon. Plunger, bellows and rotary types of hand dusters are satisfactory for home garden use. An applicator that delivers a continuous cloud of dust is generally more effective than one that delivers dust in puffs. Apply an even light coating of dust at the label recommended rate. Force it through the foliage so both sides of the leaves are covered.

Sprays

It is usually necessary to prepare sprays by mixing wettable powders or emulsifiable concentrates with water. Compressed-air, knapsack and bucket pump sprayers are best for applying sprays. The compressed- air sprayer is usually the handiest. Both plastic and metal (stainless steel and galvanized) sprayers are available. Stainless steel sprayers are more expensive but will last much longer. Plastic sprayers are quite good but must be kept from high temperatures and extended periods in direct sunlight.

If a wettable powder is used, stir it vigorously in a small amount of water to make a smooth suspension. Add the slurry to the full amount of water and stir until completely mixed. When applying a wettable powder spray, shake the applicator frequently to keep the powder from settling to the bottom.

If you use an emulsifiable concentrate, shake the pesticide container well before measuring out the spray mixture.

Advantages or Disadvantages of Dusts versus Spray Applications

Dusts:

Advantages

- Ready-to-use formulations.
- No mixing required.
- Duster less expensive than sprayer.
- Dust formulations less expensive than spray formulations.

Disadvantages

- Do not adhere to plant surfaces as well as sprays.
- Blow in the wind.
- Drift to plant blossoms, injure bees.
- Less effective control.
- Less plant protection.

Sprays:

Advantages

- Better coverage of plant surfaces with mist spray.
- Adhere to plant surface.
- Less toxic to bees.
- Less problem with drifting.
- Higher level of control.
- Better plant protection.

Disadvantages

- Mixing required.
- Agitation of wettable powder spray mixture in sprayer required.
- Formulations more expensive than dusts.

The Compressed Air Sprayer

The nozzle is the most important part of the sprayer for it determines the spray pattern of insecticide delivered to a plant surface. Different nozzle spray patterns include a solid stream, a flat fan spray, hollow cone or solid cone pattern. The nozzle determines the amount of spray output at a given pressure during a specified time. Many garden sprayers have an adjustable nozzle that will deliver two or more spray patterns. To determine the delivery rate of your sprayer in gallons per minute, follow these steps:

1. Fill the sprayer tank with clean water.
2. Pump the air pump until the desired pressure of 20 to 40 psi is reached in the tank.

3. Adjust the nozzle to deliver the desired pattern.
4. Place the spray nozzle in a bucket, can or jar to collect the liquid to be sprayed.
5. Open the valve and discharge the spray liquid into the bucket, can or jar for a specified time period of 20 or 30 seconds.
6. Measure the ounces of water collected.
7. Multiply the ounces collected in 20 seconds by 3 or in 30 seconds by 2 to determine the fraction of a gallon sprayed per minute.

Applying an Insecticide to Plants

Spraying

It is important that the sprayed plants be thoroughly covered. To get thorough coverage, spray the plant from two or three directions and from underneath as well as from above. If the label instructions say "wet thoroughly or to the drip point," apply a mist spray until the plant begins to drip.

A fine mist of spray will deposit many fine particles on the foliage, resulting in better coverage and a higher level of control.

Using Insecticides Properly to Prevent Pollution

The proper use of insecticides will reduce the pollution of our environment to a minimum. Insecticides are carried into water on soil particles which erode. Take measures necessary to prevent erosion.

DO NOT pour excess spray mixtures or insecticides into sewage systems. Every little bit disposed of in this way adds to the stream pollution problem. Wash the residues from your empty container and mix them into your garden spray. Apply the last drop of the pesticide to your plants.

Cleaned cans or bottles can be delivered to a sanitary landfill. Observe wind conditions and avoid spraying during periods of windy weather to prevent drift.

Mixing a Garden Spray

- Read the label carefully.
- Measure the amount carefully using level teaspoon or tablespoon quantities.
- Mix the insecticide thoroughly in a small volume of water, then bring the liquid up to the desired level.
- Wash all insecticides off the skin immediately.

Applying a Garden Spray

- Adjust sprayer to deliver a fine mist spray.
- Direct spray to infested areas of plant.
- Thoroughly wet plant parts to the point of runoff.
- Apply sprays during periods of favorable weather:
  - 70-85 F - temperature
  - Wind less than 5 miles per hour
  - No rain forecast within 24 hours
- Repeat application if rainfall exceeds ½ inch within 24 hours after applying.
- Keep sprayer in good condition:
  1) Wash thoroughly after each use.
  2) Hang tank upside down with pump assembly removed for complete drying.
  3) Do not use your insecticide or fungicide sprayer for spraying weed killers or vice versa.
  4) Buy two sprayers and label them.

Application Rate of Insecticides for Home Gardens

Estimate the amount of spray or dust you will need to cover your garden vegetables for effective control.

These rules of thumb for estimating amounts are based on the linear feet of a row or the number of square feet See the label for actual rates (ounces/square or linear feet).

- One-half gallon will spray 100 feet of row.
- One-half gallon will spray 250 square feet.
- Four ounces (1/4 lb.) of dust will treat 120 feet of row.
- Four ounces (1/4 lb.) of dust will treat 250 square feet.

Row Applications

- Rows 12 inches apart - 43,560 feet of row per acre
- Rows 24 inches apart - 21,780 feet of row per acre

- Rows 36 inches apart - 14,520 feet of row per acre
- Rows 48 inches apart - 10,890 feet of row per acre

Example:

How much spray should you put on 100 feet of row if the nozzles on the spray boom are 24 inches apart and the recommended application rate is 150 gallons per acre?

Calculation:

150 gallons for 21,780 feet = X gallons on 100 feet.

$X = \frac{150 \times 100}{21{,}780} =$ 0.688 gallons per nozzle per 100 ft. (slightly less than 2 ½ qts.)

Safe Handling of Insecticides

Home gardeners can control insect pests with reasonable safety by observing these safety rules:

- Keep insecticides in the original, labeled container.
- Keep insecticides in a locked storage cabinet.
- Read the label each time you use the insecticide.
- Measure the amount to be mixed carefully.
- Do not exceed the recommended rate of application.
- Handle the insecticide carefully when mixing to avoid splashing of liquid concentrates and billowing of dusts and powders.
- Wear protective clothing and other personal protection equipment, as directed by the label.
- To protect yourself when mixing insecticides, it is suggested that protective clothing and equipment such as chemical-resistant gloves, a long-sleeve shirt, long pants and protective eyewear be worn.
- Wash all insecticides off the skin immediately, using plenty of soap and water.
- Avoid breathing the spray mist or vapor.
- Always mix insecticides out of doors near a source of water.
- Clean up any spilled materials to prevent children from entering a heavily contaminated area.
- Apply insecticides only to those plants listed on the label.
- Observe the time intervals between the last application and harvest.

Fire Ants

Fire ants occasionally feed on vegetable plants in home gardens. They tunnel into potatoes underground and feed on okra buds and developing pods. The worst damage usually occurs during hot, dry weather. Ants may also be a nuisance to gardeners during weeding and harvesting. See fireants.utk.edu for more information on managing fire ants.

Treatment options

- A bait, Extinguish (methoprene), is labeled for cropland. Another fire ant bait, Esteem (pyriproxyfen), is labeled for some crops such as broccoli, cabbage, cauliflower, kale, mustard greens, cucumber, pumpkins, squash, melons, okra, pepper, tomato, etc. Extinguish and Esteem are insect growth regulators and may require several months to work. Fertilome Come and Get It Fire Ant Killer (spinosad) and Payback Fire Ant Bait with spinosad labels list home garden plants and may require a few weeks to work.
- Hi-Yield Vegetable & Ornamental Insect Control Granule, or Monterey Garden Insect Spray (spinosad, OMRI listed) may be used as an individual mound treatment in a variety of crops such as tomatoes, sweet corn, green peas, sugar snap peas, snow peas, green beans (wax beans, snap beans), dry beans (black-eyed peas, cow pea), cucumber, gourds, muskmelon, pumpkin, squash, and watermelon, broccoli, Chinese broccoli, cabbage, cauliflower, kohlrabi, eggplant, head lettuce, and peppers (bell and non-bell). Natural Guard Spinosad Bagworm, Tent Caterpillar and Chewing Insect Control is also

registered for a variety of home garden plants.

- Ant mounds can be shoveled out of the garden or treated with very hot water, taking care not to disturb or treat the garden plants. Caution should be taken to prevent hot water and/or steam from injuring the applicator.
- Since most other baits are not registered for use inside gardens, those baits can be applied around the garden perimeter. Foraging ants from colonies both inside and outside the garden will collect the bait and take it to their colonies.
- To prevent ants from entering a garden, apply insecticidal spray or granules around the perimeter of the garden as a barrier, and treat individual mounds near the garden as needed.

Slugs and Snails

Slugs and snails can be controlled in home gardens using iron phosphate (Sluggo, Escar-Go!, Worry Free) or metaldehyde baits. Do not contact plant material with slug baits. Consult the label for specific vegetables it can be used on. Grasshoppers and crickets can be controlled in the home garden using a 5 percent Sevin bait.

Preplant Insecticides for Wireworms, Fire Ants and Other Soil Insects

A single application of 0.115 percent bifenthrin (Hi-Yield Vegetable & Ornamental Insect Control Granule, or Heavy Weight Multi Insect & Fire Ant Killer) applied just prior to planting or after plants emerge and worked into the top 4 to 6 inches of soil may protect seedlings from wireworms, fire ants or other soil insects. Use 1.0 lb. of product for a 500 sq. ft. area, see label for details.

Home Vegetable Garden Insect Control

VEGETABLE/INSECT	INSECTICIDE & FORMULATION L=Liquid, D=Dust, G=Granular	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
ASPARAGUS asparagus beetle Japanese beetle	carbaryl 22.5% L	3 Tbsp	1	Treat fern and brush growth as beetles appear. Repeat applications as necessary up to 3 times prior to harvest or 5 times per crop but not more often than once every 7 days.
	permethrin 2.5% L	3 Tbsp	3	Do not apply L more than 4 times per crop.
BEANS - check product for specific beans aphids				When available, insecticide-treated seeds should be used to avoid problems with seed corn maggots and other soil insect pests.
	malathion 50% L (Spectracide)	1 ½ to 2 tsp	1	Apply up to 2 times/yr. waiting at least 7 days between applications.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	insecticide soap (potassium salts of fatty acids) 49.52% L	5 Tbsp	0	Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.
bean beetles (Mexican bean beetle, bean leaf beetle)	carbaryl 22.5% L 5 D	3 Tbsp Apply according to label	3 (fresh beans) 21 (dried beans) 3 (fresh beans) 21 (dried beans)	For both fresh and dried beans repeat as necessary up to 4 times, but not more than once every 7 days.
	bifenthrin 0.3% & Zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	gamma cyhalothrin 0.08% L	Apply according to label.	7	Wait at least 7 days between each application. Do not apply more than 9 times per growing season.
corn earworm	carbaryl 22.5% L 5 D	3 Tbsp Apply according to label	3 (fresh beans) 21 (dried beans) 3 (fresh beans) 21 (dried beans)	Repeat treatments at 7-day intervals may be needed on late beans. Do not treat fresh or dried beans more than 4 times per season.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.

VEGETABLE/INSECT	INSECTICIDE & FORMULATION L=Liquid, D=Dust, G=Granular	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
BEANS (cont'd) corn earworm	gamma cyhalothrin 0.08% L	Apply according to label.	7	Wait at least 7 days between each application. Do not apply more than 9 times per growing season.
	spinosad 0.5% L	4 Tbsp	3 succulent beans 28 dried beans	Maximum of 6 applications per year. Wait 5 days before reapplying.
cowpea curculio	See peas.			
spider mites	insecticide soap (potassium salts of fatty acids) 49.52%	5 Tbsp	0	Begin at first signs of mites and off-color. Repeat applications may be needed, especially during hot weather. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.
	malathion 50% L (Spectracide)	1 Tbsp	1	Apply up to 2 times/yr. waiting at least 7 days between applications.
stink bug	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
thrips, lima bean borer	spinosad 0.5%	4 Tbsp	3 succulent beans 28 dried beans	Maximum of 6 applications per season; Wait 5 days before reapplying.
whitefly	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	insecticide soap (potassium salts of fatty acids) 49.52% L	5Tbsp	0	Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.
BEETS, GARDEN flea beetles	carbaryl 22.5 % L	3 Tbsp	7	Repeat up to 6 times but not more often then once every 7 days.
BROCCOLI	malathion 50% L (Spectracide)	1 ½ to 2 tsp	2	Apply up to 2 times/yr. waiting at least 7 days between applications.
aphid	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	7	Wait at least 7 days between each application.

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BROCCOLI (cont'd) aphid	insecticide soap (potassium salts of fatty acids) 49.52% L	5 Tbsp	0	For suppression. Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2 week period. Do not apply during heat of day or when temps exceed 90 F.
cabbageworms	Bacillus thuringiensis subsp. kurstaki	As recommended on the label.	0	Treat as soon as damage is found and repeat weekly.
	esfenvalerate 0.425% L	As recommended on the label.	3	Wait at least 7 days between each application.
	permethrin 2.5% L 0.25% D	2 Tbsp Apply according to label.	1	Do not apply more than 8 applications of L and not more often than every 5 days. Do not apply D more than 8 times per season.
	spinosad 0.5% L	4 Tbsp	1	Maximum of 6 applications per season. Wait 4 days before reapplying.
stink bugs	carbaryl 22.5 % L	3 Tbsp	3	Repeat as necessary up to 4 times, but not more than once every 7 days.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	7	Wait at least 7 days between each application.
BRUSSELS SPROUTS aphid	malathion 50% L (Spectracide)	1 ½ to 2 tsp	2	Apply up to 2 times/yr. waiting at least 7 days between applications.
	insecticide soap (potassium salts of fatty acids) 49.52% L	5 Tbsp	0	For suppression. Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.
cabbageworms	Bacillus thuringiensis subsp. kurstaki	As recommended on the label.	0	Begin treatment when first noted and repeat weekly until harvest.

VEGETABLE/INSECT	INSECTICIDE & FORMULATION L=Liquid, D=Dust, G=Granular	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
BRUSSELS SPROUTS (cont'd) cabbageworms	permethrin 2.5% L 0.25% D	2 Tbsp Apply according to label.	1	Do not apply more than 8 applications of L and not more often than every 5 days. Do not apply D more than 8 times per season.
	spinosad 0.5% L	4 Tbsp	1	Maximum of 6 applications per season. Wait 4 days before reapplying.
CABBAGE aphid	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	7	Wait at least 7 days between each application.
	insecticide soap (potassium salts of fatty acids) 49.52% L	5Tbsp	0	Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.
cabbage maggot and cutworm	bifenthrin 0.115% G	Use 1 lb. product per 500 sq. ft.	7	A single application may be applied just prior to planting or after plants emerge and worked into the top 4 to 6 inches of soil.
cutworm	permethrin 0.25% D	Apply according to label.	1	Do not apply more than 5 times per season.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	7	Wait at least 7 days between each application.
cabbageworms	Bacillus thuringiensis subsp. kurstaki	As recommended on the label.	0	Good coverage is essential. Upper and lower leaves. Treat as soon as damage is found and repeat weekly until harvest.
	permethrin 2.5% L 0.25% D	2 Tbsp Apply according to label.	1	Do not apply L formulation more than 10 times. Do not apply D formulation more than 5 times per season for tight-heading varieties.
	esfenvalerate 0 .425% L	As recommended on the label.	3	Wait at least 7 days between each application.
	spinosad 0.5% L	4 Tbsp	1	Maximum of 6 applications per season. Wait 4 days before reapplying.
flea beetles	carbaryl 22.5% L	3 Tbsp	3	On foliage, as needed Repeat as necessary up to 4 times, but not more than once every 7 days.
	permethrin 0.25% D	Apply according to label.	1	Do not apply more than 5 times per season.

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CABBAGE (cont'd) harlequin bug	carbaryl 22.5% L	3 Tbsp	3	Apply when necessary but not more than 4 times; wait at least 7 days between applications.
CANTALOUPE aphid	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	insecticide soap (potassium salts of fatty acids) 49.52% L	5 Tbsp	0	Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.
cucumber beetles	carbaryl 22.5% L	3 Tbsp	3	Repeat as necessary up to 6 times, but not more than once every 7 days.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	permethrin 2.5% L 0.25% D	As recommended on the label.	0	Do not apply L more than 8 times per year. Do not apply D formulation more than 8 times per season. For use on adult beetles.
leafminer	spinosad 0.5% L	4 Tbsp	3	Maximum of 6 applications per season. Wait 5 days before reapplying.
pickleworm	carbaryl 22.5 % L	3 Tbsp	3	Late-planted cantaloupes are heavily attacked. Begin treatments at first bloom; repeat as necessary up to 6 times, but not more than once every 7 days.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	permethrin 2.5% L 0.25% D	As recommended on the label.	0	Do not apply L formulation more than 8 times per year. Do not apply D formulation more than 8 times per season.
	spinosad 0.5% L	4 Tbsp	3	Maximum of 6 applications per season; wait 5 days before reapplying.
spider mite	insecticide soap (potassium salts of fatty acids) 49.52% L	5Tbsp	0	Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.

VEGETABLE/INSECT	INSECTICIDE & FORMULATION L=Liquid, D=Dust, G=Granular	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
COLLARDS aphid	malathion 50% L (Bonide)	3 tsp	7	Make 2 or more applications as needed. Apply when necessary, waiting at least 7 days between applications.
cabbageworms	Bacillus thuringiensis subsp. kurstaki	As recommended on the label.	0	Begin treatments as soon as damage is found and repeat weekly until harvest.
	esfenvalerate 0.425% L	As recommended on the label.	7	Wait at least 7 days between each application.
	spinosad 0.5%	4 Tbsp	1	Maximum of 6 applications per season. Wait 4 days before reapplying.
flea beetles	carbaryl 22.5 % L	3 Tbsp	14	On foliage as needed. Repeat as necessary up to 4 times, but not more than once every 7 days.
	esfenvalerate 0.425% L	As recommended on the label.	7	Wait at least 7 days between each application.
harlequin bug	malathion 50% L (Bonide)	1 Tbsp	7	Make 2 or more applications as needed. Apply when necessary, waiting at least 7 days between applications
	carbaryl 22.5% L	3 Tbsp	14	Repeat as necessary up to 4 times, but not more than once every 7 days.
CORN, SWEET corn earworm, fall armyworm, European corn borer	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	carbaryl 22.5% L	3 Tbsp	2	Begin treating when silks appear. Repeat with sprays directed at ears as necessary up to 8 times, but not more than once every 7 days.
	cyfluthrin 0.75% L cyfluthrin 0.75% L	Ready-to-spray formula 1 Tbsp	0 0	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply ready-to-spray more than 5 times per season nor concentrate more than 10 times.
	esfenvalerate 0.425% L	As recommended on the label.	1	Wait at least 7 days between each application.

VEGETABLE/INSECT	INSECTICIDE & FORMULATION L=Liquid, D=Dust, G=Granular	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
CORN, SWEET (cont'd) corn earworm, fall armyworm, European corn borer	permethrin 2.5% L 0.25% D	 3 Tbsp Apply according to label	1	Apply L as needed every 5 days, but do not apply L or D more than 6 times per season.
	spinosad 0.5% L	4 Tbsp	1	Maximum of 6 applications per season. Wait 3 days before reapplying.
flea beetle	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	carbaryl 22.5% L	3 Tbsp	2	Early application on seedling corn is usually necessary. Repeat up to 8 times, but not more than once every 7 days. Application during pollen shed will seriously reduce bee populations.
	cyfluthrin 0.75% L cyfluthrin 0.75% L	Ready-to-spray formula 1 Tbsp	0 0	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply ready-to-spray more than 5 times per season nor concentrate more than 10 times.
stink bug	cyfluthrin 0.75% L	Ready-to-spray	0	Do not spray more than 10 times per season.
CUCUMBER aphid	insecticide soap (potassium salts of fatty acids) 49.52% L	5Tbsp	0	For suppression. Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F. Apply to cucumbers at night or during coolest part of day.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	carbaryl 22.5% L 5 D	3 Tbsp Apply according to label.	3 3	Apply Sevin late in the day to minimize killing pollinating insects. Repeat up to 6 times, but not more than once every 7 days.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.

VEGETABLE/INSECT	INSECTICIDE & FORMULATION L=Liquid, D=Dust, G=Granular	AMOUNT OF FORMULATION PER GALLON OF SPRAY (or as otherwise noted)*	MIN. INTERVAL (DAYS) BETWEEN LAST APPLICATION AND HARVEST	REMARKS AND PRECAUTIONS
CUCUMBER (cont'd) aphid	esfenvalerate 0.425% L	As recommended on the label.	3	For use on cucumber beetle adults. Wait at least 7 days between each application.
cucumber beetle, squash bug	malathion 50% L (Bonide)	3 tsp or 1 Tbsp	1	Apply when necessary, waiting at least 7 days between applications. Do not apply unless plants are dry.
	permethrin 2.5% L 0.25% D	As recommended on the label	0	For use on cucumber beetle adults. Do not apply more than 8 times per year.
spider mites	insecticide soap (potassium salts of fatty acids) 49.52% L	5Tbsp	0	For suppression. Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F. Apply to cucumbers at night or during coolest part of day.
EGGPLANT aphids	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	7	Wait at least 7 days between each application.
	malathion 50% L (Bonide)	4 tsp	3	Apply treatment when aphids present and repeat when needed. Make 2 or more applications. Wait at least 7 days between each application
	insecticide soap (potassium salts of fatty acids) 49.52% L	5Tbsp	0	For suppression. Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.
Colorado potato beetle	carbaryl 22.5% L	3 Tbsp	3	On foliage as needed. Repeat up to 7 times, but not more than once every 7 days.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	7	Wait at least 7 days between each application.
	esfenvalerate 0.425% L	As recommended on the label.	7	Wait at least 7 days between each application.
	permethrin 2.5% L 0.25% D	6 Tbsp Apply according to label.	3	Do not apply L formulation more than 16 times. Do not apply D formulation more than 10 times per season.

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EGGPLANT (cont'd) Colorado potato beetle	spinosad 0.5% L	4 Tbsp	1	Maximum of 6 applications per season. Wait 4 days before reapplying.
flea beetle	carbaryl 22.5% L	3 Tbsp	3	On foliage as needed. Repeat up to 7 times, but not more than once every 7 days.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	7	Wait at least 7 days between each application.
lacebug	malathion 50% L (Bonide)	4 tsp	3	Wait at least 7 days between each application.
spider mite	malathion 50% L (Bonide)	4 tsp	3	Repeat treatments are often necessary. Do not use Kelthane! Wait at least 7 days between each application.
	insecticide soap (potassium salts of fatty acids) 49.52% L	5Tbsp	0	For suppression. Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.
stink bug	cyfluthrin 0.75% L	Ready-to-spray	7	Do not spray more than 6 times per season.
whitefly	pyrethrin (aerosol)		1	
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	7	Wait at least 7 days between each application.
	insecticide soap (potassium salts of fatty acids) 49.52% L	5 Tbsp	0	For suppression. Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.
LETTUCE aphid	malathion 50% L (Spectracide)	1 ½ to 2 tsp.	14	Apply up to 2 times/yr. Wait 6 days between application for head lettuce and 5 days for leaf lettuce.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	7	Wait at least 7 days between each application.

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LETTUCE (cont'd)	Bacillus thuringiensis subsp. kurstaki	As recommended on the label	0	Begin treatments as soon as damage is found and repeat weekly until harvest.
cabbageworms	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	7	Wait at least 7 days between each application.
	permethrin 2.5% L 0.25% D	4 Tbsp Apply according to label.	1	Apply every 5 to 10 days as needed, but do not apply L formulation more than 10 times per season. Do not apply D formulation more than 5 times per season.
	spinosad 0.5% L	4 Tbsp	1	Maximum of 6 applications per season. Wait 4 days before reapplying.
MUSTARD GREENS aphid	malathion 50% L (Bonide)	3 tsp	7	Wait at least 7 days between each application.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	7	Wait at least 7 days between each application.
caterpillars	Bacillus thuringiensis subsp. kurstaki	As recommended on the label.	0	Begin treatments as soon as damage is found and repeat weekly or as necessary until harvest.
	spinosad 0.5% L	4 Tbsp	1	Maximum of 6 applications per season. Wait 4 days before reapplying.
flea beetles	carbaryl 22.5% L	3 Tbsp	14	Repeat up to 4 times, but not more than once every 7 days.
OKRA aphids	insecticide soap (potassium salts of fatty acids) 49.52% L	5Tbsp	0	Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.
	permethrin 2.5% L	4 Tbsp	1	Every 5 to 10 days as needed, but do not apply L formulation more than 10 times per season.
stink bug	carbaryl 22.5% L	3 Tbsp	3	Repeat up to 7 times, but not more than once every 7 days.
	cyfluthrin 0.75% L	Ready-to-spray	0	Do not spray more than 4 times per season.
ONIONS thrips	malathion 50% L (Bonide)	2 ½ tsp	3	Wait at least 7 days between each application.

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PEAS aphid	malathion 50% L (Spectracide)	1 ½ to 2 tsp	3	Make up to 2 applications per yr. Wait at least 7 days between each application.
	insecticide soap (potassium salts of fatty acids) 49.52% L	5 Tbsp	0	For suppression. Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.
cowpea curculio	esfenvalerate 0.425% L	As recommended on the label.	3 (fresh peas) 21 (dried peas)	Wait at least 7 days between each application.
European corn borer	carbaryl 22.5% L	3 Tbsp	3 (fresh peas) 21 (dried peas)	This insect is a more serious pest on late peas. Treat 1 to 2 weeks prior to bloom. Repeat applications as necessary up to 4 times, but not more often than once every 7 days.
	esfenvalerate 0.425% L	As recommended on the label.	3 (green peas) 21 (dried peas)	Wait at least 7 days between each application.
lesser cornstalk borer	spinosad 0.5% L	4 Tbsp	3 succulent peas 28 dried peas	Maximum of 6 applications per season. Wait 5 days before reapplying.
	spinosad 0.5% L	4 Tbsp	3	A problem on late peas. Maximum of 6 applications per season. Wait 5 days before reapplying.
stink bug	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
PEPPER aphid	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	7	Wait at least 7 days between each application.
	malathion 50% L (Bonide)	2 ½ tsp	3	Wait at least 7 days between each application.
	insecticide soap (potassium salts of fatty acids) 49.52% L	5Tbsp	0	For suppression. Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.

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PEPPER (cont'd) armyworms, cabbage loopers, corn earworms, leafminers	cyfluthrin 0.75% L	Ready-to-spray formula	7	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply more than 6 times per season.
	cyfluthrin 0.75% L	1 Tbsp	7	
	permethrin 0.25% D	Apply according to label.	3	Do not apply more than 8 times per season.
	spinosad 0.5% L	4 Tbsp	1	Maximum of 6 applications per season. Wait 4 days before reapplying.
flea beetle	carbaryl 22.5% L	3 Tbsp	3	Repeat applications as necessary up to 7 times, but not more often than once every 7 days.
European corn borer	carbaryl 22.5% L	3 Tbsp	3	Spray plants thoroughly, especially pepper caps, every 7 days after blossoms appear and fruit forms, but not more than 7 times.
	cyfluthrin 0.75% L	Ready-to-spray formula	7	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply more than 6 times per year.
	cyfluthrin 0.75% L	1 Tbsp		
	esfenvalerate 0.425% L	As recommended on the label.	7	Wait at least 7 days between each application.
	permethrin 2.5% L 0.25%D	4 Tbsp Apply according to label.	3	Do not apply more than 8 times per season.
	spinosad 0.5% L	4 Tbsp	1	Maximum of 6 applications per season. Wait 4 days before reapplying.
stink bug	cyfluthrin 0.75% L	Ready-to-spray	7	Do not spray more than 6 times per season.
POTATOES, IRISH aphid	esfenvalerate 0.425% L	As recommended on the label.	7	Wait at least 7 days between each application.
Colorado potato beetle	malathion 50% L (Bonide)	1 ½ tsp	0	Wait at least 7 days between each application.
	permethrin 2.5% L 0.25% D	3 Tbsp Apply according to label.	7 14	Do not apply L formulation more than 12 times. Do not apply D formulation more than 8 times per season.
	spinosad 0.5% L	4 Tbsp	7	Maximum of 6 applications per season. Wait 7 days before reapplying.

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POTATOES, IRISH (cont'd) flea beetle, leafhoppers	carbaryl 22.5% L 5 D	 3 Tbsp Apply according to label.	 7 6	Repeat applications as necessary up to 6 times, but not more often than once every 7 days.
	esfenvalerate 0.425% L	As recommended on the label.	7	Wait at least 7 days between each application.
potato tuberworm	esfenvalerate 0.425% L	As recommended on the label.	7	Wait at least 7 days between each application.
	permethrin 2.5% L 0.25% D	3 Tbsp Apply according to label.	7 7-14 see label	Do not apply L formulation more than 12 times. Do not apply D formulation more than 8 times per season.
	spinosad 0.5% L	4 Tbsp	7	Maximum of 6 applications per season. Wait 7 days before reapplying.
RADISHES aphid	malathion 50% L (Spectracide)	1 ½ to 2 tsp	7	Make up to 3 applications per year. Wait at least 7 days between each application.
	esfenvalerate 0.425% L	As recommended on the label.	7	Wait at least 7 days between each application.
cutworms	cyfluthrin 0.75% L cyfluthrin 0.75% L	Ready-to-spray formula 1 Tbsp	0	Do not apply more than 5 times per season.
	esfenvalerate 0.425% L	As recommended on the label.	7	Wait at least 7 days between each application.
flea beetles	carbaryl 22.5% L 5 D	 3 Tbsp Apply according to label.	 7 7	Do not apply L formulation more than 6 times. Do not apply D formulation more than 4 times per season.
	cyfluthrin 0.75% L cyfluthrin 0.75% L	Ready-to-spray formula 1 Tbsp	0	Do not apply more than 5 times per season.
SQUASH & PUMPKIN aphid	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	malathion 50% L (Bonide)	3 tsp	3 Pumpkin 1 squash	Do not apply unless leaves are dry. Wait at least 7 days between each application.

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SQUASH & PUMPKIN (cont'd) aphid	insecticide soap (potassium salts of fatty acids) 49.52% L	5 Tbsp	0	For summer squash. For suppression. Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.
cucumber beetles, flea beetles	carbaryl 22.5% L	3 Tbsp	3	Apply Sevin late in the day to minimize killing pollinating insects. Leaf injury may occur if tender foliage is wet or humidity is high. Repeat applications as necessary up to 6 times, but not more often than once every 7 days.
	5 D	Apply according to label.	3	
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	esfenvalerate 0.425% L	As recommended on the label.	3	Wait at least 7 days between each application.
	permethrin 2.5% L 0.25%D	4 Tbsp Apply according to label.	0 0	Do not apply L more than 8 times per year. Do not apply D more than 8 times per season.
leafminer	spinosad 0.5% L	4 Tbsp	3	Maximum of 6 applications per season. Wait 5 days before reapplying.
pickleworm, squash vine borer	carbaryl 22.5% L	3 Tbsp	3	Treat when damage to blossoms or other plant parts is noticed. More of a problem on late squash than early. Direct sprays at base of plants for vine borer control. Repeat applications as necessary up to 6 times, but not more often than once every 7 days.
	esfenvalerate 0.425% L	As recommended on the label.	3	Wait at least 7 days between each application.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	permethrin 0.25% D	Apply according to label.	0	Do not apply more than 8 times per season.
	spinosad 0.5% L	4 Tbsp	3	Maximum of 6 applications per season; wait 5 days before reapplying.

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SQUASH & PUMPKIN (cont'd) squash bug	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	esfenvalerate 0.425% L	As recommended on the label.	3	Wait at least 7 days between each application.
	permethrin 2.5% L 0.25%D	As recommended on the label.	0	Do not apply more than 8 times per season.
stink bug	cyfluthrin 0.75% L	Ready-to-spray	0	Do not spray more than 4 times per season.
TOMATO aphid	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	1	Wait at least 7 days between each application.
	malathion 50% L (Spectracide)	1 ½ to 2 tsp	1	Make up to 4 applications per yr. at least 5 day s apart.
	insecticide soap (potassium salts of fatty acids) 49.52% L	5Tbsp	0	For suppression. Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F. Apply to cucumbers at night or during coolest part of day.
beetles, blister beetles	carbaryl 22.5% L 5 D	 3 Tbsp Apply according to label	 3 3	Flea beetles are more destructive on new set plants. Blister beetles are more common later in the season. Repeat applications as necessary up to 7 times, but not more often than once every 7 days.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	1	Wait at least 7 days between each application.
	gamma cyhalothrin 0.08% L	Apply according to label.	5	Wait at least 7 days between each application. Do not apply more than 9 times per growing season.
cutworms	cyfluthrin 0.75% L cyfluthrin 0.75% L	Ready-to-spray formula 1 Tbsp	0	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply more than 6 times per season.

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TOMATO (cont'd) cutworms	carbaryl 22.5% L	3 Tbsp	3	Mix in enough water to get sufficient coverage of plants and soil around plants. Repeat applications as necessary up to 7 times, but not more often than once every 7 days.
	esfenvalerate 0.425% L	As recommended on the label.	1	Wait at least 7 days between each application.
	permethrin 2.5% L 0.25% D	3 Tbsp As recommended on the label.	0 0	Do not apply L formulation more than 8 times per season. Do not apply D formulation more than 6 times per year.
Colorado potato beetle	carbaryl 22.5% L	3 Tbsp	3	Repeat applications as necessary up to 7 times, but not more often than once every 7 days.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	1	Wait at least 7 days between each application.
	permethrin 2.5% L 0.25% D	3 Tbsp As recommended on the label.	0	Do not apply L formulation more than 8 times per season. Do not apply D formulation more than 6 times per year.
	spinosad 0.5% L	4 Tbsp	1	Maximum of 6 applications per season; wait 4 days before reapplying.
leafminer	spinosad 0.5% L	4 Tbsp	1	Maximum of 6 applications per season; wait 4 days before reapplying.
spider mite	insecticide soap (potassium salts of fatty acids) 49.52% L	5 Tbsp	0	No more than 3 applications in 2-weeks. Do not apply in heat of day when leaf temp above 90 F.
	malathion 50% L (Spectracide)	1 Tbsp	1	Make up to 4 applications per yr. at least 5 days apart.
stink bug and leaf-footed bug	carbaryl 22.5% L	3 Tbsp	3	Repeat applications as necessary up to 7 times, but not more often than once every 7 days.
	cyfluthrin 0.75% L cyfluthrin 0.75% L	Ready-to-spray formula 1 Tbsp	0	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply more than 6 times per season.
	permethrin 0.25% D	Apply according to label	0	Do not apply more than 6 times per season.

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TOMATO (cont'd) stink bug and leaf-footed bug	esfenvalerate 0.425% L	As recommended on the label.	1	Wait at least 7 days between each application.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	1	Wait at least 7 days between each application.
tomato fruitworm and hornworm	Bacillus thuringiensis subsp. kurstaki	As recommended on the label	0	Begin treatments when damage is first noted and repeat weekly until harvest. Handpicking of hornworms is often sufficient if few plants are involved.
	carbaryl 22.5% L	3 Tbsp	3	Repeat applications as necessary up to 7 times, but not more often than once every 7 days.
	cyfluthrin 0.75% L cyfluthrin 0.75% L	Ready-to-spray formula 1 Tbsp	0	Apply to flowering plants during early morning or late evening, when bees are not present. Do not apply more than 6 times per season.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	1	Wait at least 7 days between each application.
	esfenvalerate 0.425% L	As recommended on the label.	1	Wait at least 7 days between each application.
	permethrin 2.5% L 0.25% D	3 Tbsp As recommended on the label.	0 0	Do not apply L formulation more than 8 times per season. Do not apply D formulation more than 6 times per year.
	spinosad 0.5% L	4 Tbsp	1	Maximum of 6 applications per season. Wait 4 days before reapplying.
whitefly	Pyrethrin (aerosol)	According to label.	0	Inspect undersides of leaves when purchasing transplants. Do not buy if whiteflies are observed. Spray underside of leaves; repeated weekly applications needed for control.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	1	Wait at least 7 days between each application.
	insecticide soap (potassium salts of fatty acids) 49.52% L	5 Tbsp	0	No more than 3 applications in 2 weeks. Do not apply in heat of day when leaf temp above 90 F.

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TOMATO (cont'd) tomato pinworm	spinosad 0.5%	4 Tbsp	1	Maximum of 6 applications per season; wait 4 days before reapplying.
	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	1	Wait at least 7 days between each application.
TURNIPS aphid	malathion 50% L (Bonide)	3 tsp	3	On foliage as needed. Wait at least 7 days between each application.
caterpillars	Bacillus thuringiensis subsp. kurstaki	As recommended on the label.	0	Begin treatment when damage is first found and repeat weekly until harvest.
flea beetles, harlequin bug	carbaryl 5 D	Apply according to label.	7 (roots) 14 (tops)	See label for application restrictions. Maximum applications per season are not to exceed 4.
WATERMELON aphid	bifenthrin 0.3% & zeta-cypermethrin 0.075% L	RTS	3	Wait at least 7 days between each application.
	insecticide soap (potassium salts of fatty acids) 49.52% L	5 Tbsp	0	For suppression. Repeat applications may be needed. Repeat at weekly to biweekly intervals up to 3 times. Do not make more than 3 sequential applications over a 2-week period. Do not apply during heat of day or when temps exceed 90 F.
cucumber beetles	carbaryl 22.5% L 5D	3 Tbsp Apply according to label.	3 3	Apply late in the day to minimize killing pollinating insects. Repeat applications as necessary up to 6 times, but not more often than once every 7 days.
	permethrin 2.5% L 0.25%D	As recommended on the label.	0	Do not apply L formulation more than 8 times per year. Do not apply D formulation more than 8 times per season. For use on adult beetles.
rindworms	See pickleworms on cantaloupes, but check label to ensure watermelon is listed.			
spider mite	insecticide soap (potassium salts of fatty acids) 49.52% L	5 Tbsp	0	No more than 3 applications in 2 weeks. Do not apply in heat of day when leaf temp above 90 F.
thrips	spinosad 0.5%	4 Tbsp	3	Maximum of 6 applications per season; wait 5 days before reapplying.

* Rates vary according to manufacturer; read the label to determine the correct rate for the product chosen.

Listed below are some of the products used to give rate recommendations in the previous tables. These are suggested products, other products do exist. If you are unable to find the product listed but can find the active ingredient and formulation, always check the label on the pesticide container to ensure the formulation chosen can be used on the pest or site needed. As always, follow the label directions when applying pesticides.

Active Ingredient	Trade Name and Web Site
Bacillus thuringiensis subspecies *kurstaki* various strains, also referred to as Bt	Not all Bt products are labeled for all pests in all crops in which Bt is listed in this publication. Check individual label before purchasing to ensure pests and crops are listed. Bonide Thuricide http://www.bonide.com/assets/Products/Labels/l802.pdf Safer Brand Caterpillar Killer for Trees, Shrubs and Vegetables Concentrate http://images.saferbrand.com/is/content/woodstream/safer/us/content/pdf/5160gal%2Dsafer%2Dbrand%2Dcaterpillar%2Dkiller%2D1%2Dgallon%2Dconcentrate%2Dinstructions.pdf Safer Brand Caterpillar Killer for Trees, Shrubs and Vegetables Concentrate II http://www.kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/42697/70051%2D106%2D42697/70051%2D106%2D42697%5FSafer%5FBrand%5FCaterpillar%5FKiller%5Ffor%5FTrees%5FShrubs%5F%5F%5FVegetables%5FConcentrate%5FII%5F2%5F19%5F2014%5F9%5F45%5F22%5FAM%2Epdf Safer Brand Garden Dust http://www.saferbrand.com/safer-brand-garden-dust-with-bt-8-oz-5162 ferti-lome Dipel Dust http://www.fertilome.com/ProductFiles/10586_FL_1lb%202-18-15.pdf
bifenthrin 0.115% G	Heavy Weight Multi-Insect & Fire Ant Killer http://www.kellysolutions.com/erenewals/documentsubmit/KellyData%5COK%5Cpesticide%5CProduct%20Label%5C75111%5C228-496-75111%5C228-496-75111_Heavey_Weight_Multi_Insect___Fire_Ant_Killer_Granules_F__3_Months_5_14_2009_2_51_26_PM.pdf
bifenthrin 0.3% & zeta-cypermethrin 0.075% L RTS	Ortho Bug-B-Gon Insect Killer for Lawns & Gardens Ready-to-Spray[1] http://www.kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/239/279%2D9535%2D239/279%2D9535%2D239%5FOrtho%5FBug%5FB%5FGon%5FInsect%5FKiller%5Ffor%5FLawns%5F%5F%5FGardens%5F%5F%5FRTS%5F3%5F27%5F2012%5F3%5F34%5F16%5FPM%2Epdf
bifenthrin 0.1% G	Hi-Yield Vegetable & Ornamental Insect Control Granules http://www.fertilome.com/ProductFiles/32327%20Veg%20Orn%20Insect%20Control%20Approved%2007-06-11.pdf

Active Ingredient	Trade Name & Web Site
bifenthrin 0.115% G	Bonide Eight Insect Control Flower & Vegetable Above & Below Soil Insect Granules, http://www.kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/4/53883-194-4/53883-194-4_Bonide_Eight_Insect_Control_Flower___Vegetable_Above___Below_Soil_Insect_Granules_2_8_2013_1_46_24_PM.pdf
carbaryl 22.5% L	*GardenTech Sevin Concentrate Bug Killer https://www.kellysolutions.com/ok/showproductinfo.asp?Product_Name=GardenTech+Sevin+Concentrate+Bug+Killer&EPA_Id=264%2D334%2D71004 *Check label closely to ensure active ingredient is carbaryl. GardenTech Sevin Concentrate Bug Killer also sold with zeta-cypermethrin as the active ingredient
carbaryl 5% D	GardenTech Sevin-5 Ready-To-Use 5% Dust Bug Killer http://www.gardentech.com
cyfluthrin 0.75% L	Bayer Advanced Vegetable & Garden Insect Spray, Concentrate http://www.bayeradvanced.com
cyfluthrin 0.75% L (RTS)	Bayer Advanced Vegetable & Garden Insect Spray, Ready-to-spray (hose end sprayer) http://www.bayeradvanced.com
esfenvalerate 0.425% L	Monterey_Bug_Buster_II http://216.119.118.152/documents/public/products/BugBusterII-2column(01)-Bilingual.pdf
gamma-cyhalothrin 0.08%	Spectracide Triazicide Insect Killer for Lawns & Landscapes, Concentrate http://www.spectracide.com/Products-and-Solutions/Outdoor-Insect-Killer.aspx
malathion 50% L	Bonide Malathion Insect Control Concentrate http://www.bonide.com/
malathion 50% L	Spectracide Malathion Insect Spray Concentrate http://www.spectracide.com/Customer-Help/Labels-and-MSDS.aspx
permethrin 2.5% L	Bonide Eight Insect Control Vegetable, Fruit and Flower Concentrate http://www.bonideproducts.com
permethrin 0.25% D	Bayer Advanced Vegetable & Garden Insect Dust http://www.bayeradvanced.com
potassium salts of fatty acids	Safer Brand Insect Killing Soap Concentrate II http://www.saferbrand.com
spinosad 0.5% L	Natural Guard Spinosad Bagworm, Tent Caterpillar and Chewing Insect Control http://www.fertilome.com/ProductFiles/40690%20Spinosad%208oz.pdf Monterey Garden Insect Spray http://216.119.118.152/documents/public/products/MontereyGardenInsectSpray-2-column-(08)-0111-Bilingual.pdf

Ways to Minimize Pesticide Use in Gardens

Prevent Pest Problems

Choose the proper site and plants.

- Avoid planting your vegetable garden in ground that was in sod within two to three years. Soil insects are more likely to be numerous in this situation.
- Dig or plow the garden in the fall and again in the spring, at least three weeks before planting, to eliminate weeds supporting soil pests and to expose many pests to drying, cold weather and predators.
- Select resistant varieties when possible.
- Diversify plantings so plants are less visible to pests and natural enemies are better retained.
- Rotate crops to new locations in the garden to aid in reducing insects.

Encourage healthy growth of plants because stressed plants are often more susceptible to pests.

- Water plants in the morning to allow foliage to dry (furrow or drip irrigation is preferable).
- Space plants properly because overcrowding of plants can cause water, nutrient and light stress and "under crowding" can lead to weed problems.
- Control weeds constantly because destruction of a heavy weed stand can cause insect pests to migrate to the crop.
- Mulching is a good way to keep the weeds down in the garden, and it has many other benefits as well.
- Fertilize and adjust pH according to soil test results.
- Planting seeds too deep can cause them to rot before germinating or cracking through the soil.

Inspect regularly

- Inspect plants regularly for pests, pest damage, natural enemies, and conditions that lead to pest problems.
- Friend or foe? You should know! It is important to be able to distinguish pests from their natural enemies (other organisms that kill pests such as syrphid flies, lacewing larvae, parasitic wasps, lady bird beetles, insect-killing nematodes, pathogenic fungi, predatory mites, etc.).
- Early detection of pests can:
  1) reduce the spread of the pest,
  2) reduce the amount of pesticide used and therefore the cost of control, and
  3) allow for use of natural enemies or slow-acting, less toxic pesticides when there is not an imminent threat of damage.

Use alternative control methods

- Handpick pests when the pests are readily seen (Colorado potato beetles).
- Use water to force aphids and others small sucking insects from plants.
- Use physical barriers. Transplants such as tomato, pepper and eggplant can be wrapped with a 4-by-4-inch strip of aluminum foil to prevent cutworm damage and contact with the soilborne southern blight organism. Use 6-inch copper sheeting placed 2 inches into ground to block slug invasions.
- Repel insect vectors in tomatoes and cucurbits. Aluminum foil or plastic painted with a chrome-colored paint may repel thrips and aphids.
- Pick vegetables before they are overripe and are more attractive to certain insect pests.
- Encourage the conservation of natural enemies by reducing the amount of pesticide applied.
- Plant flowering plants, such as clovers and Queen Anne's lace, to provide a food source (nectar and pollen) for natural enemies and enhance their control of pests.
- Use pesticides such as microbials (*Bacillus thuringiensis*), botanical insecticides (such as pyrethrum), and insecticidal soaps because they have less nontarget effects.

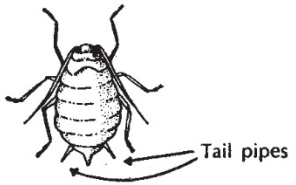
Pictorial Key of Common Adult Insects on Vegetables

Smaller than a period; adults have 8 legs

Spider mites

Larger than a period; adults have 6 legs

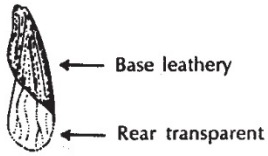
Small, soft bodied; 2 tail pipes



Aphids

No tail pipes

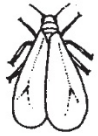
Base of front wing is leathery; rear is transparent



Front wings—entirely membranous, finely netted, usually green

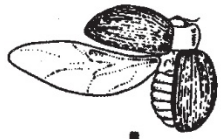
Lacewing (Beneficial)

Like tiny white moths; wings covered with whitish dust

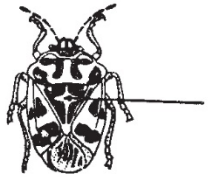


Whitefly

Front wings entirely hardshelled (beetles)

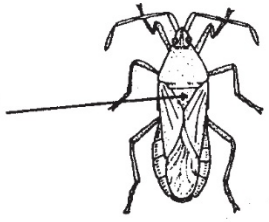


Scutellum almost ½ length of wing



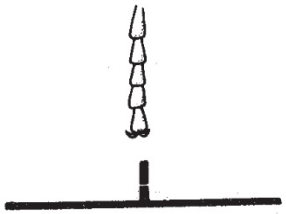
Stink bug

Scutellum much less than ½ length of wing

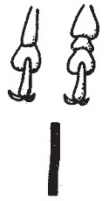


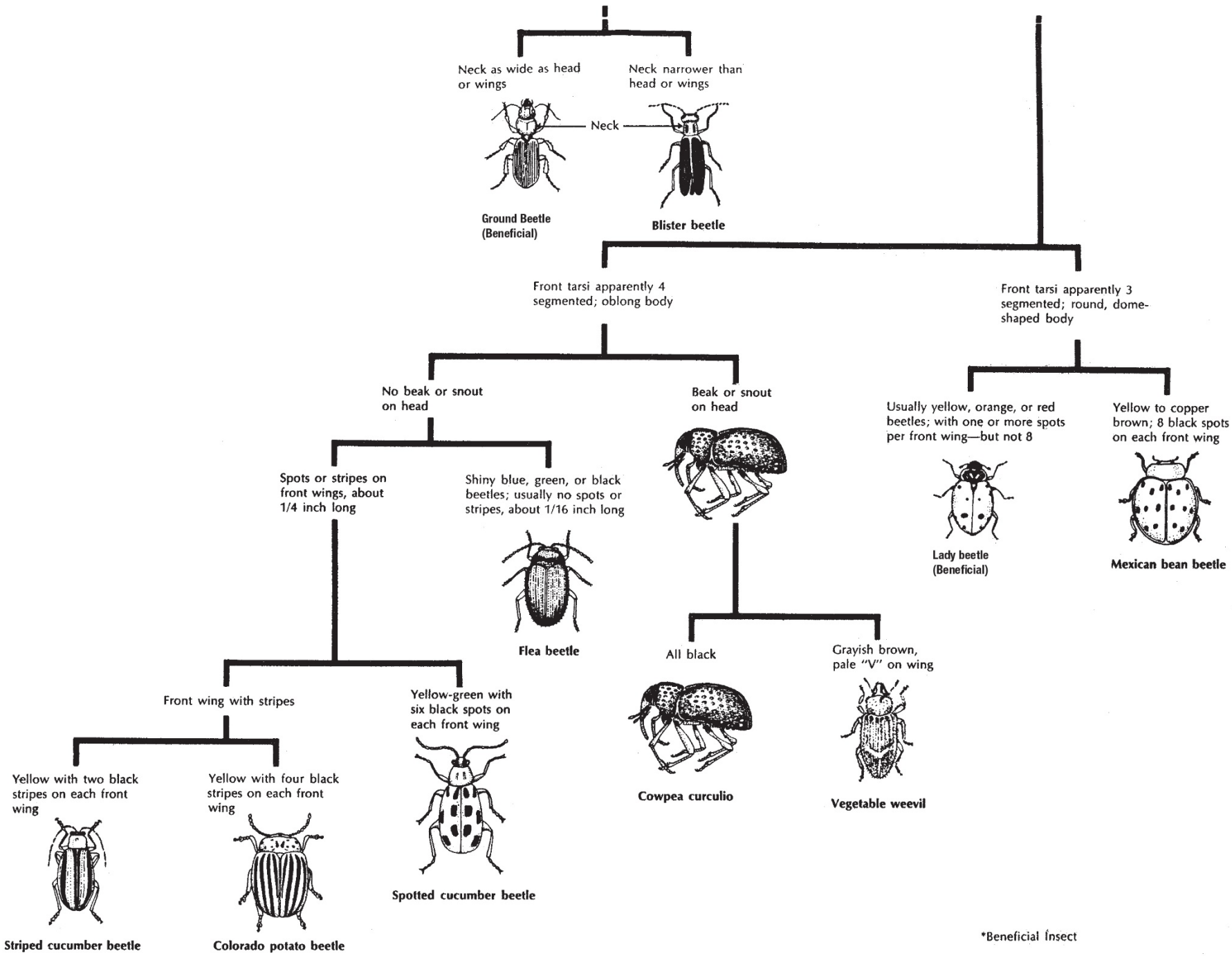
Squash bug

Tarsi (front foot)—5 segmented; beetle usually much longer than diameter of a pencil



Tarsi (front foot) — 3 or 4 segmented; beetle is about as long as or less than diameter of pencil




Neck as wide as head or wings
Neck narrower than head or wings
Neck
Ground Beetle (Beneficial)
Blister beetle
Front tarsi apparently 4 segmented; oblong body
Front tarsi apparently 3 segmented; round, dome-shaped body
No beak or snout on head
Beak or snout on head
Usually yellow, orange, or red beetles; with one or more spots per front wing—but not 8
Yellow to copper brown; 8 black spots on each front wing
Lady beetle (Beneficial)
Mexican bean beetle
Spots or stripes on front wings, about 1/4 inch long
Shiny blue, green, or black beetles; usually no spots or stripes, about 1/16 inch long
Flea beetle
All black
Grayish brown, pale "V" on wing
Cowpea curculio
Vegetable weevil
Front wing with stripes
Yellow-green with six black spots on each front wing
Yellow with two black stripes on each front wing
Yellow with four black stripes on each front wing
Spotted cucumber beetle
Striped cucumber beetle
Colorado potato beetle
*Beneficial Insect

Pictorial Key to Common Immature Insect Pests on Vegetables

Not Worm-Shaped (Nymphs)

No tail pipes extending from rear of body

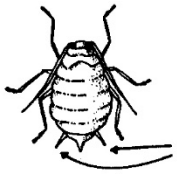
Shield-shaped; brown or green bugs often with orange or black markings; disagreeable odor

Stink bug

Oblong body; greenish brown often with 2 black spots on abdomen

Squash bug

Tail pipes extending from rear of body



Aphids (Plant Lice)

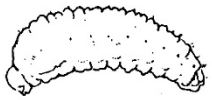
Worm-Shaped Larvae

Prolegs present; 6 true legs; caterpillars

No prolegs; 6 true legs; beetle larvae.

No true legs; no prolegs; found in soil

Not transparent; body twice as long as wide; head end distinguished by brown mouthparts



White fringed Beetle Larvae

Almost transparent; body four times long as wide; mouthparts not visible

Root Maggots

Found in soil

Found on leaves

Slender, white or brown, hardshelled worms

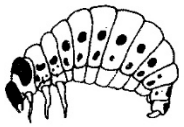
Fat, soft, C-Shaped, white grubworms

Reddish brown, hump-backed, smooth-skinned grubs without spines

Yellow, spiny larvae causing lacy appearance in leaves of beans

Wireworms

White Grubs



Colorado Potato Beetle

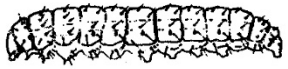
Mexican Bean Beetle

Green, brown, or black larvae without horn at rear of body

Red or black horn at rear of body

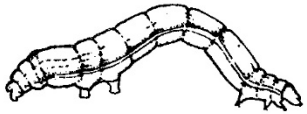
Hornworm

Light green to nearly black larvae up to 1¾ inches long with coarse black hairs and alternating light and dark stripes running lengthwise on body; 4 pairs of prolegs



Corn Earworm (tomato fruitworm)

Light green larvae up to 1½ inches long; body makes a looping motion while moving; 2 pairs of prolegs



Cabbage Looper

Light green, cigar-shaped larvae less than ¾ inch long; 3 pairs of prolegs

Diamondback Moth

Leaf green, velvety-skinned larvae; 4 pairs of prolegs

Imported Cabbage Worm

PRECAUTIONARY STATEMENT

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store, or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

DISCLAIMER STATEMENT

This publication contains pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. The label takes precedence over the recommendations found in this publication. Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others which may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product. The author(s), The University of Tennessee Institute of Agriculture and the University of Tennessee Extension assume no liability resulting from the use of these recommendations.

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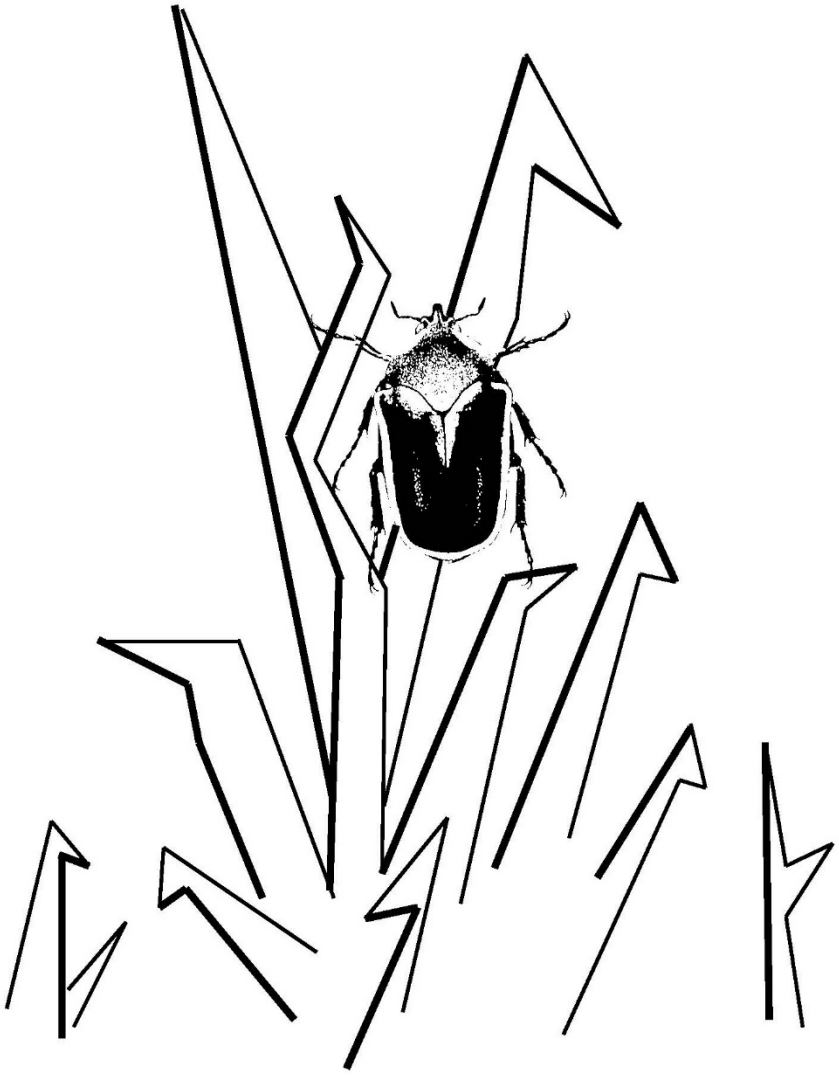
Lawn Insects: How to Control Them

2018



United States Department of Agriculture

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Lawn Insects: How to Control Them

Frank A. Hale, Professor, and Karen M. Vail, Professor,
Entomology and Plant Pathology

Many insects and insect-like pests damage lawns and other turf. They cause the grass to turn brown and die, or they build unsightly mounds. Some pests infest the soil and attack the plant roots, some feed on the plants' leaves and stems, while others suck juice from the plants. Other insects and insect-like pests inhabit lawns, but do not damage them. The pests are annoying and some of them attack people.

These pests can be controlled with insecticides. The recommendations in this publication are applicable only to lawns.

Pests That Infect Soil and Roots

White Grubs

White grubs are the larvae of several species of scarab beetles. They are whitish or grayish, have brownish heads and brownish or blackish hind parts and are usually found in a curled position when disturbed. They hatch from eggs laid in the ground by the female beetles. In Tennessee, most species of white grubs spend about 10 months in the ground; some remain in the soil two years. In mild weather, they live 1 to 3 inches below the surface of the lawn; in winter, they go deeper into the soil.

They burrow around the roots of the grass, then feed on them about an inch below the surface of the soil. Moles, skunks and birds feed on the grubs and may tear up the sod in searching for them.

You can estimate the white grub population of your lawn. Do this from mid-July to early August or in the spring after the soil warms up and the grubs are near the surface. With a spade, cut three sides of a strip 1-foot square by 2 or 3 inches deep. Force the spade under the sod and lay it back, using the uncut side as a hinge. Use a trowel to dislodge soil on the overturned roots that might contain grubs. Count the white grubs in the exposed soil. Replace the strips of sod. In the same way, cut strips of sod in several other parts of the lawn, and count the white grubs under each strip. To calculate the average number of white grubs per square foot of lawn, divide the total number of white grubs counted by the number of strips. The average number of white grubs per square foot is a measurement of white grub density. Economic thresholds based on grub density have been developed to assist in the decision-making process of whether to treat or not. A list of these economic thresholds is available in Extension publication PB 1342, Commercial Turfgrass Insect Control.

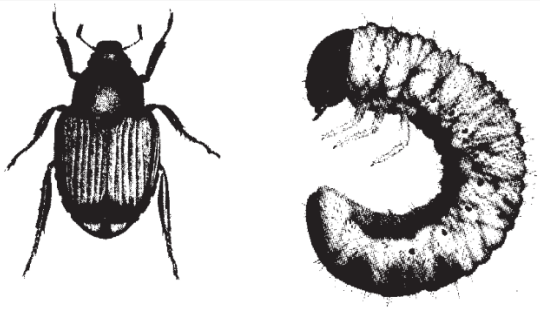
The parent beetles differ in appearance, distribution and habits. The following are important in lawns:

May Beetles — These beetles are brown or blackish-brown. More than 200 kinds are found in the United States. Sometimes they are called June beetles. The adults of the species emerge in the early spring. Most species begin emerging in late May or June and can be active through mid-summer. Eggs laid in July and early August soon hatch into larvae called white grubs. Some of them remain in the soil two years and may feed on the grass roots during a couple seasons.

Japanese Beetle — The beetle is about 1/2 inch long and has a shiny metallic-green body (see Extension publication PB 946). It has coppery-brown wing covers and six small patches of white hair along each side and the back of the body, just under the edges of the wings. The adult insect feeds on many different plants.

These insects are found mostly in the eastern states. The adult beetles begin to appear in early

June and are active for four to six weeks. The young are sometimes called annual white grubs because the life cycle of the insect is completed in one year.

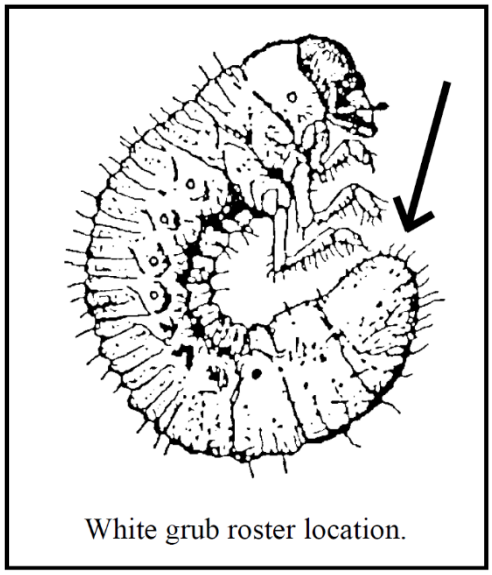


Japanese Beetle / White Grub

Baker, J.R. 1980. Insects and related pests of shrubs. North Carolina Agricultural Extension Service.

Asiatic Garden Beetle — The beetle is about 1/4 inch long, is chestnut brown and has a velvety appearance. The underside of the body is covered with short yellow hairs. The insect flies only at night and feeds on various kinds of foliage. They are most abundant from mid-July to mid-August. They complete their life cycle in one year.

Oriental Beetle — The beetle is about 5/8 inch long, is straw-colored and has some dark markings on the body. The beetles have been detected using traps in Knox and Davidson counties in Tennessee. At present, the distribution of this pest in Tennessee in uncertain. They appear in late June and July. Grubs prefer unshaded lawn and short grass.



White grub roster location.

Photo credit: David Shelter

Masked Chafers — These beetles are 1/2 inch long and brown. They have a darker front part of the head that gives them their “masked” name. The adults live in the soil during the day and emerge at night; they are especially active on warm humid evenings.

The northern masked chafer is found from Connecticut south to Alabama and west to California. In Tennessee, the distribution of the northern masked chafer overlaps southern masked chafer, which is common in the Southeastern states. Masked chafers appear in late May, June and July and are active one or two months.

These annual white grubs have irregularly arranged spines on the underside of the last body segment (raster).

Rose Chafer — The beetle is 1/2 inch long and is yellowish brown; it has long spiny legs. Rose chafers feed on almost any vegetation and are very destructive to roses in bloom. They prefer areas in which the soil is light and sandy. They are abundant in June and early July. The grubs are not as harmful to lawns as some of those mentioned above.

Green June Beetle — The beetle is nearly 1 inch long. The body is nearly flattened; it is velvety-green and has bronze to yellow edges. The insects feed on ripening fruit and also on foliage of many trees and plants. The females often lay eggs in piles of grass clippings, mulched plant beds and in the soil. They are active in June, July and August. They produce one generation a year.

The grubs feed mainly on decaying vegetable matter. Their burrowing tends to disturb grass roots by separating them from the soil, causing the grass to dry out and die. The grubs can be especially damaging in newly sown lawns. Damage is most severe in dry seasons and is most apparent in the fall.

Sometimes after a heavy rain or during warm nights with heavy dew, the grubs come out of the soil and crawl on the surface of the ground. They have the unusual habit of crawling on their backs.

Ants

Many ants are considered beneficial because they prey on pest insects, such as sod webworms, white grubs, cutworms, ticks, fleas, etc., and aerate the soil and recycle nutrients when building foraging tunnels and mounds (see Extension publication PB 1629). But some ants are considered pests when they build unsightly nests in the ground or when they tend and protect pestiferous sucking insects, such as aphids, for their honeydew production. Fire ants (see fireants.utk.edu), field ants and Allegheny mound ants can build large mounds. Ants also destroy grass seeds in the ground and prevent good stands. Some ants bite or sting people and animals. Imported fire ants are especially vicious.

Mole Crickets

Mole crickets are light brown with a lower surface lighter than the upper and often tinged with green. They are about 1 1/2 inches long and have short, stout forelegs, shovel-like feet and large, beady eyes.

Mole crickets feed on the roots of the grass. In addition, their burrowing uproots seedlings and causes the soil to dry out quickly. The type of mole cricket found in Tennessee is called the Northern mole cricket. It is not as damaging as some of the species found in coastal states. It can be a pest, especially in golf course greens.

Wireworm

Wireworms, which are the larvae of click beetles, are 1/2 to 1 1/2 inches long and are usually hard, dark brown, smooth and slender. Some wireworms are soft and white or yellowish. Wireworms bore into the underground part of the stems and feed on the roots of the grass. The boring causes the plant to wither and die.

The adults are about an inch long and brownish, grayish or nearly black. They are hard-shelled and their bodies taper somewhat at each end. When they fall on their backs, the beetles flip the middle part of the body against the ground, throw themselves several inches into the air and make a clicking sound.

Cicada Killer Wasp

This insect is about 1 1/2 inches long and has yellow and black markings on its body (see Extension publication SP 341-T). The wasps dig deep nests or burrow in the ground and mound the soil at the entrance to the nests. The female paralyzes a dog-day cicada by stinging it, then places it in the nest and lays an egg on it. When the egg hatches, the larva feeds on and eventually kills the dog-day cicada.

These solitary wasps, which appear in late July and August, cause limited damage to lawns by their burrowing. While they fly around aggressively, they usually do not sting people unless they are provoked.

Native Bees

Some kinds of native bees occasionally damage lawns by digging up the soil, making holes and forming mounds. The amount of damage is usually of little consequence and these bees are pollinators and therefore considered beneficial. These solitary bees don't tend to sting. Thus, chemical control measures are not recommended, although watering the area once or twice a day may discourage the bees from nesting in the lawn.

Periodical Cicada

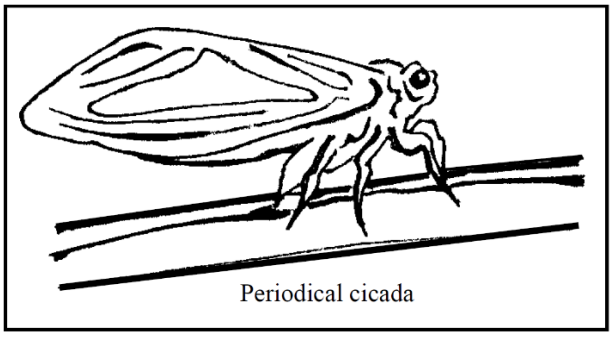

Periodical cicada

Photo credit: Callie McPherson

The young, or nymphs, leave many small holes in lawns, especially under trees, when they emerge to become adults. If you hear the day-long song of the cicada in the spring of a year in which a brood is scheduled to appear in your region, the holes in your lawn were probably made by the emerging nymphs. These holes are not harmful and can be filled in with soil or sand if desired.

If a large brood is emerging, control of adults or protection of ornamental trees and shrubs in the lawn is recommended (see Extension publication SP 341-F, Periodical Cicadas).

Billbugs

Billbugs are a type of beetle with elongated, slender snouts or bills. At the tip are a pair of strong chewing mandibles. The adult is 5/16 inch long and its color is reddish brown to jet black. In the early spring, the adult billbug chews a hole in the stem of the grass and inserts an egg. The resulting white legless larva or grub hollows out the grass stem and fills it with fine, grit-like frass (insect excrement). When the larva is too big for the stem, it emerges and feeds on other plant tissue around the base of the plant. The fully grown larva is 3/8 inch long with a distinct brown head. The larva can chew roots, rhizomes and stolons into pieces, which causes sod to fall apart when lifted.

Several species of billbugs damage lawns. The bluegrass billbug is a pest of Kentucky bluegrass, while the hunting billbug causes damage to zoysia grass and bermudagrass.

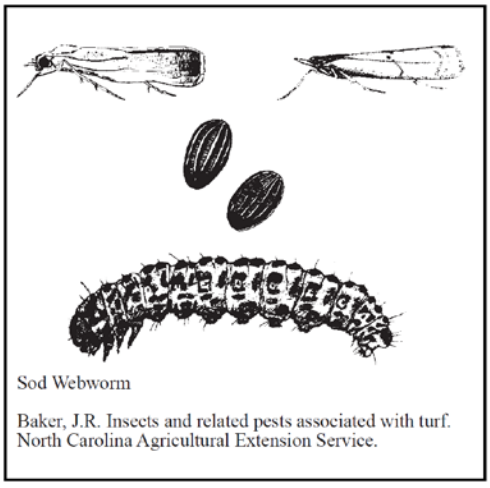
Earthworms

When earthworms are numerous, they sometimes become pests in lawns. They make small mounds of castings that ruin the appearance of the grass. An imported species, the oriental earthworm is found in some of the eastern United States. It is 6 to 8 inches long and about 1/5 inch in diameter. It is light green on the upper surface and has a purplish-green line down the center of the back. It throws up abundant castings of soil.

Pests That Feed on Leaves and Stems

Sod Webworms

Sod webworms are about 3/4 inch long and light brown. Their bodies are covered with fine hairs.


Sod Webworm

Baker, J.R. Insects and related pests associated with turf. North Carolina Agricultural Extension Service.

Sod webworms are the larvae of lawn moths. The adults are small, whitish or gray moths (or millers). They fold their wings closely about their bodies when at rest. They hide in the shrubbery or other sheltered spots during the day. In the early evening, they fly over the grass and the females scatter eggs over the lawns.

The worms are active only at night. They live in protective silken webs or nets that they form about their bodies. As soon as they are hatched, they start feeding on the grass leaves. When they grow larger, they build burrows or tunnels close to the surface of the soil; they reinforce the tunnels with bits of dirt and pieces of grass, then line them with silk and live in them. They cut off blades of grass and eat them. Some species feed on the grass crowns at ground level and on the roots. As partly grown larvae, they overwinter in their silken webs.

Sod webworms prefer new lawns. They attack bentgrass, bluegrass, fescue and other grass. Irregular brown spots are the first signs of damage. Fortunately, significant turf damage rarely occurs.

Several species infest lawns. The dirty white sod webworm larvae live in silk-lined tubes about 3/8 inch in diameter that extend 2 to 3 inches into the soil.

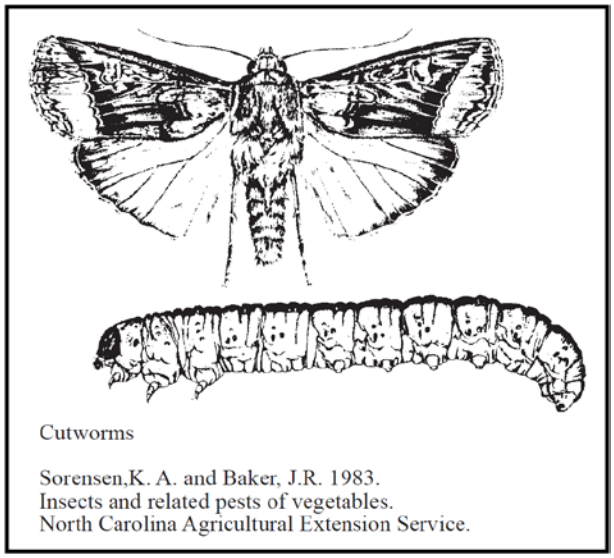
You can find sod worms, other caterpillar pests and billbug adults by pouring a soap solution of two teaspoons of liquid dishwashing detergent in a gallon of water over a 4-foot-square area. If there are four to six or more of them, apply an insecticide.

Armyworms

Armyworms and fall armyworms are the larvae (caterpillars) of moths. When they are numerous, they may devour the grass down to the ground. Their feeding causes circular bare areas in lawns or in heavy infestations whole lawns may be devoured.

These larvae are 1 1/2 inches long; they are greenish to brown with alternating dark and light stripes. The best diagnostic features of the fall armyworm are its darker head with contrasting white to yellow inverted “Y” lines on the front of the head and four distinctive black dots on the top of each abdominal segment.

The adults of the armyworm are tan with bronze front wings with a single white dot in the middle. Their wings measure about 1 1/2 inches across when expanded.



Cutworms

Sorensen,K. A. and Baker, J.R. 1983.
Insects and related pests of vegetables.
North Carolina Agricultural Extension Service.

Cutworms

Cutworms are dull-brown, gray or nearly black caterpillars and are 1 1/2 to 2 inches long. Some cutworms are spotted, others are striped. Usually they hide in the soil during the day and feed at night. They are the larvae of night-flying brown or grayish moths.

Cutworms infest lawns occasionally. They feed on the leaves or cut off the grass near the soil and may do severe damage to seedlings of bermudagrass, bentgrass and ryegrass. Sample for cutworms by pouring a soap solution of 2 teaspoons of liquid dishwashing detergent in a gallon of water over a 4-feet-square area. If one or more cutworms are detected, apply an insecticide.

Billbugs

Billbugs feed on stems and grass leaves. For a description of the insects, see billbugs in the previous section.

Grasshoppers

Grasshoppers do not feed on the grasses of a well-kept lawn except when they are very numerous and forage is scarce. They usually migrate to lawns from croplands or wastelands. Control measures in lawns are seldom necessary. See Extension publication SP 290-X.

Frit Fly

This insect pest from Europe is widely distributed across the country. It occasionally attacks bluegrass lawns, bentgrass golf greens and some other grasses. The adult fly is black and about 1/16 inch long. The female lays eggs on the grass and the hatching maggots bore into the stems.

Pests That Suck Plant Juice

Chinch Bugs

The immature nymphs of the common chinch bug and the southern chinch bug cause most of the damage by feeding with their piercing-sucking mouthparts. Yellowish spots appear in the infested lawn; they turn rapidly into brown, dead areas. Nymphs hatch from eggs laid by the female adults. A first instar nymph (first-stage nymph) is about half the size of a pinhead. The first instar of the southern chinch bug is bright red and has a white band across the back. As it grows, it molts (sheds its skin) four times. The full-grown nymph is black and has a white spot on the back between the wing pads. The adults are about 1/6 inch long.

The adults overwinter in thatch or leaf litter and lay eggs in the leaf sheaths or on the roots in the early spring. The eggs hatch in the spring and nymphs infest lawns until late fall.

False Chinch Bug

The false chinch bug is frequently mistaken for a chinch bug. It feeds on grasses in the same way as the chinch bug, but rarely is a lawn pest. The nymphs are greenish-gray; the adults are gray.

Leafhoppers

Leafhoppers are tiny triangular or wedge-shaped insects that fly or hop short distances. They are less than 1/5 inch long and are green, yellow or brownish gray.

Many species of leafhoppers infest lawns. They suck the sap from the leaves and stems of the grass. New lawns may be damaged so extensively that reseeding is necessary. Damage to established lawns is evident in whitened patches. It is often mistaken for damage due to dry weather or disease.

Mites

Several species of mites attack grasses. They suck the sap and cause the leaves to be blotched and stippled. Severe infestations can kill the plants.

The Banks grass mite occurs throughout most of the United States and occasionally attacks lawns. It is not ordinarily a pest in well-managed lawns.

Clover mites feed on clover and other lawn plants. They are very tiny and brown. Although they feed only on plants, they are a nuisance when they enter homes. This usually occurs in spring and fall.

Spittlebugs

Spittlebugs seldom damage well-managed lawns. The nymphs live inside masses of spittle and suck the juices from the plants. The adults resemble leafhoppers in appearance and habits, but they are more robust. Two species are sometimes found in lawns.

The meadow spittlebug is found in Tennessee. The nymphs are yellowish green. The adults are about 1/4 inch long, are gray or brown and have

dark brown markings. They usually feed on clover or weeds.

The two-lined spittlebug occasionally infests lawns in Tennessee. The nymph is ivory and its head and thorax are brownish. The adult is about 3/8 inch long, is dark brown or black, and has two orange stripes on its wings. These insects feed on bermudagrass, St. Augustinegrass, centipedegrass and several other plants. Thatch control is important in preventing and controlling spittle bugs in lawns. Proper dethatching and fertilization practices can disrupt the humid conditions essential for spittlebug development. Chemical control measures in lawns are seldom necessary.

Pests That Inhabit but Do Not Damage Lawns

Earwigs

Earwigs are beetle-like insects. They are about 3/4 inch long and are reddish-brown. The insect has a prominent pair of forcep-like cerci at the rear of the body. The cerci of the male are curved. Earwigs hide during the day and forage at night.

These insects are found occasionally in lawns. Sometimes they breed in enormous numbers in piles of lawn clippings. They feed on all kinds of food.

Ticks

Several kinds of ticks infest lawns (see Extension publication PB 726). They drop on the grass from dogs, rodents and other animals. Most of them attack people. Pain may result from their bites. Some ticks transmit diseases, including Rocky Mountain spotted fever, human monocytic ehrlichiosis, Lyme disease and tularemia.

Chiggers

Chiggers, or “red bugs,” invade lawns from surrounding grassy or woody areas. These mites are annoying to people. They attach themselves temporarily to the skin and release a poison that causes severe irritation and intense itching. They are very tiny and are seldom seen.

Thrips

Thrips are found in lawns and sometimes in homes. They come from nearby grass or flowers. These tiny black or brown insects may inflict painful bites on people working about the lawn. Control measures in lawns are seldom practical.

Slugs and Snails

Slugs and snails may often move about on the lawn and may injure adjacent plants. They are night feeders and leave mucous trails on plants and sidewalks.

Millipedes and Centipedes

Millipedes (thousand-legged worms) and centipedes (hundred-legged worms) are dark brown and have many segments. Most of them coil up when disturbed.

Millipedes and centipedes do not usually damage lawns. Occasionally, millipedes congregate in yards after heavy rains (see Extension publication W 357). Their food is chiefly decaying vegetable matter.

Some of the larger centipedes may bite people. Most species are not dangerous. Control of centipedes in lawns is seldom necessary.

Sowbugs and Pillbugs

Sowbugs and pillbugs are light gray to slate-colored; they are 1/2 inch long; they have segmented bodies and seven pairs of legs. When disturbed, pillbugs roll up into tiny balls.

Sowbugs and pillbugs are usually found on damp ground under stones, boards, dead leaves or in damp basements. They feed on organic matter in the soil and sometimes on grass and other plants.

Control measures in lawns are seldom necessary; if they should be needed, apply one

of the insecticides recommended for control of grubs.

Spiders and Scorpions

Spiders are found about the lawn and on flowers, plants and shrubbery. Most spiders are harmless to people and are even beneficial because they capture and devour large numbers of harmful insects. They do not damage the grass or other vegetation. Two poisonous spiders found in Tennessee are the black widow spider (see Extension publication PB 1193) and the brown recluse spider (see Extension publication PB 1191). Consult a physician at once if bitten by either of these spiders.

Scorpions appear occasionally on lawns and about the yard. There are two species of scorpions in Tennessee. Their sting is similar in intensity to that of a bee or wasp. Control measures in lawns are seldom necessary for scorpions.

Fleas

Fleas occasionally spread to lawns from infested dogs, cats or nearby animal quarters (see Extension publication PB 1596). They may attack people or pets.

Common and Scientific Names

Ants	Formicidae (many species)
Armyworms	Noctuidae (several species)
Asiatic garden beetle	*Maladera castanea* (Arrow)
Banks grass mite	*Oligonychus pratensis* (Banks)
Bees	Hymenoptera (several species)
Bermudagrass mite	*Eriophyes cynodoniensis* (Sayed)
Billbugs	*Sphenophorus* spp.
Centipedes	Chilopoda
Chiggers	*Trombicula* spp.
Cicada killer	*Sphecius speciosus* (Drury)
Clover mite	*Bryobia praetiosa* Koch
Common Chinch Bug	*Blissus leucopterus leucopterus* (Say)
Cutworms	Noctuidae (Several species)
Earthworms	Annelida
Earwigs	Dermaptera
False chinch bug	*Nysius raphanus* Howard
Fleas	Siphonaptera (several species)
Frit fly	*Oscinella frit* (Linnaeus)
Grasshoppers	Orthoptera (Many species)
Green June beetle	*Cotinis nitida* (Linnaeus)
Hunting billbug	*Sphenophorus venatus vestitus* Chittenden
Japanese beetle	*Popillia japonica* Newman
Lawn armyworm	*Spodoptera mauritia* (Boisduval)
Leafhoppers	Cicadellidae (several species)
May beetles	*Phyllophaga* spp.
Meadow spittlebug	*Philaenus spumarius* (Linnaeus)
Millipedes	Diplopoda
Northern masked chafe	*Cyclocephala borealis* Arrow
Northern mole cricket	*Neocurtilla hexadactyla* (Perty)
Oriental beetle	*Anomala orientalis* (Waterhouse)
Periodical cicada	*Magicicada* spp.
Rose chafer	*Macrodactylus subspinosus* (Fabricius)
Scorpions	Scorpionida
Slugs and snails	Gastropoda
Sod webworms	Crambidae
Southern chinch bug	*Blissus insularis* Barber
Southern masked chafer	*Cyclocephala lurida* Bland
Sowbugs and pillbugs	Crustacea
Spiders	Araneida
Thrips	Thysanoptera (several species)
Ticks	Acarina
Two-lined spittlebug	*Prosapia bicincta* (Say)
Wireworms	Elateridae (several species)

Control

The user is cautioned to read and follow all directions and precautions given on the label of the pesticide formulation that will be used. Insecticides are sold under various trade names by garden supply houses and hardware, seed and drug stores.

Granules are ready-made formulations that are used dry. Apply them with lawn fertilizer spreader.

Wettable powders and other formulations are used in sprays. Mix the purchased product with water and apply with a garden type compressed air sprayer or a knapsack sprayer. The quantity of water to use depends on the type of sprayer you have. If a wettable powder is used, agitation of the mixture is necessary.

A quart jar attachment for a garden hose will provide good distribution of an insecticide on a lawn. Use an attachment that delivers a coarse spray and large volume of water. Usually a quart jar full of an insecticide mixture will cover about 500 square feet of lawn. Baits are usually purchased ready mixed.

Control of soil insects is sometimes difficult. Therefore, it is important to apply the pesticide at the time of the year when the insect is most susceptible to control. This information will be on the pesticide label. To control underground lawn pests, apply an insecticide and, immediately afterward, water the lawn according to label. To control aboveground lawn pests, apply an insecticide to the grass. Follow label directions on whether to irrigate or not after application.

Use of Pesticides

Pesticide use is governed by a federal law that is administered by the U.S. Environmental Protection Agency. This law requires manufacturers to register pesticides and makes it illegal for people to use them except in accordance with the instructions on the label.

You may, if you wish, use less of any pesticide than the maximum amount the instructions permit. However, always remember: (1) Be sure the pesticide comes in contact ONLY with plants or areas you intend to spray, and (2) Be sure to spray the pesticides uniformly. You can always get reliable, free information about any pesticide by calling your county Extension office.

Special Precautions

Store pesticides in original containers, out of reach of children and pests, and away from foodstuff. Apply pesticides selectively and carefully. Do not apply a pesticide when there is danger of drift to other areas. Avoid prolonged inhalation of a pesticide spray or dust. When applying a pesticide, it is advisable that you be fully clothed and use all the personal protection equipment stated on the label.

Do not apply insecticides to a lawn when people or animals are on it. Follow label directions and observe the re-entry interval before allowing people or pets on to the lawn. After handling a pesticide, do not eat, drink or smoke until you have washed. If a pesticide is swallowed or gets in your eyes, follow the first aid treatment given on the label and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

When the pesticide container is empty, triple rinse the container and dispose of the container according to the “Storage and Disposal” statement on the pesticide label.

npic.orst.edu/health/disposal.html

epa.gov/safepestcontrol/safe-disposal-pesticides

It is difficult to remove all traces of a herbicide (weed killer) from equipment. Therefore, to prevent injury to desirable plants, do not use the same equipment for insecticides and fungicides that you use for a herbicide.

Remove thatch prior to treatment to reduce pest harborage sites and to allow insecticide and water to reach the soil.

Sampling and Economic Thresholds for Turfgrass Insect Pests

White grubs — Sample several square-foot sections of turf by using a shovel or spade to cut out a square-foot section and lift the turf back to count grubs. Treatment should be made if white grubs have reached the economic threshold. See above and Extension publication PB 1690 for treatment times.

Threshold Targets for White Grubs

Assuming Adequate Growing Conditions and No Digging Animals

- Annual White Grubs 5-10 grubs per square foot
- (Japanese beetle, Oriental beetle, European chafer, Asiatic garden beetle)
- Masked Chafer (Annual White Grub) 15-20 grubs/square foot
- Black Turfgrass Ataenius 30-50 grubs/square foot
- May/June Beetles: 3-8 grubs per square foot
- Green June Beetle Grubs: 6-8 grubs per square foot

Adapted from D.J. Shetlar (1995) and D.A. Potter (1982) in Hale (2012) Commercial Turfgrass Insect Control (see Extension publication PB 1690).

Sod webworms — These caterpillars feed on the blades of grass. The light-colored caterpillars with dark spots make silk tunnels in the grass. Check for sod webworms and cutworms by preparing a soap solution of 2 teaspoons of liquid dishwashing detergent in a gallon of water. Pour this solution over a 2-feet-by-2-feet (4 square feet) area. Treat when four to six or more sod webworms per 4 square feet are found.

Cutworms — These dark, dingy-colored caterpillars feed at night and hide in the ground in the daylight. They clip off the blades of grass at the crown. Treat when one or more cutworms per 4 square feet are found.

References

Potter, D.A. 1982. Influence of feeding by grubs of the southern masked chafer on quality and yield of Kentucky bluegrass. J. Econ. Entomol. 75: 21-24.

Shetlar, D.J. 1995. Lawns and Turf/North. pp. 316-317. In R. Foster, E. Knake, R.H. McCarty, & J.J. Mortvedt [eds.], 1995 Insect Control Guide. Meister Publishing Co., Willoughby, Ohio.

Pesticides labeled for common lawn insects and arthropod pests.

PEST	INSECTICIDE	AMOUNT/1,000 SQ. FT. (or as noted)	REMARKS, PRECAUTIONS
IMPORTED FIRE ANTS around residences, try **Program 1,** **Two-step method:** Broadcast one of the baits first. IGR baits are distributed well because they don't affect the worker. **2.** 7-10 days later, apply a drench, dust, fast-acting bait (hydramethylnon, indoxacarb, abamectin, or spinosad), granules, dust or drench to the individual mounds that are likely to be encountered by people. See fireant.utk.edu **or** extension.org/fire+ants for more fire ant control strategies. Contact your local county Extension agent or TDA if fire ants are located in regions of the state where they have not been seen before. Fire ants are in all (A) or part (P) of **66** counties as of March 1, 2018: Anderson (A), Bedford (A), Benton (A), Bledsoe (A), Blount (A), Bradley (A), Cannon (A), Carroll (A), Chester (A), Cocke (A), Coffee (A), Crockett (A), **Cumberland (A)**, Davidson (P), Decatur (A), DeKalb (A)**,** Dickson (P), Fayette (A), Franklin (A), Gibson (P), Giles (A), Grundy (A), **Hamblen (A)**, Hamilton (A), Hardeman (A), Hardin (A), Haywood (A), Henderson (A), Hickman (A), Houston (A), Humphreys (A), **Jefferson (A),** Knox (A), Lauderdale (P), Lawrence (A), Lewis (A), Lincoln (A), Loudon (A), Madison (A), Marion (A), Marshall (A), Maury (A), McMinn (A), McNairy (A), Meigs (A), Monroe (A), Moore (A), Morgan (P), Perry (A), Polk (A), Rhea (A), Roane (A), Rutherford (A), Sequatchie (A), Sevier (A), Shelby (A), Stewart (P), Tipton (A), **Trousdale (P),** Union (P), Van Buren (A), Warren (A), Wayne (A), White (A), Williamson (A), Wilson (A). Changes are in bold. For details on quarantine lines and other info, see fireants.utk.edu or TDA's website at: tn.gov/agriculture/businesses/plants/plant-pests--diseases-and-quarantines/ifa.html	**BAITS** Extinguish bait (IGR) 0.5% methoprene	broadcast 1-1.5 lb/acre or 3-5 Tbsp. around the mound (& labeled for pasture, cropland)	Most available fire ant baits use soybean oil as a feeding attractant. Baits that are old (over 2 years old in an air-tight container), left in unsealed bags, or stored at high temperatures may become rancid and will not be fed upon by foraging workers. ***Keep baits dry.*** Wet baits are not attractive to fire ants. Apply baits when the grass and ground are dry or drying, and rain is not expected, preferably for the next 24 hours. ***Apply baits when fire ants are actively foraging.*** Foraging activity can be determined by spreading bait in a small pile in the area to be treated. If fire ants are actively foraging, you should see ants removing the bait within 10 to 30 minutes. This also will indicate that the bait is attractive and not too old. Fire ants generally will forage when air temperatures are between 70 and 90 F. During hot, summer weather, apply baits in the late afternoon or evening because fire ants will forage at night under these conditions. **Broadcast the bait, or apply it as directed 2-4 ft. around, NOT ON, the mound.** **Avoid disturbing the ants right before applying the bait.** **Do not contaminate baits with fertilizer or other pesticides.**
	Distance bait (IGR) 0.5% 2-[1-Methyl-2(4-phenoxyphenoxy) ethoxy]pyridine	broadcast 1-1.5 lb/acre or 1-4 Tbsp. around the mound	
	Award II /Optigard 0.011% abamectin For use by professionals	broadcast 1 lb/acre, limited to 4 lb per acre per yr. or for 12 or less mounds per acre 5-7 Tbsp. around the mound.	
	PT Ascend Fire Ant Bait Formula 1 0.011% abamectin	broadcast 0.4 oz/1,000 sq. ft. or 5-7 Tbsp. around the mound	
	Spectracide Ant Shield Insect Killer Plus Preventer Bait 0.016% indoxacarb	broadcast 0.5 lb/1,000 sq. ft. or 4 Tbsp. around the mound	
	Advion Fire Ant Bait 0.045% indoxacarb	broadcast 1.5 lb/acre or 0.5 oz/1,000 sq. ft. or 4 Tbsp. around the mound; up to 4 app/yr.	
	Amdro Fire Ant Bait 0.73% hydramethylnon Other hydramethylnon fire ant baits include ProBait, AmdroPro, etc.	broadcast 1-2 lb/acre or 2-5 level Tbsp. around the mound See labels for other hydramethylnon baits.	
	Siesta Fire Ant Bait 0.063% metaflumizone	apply 1.5 pounds per acre. If needed, re-treat after 4 to 8 weeks. DO NOT exceed 6.0 lbs/A total or 4 apps. per year.	
	Extinguish Plus (IGR & Other) 0.37% hydramethylnon 0.25% s-methoprene	broadcast 1-1.5 lb/acre or 2-5 Tbsp. around the mound (& labeled for pasture)	
	Spinosad baits, such as Ferti-Lome and Southern Ag Payback. Spinosyns are produced by a soil microorganism (*Saccharopolyspora spinosa*)	See label. Usually 4 Tbsp. around the mound	

PEST	INSECTICIDE	AMOUNT/1,000 SQ. FT. (or as noted)	REMARKS, PRECAUTIONS
IMPORTED FIRE ANTS CONT'D **Program 2.** Small areas where less than 20-30 mounds per acre. Apply individual mound (drench, dust or granular) treatments as needed. See the following web sites for more fire ant management info: fireants.utk.edu extension.org/fire+ants	**DRENCHES**	See label	For a list of many products available to treat fire ants see fireants.utk.edu/resources/updates.html For a list of Alabama products by price and application type (broadcast vs. individual mound treatment) see aces.edu/pubs/docs/A/ANR-0175-A/ANR-0175-A.pdf
	DUSTS	See label	
	GRANULES	See label	
Program 3. Ant Elimination Method. 1. Broadcast a bait (optional) 2. Broadcast a contact insecticide (granule) to lawn when fire ant activity noted.			For a list of many products available to treat fire ants in Tennessee see fireants.utk.edu/resources/updates.html
ARMYWORMS AND CUTWORMS	Bayer Advanced Complete Insect Killer for Soil and Turf ready-to-spray imidacloprid 0.72% β-cyfluthrin 0.36%	dilutes automatically, see label	See label at bayeradvanced.com Imidacloprid for early instar white grubs and β-cyfluthrin for above ground pests such as armyworms, cutworms, sod webworms, etc.
	Bayer Advanced Complete Insect Killer for Soil and Turf ready-to-spread granules imidacloprid 0.15% β-cyfluthrin 0.05%	2 to 3 lbs.	See label at bayeradvanced.com Imidacloprid for early instar white grubs and β-cyfluthrin for above ground pests such as armyworms, cutworms, sod webworms, etc.
	Spectracide Triazide Insect Killer for Lawns & Landscapes Conc. gamma-cyhalothrin 0.08%	see label	See label at spectracide.com/Customer-Help/Labels-and-MSDS.aspx
	Bayer Advanced Vegetable & Garden Insect Spray Concentrate cyfluthrin 0.75%	3 fl. oz./gallon per 500 sq. ft.	See label at kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/72155/72155%2D39/72155%2D39%5FBayer%5FAdvanced%5FVegetable%5F%5F%5FGarden%5FInsect%5FSpray%5FConcentrate%5F1%5F26%5F2015%5F11%5F15%5F55%5FAM%2Epdf

PEST	INSECTICIDE	AMOUNT/1,000 SQ. FT. (or as noted)	REMARKS, PRECAUTIONS
ARMYWORMS AND CUTWORMS CONT'D	Bayer Advanced PowerForce Multi-insect Killer Ready-to-Spread Granules β-cyfluthrin 0.05%G	2-3 lbs.	See label at kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/72155/72155-35/72155-35_Bayer_Advanced_PowerForce_Multi_Insect_Killer_RT_Spread_Granules_6_28_2006_1_01_02_PM.pdf
	Monterey Garden Insect Spray spinosad 0.5%	2 oz. per gallon	For armyworms only Mix and apply a minimum of 3 gal. of spray per 1,000 sq. ft. Delay watering or mowing for 24 hr. after application. For best results apply in early morning or late afternoon. See label at montereylawngarden.com/documents/public/products/MontereyGardenInsectSpray-2-column-(08)-0111-Bilingual.pdf
	Grub Ex_1 chlorantraniliprole 0.08%	See label	Apply spring to late summer to dry lawn with a spreader and lightly water to activate. See label at kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/538/538-306/538-306_GrubEx_1_7_6_2009_9_50_42_AM.pdf
BEES, WASPS, CICADA KILLERS, YELLOWJACKETS See SP 341-M	Bee/Wasp Killer Aerosols Apicide Carbaryl 5% D		Apply spray directly into nest entrance at dusk when wasps are less active. Repeat at 2-3 day intervals if activity in nest continues. See label at https://www.mysticchemical.com/wp-content/uploads/2014/04/Apicide-Dispenserlabel2010.pdf
GREEN JUNE BEETLES (Grubs Only)	GardenTech Sevin Lawn Insect Granules carbaryl 2% G	2.25 lbs.	See label at kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/71004/432%2D1212%2D71004/432%2D1212%2D71004%5FGarden%5FTech%5FSevin%5FLawn%5FInsect%5FGranules%5F2%5F6%5F2007%5F9%5F32%5F52%5FAMSecured%2EPdf
	GrubEx$_1$ chlorantraniliprole 0.08%G	See label	Apply spring to late summer to dry lawn with a spreader and lightly water to activate. http://kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/538/538-306/538-306_GrubEx_1_7_6_2009_9_50_42_AM.pdf

PEST	INSECTICIDE	AMOUNT/1,000 SQ. FT. (or as noted)	REMARKS, PRECAUTIONS
WHITE GRUBS of MAY BEETLES, CHAFERS, JAPANESE BEETLE, GREEN JUNE BEETLES, ETC.	Bayer Advanced 24-Hour Grub Killer Plus[I] Ready-To-Spread Granules trichlorfon 9.3 % G	2 lbs.	Treat lawn early to mid-August. When grubs are present. Water grass thoroughly after application. See label at bayeradvanced.com
	Bonide Insect & Grub Control Imidacloprid 0.5% Lambda-cyhalothrin 0.1%	1.2 to 1.8 lbs.	Immediately water grass thoroughly after application. Apply once, anytime from mid-June through mid-July. See directions for further instructions. bonide.com/assets/Products/Labels/l60360.pdf
	Bayer Advanced Lawn Season Long Grub Control ready-to-spray imidacloprid 1.47%	dilutes automatically, see label	You may spray this product over soil or mulch. Remove weed barrier before applying. See label at bayeradvanced.com
	Bayer Advanced Complete Insect Killer for Soil and Turf ready-to-spray imidacloprid 0.72% β-cyfluthrin 0.36%	dilutes automatically, see label	See label at bayeradvanced.com Imidacloprid should control early instar white grubs and beta-cyfluthrin should control above ground pests such as armyworms, cutworms, sod webworms, etc.
	GrubEx$_1$ chlorantraniliprole 0.08%	See label	Apply spring to late summer to dry lawn with a spreader and lightly water to activate. http://www.kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/538/538-306/538-306_GrubEx_1_7_6_2009_9_50_42_AM.pdf
MILLIPEDES, SOWBUGS, PILLBUGS	GardenTech Sevin Lawn Insect Granules carbaryl 2% G	2.25 lbs.	See label at kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/71004/432%2D1212%2D71004/432%2D1212%2D71004%5FGarden%5FTech%5FSevin%5FLawn%5FInsect%5FGranules%5F2%5F6%5F2007%5F9%5F32%5F52%5FAMSecured%2EPdf
	Hi-Yield Bug Blaster II Turf insect Control Granules Bifenthrin 0.2% G	2.3 lb for millipedes 4.6 lb for sowbugs and pillbugs	http://www.fertilome.com/ProductFiles/33326%20Bug%20Blaster%20Approved%207-6-12.pdf
SOD WEBWORMS	Bayer Advanced Complete Insect Killer for Soil and Turf ready-to-spray imidacloprid 0.72% β-cyfluthrin 0.36%	dilutes automatically, see label	See label at bayeradvanced.com Imidacloprid should control early instar white grubs and β-cyfluthrin should control above ground pests such as armyworms, cutworms, sod webworms, etc.
	Bayer Advanced Complete Insect Killer for Soil and Turf ready-to-spread granules imidacloprid 0.15% β-cyfluthrin 0.05%	2 to 3 lbs.	See label at bayeradvanced.com Imidacloprid should control early instar white grubs and β-cyfluthrin should control above ground pests such as armyworms, cutworms, sod webworms, etc.

PEST	INSECTICIDE	AMOUNT/1000 SQ. FT. (or as noted)	REMARKS, PRECAUTIONS
SOD WEBWORMS CONT'D	Bayer Advanced Vegetable & Garden Insect Spray Concentrate cyfluthrin 0.75%	3 fl. oz./gallon per 500 sq. ft.	See label at bayeradvanced.com
	Spectracide Triazide Lawn and Landscape Concentrate gamma-cyhalothrin 0.08%	3 Tbsp per gallon per 240 sq. ft.	Thoroughly wet grass before applying. Delay additional watering or mowing for 24 hours. spectracide.com/Customer-Help/Labels-and-MSDS.aspx
	Monterey Garden Insect Spray spinosad 0.5%	2 oz. per gallon	Mix and apply a minimum of 3 gal. of spray per 1,000 sq. ft. Delay watering or mowing for 24 hr. after application. montereylawngarden.com/product_labels_msds.aspx
	GrubEx$_1$ chlorantraniliprole 0.08%	See label	Apply spring to late summer to dry lawn with a spreader and lightly water to activate. kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/538/538-306/538-306_GrubEx_1_7_6_2009_9_50_42_AM.pdf
	Bayer Advanced 24-Hour Grub Killer Plus 1 Ready-to-Spread Granules trichlorfon 9.3% G	1.33 lbs.	See label at bayeradvanced.com

PRECAUTIONARY STATEMENT

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store, or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

DISCLAIMER STATEMENT

This publication contains pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. The label takes precedence over the recommendations found in this publication. Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others which may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product. The author(s), the University of Tennessee, the Institute of Agriculture and University of Tennessee Extension assume no liability resulting from the use of these recommendations.

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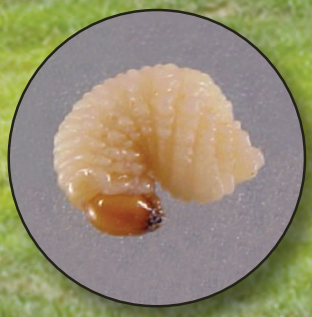
Commercial Turfgrass Insect Control



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UTEXTENSION
INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

Commercial Turfgrass Insect Control

Frank A. Hale, Professor
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Originally prepared by Jaime Yanes Jr.
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Commercial Turfgrass Insect Control Calendar

PESTS	+	++	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ants	II	a	********** S,G, or B **********											
Armyworms, Cutworms	III	a	**********S or G **********											
Yellowjackets	III	a	********** S **********											
Bees and Wasps	II	a	****** S or G **********											
Billbugs	III	d,e,f	********** S or G **********											
Chinch Bugs	III	b	******** S or G **********											
White Grubs	I	a	***S or G**							********S or G*****				
Green June Beetle	I	a	**S or G***							**********S or G*				
Leafhoppers & Spittlebugs	II	a	**********S**********											
Mole Crickets	III	g	*** S, G or B ****							**** B ******				
Sod Webworms	I	c,d, e,g	********** S or G ********											

+ Degree of importance of pest:

- **I - Important pest, frequent occurrence**
- **II - Usually present but generally not a pest**
- **III - An occasional pest**

- **S - Sprays**
- **G - Granules**
- **B - Baits**

++ Preferred grass species:

- **a - Fescue and many other grasses**
- **b - St. Augustine**
- **c - Fescue**
- **d - Bluegrass**
- **e - Bermudagrass**
- **f - Zoysiagrass**
- **g - Bentgrass**

Commercial Turfgrass Insect Control

Pest	Insecticide and Formulation	Amount per 1,000 sq ft	Precautions and Remarks
ANTS (Also see imported fire ants.)	chlorpyrifos (Dursban Pro) 2 E (Dursban 50W) 50 WSP	1.5 fl oz 2 lb./acre	For turfgrass use on golf courses, road medians and industrial plant sites. Dursban 50 W can be used in addition on turfgrass grown for sod or seed. Treat mounds and surrounding areas or apply broadcast to entire area.
	carbaryl (Sevin Brand SL) 4 SL	1 1/2 to 3 fl oz	
	lambda-cyhalothrin (Scimitar CS, 9.7 CS Scimitar GC)		Use 0.5 fl. oz. per 2.5 gallons of water and thoroughly cover and soak each mound and treat a 4-foot diameter circle around the mound. Scimitar GC can be used on golf courses.
	deltamethrin (DeltaGard G) 0.1 G	2 to 3 lb	Irrigate with an adequate quantity of water to thoroughly moisten grass and thatch and dissolve the insecticide granules.
	cyfluthrin (Tempo 20 WP) 20 WP	(1 packet) 50 gm per 7,500 to 10,000 sq ft	Tempo 20 WP not for use on sod farms or golf courses.
	(Tempo 20 WP GC) 20 WP	55 gm (1 packet) per 11,000 sq ft	Tempo 20 WP GC for use on residential and commercial sites including golf courses.
	beta-cyfluthrin (Tempo SC Ultra) 1 SC	4-6 ml	Not for use on sod farms or golf courses.
	bifenthrin (Talstar Lawn & Tree) 7.9 F (Talstar GC) 7.9 F	0.5-1 fl oz 1 fl oz	
	fipronil (Topchoice) 0.0143% G	2 lb or 87 lb/acre	For best results, treated turf should be watered or irrigated after application.
	thiamethoxam 11.6% plus lambda-cyhalothrin 3.5% (Tandem)	28 fl oz/acre (single application) 14 fl oz/acre On a 3 to 5 week interval (two applications)	
	Imidacloprid 5.0% plus bifenthrin 4.0% (Allectus SC)	1.32 to 1.65 fl oz or 3.6 to 4.5 Pint / acre.	

Pest	Insecticide and Formulation	Amount per 1,000 sq ft	Precautions and Remarks
Ants (cont'd.)	clothianidin 24.7% bifenthrin 12.3% (Aloft GCSC)	0.27–0.44 oz or 11.65–19 fl oz/acre	For use on athletic fields, residential turf, golf courses, sod farms and other listed sites. Make an application in the fall before ants stop foraging or after they become active in the spring.
	Aloft (LCSC)	0.27-0.54 fl oz or 11.65-23.3 fl oz/acre	Excluding fire, harvester, pharaoh and carpenter ants; **not** for use on golf courses and sod farms.
	clothianidin 50 WDG (Arena 50WDG)	9.6-12.8 oz/acre	Apply when pest first appears.
	zeta-cypermethrin 2.70% bifenthrin 7.87% imidacloprid 13.83% (Triple Crown T&O)	0.46-0.80 20-35 fl oz / acre	
YELLOW JACKETS (Also other burrowing bees and wasps)	carbaryl (Carbaryl 80 S) 80 WP (Sevin Brand SL) 4 SL	4 oz 3 fl oz per gallon of water	Most burrowing wasps and bees are parasitic on other insects. Treatment is seldom needed. Water in thoroughly and apply in late afternoon. Bee, wasp and hornet sprays in pressurized cans are also effective.
BILLBUGS	bifenthrin (Talstar Lawn & Tree) 7.9 F (Talstar GC) 7.9 F	0.25-0.5 fl oz 0.25-0.5 fl oz	For control of adult billbugs when they are first observed during April or early May.
	clothianidin (Arena 50 WDG) 50WDG	6.4-12.8 oz/acre	Do not apply more than 12.8 oz of Arena 50 WDG per acre per season.
	chlorantraniliprole (Acelepryn) 1.67 SC 0.2% G	0.184 - 0.46 fl oz 8 - 20 fl oz/acre 1.15 - 2.3 lb 50 - 100 lb/acre	Apply when overwintered adult billbugs are first observed in April. This application will also provide white grub control.
	imidacloprid (Merit 75WP) 75 WP (Merit 0.5 G) 0.5 G	6.4 to 8.6 oz/acre 1.4 to 1.8 lb	For optimum control, make application prior to egg hatch, followed by sufficient irrigation or rainfall within 24 hours of application. Not for use on commercial sod farms.
	deltamethrin (DeltaGard G) 0.1 G	2 to 3 lb	Irrigate with an adequate quantity of water to thoroughly moisten grass and thatch and dissolve the insecticide granules.
	halofenozide (MACH 2) 1.5 G 2 L	2.3 lb 2.2 fl oz	MACH 2 Granular is labeled for use on all turfgrass sites while MACH 2 Liquid is registered for use on commercial sites including golf courses, sod farms, commercial lawns and cemeteries. Make only one application.
	zeta-cypermethrin 2.70% bifenthrin 7.87% imidacloprid 13.83% (Triple Crown T&O)	0.23-0.46 10-20 fl oz / acre	

Pest	Insecticide and Formulation	Amount per 1,000 sq ft	Precautions and Remarks
CHINCH BUGS	cyfluthrin (Tempo 20 WP) 20 WP	(1 packet) 50 gm per 7,500 sq ft	Tempo 20 WP not for use on sod farms or golf courses.
	zeta-cypermethrin 2.70% bifenthrin 7.87% imidacloprid 13.83% (Triple Crown T&O)	0.46-0.80 20-35 fl oz / acre	
	(Tempo 20 WP GC) 20 WP	55 gm (1 packet) per 7,800 sq ft	Tempo 20 WP GC for use on residential sites including golf courses.
	beta-cyfluthirn (Tempo SC Ultra) 1 SC	6 ml	Not for use on sod farms or golf courses.
	chlorpyrifos (Dursban Pro) 2 EC (Dursban 50W) 50 WSP	1.5 fl oz 2 lb/acre	For turfgrass use on golf courses, road medians, and industrial plant sites. Dursban 50 W can be used in addition on turfgrass grown for sod or seed.
	clothianidin (Arena 50 WDG) 50 WDG	12.8 oz/acre	Do not apply more than 12.8 oz of Arena 50 WDG per acre per season.
	dinotefuron (Zylam) 20 SG	1 oz or 2.7 lb/acre	For suppression of chinch bugs, make application prior to hatching of first instar nymphs.
CUTWORMS, ARMYWORMS	carbaryl (Sevin Brand SL) 4 SL	1 1/2 to 3 fl oz	Treat in late afternoon. Apply in adequate water for good coverage, but do not flood or water in. Do not cut grass for one to three days after treatment.
	acephate (Orthene Turf, Tree & Ornamental Spray) 75 SP	0.5 to 2.4 oz	For golf course and sod farm turfgrass. Use higher labeled rates for cutworms. Not for homeowners lawn uses except for imported fire ant mound treatments.
	chlorpyrifos (Dursban Pro) 2 EC (Dursban 50W) 50 WSP	1.5 fl oz 2 lb/acre	For turfgrass use on golf courses, road medians and industrial plant sites. Dursban 50 W can be used in addition on turfgrass grown for sod or seed.

Pest	Insecticide and Formulation	Amount per 1,000 sq ft	Precautions and Remarks
CUTWORMS, ARMYWORMS (cont'd.)	trichlorfon (Dylox 80) 80 SP	2.5 to 3.75 oz	
	bifenthrin (Talstar Lawn & Tree) 7.9 F (Talstar GC) 7.9 F	0.18-0.25 fl oz 0.25 fl oz	Delay watering or mowing for 24 hours after application.
	cyfluthrin (Tempo 20 WP) 20 WP	(1 packet) 50 gm per 7,500 to 10,000	Delay watering or mowing for 24 hours for optimum control. Tempo 20 WP not for use on sod farms or golf courses.
	(Tempo 20 WP GC) 20 WP	55 gm (1 packet) per 7,800 to 11, 000 sq ft	Tempo 20 WP GC for use on residential and commercial sites including golf courses.
	beta-cyfluthrin (Tempo SC Ultra) 1 SC	4-6 ml	Not for use on sod farms or golf courses.
	spinosyn A and spinosyn D (Conserve SC) 1 SC	0.25 fl oz-small armyworm larvae 1.25 fl oz-large armyworm larvae 0.8 fl oz-small cutworm larvae 1.25 fl oz-large cutworm larvae	Conserve SC is labeled for use on all turfgrasses.
	azadirachtin (Turplex BioInsecticide) 3% EC	0.25 to 0.5 fl oz	Use 1-5 gallons of water per 1,000 square feet. Irrigate well before applying.
	Steinernema sp. Entomopathagenic nematodes	see label	Application should be made when small larvae or damage is first detected.
	lambda-cyhalothrin (Scimitar WP) 10 WP (Scimitar CS) 9.7 CS (Scimitar GC) 9.7 CS	3 to 6 grams 3.4 to 7 ml 3.4 to 7 ml	Scimitar GC can be used on golf courses.
	dinotefuron (Zylam) 20 SG	1 oz or 2.7 lb/acre	For cutworms only.

Pest	Insecticide and Formulation	Amount per 1,000 sq ft	Precautions and Remarks
CUTWORMS, ARMYWORMS (cont'd.)	halofenozide (MACH 2) 1.5G 2 L	1.55 lb 1.5 fl oz	MACH 2 Granular is labeled for use on all turfgrass sites, while MACH 2 Liquid is registered for use on commercial sites including golf courses, sod farms, commercial lawns and cemeteries. A single repeat application can be made if needed.
	deltamethrin (DeltaGard G) 0.1 G	2 to 3 lb	Irrigate with an adequate quantity of water to thoroughly moisten grass and thatch and dissolve the insecticide granules.
	chlorantraniliprole (Acelepryn) 1.67 SC 0.2%G	0.046-0.092 fl oz 2-4 fl oz/acre 1.15 - 2.3 lb 50 - 100 lb/acre	Delay watering or mowing for 24 hours after application of Acelepryn 1.67 SC. If a mowing height of greater than 1 inch is used, then the higher rate may be required during periods of high pest pressure for either of the formulations.
	zeta-cypermethrin 2.70% bifenthrin 7.87% imidacloprid 13.83% (Triple Crown T&O)	0.23-0.34 10-15 fl oz / acre	
EARTHWORMS			Usually not a problem, except on greens. No labeled controls available.
FALL ARMYWORMS	chlorpyrifos (Dursban Pro) 2 EC (Dursban 50W) 50 WSP	1.5 fl oz 2 lb/acre	Treat in late afternoon. Use adequate water for good coverage, but do not flood. Do not cut grass for one to three days after treatment. Not for residential use.
	zeta-cypermethrin 2.70% bifenthrin 7.87% imidacloprid 13.83% (Triple Crown T&O)	0.23-0.34 10-15 fl oz / acre	
	chlorantraniliprole (Acelepryn) 1.67 SC 0.2%G	0.046-0.092 fl oz 2-4 fl oz/acre 1.15 - 2.3 lb 50 - 100 lb/acre	Delay watering or mowing for 24 hours after application of Acelepryn 1.67 SC. If a mowing height of greater than 1 inch is used, then the higher rate may be required during periods of high pest pressure for either of the formulations.

Pest	Insecticide and Formulation		Amount per 1,000 sq ft	Precautions and Remarks
GRASSHOPPERS (refer to UT Extension fact sheet SP 290-X)	chlorpyrifos (Dursban Pro) (Dursban 50W)	2 EC 50 WSP	1.5 fl oz 2 lb/acre	For turfgrass use on golf courses, road medians and industrial plant sites. Dursban 50 W can be used in addition on turfgrass grown for sod or seed.
	deltamethrin (DeltaGard G)	0.1 G	2 to 3 lb	Irrigate with an adequate quantity of water to thoroughly moisten grass and thatch and dissolve the insecticide granules.
	zeta-cypermethrin 2.70% bifenthrin 7.87% imidacloprid 13.83% (Triple Crown T&O)		0.23-0.46 10-20 fl oz / acre	
WHITE GRUBS (May beetle, masked chafers, green June beetle, Japanese beetle and others)	trichlorfon (Dylox 80) (Dylox 6.2G)	80 SP 6.2 G	3.75 oz 3 lb	Dylox not for use on sod farms. Thoroughly irrigate following application.
	imidacloprid (Merit 75 WP) (Merit 0.5 G)	75 WP 0.5 G	6.4 oz/acre 1.4 lb	For optimum control, make application prior to egg hatch, followed by sufficient irrigation or rainfall within 24 hours of application. Not for use on commercial sod farms.
	clothianidin (Arena 50 WDG)	50 WDG	6.4-12.8 oz/acre	Do not apply more than 12.8 oz of Arena 50 WDG per acre per season.
	halofenozide (MACH 2)	1.5 G 2 L	2.3 lb 2.2 fl oz	MACH 2 Granular is labeled for use on all turfgrass sites, while MACH 2 Liquid is registered for use on commercial sites including golf courses, sod farms, commercial lawns and cemeteries. Make only one application.
	thiamethoxam (Meridian)	25WG 0.33G	1.5-1.95 oz/5,000 sq ft 12.7-17 oz/acre 7.1-9.4 lb/5,000 sq ft 60-80 lb/acre	Apply up to 45 days before the historical peak of adult flight to second instar grub of the species being targeted. For optimum control, treat from peak flight to peak egg hatch.
	chlorantraniliprole (Acelepryn)	1.67 SC 0.2 G	0.184 - 0.367 fl oz 8-16 fl oz/acre 1.15 - 2.3 lb 50 - 100 lb/acre	May be applied from early April to early September for preventative and early curative control of white grubs infesting turfgrass. The higher rate listed for white grub control may be required in late August or early September when less sensitive mid-instar grubs are present at time of application.
	zeta-cypermethrin 2.70% bifenthrin 7.87% imidacloprid 13.83% (Triple Crown T&O)		0.46-0.80 20-35 fl oz / acre	

Pest	Insecticide and Formulation	Amount per 1,000 sq ft	Precautions and Remarks
GREEN JUNE BEETLE GRUBS (only)	carbaryl (Sevin Brand SL) 4 SL	1 1/2 to 3 fl oz	Water in, but do not flood.
IMPORTED FIRE ANTS	hydramethylnon (Amdro Pro Fire Ant Bait, Siege Fire Ant Bait) 0.73% bait	2.0-3.0 oz/5,000 sq ft or 1.0-1.5 lb/acre	Uniformly broadcast 1-1.5 lb of bait per acre with ground equipment on pastures, rangegrass, lawns, sod farms, golf courses, athletic fields, noncropland, container- and field-grown ornamental nonbearing nursery stock, and other listed sites. Or uniformly distribute 2-5 level tablespoons of bait around the base of each mound. Do not apply directly to the top of the mound. Do not exceed 1.5 lb/acre. A blend of Amdro Pro Fire Ant Bait plus Extinguish Profesional Five Ant Bait can be used to control imported fire ants in non-agricultural levels.
	abamectin (PT370 Ascend Fire Ant Stopper Bait) 0.011% bait (Varsity Fire Ant Bait) 0.011% bait	0.4 oz 1 lb/acre	Broadcast: Uniformly apply 1 lb of bait per acre to turf, lawns and noncrop areas. Individual mound: Use 5-7 tablespoons of bait per mound. Apply evenly over mound and for a distance of about 2 feet out from the base. Do not use in pastures, rangelands or croplands.
	fenoxycarb (Award Brand of Logic Fire Ant Bait) 1% bait		Do not apply on pasture or rangegrass to be grazed. Broadcast 1-1.5 lb per acre or apply 1-3 level tablespoons uniformly 3-4 feet around the mound. May need to retreat in three to four months. Do not apply during excessively hot periods of the day or when heavy rainfall is expected within two to three hours after application.
	pyriproxyfen (Distance Fire Ant Bait) 0.5% bait (Spectracide Fire Ant Bait) 0.05% bait	0.35-0.5 oz or 1-1.5 lb/acre or 1-4 Tbsp/mound 1 lb/4,400 sq ft	For use on sod farms, uncultivated nonagricultural areas, non-grazed pastures and rangeland, and other listed sites. For mound treatment, do not apply to top of mound. Instead uniformly distribute bait 3-4 feet around the mound. For Spectracide Fire Ant Bait use 2-4 tablespoons of bait per mound. Evenly sprinkle bait in a 1-foot circle around the center of each mound.

Pest	Insecticide and Formulation	Amount per 1,000 sq ft	Precautions and Remarks
IMPORTED FIRE ANTS (cont'd.)	s-methoprene (Extinquish Professional Fire Ant Bait) 0.5% bait	3.5 Tbsp or 1-1.5 lb/acre or 3-5 Tbsp/mound to a perimeter of 4 ft.	For use on turfgrass and landscapes, golf courses, school grounds, roadsides, sports fields, pastures, rangeland, cropland, sod farms, commercial nurseries including field-grown and container stock, and other listed sites.
	fipronil (Ceasefire) 0.00015% bait	1.5-15 lb/acre or 5 Tbsp/mound	For use on home lawns, golf courses and commercial and recreational turf and sod farms. May make a total of four applications per year if necessary.
	(Topchoice) 0.0143% G	2 lb or 87 lb/acre	For best results, treated turf should be watered or irrigated after application. Do not apply more than one application per year of 87 pounds of product per acre. Two applications (87 lbs/acre per application) may only be used on sodfarms within USDA APHIS Quarantine areas.
	Indoxacarb (Advion Fireant bait) 0.045 G	0.5 oz or 1.5 lb/acre	For use on home lawns, golf courses, athletic fields, and recreational turf, parks, cemeteries and other listed sites.
	thiamethoxam (Meridian 25WG) 25 WG		Prepare drench solution at a concentration of 1-3 oz of Meridian 25 WG per 10 gallons water. Thoroughly mix solution and apply directly to the mounds. For optimum control of small ant mounds (less than 6 in diameter at surface) apply 1 gallon of the drench solution per mound. For optimum control of larger ant mounds apply 2-3 gallons of drench solution per mound. The drench application should be directed at the center of the mound and include a 6-inch diameter circle around the center of the mound.
	chlorpyrifos (Dursban Pro) 2 EC (Dursban 50W) 50 WSP		For individual fire ant mounds: Apply 2 fl oz of Dursban Pro per 4 gallons of water as a drench. Dilute 0.75 lb of Dursban 50W per 50 gallons of water. Sprinkle 1-2 gallons of the diluted insecticide over the surface of each mound and surrounding areas to a 2-foot diameter. Not for residential use. For imported fire ants on sod farms, apply 16 lb (64 4-oz packets) Dursban 50W as a spray to the area of sod to be cut. Immediately after application, irrigate treated area with at least 1/2 acre-inch of water or a sufficient volume to thoroughly soak below the cut line. Do not apply a volume or rate of water to cause runoff. Sod can be cut when vegetation has dried and when soil is moist but not wet.
	lambda-cyhalothrin (Scimitar CS, Scimitar GC) 9.7 CS		Use 0.5 fl oz per 2.5 gallons of water and thoroughly cover and soak each mound and treat a 4-foot diameter circle around the mound. Scimitar GC can be used on golf courses.

Pest	Insecticide and Formulation	Amount per 1,000 sq ft	Precautions and Remarks
IMPORTED FIRE ANTS (cont'd.)	acephate (Orthene Turf, Tree & Ornamntal Spray) 75 SP 75 SP		For residential recreational and commercial turf. Mix 1 oz in 5 gallons of water. Apply one gallon of mix per mound with sprinkler can. Thoroughly wet 4-foot diameter area around the mound. Evenly distribute 1-2 tsp without water over the mound.
	deltamethrin (DeltaGard G) 0.1 G	2 to 3 lb	Irrigate with an adequate quantity of water to thoroughly moisten grass and thatch and dissolve the insecticide granules.
	bifenthrin (Talstar One)	1.0 oz (Broadcast Treatment)	For mound treatment, dilute 1 teaspoon per gallon of water and apply 1-2 gallons of finished spray per mound. Allow the Talstar One insecticide to flow into the ant tunnels and also treat a 4-foot circle around the mound. Talstar One not for use on sod farms, golf courses or grass grown for seed.
	(Talstar GC) 0.2 % granular	4.6 lb (Broadcast Treatment)	For mound treatment, apply 1/2 cup of the granular insecticide per mound and then drench mound with 1-2 gallons of water so as to allow the insecticide to flow into ant tunnel. Talstar GC for use on lawns around residential, institutional, public, commercial and industrial buildings, parks, recreational areas, golf courses, sod farms, and athletic fields.
	(OnyxPro) 23. 4%	0.16-0.32 fl oz (Broadcast Treatment)	Control will be optimized by combining broadcast applications with mound drenches. Mounds must be treated by applying 0.32 oz OnyxPro per mound in 1-2 gallons water by sprinkling the mound until it is wet and treat 3 feet out around the mound. **Imported Fire Ant Quarantine Treatment of grass sod for sale (sod farms).** Apply OnyxPro as a broadcast treatment. Use higher volumes up to 10 gallons of carrier per 1,000 sq ft to get uniform coverage when treating dense grass foliage. Make two applications of 0.32 fl oz per 1,000 sq ft seven days apart. This application will provide control within four weeks followed by 16 weeks of certification.

Pest	Insecticide and Formulation	Amount per 1,000 sq ft	Precautions and Remarks
IMPORTED FIRE ANTS (cont'd.)	Zeta-cypermethrin 0.05% plus bifenthrin 0.20% (Talstar XTRA G)		Control will be optimized by combining broadcast applications that will control foraging workers and newly mated fly-in queens with mound treatments that will eliminate existing colonies. If the soil is not moist, then it is important to irrigate before or soon after application. Broadcast treatments should apply no more than 0.50 lbs ai per acre (4.6 lbs/1,000 sq ft). Mounds should be treated by applying 1/2 cup of Talstar XTRA Granular per mound and then drenching the mound with 1 to 2 gallons of water. The mounds should be treated with sufficient force to break their apex and allow the insecticide solution to flow into the ant tunnels. Treat 3 feet out around the mound. For best results, apply in cool weather (65-80 F) or in early morning or late evening hours.
LEAFHOPPERS and SPITTLEBUGS	chlorpyrifos (Dursban Pro) 2 EC (Dursban 50W) 50 WSP	1.5 fl oz 2 lb/acre	Thatch control is important in preventing and controlling spittlebugs. Proper dethatching and fertilization practices can disrupt the humid conditions essential for spittlebugs.Treat infested areas. Not for residential use.
	deltamethrin (DeltaGard G) 0.1 G	2 to 3 lb	Irrigate with an adequate quantity of water to thoroughly moisten grass and thatch and dissolve the insecticide granules.
	zeta-cypermethrin 2.70% bifenthrin 7.87% imidacloprid 13.83% (Triple Crown T&O)	0.23-0.46 10-20 fl oz / acre	
MILLIPEDES	carbaryl (Sevin Brand SL) 4 SL	1 1/2 to 3 fl oz	
	zeta-cypermethrin 2.70% bifenthrin 7.87% imidacloprid 13.83% (Triple Crown T&O)	0.23-0.46 10-20 fl oz / acre	
MOLE CRICKETS	deltamethrin (DeltaGard G) 0.1 G	2 to 3 lb	Irrigate with an adequate quantity of water to thoroughly moisten grass and thatch and dissolve the insecticide granules.
	bifenthrin (Talstar Lawn & Tree) 7.9 F (Talstar GC) 7.9 F	0.5-1.0 fl oz 0.25-0.5 fl oz	Application should be made as late in the day as possible and should be watered in with up to 0.5 inches of water immediately after treatment. If the soil is not moist, then it is important to irrigate before application to bring the mole crickets closer to the soil surface.
	dinotefuron (Zylam) 20SG	1 oz or 2.7 lb/acre	Make application prior to or during the peak egg hatch period. When adults or large nymphs are present and actively tunneling, tank mix with a curative insecticide.

Pest	Insecticide and Formulation	Amount per 1,000 sq ft	Precautions and Remarks
MOLE CRICKETS (cont'd.)	acephate (Orthene Turf, Tree & Ornamental Spray) 75 SP	1 to 1 1/2 oz	Water soil prior to application. Do not water in. For golf courses and sod farm turfgrasses. Not for homeowner lawn use except for imported fire ant mound treatments.
	cyfluthrin (Tempo 20 WP) 20 WP	(1 packet) 50 gm per 7,500 sq ft	Tempo 20 WP not for use on sod farms or golf courses.
	(Tempo 20 WP GC) 20 WP	(1 packet) 55 gm per 7,800 sq ft	Tempo 20 WP GC for use on residential and commercial sites including golf courses.
	fipronil (Chipco TopChoice) 0 .0143%G	87 lb/acre	The primary purpose of TopChoice is to control imported fire ants. Mole crickets at this rate will be controlled for approximately four months. For best results, treated turf should be watered or irrigated after application.
	beta-cyfluthrin (Tempo SC Ultra) 1 SC	6 ml	Not for use on sod farms or golf courses.
	zeta-cypermethrin 2.70% bifenthrin 7.87% imidacloprid 13.83% (Triple Crown T&O)	0.46-0.80 20-35 fl oz / acre	
SOWBUGS, PILLBUGS	carbaryl (Sevin Brand SL) 4 SL	1 1/2 to 3 fl oz	
	deltamethrin (DeltaGard G) 0.1 G	2 to 3 lb	Irrigate with an adequate quantity of water to thoroughly moisten grass and thatch and dissolve the insecticide granules.
	zeta-cypermethrin 2.70% bifenthrin 7.87% imidacloprid 13.83% (Triple Crown T&O)	0.23-0.46 10-20 fl oz / acre	
SLUGS and SNAILS	metaldehyde (2%) and carbaryl (5% Sevin) granules (Bug-geta Plus)	0.5 lb	If ground is dry, water area to be treated thoroughly.
SOD WEBWORMS (Refer to UT Extension fact sheet SP 290-L)	carbaryl (Sevin Brand SL) 4 SL	4.4 to 6 fl oz	Treat in late afternoon. Repeat as needed. Apply adequate water for good coverage. Do not cut grass for one to three days after application.
	chlorpyrifos (Dursban Pro) 2 EC (Dursban 50W) 50 WSP	1.5 fl oz 2 lb/acre	Watering or mowing of the treated area should be delayed for 12 to 24 hours after treatment. Not for residential use.
	dinotefuron (Zylam) 20SG	1 oz or 2.7 lb/acre	

Pest	Insecticide and Formulation		Amount per 1,000 sq ft	Precautions and Remarks
SOD WEBWORMS (cont'd.) (Refer to UT Extension fact sheet SP 290-L)	trichlorfon (Dylox 80) (Dylox 6.2G)	 80 SP 6.2 G	 2.5 to 3.75 oz 2 lb	Dylox 80 and 6.2G not for use on turf being grown for sale.
	deltamethrin (DeltaGard G)	 0.1 G	 2 to 3 lb	Irrigate with an adequate quantity of water to thoroughly moisten grass and thatch and dissolve the insecticide granules.
	methomyl (Lannate)	 90 SP	 2/5 oz	For use on sod farms only. After application, sprinkle irrigate for 15 minutes.
	Bacillus thuringiensis (Dipel 2X)	 WP	 0.37 to 0.73 oz	
	spinosyn A and spinosyn D (Conserve SC)	 1 SC	 0.25 fl oz	Conserve SC is labeled for use on all turfgrasses.
	cyfluthrin (Tempo 20 WP) (Tempo 20 WP GC)	 20 WP 20 WP	 50 gm (1 packet) per 7,500 to 10,000 sq ft 55 gm (1 packet) per 11,000 sq ft	Delay watering or mowing for 24 hours for optimum control. Tempo 20 WP not for use on sod farms and golf courses. Tempo 20 WP GC for use on residential and commercial sites including golf courses.
	beta-cyfluthrin (Tempo SC Ultra)	 1 SC	 4-6 ml	Not for use on sod farms or golf courses.
	Steinernema sp. Entomopathogenic nematodes		 see label	Application should be made when small larvae or damage is first detected.
	azadirachtin (Turplex BioInsecticide)	 3% EC	 0.25 to 0.5 fl oz	Use 1-5 gallons of water per 1,000 square feet. Irrigate well before applying.
	lambda-cyhalothrim (Scimitar WP) (Scimitar CS) (Scimitar GC)	 10 WP 9.7 CS 9.7 CS	 3 to 6 grams 3.4 to 7 ml 3.4 to 7 ml	Scimitar GC can be used on golf courses.
	permethrin (Astro)	 3.2 EC	 0.4 to 0.8 fl oz	For use on lawns (residential lawns and sod farms).

Pest	Insecticide and Formulation	Amount per 1,000 sq ft	Precautions and Remarks
SOD WEBWORMS (cont'd.) (Refer to UT Extension fact sheet SP 290-L)	halofenozide (MACH 2) 1.5 G 2 L	1.55 lb 1.5 fl oz	MACH 2 Granular is labeled for use on all turfgrass sites while MACH 2 Liquid is registered for use on commercial sites including golf courses, sod farms, commercial lawns and cemeteries. A single repeat application can be made if needed.
	bifenthrin (Talstar Lawn & Tree) 7.9 F (Talstar GC) 7.9 F	0.18-0.25 fl oz 0.25 fl oz	Delay watering or mowing for 24 hours after application.
	clothianidin (Arena 50 WDG)	6.4-12.8 oz/acre	Do not apply more than 12.8 oz of Arena 50 WDG per acre per season.
	chlorantraniliprole 1.67 SC (Acelepryn) 0.2%G	0.046-0.092 fl oz 2-4 fl oz/acre 1.15 - 2.3 lb 50 - 100 lb/acre	Delay watering or mowing for 24 hours after application of Acelepryn 1.67 SC. If a mowing height of greater than 1 inch is used, the higher rate may be required during periods of high pest pressure for either of the formulations.
	zeta-cypermethrin 2.70% bifenthrin 7.87% imidacloprid 13.83% (Triple Crown T&O)	0.23-0.34 10-15 fl oz / acre	

Formulation Abreviations Used

WSP	-	Water soluble packets	E or EC	-	Emulsifiable concentrate
WP	-	Wettable powder	SL	-	Suspended liquid
SP	-	Soluble powder	F	-	Flowable
			G	-	Granules

Sampling and Aesthetic Thresholds for Turfgrass Insect Pests

White grubs — Treat from July to mid-August when the aesthetic threshold determined by sampling has been reached. Sample several square foot sections of turfgrass by using a shovel or spade to cut out a square foot section and lift the turf back to expose the roots and count white grubs.

Threshold Targets for White Grubs
Assuming Adequate Growing Conditions and No Digging Animals

Annual White grubs *5-10 grubs/square foot*
(Japanese Beetle, Oriental Beetle, European Chafer, Asiatic Garden Beetle) Southern and Northern masked Chafers
(Annual White Grubs) *15-20 grubs/square foot*

Black Turfgrass Ataenius *30-50 grubs/square foot* May/June Beetles *3-8 grubs/square foot*
Green June beetle *6-8 grubs/square foot* Adapted from D.J. Shetlar (1995) and D.A. Potter (1982)

Sod webworms — These caterpillars feed on the blades of grass. The light colored caterpillars with dark spots make silk tunnels in the grass. Check for sod webworms and cutworms by preparing a soap solution of 2 teaspoons of liquid dishwashing detergent in a gallon of water. Pour this solution over a 2 foot by 2 foot area (4 ft^2). Treat when four to six or more sod webworms per 4 ft^2 are found.

Cutworms — These dark, dingy colored caterpillars feed at night and hide in the ground in the daylight. They clip off the blades of grass at the crown. Treat when one or more cutworms per 4 ft^2 are found.

Armyworm and fall armyworm — These caterpillars reach high population levels and can totally defoliate fields or yards. They can also be detected by using a soap solution flush. Sample periodically thought the spring and summer and treat when any populations of these caterpillars and detected.

References

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Disease Control for Trees, Shrubs and Flowers, 2018

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Entomology and Plant Pathology

Disease	Hosts	Management Strategies*
Powdery mildew is easily identified by the presence of white to gray mycelium on affected leaves and/or flowers. The first sign of disease is usually isolated colonies of white fungal growth. With time whole leaves may be totally covered with fungal growth. On some plants, such as pin oak, mildew may be present only on the undersides of leaves. On dogwood, crape myrtle and nandina, infected leaves may be curled, twisted or otherwise distorted. Leaves may be abnormally red with little mycelium visible; on sedum, lesions are scabby and brown.	Amelanchier, azalea, begonia, columbine, crabapple, crape myrtle, dogwood, euonymus, hydrangea, lilac, magnolia, nandina, oak, phlox, rhododendron, rose, sedum, tulip tree, verbena, zinnia	**Host Resistance** — Use disease-resistant species/cultivars for crabapple, crape myrtle, dogwood, lilac, rose, zinnia **Chemical Control** — Azoxystrobin, chlorothalonil, copper hydroxide, copper octanoate, kresoxim-methyl, myclobutanil, polyoxin D, propiconazole, pyraclostrobin, tebuconazole, triadimefon, trifloxystrobin, triflumizole
Downy mildew — Although this sounds similar to powdery mildew, the diseases are very different; caused by fungi from entirely different taxonomic classes. The fungi that cause downy mildew are more closely related to fungi that cause phytophthora and pythium root rots than the fungi that cause powdery mildew. Symptoms of downy mildew can range from leaf spots and defoliation to rapid blighting of diseased shoots. Angular leaf spots on rose may range from red to brown to black. Signs to look for include gray-to-white tufts of mycelium on the undersides of leaves, directly below chlorotic lesions. Look for mycelium early in the morning while the leaves are still wet.	Alyssum, brambles, coleus, grape, impatiens, pansy, rose, rudbeckia, salvia, snapdragon, tobacco, viburnum	**Host Resistance** — For downy mildew of garden impatiens use begonias, coleus, New Guinea impatiens or SunPatiens, Torenia **Chemical Control** — Azoxystrobin, cyazofamid, dimethomorph, fenamidone, fluopicolide, fluoxastrobin, fosetyl-al, mancozeb, mefenoxam, potassium salt of phosphorus acid, potassium phosphite
Gray mold may be found on herbaceous and woody ornamentals usually during cloudy, cool, moist weather. Stems, leaves and flowers may be attacked. Woody ornamentals in overwintering structures may become infected. Symptoms of infection are blighting of flowers, tan-to-brown leaf spots, shoot blights and stem rot. A sign of disease is	Almost any herbaceous or woody plant	**Sanitation** — In greenhouses and propagation areas, remove infected plant parts or plants. **Environmental** — In greenhouses use fans and vent to remove moist air at the end of the day. Minimize leaf wetness.

Disease	Hosts	Management Strategies*
gray-brown mold on diseased plant parts.		
		Chemical Control — Chlorothalonil, copper sulphate pentahydrate, fenhexamid, fludioxonil, iprodione, mancozeb, triflumizole
Rusts —Signs include bright yellow, orange, reddish-brown or chocolate-brown raised pustules are visible usually on the undersides of leaves. Gelatinous tendrils of rust spores are produced from galls each spring on eastern red cedar infected with cedar-apple rust. Pine needle rust produces pustules on pine during spring. Early symptoms on leaves are yellow leaf spots. Rust galls may appear on stems of pine, cedar and hawthorn. Twig rust may cause branch dieback on plants as diverse as hawthorn and hemlock. Daylily rust was first found in the U.S. in 2000 and in TN in 2001.	Amelanchier, apple, aster, azalea, cedar, crabapple, daylily, fuchsia, geranium, grasses, hawthorn, hemlock, hollyhock, iris, jack-in-the-pulpit, juniper, mayapple, oak, pear, pine, potentilla, quince, snapdragon, sunflower	**Host Resistance** — Cedar rust resistant cultivars are available for apple, crabapple, hawthorn. **Chemical Control** — Azoxystrobin, chlorothalonil, mancozeb, myclobutanil, propiconazole, pyraclostrobin, tebuconazole, triadimefon, trifloxystrobin
Virus Diseases — Plants infected with viruses exhibit a variety of symptoms, including mosaic, ringspots, stem lesions, rosette (witches broom), "oak-leaf" pattern, stem pitting, stunting, flower break, etc. Hosta virus X (HVX) is fairly common on hosta. HVX is most easily diagnosed on gold hosta cultivars where abnormal green stripes appear parallel with veination of leaves. Canna yellow mottle virus is very prevalent on the Tropicana series of canna. Symptoms include stunted plants, necrotic streaks in leaves and muted variegation. Rose rosette is a viral disease transmitted by eriophyid mites. Virus diseases may be difficult to diagnose unless you are familiar with symptoms associated with specific virus diseases.	***Canna yellow mottle virus*** — Tropicana series of canna lily ***Hosta Virus X*** — Many common cultivars of hosta ***Impatiens necrotic spot virus*** — Over 350 ornamental plants ***Tomato ringspot* virus** — dogwood, fringetree, peach, cherry **Tomato spotted wilt virus** — Perennial plants ***Rose mosaic virus and Rose rosette*** — Rose	**Sanitation and Cultural Control** — Do not propagate plants with symptoms of a viral disease. In production, remove and discard infected plants. For impatiens necrotic spot, monitor and manage thrips populations in greenhouses. **Rose rosette** — Remove roses with symptoms of rose rosette. Break up mass plantings by using a non-host as a barrier between smaller plantings. Remove multiflora rose near rose plantings. Pruning and control of the vector (eriophyid mites) are being evaluated.
Leaf spot diseases are usually caused by fungi, but a few may be caused by bacteria. These are among the most common plant diseases. Symptoms vary depending on the pathogen and host. Some common symptoms include frogeye or bull's eye spot marked with concentric rings; irregular, round tan spots with small black fruiting bodies;	***Alternaria LS*** — Aucuba, impatien, marigold, zinnia **Black spot** — Rose ***Bull's eye LS*** — Magnolia, maple ***Cercospora LS*** — Buckeye, crape myrtle,	**Host Resistance** — Choose disease-resistant cultivars of rose, crabapple, Indian hawthorn, buckeye, horse chestnut **Sanitation and Cultural Control** — Rake and remove diseased leaves. Minimize leaf wetness; use drip irrigation. **Chemical Control** — Azoxystrobin, chlorothalonil, copper hydroxide, copper

Disease	Hosts	Management Strategies*
angular tan or black spots; black or tan spots surrounded by a yellow "halo"; oval-shaped leaf spots; and tan-to-gray spots with red or purple margins. Fungal leaf spot diseases are usually favored by wet seasons, high humidity and/or frequent overhead irrigation. Many leaf spots cause premature defoliation.	leucothoe, laurel, red bud, rose ***Entomosporium LS*** — Indian hawthorn, pear, photinia **Leaf blotch** — Buckeye, horse chestnut ***Phyllosticta LS*** — Holly, magnolia, maple, witch hazel **Scab** — Crabapple	octanoate, fludioxonil, kresoxim methyl, mancozeb, myclobutanil, propiconazole, Pyraclostrobin, tebuconazole, Thiophanate methyl, trifloxystrobin, triflumizole
Shot Hole Diseases — Some plants shed diseased leaf tissue in response to fungal or bacterial infections. Infected leaves are covered with circular, "shot" holes where diseased tissue has fallen out. Infected leaves may become chlorotic and drop prematurely. Shot-hole diseases may be caused by fungi or bacteria. Damage from shot-hole disease may be confused with insect feeding. Remember, shot-hole disease only occurs on plants in the genus *Prunus*. Similar symptoms on other plants may be caused by insects.	Almond, apricot, cherry, cherry-laurel, peach, plum (plants in the genus *Prunus*)	**Sanitation and Cultural Control** — Rake and remove fallen leaves. Minimize leaf wetness, especially for bacterial shot hole diseases of laurel. **Chemical Control** — Chlorothalonil, copper hydroxide, copper octanoate, mancozeb
Anthracnose refers to diseases that cause leaf, stem and/or fruit lesions. These diseases may appear as irregular leaf spots/lesions along leaf margins and across or between veins. Anthracnose may kill entire leaves, young shoots and twigs, plus cause premature defoliation. Diseased leaf tissue may fall out of leaf lesions. Stem cankers may form at the base of succulent shoots. Look for anthracnose diseases of ash, dogwood, maple and sycamore during April and May.	Ash, dogwood, euonymus, hosta, maple, oak, sycamore	**Sanitation and Cultural Control** — Rake and remove fallen leaves. Prune and remove cankered or dead branches. Space to increase air movement and minimize leaf wetness. Use drip irrigation to minimize leaf wetness. **Chemical Control** — Chlorothalonil, cupper hydroxide, copper octanoate, tebuconazole, thiophanate methyl
Needle Blight and Cast of Conifers — Basically a leaf spot disease of conifers that leads to premature shedding of needles. During certain times of the year, distinct yellow-to-brown lesions are visible on pine needles. Infected needles turn brown and shed. Fungi that cause needle cast are generally weak pathogens that infect older needles in the interior of the tree's canopy. Black fruiting bodies of various fungi may be observed in single or multiple rows along the length of infected needles.	***Cyclaneusma needle cast*** — Scots pine ***Lophodermium needle cast*** — Eastern white pine ***Ploioderma needle cast*** — Loblolly pine ***Rhizosphaera needle cast, Stigmina needle cast*** — Spruce ***Phomopsis blight*** — Juniper	**Sanitation and Cultural Control** — For field grown plants, choose locations with good air movement. Space plants to minimize needle wetness. For needle blights such as Kabatina, prune if desired to remove diseased shoots. **Chemical Control** — Chlorothalonil, copper hydroxide, thiophanate methyl + chlorothalonil

Disease	Hosts	Management Strategies*
Conifers infected with needle cast have brown needles and thin canopies. The most common tip blight diseases of juniper include phomopsis blight, which attacks new flushes of growth in late spring or early summer. Kabatina blight of juniper attacks juniper injured from snow or ice in late winter through early spring. Tip blights rarely kill more than 4 inches of the terminal of juniper shoots.	***Kabatina blight*** — Juniper, Leyland cypress **Passalora needle blight** — Leyland cypress	
Canker Diseases — Canker-causing fungi may live as endophytes on susceptible host. An endophyte means the fungus is living on and/or in host tissue, but there are no signs of disease. But let the plant come under significant stress and dieback may not be far away. Leaf death and twig dieback are some of the first symptoms of canker diseases. Cankers are usually found on branches but may infect trunks of young trees. Initially the disease may be undetectable except by shaving the surface of a branch to reveal brown discoloration of bark and/or underlying sapwood. As cankers enlarge, oval, sunken areas may develop on branches. Large cankers may girdle and kill branches and entire plants if they develop on the trunk or main stems of shrubs. Gum production (gummosis) is often associated with fungal and bacterial cankers of cherry. Resin is often associated with canker diseases of junipers. Fire blight is a bacterial disease that may cause cankers. Fire blight is usually observed on plants in the Rosaceae family. Early symptoms may be blossom blight during bloom, followed by the shoot blight phase and signature symptoms such as shoots killed rapidly in the shape of a "shepherd's crook." Water-soaked cankers may be found on the trunk and branches of infected plants.	***Botryosphaeria canker*** — Ash, crabapple, dogwood, juniper, laurel, Leyland cypress, red bud, maple, rhododendron ***Endothia canker*** — Pin oak ***Fire blight*** — Apple, cotoneaster, crabapple, hawthorn, pear, pyracantha, serviceberry ***Nectria canker*** — Dogwood, pear ***Phomopsis canker*** — Azalea, ash ***Seiridium canker*** — Leyland cypress, Arizona cypress ***Thyronectria canker*** — Honey locust	**Sanitation and Cultural Control** — For fungal canker diseases, keep plants irrigated during dry periods, remove diseased branches, remove heavily cankered plants. **Fire blight** — Streptomycin may be used during bloom, copper sprays afterward. Dormant pruning to remove cankered branches. There are apple, crabapple and pear cultivars resistant to fire blight. **Chemical Control** — Thiophanate methyl or mancozeb may be applied to wounds immediately after pruning to minimize canker diseases.
Leaf galls — Conspicuous white, yellow, red or gray blisters or galls develop on leaves. Leaves may become puffy, puckered, thickened or curled. Infected leaves may drop early. The most common leaf gall diseases are azalea	***Leaf gall*** — Azalea, blueberry, camellia, rhododendron ***Leaf blister*** — Red oak, water oak, willow oak ***Leaf curl*** — Peach, plum	**Azalea leaf gall** can be removed and destroyed. **Peach leaf curl** — Two to three fungicide sprays. At 50% leaf fall in late October, one to two dormant sprays in late winter before flower buds open. Chlorothalonil,

Disease	Hosts	Management Strategies*
leaf gall, peach leaf curl and oak leaf blister. Symptoms may be confused with insect or mite induced galls, which are more numerous.		Bordeaux mixture, lime sulfur, fixed copper.
Crown gall — Rough-surfaced, hard or soft, spongy, swollen tumors or galls up to several inches in diameter may form on stems or roots. Galls may be flesh-colored, greenish or dark. Galls are usually found near or below the soil line. Galls may form at wounds made during propagation. As galls continue to develop and enlarge, surface layers may become brown, woody and roughened. Plants with crown gall usually become unthrifty and possibly stunted. Plant death may eventually occur.	Apple, crabapple, Euonymus, holly, maple, peach, plum, rhododendron, rose, willow, wisteria	**Sanitation and Cultural** — Crown gall may be more severe in heavy soils where water stands. Avoid fields with a history of crown gall. Destroy infected ornamental plants with crown gall.
Stem Rots ***Southern blight*** — Usually occurs in gardens, perennial borders and nurseries during hot weather, near mid-summer. Symptoms include wilting, leaf scorch, followed by plant death. Signs of disease include white mycelium on the stem of infected plants and tan to reddish-brown round, spherical resting structures of the fungus (sclerotia) on the stem and soil surface. ***Sclerotinia crown rot*** — Unlike southern blight, this disease usually appears during mid-spring to early summer when conditions are cool and moist. Affected plants usually wilt and die. White mycelium may be visible on stems near the soil surface. Black, oblong sclerotia may be present on the outer surface of woody plants or in the stem pith of herbaceous plants. Diseased stems should be split lengthwise and examined for signs of sclerotia. ***Rhizoctonia stem rot/damping off*** - This disease is often the cause of damping off (stem rot) of seedling plants. Seedling annual or perennial flowers or woody ornamentals may be killed by this fungus after it attacks the stem near the soil surface. Diseased seedlings often fall over and die. In the field, the fungus may move short distances down the row killing several adjacent plants.	***Southern Blight*** — Ajuga, apple, clematis, crabapple, forsythia, hosta, many annual and perennial flowers, rarely on some turf species ***Sclerotinia Stem Rot*** — Campanula, euonymus, several herbaceous flowers ***Rhizoctonia stem rot*** — Many herbaceous plants and seedlings of woody plants and conifers	**Sanitation and Cultural Control** — For southern blight and Sclerotinia crown rot, remove infested plants plus soil near the stem as to remove sclerotia. **Chemical Control** — **Southern blight and Rhizoctonia stem rot** — Azoxystrobin or flutolanil as directed spray or drench for prevention of stem rots **Sclerotinia crown rot** — Thiophanate methyl

Disease	Hosts	Management Strategies*
In propagation beds or flats, diseased plants may be killed in circular areas as the fungus moves outward.		
Nematode Diseases — Millions of nematodes may live in a square meter of soil; however, only a few are parasites of plants. Most plant parasitic nematodes attack plant roots; some attack foliage. Nematode damage can be difficult to diagnose as most of the damage occurs below ground. Plants damaged by nematodes may appear stunted, unthrifty, discolored and have discolored roots with lesions or galls. One sure way to identify nematode problems is to submit a soil and/or root sample for analysis at a plant diagnostic laboratory; submit symptomatic foliage where foliar nematode is suspected.	***Root knot nematode*** — Abelia, aucuba, begonia, boxwood, dogwood, gardenia, holly, hydrangea, impatien, ligustrum, nandina, photinia, rose ***Foliar nematode*** — African violet, anemone, begonia, brunnera, hosta, many shade loving perennials ***Lesion nematode*** — Boxwood, juniper	**Sanitation and Cultural Control** — Avoid planting susceptible hosts into infested soil. Destroy infested plants. Do not propagate plants infested with foliar nematodes or root knot nematode.
Wilt diseases are usually responsible for the slow to moderate decline of trees and some shrubs. Individual branches may discolor and die. Some wilts may affect only one side of the plant. A common symptom associated with wilt diseases is vascular discoloration (discolored sapwood). Leaf scorch and a reduction in canopy size are additional symptoms. Wilt pathogens may be spread by insects (Dutch elm disease by elm bark beetles; Bacterial leaf scorch by leaf hoppers). Bacterial leaf scorch is very common on pin oak, other oaks in the red oak family.	***Bacterial leaf scorch*** — Elm, red maple, mulberry, sycamore, pin oak, shingle oak ***Dutch elm disease*** Elm ***Verticillium wilt*** — Ash, barberry, boxwood, buckeye, catalpa, daphne, elm, lilac, euonymus, smoke tree, maple ***Fusarium wilt*** — Mum, more common on herbaceous plants	**Sanitation and Cultural Controls** — Plant diversity prevents the loss of large numbers of street trees. Plant diverse tree species. **Dutch elm disease** — Remove and destroy infected trees to limit spread of elm bark beetles. Trees of high value may be injected with fungicides by arborists. **Verticillium wilt** — Do not plant susceptible maple into infested fields. Replace diseased shade trees with resistant species.
Root Rot — Plants affected with fungal root rots may be stunted, wilted, look generally unthrifty (mimic nutrient deficiency), and eventually die. Discolored decayed roots are sure symptoms of root rot diseases. Poor drainage, standing water, improperly constructed landscape beds, planting infected plants, and excessive irrigation favor phytophthora and/or pythium root rots.	***Black root rot*** — Japanese holly, blue holly, inkberry, vinca, pansy, petunia ***Phytophthora root rot*** — Azalea, dogwood, forsythia, fir, holly, juniper pieris, rhododendron, yew	**Sanitation and Cultural Controls** — Check root health, if possible, prior to purchasing plants in containers. **Phytophthora root rot** — Avoid planting susceptible plants into heavy, poorly drained soils. Avoid soil contamination of new pots and bark media. Place container plants on gravel or ground cloth. Irrigate from water sources free of Phytophthora. **Black Root Rot** — Alkaline soil pH favors disease development. Avoid soil contamination of flats, pots and soil-less media. **Chemical Control –** **Phytophthora root rot** — Cyazofamid, etridiazole, fluopicolide, fosetyl-Al,

Disease	Hosts	Management Strategies*
		mefenoxam, mono and di-potassium salts of phosphorous acid, potassium phosphite **Black root rot** — Thiophanate methyl, thiophanate methyl + iprodione, fludioxinil, polyoxin D,
Boxwood Blight — The two distinctive symptoms of boxwood blight are circular necrotic lesions on leaves and small black lesions on green twigs. Infected plants may defoliate.	***Buxus sempervirens, Buxus microphylla, Buxus sinica, B. sempervirens 'Suffruticosa',*** most cultivated boxwood species/cultivars are susceptible to this disease, but vary in sensitivity.	Know the symptoms of boxwood blight before purchasing plants. Isolate plants for 2-4 weeks after purchase and observe for symptoms. Clean shears after clipping hedges. **Chemical Control** — Chlorothalonil and propiconazole will protect healthy plants, but not cure infected plants. Fungicides can be applied to suppress disease after infection, but will have to be applied often (7-14 days) and indefinitely.

Updated May 2018

Images of many of the diseases listed in this document are archived at the Soil, Plant and Pest Center Facebook page: facebook.com/SoilPlantPestCenter

*Precautionary Statement

In order to protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store, or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label. Persons who do not obey the law will be subject to penalties.

Disclaimer Statement

Pesticides recommended in this publication were registered for the prescribed uses when printed. Pesticides registrations are continuously reviewed. Should registration of a recommended pesticide be canceled, it would no longer be recommended by the University of Tennessee.

Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others which may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product.

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PB 1589

Commercial Insect and Mite Control for Trees, Shrubs and Flowers

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Department of Entomology and Plant Pathology

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Credit: This publication was adapted from "Insect and Mite Control on Woody Ornamentals and Herbaceous Perennials," Bulletin 504, an Ohio State University Extension publication authored by D.J. Shetlar, Department of Entomology, The Ohio State University, Columbus OH; "Insect Control for Shade Trees," EC 851, and "Insect Control for Shrubs," EC 780, authored by H.E. Williams, Professor Emeritus, Entomology and Plant Pathology, UT Extension.

Seasonal Appearance of Ornamental Pests
and
Normal Time Frame to Apply Control Measures

The following information serves as a guide to help you know the approximate time when control measures can be implemented. Consult the text for more detailed instructions and information:

Dormant - Before Growth Starts

Host	Pest
Arborvitae	tip dwarf mite, Fletcher scale, spruce spider mites
Ash	ash flower gall mite, scurfy scale, oystershell scale
Bittersweet	euonymus scale
Cotoneaster	San Jose scale
Douglas fir	Cooley spruce gall adelgid
Elm	European elm scale, Putnam scale, scurfy scale, San Jose scale
Euonymus	euonymus scale, winged euonymus scale
Fir	pine needle scale
Flowering fruit trees	mites, maple bladder gall mite, maple pouch gall mite, San Jose scale, scurfy scale, terrapin scale, aphids, white peach scale, pear psylla, European fruit lecanium scale
Hackberry	Putnam scale
Hawthorn	terrapin scale, European red mite
Hemlock	Hemlock scale, pine needle scale, Fiorinia scale
Hickory	Hickory leaf stem gall
Juniper	Juniper scale, tip dwarf mite, spider mites
Lilac	oystershell scale
Linden	cottony maple scale
Maple	terrapin scale, cottony maple scale, Putnam scale, oystershell scale, scurfy scale, lecanium scale, maple mealybug
Oak	golden oak scale, kermes scales, obscure oak scale, lecanium scale
Pine	pine bark adelgid, pine needle scale, eriophyid (rust) mites, white pine aphid
Poplar	oystershell scale
Spruce	spruce spider mite, spruce gall adelgid
Sweetgum	sweetgum pit-making scale
Tulip tree	tuliptree scale
Willow	oystershell scale
Yew (Taxus)	Fletcher scale, mealybugs

After Growth Starts

Late March-April (early)

Host	Pest
Ash	ash flower gall mite
Boxwood	boxwood psyllid
*Douglas fir	Cooley spruce gall adelgid
Pine	Pales weevil, Northern pine weevil, Zimmerman pine moth
Spruce (Norway, red, black, white, Colorado)	eastern spruce gall adelgid, spruce spider mite, Cooley spruce gall adelgid, spruce needle miner

*Cooley spruce gall adelgid of Douglas fir can be controlled from spring through fall when temperature is above 60 F.

April (early)

Host	Pest
Azalea	azalea lace bug
Boxwood	boxwood psyllid
Flowering fruit trees	eastern tent caterpillar
Honey locust	honey locust pod gall midge
Juniper	juniper webworm
Pine	white pine weevil, white pine aphid, European pine shoot moth, Nantucket pine tip moth
Spruce	northern pine weevil, Pales weevil, white pine weevil, spruce spider mite, spruce needle miner, gall adelgids

April (mid)

Host	Pest
Boxwood	boxwood psyllid
Fir	balsam twig aphid
Douglas fir	Cooley spruce gall adelgid
Flowering fruit trees	eastern tent caterpillar
Inkberry	inkberry leafminer
Magnolia	yellow poplar weevil
Maple	maple bladder gall mite
Pine	northern pine weevil, Pales weevil
Spruce (Colorado)	eriophyid mite, spruce spider mite
Tuliptree	yellow poplar weevil

April (late)

Host	Pest
Arborvitae	arborvitae leafminer
Ash	forest tent caterpillar
Birch	forest tent caterpillar
Boxwood	boxwood leafminer, boxwood psyllid
Elm	woolly apple aphid, elm leaf beetle
Euonymus	euonymus scale
Fir	balsam twig aphid
Flowering fruit trees	eastern tent caterpillar, lesser peachtree borer
Hackberry	hackberry nipple gall psyllid
Hawthorn	woolly apple aphid, hawthorn lace bug, hawthorn leafminer
Hemlock	spruce spider mite, hemlock scale, pine needle scale, fiorinia scale
Juniper	juniper webworm
Maple	eriophyid mite, maple shoot moths, forest tent caterpillar
Mountain ash	woolly aphid
Oak	forest tent caterpillar, gypsy moth
Pine	sawflies, spotted pine aphid, Nantucket pine tip moth, Zimmerman pine moth, pine tube moth, pine needle scale
Poplar	forest tent caterpillar
Spruce	balsam twig aphid, spruce spider mite, woolly larch aphid, pine needle scale
Sweetgum	forest tent caterpillar
Wild cherry	eastern tent caterpillar

May (early)

Host	Pest
Arborvitae	spruce spider mite, arborvitae leafminer
Ash	lilac (=ash) borer, forest tent caterpillar
Azalea	azalea mite, rhododendron borer, azalea lace bug
Birch	birch leafminer, forest tent caterpillar
Boxwood	boxwood leafminer
Dogwood	dogwood borer
Douglas fir	Cooley spruce gall adelgid
Elm	cankerworm
Flowering fruit trees	eastern tent caterpillar
Hackberry	lace bugs
Hawthorn	hawthorn leafminer, cankerworm
Holly	holly leafminer
Juniper	juniper midge, juniper tip midge, juniper scale
Laurel	rhododendron borer
Maple	forest tent caterpillar, fall cankerworm
Magnolia	magnolia borer
Mountain ash	lace bugs
Oak	lace bugs, oak kermes scale, golden oak scale, forest tent caterpillar
Pieris	andromeda lace bug

Pine	pine bark adelgid, spittlebug, eriophyid mite
Poplar	forest tent caterpillar
Rhododendron	rhododendron borer, lace bugs
Serviceberry	hawthorn lace bug
Shade trees	cankerworms Spruce spruce spider mite
Sweetgum	forest tent caterpillar
Sycamore	sycamore lace bug
Tuliptree	root collar borer
Yew (Taxus)	mealybugs

May (mid)

Host	Pest
Arborvitae	arborvitae leafminer, spruce spider mite
Ash	Putnam scale, oystershell scale
Birch	bronze birch borer, oystershell scale
Bittersweet	euonymus scale
Elm	flatheaded appletree borer, white-marked tussock moth
Euonymus	euonymus scale
Flowering fruit trees	flatheaded appletree borer, Putnam scale
Hackberry	Putnam scale
Hawthorn	hawthorn leafminer, scurfy scale, oystershell scale
Hemlock	Fiorinia scale
Hickory	hickory petiole gall adelgid
Juniper	juniper scale
Lilac	oystershell scale, lilac (=ash) borer
Linden	scurfy scale
Maple	oystershell scale, flatheaded apple-tree borer, green-striped maple worm
Mountain ash	lace bugs
Oak	flatheaded appletree borer, golden oak scale, oak kermes scale, May/June beetles, orange-striped oakworm
Pachysandra	euonymus scale, twospotted spider mite
Pieris	andromeda lace bug
Pine	spruce spider mite, eriophyid mite
Rhododendron	azalea leafminer, rhododendron borer
Serviceberry	hawthorn lace bug
Shade trees	white-marked tussock moth, scurfy scale
Sycamore	sycamore lace bug
Tuliptree	yellow poplar weevil
Willow	scale
Yew (Taxus)	mealybugs

May (late)

Host	Pest
Arborvitae	spruce spider mite,
Ash	oystershell scale, lilac (=ash) borer, fall webworm, elm spanworm
Azalea	lace bugs, rhododendron borer, azalea whitefly
Birch	bronze birch borer, oystershell scale Bittersweet euonymus scale
Boxwood	boxwood leafminer, lecanium scale
Dogwood	dogwood borer
Douglas-fir	bagworms
Euonymus	euonymus scale, winged euonymus scale
Flowering fruit trees	terrapin scale, (peach, plum, apricot)
Hawthorn	oystershell scale
Hemlock	spruce spider mite
Hickory	elm spanworm
Honeysuckle	honeysuckle leafminer
Juniper	juniper tip dwarf mite, juniper scale, spruce spider mite
Lilac	oystershell scale, lilac (=ash) borer
Magnolia	yellow poplar weevil
Maple	oystershell scale, green-striped maple worm
Mountain ash	European red mite, lace bugs
Mountain laurel	azalea leafminer, lace bug
Oak	golden oak scale, oak kermes scale, orange-striped oakworm, elm spanworm, an oak clearwing borer
Pachysandra	oystershell scale, euonymus scale
Pieris	andromeda lace bug
Pin oak	May beetles
Poplar	oystershell scale, euonymus scale
Rhododendron	azalea whitefly, azalea leafminer, rhododendron borer
Shade trees	terrapin scale, leafhoppers
Spruce	spruce spider mite
Tulip tree	yellow poplar weevil
Yew (Taxus)	mealybugs
Willow	oystershell scale

June (early)

Host	Pest
Arborvitae	arborvitae leafminer, bagworms, black vine weevil, Fletcher scale
Ash	elm spanworm
Azalea	azalea bark scale, black vine weevil
Birch	bronze birch borer
Flowering fruit trees	flatheaded appletree borer, woolly apple aphid
Hemlock	strawberry root weevil
Hickory	elm spanworm
Juniper	juniper tip midge, juniper scale

Linden	webworms
Maple	flatheaded appletree borer, lecanium scale
Oak	oak skeletonizers, May/June beetles, flatheaded appletree borer, lecanium scale, elm spanworm
Pine	European pine shoot moth, Nantucket pine tip moth
Rhododendron	azalea bark scale, black vine weevil
Spruce	spruce needle miner, spruce spider mite
Sweet gum	sweet gum pit-making scale
Sycamore	sycamore lace bug
Walnut	fall webworm
Yew (Taxus)	black vine weevil

June (mid)

Host	Pest
Arborvitae	arborvitae leafminer, bagworms, black vine weevil, Fletcher scale
Azalea	oystershell scale
Bald-cypress	bagworms
Birch	birch leafminer, bronze birch borer
Buckthorn	bagworms
Cedars	bagworms
Cotoneaster	San Jose scale, black vine weevil
Fir	bagworms, black vine weevil
Flowering fruit trees	San Jose scale, bagworms, peachtree borer
Hemlock	spruce spider mite, bagworms, black vine weevil
Hornbean	bagworms
Ivy	Japanese beetle
Juniper	bagworms, juniper scale
Larch	bagworms
Linden	linden leaf beetles, Japanese beetle, bagworms
Maple	bagworms, lecanium scale
Oak	bagworms
Pine	pine tortoise scale, bagworms
Rhododendron	black vine weevil
Shade trees	bagworms, leafhoppers
Shrubs	Japanese beetle
Spruce	spruce spider mite, spruce needle miner
Walnut	walnut caterpillar
Willow	bagworm
Yew (Taxus)	Fletcher scale, black vine weevil

June (late)

Host	Pest
Arborvitae	bagworms
Euonymus	bagworms
Fir	bagworms
Flowering fruit trees	flatheaded appletree borer, San Jose scale, lesser peachtree

	borer (peach, plum, apricot), bagworms
Hemlock	bagworms
Honey locust	mimosa webworm
Juniper	bagworms
Linden	bagworms
Locust l	ocust leafminer
Maple	flatheaded appletree borer, cottony maple scale, bagworms
Mimosa	mimosa webworm
Oak	flatheaded appletree borer, bagworms
Pine	bagworms, pine tortoise scale
Silver maple	cottony maple scale, bagworms
Spruce	spruce bud scale
Yew (Taxus)	black vine weevil

July (early)

Host	Pest
Arborvitae	Fletcher scale, bagworms
Elm	elm leaf beetle
Euonymus	euonymus scale, bagworms
Flowering fruit trees	San Jose scale, bagworms
Hemlock	hemlock scale, pine needle scale, bagworms
Honey locust	mimosa webworm
Linden	cottony maple scale, bagworms
Oak	flatheaded appletree borer, bagworms
Pine	pine tube moth, pine webworm, bagworms
Silver maple	cottony maple scale, bagworms
Spruce	pine needle scale
Walnut	walnut caterpillar
Yew (Taxus)	black vine weevil, Fletcher scale

July (mid)

Host	Pest
Barberry	barberry webworms
Bittersweet	euonymus scale
Euonymus	euonymus scale, winged euonymus scale
Flowering fruit trees	San Jose scale
Honey locust	mimosa webworm
Maple	cottony maple scale
Oak	kermes scale, obscure scale, yellownecked caterpillar
Pine	pine tortoise scale, Pales, northern pine and white pine weevil adults
Yew (Taxus)	black vine weevil, mealybugs,Fletcher scale

July (late)

Host	Pest
Hemlock	hemlock looper
Honey locust	mimosa webworm
Juniper	juniper tip midge
Oak	oak skeletonizers, yellownecked caterpillar
Yew (Taxus)	black vine weevil

August (early)

Host	Pest
Honey locust	mimosa webworm
Mimosa	mimosa webworm
Pine	aphid, pine webworm

August (mid)

Host	Pest
Ash	banded ash clearwing

September (early)

Host	Pest
Arborvitae	Fletcher scale
Locust	locust borer
Magnolia	magnoila scale, magnolia borer
Maple	cottony maple scale
Pine	pine root collar weevil
Sweet gum	sweet gum pit-making scale
Tuliptree	tuliptree scale, root collar borer

September (mid)

Host	Pest
Juniper	juniper tip midge
Spruce	spruce gall adelgids

September (late through October)

Host	Pest
Juniper	juniper webworm
Pine	Pales weevil (adults)

Micro-Injection of Systemic Insecticides into Trees

Systemic insecticides, used as foliar sprays, soil drenches and granular applications to trees for control of a number of important pests, are not new.

Several companies have been developing various methods of injecting these same systemic insecticides directly into the trunks of trees to allow the vascular transport system to distribute the pesticide throughout the plant. Some of these injection systems use 3/8-inch to 1/2-inch holes for injecting or implanting capsules. Recent evidence indicates that these larger diameter holes may not heal rapidly on some species of trees. Therefore, these techniques should probably be avoided.

Other injection systems use much smaller injection holes, "micro-injection," which seem to heal more rapidly. The following two systems are nationally available:

Mauget System -

The J. J. Mauget Company, 5435 Peck Rd., Arcadia, CA 91006 provides a micro-injection system which uses prepacked plastic containers which can be compressed to provide internal pressure. An 11/64-inch drill bit is used to make holes in the tree trunk and a microinjector tube is inserted. The compressed container is then attached and the pesticide is injected into the tree vascular system. Mauget provides the following products:

IMICIDE (imidacloprid), IMISOL (imidacloprid plus DEBC), ABACIDE (abamectin) and ABASOL (abamectin plus DEBC) are labeled for use on ornamental trees and shrubs. INJECT-A-CIDE B (dicrotophos) is for use on trees listed on the label. IMICIDE and IMISOL have adelgids, aphids, beetles, borers, lace bugs, leafhoppers, mealybugs, pine tip moth, scale, thrips and whiteflies listed on the label. ABACIDE and ABASOL have bagworms, beetles, caterpillars, leafminers, mites and spittlebug listed on the label. INJECT-A-CIDE B has aphids, beetles, borers, caterpillars, galls, lace bugs, leafhoppers, leafminers, mites, pine beetles, pine tip moth, psyllids, scales and spittlebugs listed on the label.

Tree Tech Microinjection Systems, Inc.

Tree Tech Microinjection Systems, Inc., 950 215th Ave., Morriston, Fl 32668 has developed a micro-injection system which uses prepacked plastic containers which can be compressed to provide internal pressure. A 11/64-inch drill bit is used to make holes in the tree trunk and a tip with container is inserted. A tap with a mallet seats the tip and compresses the container.

Vivid II (abamectin) is labeled for use on ornamental trees (including forest, non-cropbearing as well as woody shrubs) for control of adelgids, aphids, browntail moth, elm leaf beetle, lace bug, lygus bug, mites, oakworm, scale, white pine weevil, engraver beetle, eucalyptus borer and flatheaded borer.

Dendrex (acephate) is labelled for use on flowering crabapple for control of aphids, tent caterpillars and leafrollers. It is labeled for other trees and shrubs for control of aphids, bagworms, birch leafminer, tent caterpillars, lace bugs, tussock moth larvae, Gypsy moth larvae, scale crawlers, grasshoppers, cankerworms (spring and fall), Nantucket pine tip

moth, Zimmerman pine moths, root weevil adults, boxelder bugs, thrips, whiteflies, bronze birch borer, Japanese beetles, elm leaf beetle (larvae), and other listed pests.

Harpoon (oxydemeton-methyl) is labeled for the following trees and pests: cedars (bark beetle), cottonwoods (aphids), Douglas-fir (cone moths, engraver beetles), elms (elm leaf beetles), junipers (bark beetles), pines [except pinyon] (6-spined engraver beetles, flatheaded borer, black turpentine beetle, Nantucket pine tip moth, pine needle scale and a few other listed pests), redwood (bark beetles, mites and needle scale), spruce (adelgids) and walnuts and pecans [non-bearing] (aphids, mites).

Insect & Mite Control Recommendations for Trees & Shrubs

Use Pesticides Properly to Prevent Pollution

The proper use of pesticides will reduce the pollution of our environment to the necessary minimum. Pesticides are carried into water on soil particles that erode. Take measures necessary to prevent erosion. Do not pour excess spray mixtures or pesticides into the sewage systems. Every little bit disposed of in this way adds to the stream pollution problem. Wash the residues from your empty container and mix it into your garden spray. Apply the last drop of the pesticide to your plants. Triple or pressure rinse container, puncture or crush and put in a sanitary landfill. Observe wind conditions and avoid spraying during periods of windy weather to prevent drifts.

Anticipate Pest Problems

Every ornamental plant is host to a variety of insect pests during the growing season. Anticipate insect problems and inspect the leaves, stems, buds and flowers of ornamentals regularly. Frequently, the problem can be identified by observing the injury which results from the feeding activities of the insect. Damage from a heavy infestation can be prevented by early detection and control.

Emergence of Insects

Insects will begin to feed and deposit eggs when the temperatures rise to 50 to 65 F or above and remain in this range for one to two weeks. In some years, pests may appear one to two weeks earlier or later than in other years because of an early or late spring.

Effective Spraying

Insecticides are most effective when they are applied to the parts of the plant on which the young larvae or nymphs are feeding. A fine-mist spray will thoroughly wet the plant surfaces. Stop spraying when the plant surfaces are wet to the point of run-off or dripping. Repeat the spray applications at regular intervals to control the late-hatching, emerging or migrating insects.

Apply an insecticide when weather conditions are favorable. The temperatures should be in the 60 to 80 F range with a wind velocity of less than five miles per hour, with no rain forecast for 24 hours. If one-half inch or more of rainfall occurs within 12 hours after spraying, repeat the application.

Table 1. Ornamental Pests

Updated April 2018

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Aphids	E	Crevices of bark on twigs of most deciduous plants	dormant oil	February-March
	N & A	Undersides of leaves of elm, linden, maple, oak and many other plants; also twigs; also needles of some conifers.	Malathion, Diazinon, Dursban, Dimethoate, Merit, Talstar, Orthene, Discus L, insecticidal soap, Marathon, Endeavor, Flagship, Safari, Zylam Liquid, TriStar, Meridian, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April-September
Bagworm	L	Foliage of many trees, shrubs, hedges, especially arborvitae, white cedar	Sevin, Carbaryl, Bt (Dipel, Javelin & others), Malathion, Diazinon, Orthene, Dursban, Dylox, Talstar, Mavrik, Aquaflow, Tempo, Decathlon, Tempo SC Ultra, Conserve SC, Entrust SC, Scimitar, Onyx, Onyx Pro, Acelepryn, Provaunt, Mainspring GNL	late May-July
Arborvitae Leafminer	A & L	All foliage of arborvitae	Dursban, Orthene, Discus L, Dimethoate, Merit, Marathon, Arena, TriStar, Safari, Zylam Liquid, Conserve SC, Flagship, Meridian, Azatin XL, Acelepryn, Distance, Fulcrum, Dimilin, Sevin, Carbaryl, Conserve SC, Entrust SC, MSR Spray Concentrate, Mainspring GNL	March - April (soil drenches of Orthene, Discus L, Dimethoate, Merit, Marathon, Arena, TriStar, Safari, Zylam Liquid, Flagship, Meridian, Acelepryn) late April-May when moths are flying (foliar application) Infested leaves should be removed and destroyed throughout the year
Fletcher Scale	N	Foliage and twigs of Taxus and arborvitae	horticultural oil	April
	C		Merit, Diazinon, Malathion, horticultural oil, Dimethoate, Orthene, Discus L, Fulcrum, Dursban, Tempo, Decathlon, Tempo SC Ultra, Marathon, Flagship, Safari, Arena, Talus, Meridian, Distance, Fulcrum, Aria, Kontos, TriStar, Mainspring GNL	May-June
Spruce Mite	E	Foliage, especially inner foliage	dormant oil	February-March
	N A		Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Azatrol EC insecticide, Ancora	April-June, September-October Two sprays made one week apart. Hexygon should only be used once per crop cycle or once per year and since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan in combination with a registered contact adult miticide. Hexygon DF, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.
Lilac Borer/Ash Borer and Banded Ash Clearwing	L A	Bore into branches and trunk, scar wounds. Sawdust (boring dust) protruding from boring holes.	Dursban, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	Mid-April and mid-July for ash. Prune and burn dead and dying branches. Remove larvae with sharp knife. Insert wire into boring hole. Entomopathogenic nematodes can be applied to the trunk from May to September to control borers in an infested tree or shrub. Dursban or permethrin can be used 2 weeks after using entomopathogenic nematodes.

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Emerald Ash Borer	L A	Larvae bore into the trunk and branches. The vascular tissue beneath the bark is devoured, effectively girdling the tree and killing it within a few years.	Discus L, Merit, or Safari applied as a drench around the base of the tree.	Merit or Discus L in early to mid-spring or mid-fall. Safari in mid to late spring. OR Trunk injection of Azasol, TreeAzin, Imicide or TREE-äge should be made by a trained professional in mid to late spring after trees have leafed out. OR Systemic bark sprays of Safari should be made in mid to late spring after trees have leafed out.
Ash flowergall mite (Eriophyid mite)	E N A	Twigs Foliage and blossoms	dormant oil horticultural oil, Sevin, Carbaryl, Savate, Forbid, Avid, Akari, Kontos	February-March Treat when first blossoms begin to form.
Plant/leaf bugs	N A	Foliage	Sevin, Carbaryl, Dursban, Malathion, Mavrik Aquaflow, Scimitar, Talstar, Tempo, Decathlon, Flagship, Meridian, Arena, TriStar, Altus, Ancora	Treat when young nymphs appear in early spring and repeat as needed.
Aphids	N & A	Undersides of leaves and stems	Merit, Malathion, Diazinon, Orthene, Discus L, Talstar, insecticidal soap, Marathon, Flagship, TriStar, Safari, Zylam Liquid, Meridian, Arena, Endeavor, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April-October
Azalea Caterpillar	L	Foliage	Decathlon, Sevin, Carbaryl, Conserve SC, Entrust SC, Tempo, Talstar, Scimitar, Onyx, Onyx Pro, Acelepryn, Provaunt, Mainspring GNL, Intrepid 2F	June-September
Azalea Bark Scale	N	Bark of twigs and branches of azalea, rhododendron, Andromeda	Diazinon, Sevin, Carbaryl, Malathion, Orthene, Merit, Marathon, Safari, Zylam Liquid, TriStar, Talus, Meridian, Distance, Fulcrum, Aria, Kontos	May-June
Lace Bug	N A	Undersides of leaves	Drench with Safari, Zylam Liquid, Merit, Marathon or Altus (greenhouse and container nursery ornamentals) or use granular Arena as an alternative to foliar sprays. Dimethoate, Orthene, Discus L, Tempo, Diazinon, Decathlon, Merit, Tempo SC Ultra, Marathon, Flagship, Dursban 50W, Safari, Zylam Liquid, Arena, Acelepryn, BotaniGard, Mainspring GNL, Altus	February-March April-October
Azalea Leafminer	L	Foliage, larvae within rolled leaves of azalea	Merit, Dimethoate, Diazinon, Malathion, Sevin, Carbaryl, Azatin, Orthene, Talstar, Dursban 50W, Marathon, TriStar, Mainspring GNL	May-August
Azalea Leaf Tier	L	Foliage of azalea (see also fruittree leaf roller)	Sevin, Carbaryl, Talstar, Azatin, Orthene, Acelepryn, Mainspring GNL, Intrepid 2F	May-June
Azalea Stem Borer	A L	Tips of twigs, trunk Circles stems, bores in stems and trunk	prune and burn dead and dying twigs Dursban, Orthene	May, June

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Azalea Whitefly	N & A	Undersides of leaves of azalea, rhododendron, andromeda	Dimethoate, Malathion, Diazinon, Dursban 50W, Orthene, Discus L, Talstar, Azatin, Marathon, Meridian, Merit, Flagship, TriStar, Safari, Zylam Liquid, Arena, Forbid, Talus, Distance, Fulcrum, Endeavor, Aria, Magus, Sanmite, Forbid, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	May-August
Black Vine Weevil	A	Foliage, bark or trunk and branches, and the surfaces of ground beneath where beetles walk after emerging	Tempo, Decathlon, Tempo SC Ultra, Diazinon, Meridian, Orthene, Dursban, Talstar, Mavrik Aquaflow, BotaniGard	May-September Treat three weeks until no adults are found. If adults can overwinter in container plants in polyhouses begin treatments in March-April.
	L	Roots	Merit, Marathon, entomopathogenic nematodes, Ancora	May-September
Two-banded Japanese Weevil	L & A	Foliage, roots. Adults notch leaves eventually leaving only the petiole.	Talstar, Orthene, BotaniGard	April-September
Southern Red Mite	E, N & A	Underside of leaves	Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Azatrol EC insecticide, Ancora	May-October Two sprays made one week apart. Hexygon should only be used once per crop cycle or once per year and since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan in combination with a registered contact adult miticide. Hexygon DF, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.
BARBERRY				
Aphids	All	Undersides of leaves, stems, on new shrubs	Merit, Diazinon, Malathion, Orthene, Discus L, Dursban, Talstar, Endeavor, Marathon, Flagship, TriStar, Safari, Zylam Liquid, Meridian, Arena, Endeavor, Aria, Kontos, BotaniGard, Mainspring GNL, Ancora	April-August
Barberry Looper	L	Thorough coverage of foliage	Orthene, Talstar, Tempo, Mavrik Aquaflow, Decathlon, Tempo SC Ultra, Scimitar, Acelepryn, Provaunt, Mainspring GNL, Intrepid 2F	May-July
Webworm	L	Twigs and leaves webbed together	Sevin, Malathion, Dylox, Orthene, Tempo, Decathlon, Talstar, Mavrik Aquaflow, Scimitar, Acelepryn, Provaunt, Mainspring GNL, Intrepid 2F	July-September
Whitefly	E, N & A	Undersides of leaves	Diazinon, Malathion, Dursban, Azatin, Merit, Meridian, Arena, Marathon, Flagship, TriStar, Safari, Zylam Liquid, Talus, Distance, Fulcrum, Endeavor, Aria, Magus, Sanmite, Forbid, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April-September
BIRCH				
Bronze Birch Borer (flatheaded borer)	A	Treat entire tree especially the upper part of tree and the unshaded areas of trunk with	Merit, Marathon or Discus L drench around the base of the tree as an alternative to trunk sprays.	February to mid-April
	L	wounds or cracks in the bark. Tunnels under bark and in sapwood. Stressed trees are very susceptible.	Fertilize to maintain vigor. Protect trunk from physical injury and sun scald. Dursban, Onyx, Onyx Pro, Perm-Up, permethrin (Astro, and others)	Late May, early July
Yellownecked caterpillar	L	Foliage of birch and other hardwoods such as oak, maple, hickory, crabapple, quince, elm, butternut, walnut and locust.	Sevin, Carbaryl, Bt (Dipel, Javelin and others), Dursban, Conserve SC, Entrust SC, Talstar, Onyx, Onyx Pro, Scimitar, permethrin, Decathlon, Tempo, Acelepryn, Provaunt, Mainspring GNL, Intrepid 2F	July-August

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Birch Leafminer	L E A	Large, blotched, or blistered areas on leaves. New leaf growth attacked generally in early season.	MSR Spray Concentrate, Sevin, Carbaryl, Talstar, Malathion, Orthene, Dimethoate, Merit, Marathon, Acelepryn, TriStar, Mainspring GNL	May-August Apply Merit to the soil (not mulch) in February-March as a soil drench or a soil injection
Aphids	E	branches	dormant oil	February-March
Spiny Witch-hazel Leaf Gall Aphid	hibernating female N	foliage	dormant oil (Systemic drenches of Merit, Marathon, Discus L, Flagship, Zylam Liquid, Safari and Mainspring GNL can be made during February-March instead of an April-May spray) Orthene, Dimethoate, Discus L, Merit, Marathon, Flagship, Safari, Zylam Liquid, Meridian, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	February-March April-May
Dusky Birch Sawfly	L	foliage	Tempo, Decathlon, Tempo SC Ultra, Scimitar, Talstar, Dursban, Orthene, Merit, Marathon, Discus L, Meridian,	April-May June-August
BOXELDER				
Boxelder Bug	N A	Leaves, stems, trunk, seeds. Male trees do not produce seed on which bugs feed. The false boxelder bug or red shoulder bug is similarly associated with the goldenraintree.	Tempo, Decathlon, Tempo SC Ultra, Sevin, Carbaryl, Malathion, Diazinon, Dursban, Talstar	May-September
BOXWOOD				
European Hornet	A	Bark of twigs, especially lilac, also ash, rhododendron, birch (locate and spray nest)	Sevin, Dursban	June-July
Boxwood Leafminer	A L L	Thorough coverage of foliage of boxwood. Soil drench as an alternative to a foliar spray in April-May. Underside of leaves of boxwood	Sevin, Carbaryl, Dimethoate, Mainspring GNL Merit, Marathon, Discus L, Safari, Zylam Liquid, Mainspring GNL Dimethoate, Orthene, Discus L, Merit, Marathon, TriStar, Safari, Zylam Liquid, Mainspring GNL	April February-early April for Merit, Marathon or Late March-Early April for Safari or Mainspring GNL April-May
Mealybugs	All	Stems and leaves	Malathion, Dimethoate, Orthene, Discus L, Dursban,Talstar, Merit, Marathon, Flagship, TriStar, Safari, Zylam Liquid, Meridian, Arena, Talus, Aria, Kontos, BotaniGard, Altus	April-September
Boxwood Mite	E L N A	Underside of leaves of boxwood	dormant oil Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Azatrol EC insecticide, Ancora	February-March Late April-June Two sprays made one week apart. Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.
Boxwood Psyllid	A	Underside of leaves of boxwood	Malathion, Dursban, Dimethoate, Talstar, Orthene, Discus L, Tempo, Decathlon, Tempo SC Ultra, Merit, Marathon, Sanmite, Kontos, BotaniGard, Altus, Ancora	Late March-May
Webworms	L	Leaves webbed together, turn brown	Sevin, Dylox, Orthene, Dursban, Acelepryn, Conserve SC, Entrust SC, Talstar, Onyx, Onyx Pro, Scimitar, permethrin (Astro, and others), Decathlon, Tempo, Provaunt, Mainspring GNL, Intrepid 2F	May-September

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
CATALPA				
Catalpa Sphinx	L	Leaves of tree, defoliate tree.	Dursban, Sevin, Carbaryl, Orthene, Acelepryn, Bt (Dipel, Javelin & others), Talstar, Onyx, Onyx Pro, Decathlon, Tempo, permethrin (Astro, Perm-Up and others), Scimitar, Conserve SC, Entrust SC, Provaunt, Mainspring GNL	May, July
CHESTNUT				
Large Chestnut Weevil, Small Chestnut Weevil	E L A P	Nuts, leaves and burrs, soil.	Sevin, BotaniGard	Apply four sprays on a 7-10 day interval beginning August 7. Gather nuts daily so that emerging weevil larvae cannot enter the soil.
Giant Bark Aphid (Hickory Aphid)	E N A	Bark of trunk and limbs. Several generations. Large population causes severe damage.	insecticidal soap, Merit, Malathion, Diazinon, Orthene, Discus L, Arena, horticultural oil, Meridian, Marathon, Endeavor, Flagship, TriStar, Safari, Zylam Liquid, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April, May, June, July, August
Fall Webworm	E L	Web encloses leaves and twigs on terminal end of branches.	Bt (Dipel, Javelin, and others), Orthene, Dursban, Diazinon, Malathion, Sevin, Carbaryl, Entrust SC, Conserve SC, Scimitar, Talstar, Onyx, Onyx Pro, Decathlon, Tempo, Acelepryn, Provaunt, Mainspring GNL, permethrin (Astro, Perm-Up and others), Intrepid 2F	May-June, August-September
Twig Pruner	L E	Bore under bark and in center of twigs. Cut twig off by making concentric circular cuts from center of twig outward.	Chemical control is not practical	Collect and burn fallen twigs.
Granulate Ambrosia Beetle (formerly called Asian Ambrosia Beetle)	A	Trunk and branches. Treat at first sign of attack, usually when tree is just about to come out of winter dormancy. Look for tiny shotholes in tree with toothpick diameter protrusions composed of sawdust- like frass.	permethrin (Astro, Perm-Up and others), Dursban (use ambrosia beetle rate), Onyx, Onyx Pro	March-May when flying adults caught in ethyl alcohol baited traps or when attack first seen. This usually corresponds with warm (70 F or higher) temperatures for several consecutive days.
CRAPE MYRTLE				
Crape Myrtle Aphid	E N & A	Crevices of bark on twigs. Undersides of leaves.	dormant oil Malathion, Diazinon, Dursban, Dimethoate, Merit, Talstar, Orthene, Discus L, insecticidal soap, Marathon, Endeavor, Flagship, Safari, Zylam Liquid, TriStar, Meridian, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	February-March April-September
Crape Myrtle Bark Scale	N C, N, A C	Trunk and branches.	horticultural oil Flagship, Safari, Zylam Liquid, Discus L, Meridian, Arena TriStar, Distance, Talus, Fulcrum, Aria, Kontos	March-early April as delayed/dormant application April-May as a soil drench. May, July-August as a foliar application. Horticultural oil at 0.5% can be tank mixed with Distance, Talus and Fulcrum
Granulate Ambrosia Beetle (formerly called Asian Ambrosia Beetle)	A	Trunk and branches. Treat at first sign of attack, usually when tree is just about to come out of winter dormancy. Look for tiny shotholes in tree with toothpick diameter protrusions composed of sawdust- like frass.	permethrin (Astro, Perm-Up and others), Dursban (use ambrosia beetle rate), Onyx, Onyx Pro	March-May when flying adults caught in ethyl alcohol baited traps or when attack first seen. This usually corresponds with warm (70 degrees F or higher) temperatures for several consecutive days.
DOGWOOD				
Dogwood Borer	L	Trunk and lower limbs from soil line to lower limb scaffold.	Dursban, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	Late-April, mid-July, and early-September. Entomopathogenic nematodes can be applied to the trunk from May to September to control borers in an infested tree or shrub. Dursban or permethrin can be used 2 weeks after using entomopathogenic nematodes.

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Dogwood Club Gall (Midge)	A L	Leaves and small branches.	Sevin, Carbaryl	Treat when leaves are expanding in early spring.
Dogwood Twig Borer	L	Tunnels in limbs, holes and boring dust along underside of infested wilting limb. Prune and burn infested limbs in May or June before borer matures.	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to bark sprays. Dursban, permethrin (Astro, Perm-Up and others)	Mid-May Mid-June
Rose Leafhopper	N A A	Foliage commonly stippled white.	Sevin, Carbaryl, Malathion, Flagship, Discus L, Marathon, Merit, TriStar, Meridian, Safari, Zylam Liquid, Talus, Aria, Kontos, BotaniGard, Sanmite, Provaunt, Altus	April-August
Whitefringed Beetle	A	Larvae girdle trunk and roots below soil line, especially on seedlings.	Sevin, Carbaryl, Imidan Mow and rake before spraying.	June-September Spray the plants and all of the ground on a 10 day schedule to control the adults and prevent egg laying. Keep infested fields free of weeds. Do not use leguminous cover crops such as red clover. Instead, use oats, sudex or small grains. Do not plant dogwood near kobus magnolia or yellowwood.
Japanese Beetle White Grubs	L	Larvae feed on fibrous roots. This is primarily a regulatory problem when shipping nursery stock to states west of the Mississippi river. Check with the TN Dept. of Agriculture for current shipping certification of ball and burlap nursery stock.	Merit, Marathon	June-July
Dogwood Sawfly	L	Foliage	Malathion, Diazion, Dursban, Orthene, Sevin, Carbaryl, Scimitar, Talstar, Tempo, Decathlon, Tempo SC Ultra, Entrust SC, Conserve SC, Merit, Marathon, Discus L, Meridian	July-August
Flatheaded Appletree Borer	all	Larvae bore into trunk and feed in phloem and on the sapwood. Newly transplanted trees are very susceptible	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to trunk sprays. Dursban, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	February to mid-April Early May – mid-June
Granulate Ambrosia Beetle (formerly called Asian Ambrosia Beetle)	A	Trunk and branches. Treat at first sign of attack, usually when tree is just about to come out of winter dormancy. Look for tiny shotholes in tree with toothpick diameter protrusions composed of sawdust- like frass.	permethrin (Astro, Perm-Up and others), Dursban (use ambrosia beetle rate), Onyx, Onyx Pro	Late March-May or when attack is seen.
ELM				
Elm Coxcomb Gall	E N A	Leaves, series of elevations with red tips filled with green or brown aphids. Resembles a rooster's comb.	Malathion, Diazinon	March, April, May
Elm Leaf Aphid	E N A	Leaves, small yellow to green aphids.	Marathon, Meridian, Arena, insecticidal soap, Diazinon, horticultural oil, Safari, Zylam Liquid, Malathion, Dursban, Aria, Kontos, BotaniGard, Merit, Endeavor, Flagship, TriStar, Altus, Ancora	April, May-June
Elm Sack Gall	E N A	Leaves, bladder-like galls attended by ants.	Diazinon, Malathion	March, April-May

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Elm Bark Beetle (Native Elm Bark Beetle)	E L A	Bark of small branches and trunk carry Dutch Elm disease.	Dursban, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	May
European Elm Bark Beetle	E L A	Principal vector of Dutch Elm disease. Crotches of small twigs in outer perimeter of crown.	Dursban, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	February, May
European Elm Scale (Brown Elm Scale)	E C N A	The overwintering nymphs adhere to the twigs and base of buds. Crawlers hatch in late May to mid- June and move to the leaves where they develop for the rest of the summer.	dormant oil horticultural oil, Diazinon, Malathion, Tempo, Decathlon, Tempo SC Ultra, Sevin, Carbaryl, Dursban, Discus L, Merit, Marathon, TriStar, Distance, Meridian, Talus, Fulcrum, Aria, Kontos, Mainspring GNL	February-March June-August
White-Banded Leafhopper	E N A	Vector of phloem necrosis. Bark, leaves.	Sevin, Carbaryl, Diazinon, Dursban, Merit, Discus L, Marathon, Flagship, TriStar, Arena, Safari, Zylam Liquid, Talus, Aria, Kontos, BotaniGard, Altus	May, June
Elm Leaf Beetle	E L P A	Leaves skeletonized, will turn brown.	Sevin, Carbaryl, Dursban, Conserve SC, Entrust SC, Merit, Marathon, Discus L, BotaniGard, Mainspring GNL	April, May, July
Larger Elm Leaf Beetle	E L P A	Large yellow to brown beetle with greenish patches at end of wing covers (elytra). Larvae are reddish- brown, metallic lustered.	Sevin, Malathion, Conserve SC, Entrust SC, Merit, Marathon, Discus L, Mainspring GNL	May, June
Elm Leafminer	L	Foliage of elm.	Dursban, Discus L, Merit, Marathon, Talstar, TriStar	May-June
Whitefringed Beetle	A	Larvae girdle trunk and roots below soil line, especially on seedlings.	Sevin, Carbaryl, Imidan Mow and rake before spraying.	June-September Spray plants and surface of soil on a 10 day schedule to control the adults and prevent egg laying. Keep infested fields free of weeds. Do not use leguminous cover crops such as red clover. Instead, use oats, sudex or small grains. Do not plant elm near kobus magnolia or yellowwood.
EUONYMUS				
Bean Aphid	All	Undersides of leaves and stems	Merit, Marathon, Malathion, Diazinon, Orthene, Discus L, insecticidal soap, horticultural oil, Endeavor, Flagship, TriStar, Safari, Zylam Liquid, Meridian, Arena, Aria, Kontos, BotaniGard, Mainspring GNL, Altus	April-September
Euonymus Scale (an armored scale)	E, A C, N	Foliage, twigs and stems of euonymus bittersweet, pachysandra	dormant oil horticultural oil, Malathion, Sevin, Carbaryl, Orthene, Dursban, insecticidal soap, Dimethoate, Safari, Zylam Liquid, TriStar, Distance, Talus, Fulcrum, Aria, Kontos	February-March April-August. Two sprays 10 days apart whenever crawlers are emerging. Two more sprays at 10 day intervals will be needed for each flush of crawlers. Only make one soil directed application per year of a systemic insecticide. If needed, target crawlers with a foliar application of an insecticide with a different mode of action.

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
WINGED EUONYMUS (BURNING BUSH)				
Twospotted Spider Mite	E L N A	Foliage	Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Notavo, Azatrol EC insecticide, Ancora	April-August Two to three sprays made 5 days apart. Do not use horticultural oil more than once per week. Hexygon should only be used once per crop cycle or once per year; since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan in combination with a registered contact adult miticide. Hexygon DF, Notavo, Azatrol EC insecticide, Kontos and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.
Indian Wax Scale	A C N		dormant oil Merit, Marathon, Discus L, Dursban, Orthene, Dimethoate, Flagship, Talus, Safari, Zylam Liquid, TriStar, Distance, Meridian, Fulcrum, Aria, Kontos	February-March Applications of systemic insecticide should be made in late April to the soil. Wait until mid-May to make foliar applications of other listed insecticides. A second foliar application should be made 10-14 days after the first application. Since there are 2-3 generations per year, spray again with the two spray regiment whenever crawlers are seen emerging.
FRUIT TREE FLOWERING ORNAMENTAL (Ornamental Crabapple, Cherry, Plum, Pear; fruit not for consumption)				
Aphids (crabapple, pear, plum, cherry)	E N A	Leaves, twigs, buds, discoloration, distortion, honeydew.	insecticidal soap, horticultural oil, Meridian, Arena, Malathion, Diazinon, Orthene, Discus L, Merit, Marathon, Endeavor, Flagship, TriStar, Safari, Zylam Liquid, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April, May, June, July, August Note: Do not use Orthene on flowering crab apple as foliar injury may occur.
Green Peach Aphid (Plum, cherry)	E N A	Slender, light green or yellow. Treat foliage.	insecticidal soap, Meridian, Arena, Malathion, Discus L, Merit, Marathon, Diazinon, Orthene, Safari, Zylam Liquid, Endeavor, horticultural oil, Flagship, TriStar, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April, May, June
Apple Aphid (crabap ple)	E N A	Treat foliage. This aphid is green.	insecticidal soap, Meridian, Arena, Malathion, Diazinon, Discus L, Merit, Marathon, Endeavor, horticultural oil, Flagship, TriStar, Safari, Zylam Liquid, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	March, April, May
The Rosy Apple Aphid (crabapple)	E N A	Dark purple, rosy pink, or slate. Treat foliage.	Talstar, Discus L, Arena, Merit, Marathon, insecticidal soap, horticultural oil, Diazinon, Malathion, Endeavor, Flagship, TriStar, Safari, Zylam Liquid, Meridian, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	March, April, May
Woolly Apple Aphid	E N A	Leaves, twigs, buds, roots, blue-black with white, wooly covering over rear end of body. Treat balled and burlapped and container grown plants.	horticultural oil, Diazinon, Di-Syston, Malathion, Mavrik Aquaflow, MSR Spray Concentrate, Discus L, Merit, Marathon, Dursban, Talstar, Endeavor, Meridian, Flagship, TriStar, Safari, Zylam Liquid, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April, May, June, July,

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Peachtree Borer (cherry, plum, peach)	E L A	Roots, trunk and lower limb scaffold.	Dursban, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	Late May, July 15 Entomopathogenic nematodes can be applied to the trunk from late June to September to control borers in an infested tree or shrub. Dursban can be used 2 weeks after using entomopathogenic nematodes.
Shothole borer	A	Trunk and limbs	Dursban, permethrin (Astro, Perm-Up and others)	Later May, July 15 Same timing of sprays as with peachtree borer.
Lesser Peachtree Borer (cherry, plum, peach)	E L A	Injured areas of trunk limbs.	Dursban, Onyx, permethrin (Astro, Perm-Up and others)	Late April, Mid-June Entomopathogenic nematodes can be applied to the trunk from late May-September to control borers in an infested tree or shrub. Dursban can be used 2 weeks after using entomopathogenic nematodes.
Round-headed Appletree Borer (crabapple, mountain ash, hawthorn, serviceberry,	E L A	Trunk near ground. Young seedling trees frequently damaged.	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to trunk sprays. Dursban, permethrin (Astro, Perm-Up and others)	March April, June
Flatheaded Appletree Borer	All	A pest of crabapple.	Marathon, Discus L, or Merit drench around the base of the tree as an alternative to trunk sprays. Dursban, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	February to mid-April Early-May, mid-June
Fall Webworm (crabapple, cherry, pear, plum)	L	Tents over terminal end of branches.	Dursban, Orthene, permethrin (Astro, Perm-Up and others), Sevin, Carbaryl, Malathion, Bt (Dipel, Javelin and others), Tempo, Decathlon, Tempo SC Ultra, Talstar, Scimitar, Diazinon, Conserve SC, Entrust SC, Acelepryn	June, August Note: Do not use Orthene on flowering crab apple as foliar injury may occur.
White Apple Leafhopper (crabapple)	N A	Leaves are strippled and blotched by feeding of leafhoppers	Discus L, Merit, Marathon, Sevin, Carbaryl, permethrin (Astro, Perm-Up and others), Flagship, TriStar, Meredian, Arena, Safari, Zylam Liquid, Talus, Aria, Kontos, BotaniGard, Sanmite, Provaunt, Altus	April, May, June, July, August, September
Rose Leafhopper (crabapple)	N A	Leaves are stippled and blotched by feeding of leafhoppers.	Sevin, Carbaryl, Discus L, Merit, Marathon, permethrin (Astro, Perm-Up and others), Flagship, TriStar, Meridian, Arena, Safari, Zylam Liquid, Talus, Aria, Kontos, BotaniGard, Sanmite, Provaunt, Altus	April, May, August, September
Mites -- European red mite, Twospotted spider mite, (crabapple, pear, cherry, plum)	E L N A	Limbs, crevices of bark on limbs and trunk. Foliage	dormant oil (not for twospotted spider mites) Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Notavo, Azatrol EC insecticide, Ancora	February-March April-September Two to three sprays made 5 days apart. Do not use horticultural oil more than once per week. Hexygon should only be used once per crop cycle or once per year and since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan in combination with a registered contact adult miticide. Hexygon DF, Notavo, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Pear Slug Sawfly (pear)	E L A	Leaves are skeletonized by feeding larvae.	Diazinon, Carbaryl, Sevin, Marathon, Conserve SC, Entrust SC, Discus L, Merit, Meridian	April-May, July
Pear Psylla (pear)	E N A	Crevices of bark on trunk, debris or ground cover. They feed on buds and leaves, causing leaf drop and deformed buds	dormant oil Diazinon, Azatin XL, Ornazin, Sanmite, Kontos, BotaniGard	February-March Spray foliage two weeks after petal fall and again two weeks later.
San Jose Scale (crabapple, pear, cherry, plum) (an armored scale)	E C N A	Females circular, size of a pinhead, dark brown to black, raised dull yellow center while males are oval. Lemon yellow crawlers on stems, buds, leaves and fruit.	dormant oil horticultural oil, Diazinon, Sevin, Carbaryl, Malathion, Orthene, TriStar, Talus, Dursban, Safari, Zylam Liquid, Distance, Fulcrum, Aria, Kontos	February-March May, June-July, August Note: Do not use Orthene on flowering crab apple as foliar injury may occur.
Oystershell Scale (crabapple, pear, cherry, plum) (an armored scale)	E C N A	Brown to gray, oyster shell shape, 1/8 inch long, narrow at one end, widened and rounded at other end. Males are smaller and oval.	dormant oil horticultural oil, Diazinon, Sevin, Carbaryl, Malathion, Orthene, Tempo, Decathlon, Tempo SC Ultra, Safari, Zylam Liquid, Tri-Star, Distance, Talus, Fulcrum, Aria, Kontos	February-March May-June, July-August Note: Do not use Orthene on flowering crabapple as foliar injury may occur.
Granulate Ambrosia Beetle (formerly called Asian Ambrosia Beetle)	A	Trunk and branches. Treat at first sign of attack, usually when tree is just about to come out of winter dormancy. Look for tiny shotholes in tree with toothpick diameter protrusions composed of sawdust- like frass.	permethrin (Astro, Perm-Up and others), Dursban (use ambrosia beetle rate), Onyx, Onyx Pro	Late March-May or when attack is seen.
Terrapin Scale (crabapple, pear, plum, cherry)	E C N A	One of largest native scales, dark brown, hemispherical, convex, crimped or fluted around edges. Crawlers flattened, lighter in color, leaves, twigs.	dormant oil horticultural oil, Malathion, Diazinon, Sevin, Carbaryl, Orthene, Discus L, Merit, Marathon, Flagship, Safari, Zylam Liquid, TriStar, Distance, Arena, Talus, Meridian, Fulcrum, Aria, Kontos, Mainspring GNL	February-March May-June Note: Do not use Orthene on flowering crabapple as foliar injury may occur.
European Fruit Lecanium Scale (crabapple, pear, plum, cherry)	E C N A	Larger but similar in appearance to Terrapin scale. May be partly covered with white powdery substance.	dormant oil horticultural oil, Diazinon, Malathion, Sevin, Carbaryl, Merit, Orthene, Discus L, TriStar, Marathon, Flagship, Safari, Zylam Liquid, Arena, Talus, Meridian, Distance, Fulcrum, Aria, Kontos, Mainspring GNL	February-March June-August Note: Do not use Orthene on flowering crabapple as foliar injury may occur.
Japanese Beetle	A	The beetles are 3/8 inch long, metallic green with coppery wing covers	Merit, Marathon, Discus L, Sevin, Tempo, Decathlon, Tempo SC Ultra, Talstar, Scimitar, TriStar, Mainspring GNL	April (soil application) June, July & early August (spray weekly)
White Peach Scale (plum, cherry, peach) (an armored scale)	E C N A	Circular, white tinged with brown.	dormant oil horticultural oil, Malathion, Diazinon, Orthene, Dursban, Safari, Zylam Liquid, TriStar, Distance, Talus, Fulcrum, Aria, Kontos	February-March May, July, September Three generations - treat when crawlers are present. Note: Do not use Orthene on flowering crabapple as foliar injury may occur.
Fall Cankerworm (crabapple)	E L A	Adults emerge to lay eggs in November and December. Larvae appear as foliage develops in the spring. Slender, green, striped, looping caterpillars.	dormant oil Sevin, Carbaryl, Bt (Dipel, Javelin, and others), Conserve SC, Entrust SC, Scimitar, Talstar, Acelepryn, Provaunt, Mainspring GNL, Intrepid 2F Trap the emerging adult females crawling up the trunk to lay eggs with a sticky adhesive band of tangle foot.	February-March April
Eastern Tent Caterpillar (crabapple, cherry, peach)	L	Dirty white webs in limb crotches beginning in March when wild cherry leaves are developing. Larvae remain in web during cloudy or rainy weather, defoliate trees.	horticultural oil, Tempo, Decathlon, Tempo SC Ultra, Talstar, Sevin, Carbaryl, Bt (Dipel, Javelin, and others), Scimitar, Acelepryn, Dursban, Orthene, Malathion, Diazinon, Conserve SC, insecticidal soap, Entrust SC, Provaunt, Mainspring GNL, Intrepid 2F	March-April Note: Do not use Orthene on flowering crabapple as foliar injury may occur.

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Oriental Fruit Moth (crabapple, cherry, pear and plum)	L P A	Pinkish white 1/2- inch larva tunnel in succulent shoot tip.	Dursban, Acelepryn, permethrin (Astro, Perm-Up and others), Talstar, Scimitar, Onyx, Onyx Pro, Provaunt, Mainspring GNL, Intrepid 2F	April, July, August
HACKBERRY				
Psyllids (hackberry Nipple Gall)	E N A	Nipple-shape gall on underside of leaf. Cup-shaped impression on upper side of leaf.	Discus L, Malathion, Merit, Marathon, Sevin, Carbaryl, Dursban, Sanmite, Kontos, BotaniGard, Altus, Ancora	Treat when leaf buds are showing some green and again when leaves are one-half expanded.
Psyllids (Blister Gall)	E N A	Blister gall on leaf, circular, flat and blister-like. Convex on underside with a nipple in the center.	Malathion, Dursban, Sevin, Carbaryl, Merit, Marathon, Discus L, Sanmite, Kontos, BotaniGard, MSR Spray Concentrate (soil injection), Altus, Ancora	Treat when leaf buds are showing some green and again when leaves are one-half expanded.
Asian Woolly Hackberry Aphid	E N A	Twigs of hackberry and sugarberry root zone foliage	dormant oil Drench with Merit, Discus L, Marathon, Flagship, Meridian, Mainspring GNL Marathon II, Flagship, Tristar, Safari, Zylam Liquid, Meridian, Arena, Aria, Kontos, BotaniGard, Mainspring GNL, Altus	February-March March-June July-September
HEMLOCK				
Spruce Mite	E N A	Needles turn yellow, webbing between leaves.	dormant oil Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Azatrol EC insecticide, Ancora	February-March April, September-October Two sprays made one week apart. Hexygon should only be used once per crop cycle or once per year and since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan in combination with a registered contact adult miticide. Hexygon DF, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.
Hemlock Eriophyid Mite (Rust Mites)	E N A	Needles with grayish cast, feed on upper and lower needle surfaces.	dormant oil horticultural oil, Sevin, Carbaryl, Avid, Dimethoate, Savate, Forbid, Akari, Kontos	February-March April-May Two sprays made one week apart.
Hemlock Looper	L	Foliage.	Sevin, Carbaryl, Entrust SC, Conserve SC, Acelepryn, Talstar, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others), Tempo, Scimitar, Decathlon, Provaunt, Mainspring GNL, Intrepid 2F	May, June
Elongate Hemlock Scale (an armored scale)	A C	Foliage. Crawlers are yellow while the adult female is 1.5 mm long, elongate with a light yellow brown to brownish orange waxy cover. The smaller males have a white waxy cover in the nymphal stages.	horticultural oil, Safari, Zylam Liquid, TriStar, Distance, Talus, Fulcrum, Aria, Kontos	May, June, July
Hemlock Scale (an armored scale)	A C E N	Foliage. Small, oblong, dark gray or nearly black, undersides of needles; needles drop prematurely.	dormant oil horticultural oil, Talus, TriStar, Distance, Dimethoate, Safari, Zylam Liquid, Fulcrum, Aria, Kontos	February-March April, May, August

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Hemlock Woolly Adelgid	N,A	root zone	Drench with Merit, Discus L, Marathon, Meridian, Safari, Zylam Liquid, Mainspring GNL	Mid-March to Mid-June or late August-early December.
		trunk injection	Imicide	One week before to 2 weeks after leaf out in the spring or during September, about a month before partial leaf shed.
		Trunk Spray	Safari, Zylam Liquid	mid-May to mid-June or late July-October
		underside of foliage	Merit, Marathon, Flagship, Discus L, Meridian, TriStar, Safari, Zylam Liquid, Kontos, insecticidal soap, horticultural oil, Mainspring GNL, Altus	May-September, October-April Note: if using horticultural oil, use a 1% spray solution from May-September and a 2% spray solution from October-April. Horticultural oil will aid in control of eggs, if present.
Psyllids (Blister Gall)	E N A	Blister gall on leaf, circular, flat and blister-like. Convex on underside with a nipple in the center.	Malathion, Dursban, Sevin, Carbaryl, Merit, Marathon, Discus L, Sanmite, Kontos, BotaniGard, MSR Spray Concentrate (soil injection), Altus, Ancora	Treat when leaf buds are showing some green and again when leaves are one-half expanded.
HICKORY				
Giant Bark Aphid	E N A	See under CHESTNUT.		
Hickory Leafstem Gall Phylloxera	E N A	Twigs of hickory	dormant oil Sevin, Carbaryl, Diazinon, Malathion, Merit, Dursban	Treat overwintering eggs with dormant oil spray in March. Control stem mothers in April at bud split.
Twig Girdler	L	Twigs girdled by adult break off and fall to ground.	Chemical control is not practical.	Rake and destroy fallen twigs in the late fall, winter, spring and early Summer.
Twig Pruner	L	See under CHESTNUT.	Chemical control is not practical.	Rake and destroy fallen twigs before April 1.
Hickory Horned Devil	L	Largest native caterpillar 4 to 5 inches long. The green body is covered with spines and has long, reddish spines in back of the head.	No controls needed. Usually occur in small numbers.	July, August, September
Hickory Bark Beetle	E P L A	Leaf petioles, twigs, bark of trunk.	Water trees during periods of drought. permethrin (Astro, Perm-Up and others)	June, July, August
Hickory Spiral Borer	E L A	Terminal twigs under bark, spiral burrows, twigs break off and fall.	Rake and destroy fallen twigs before April.	May, July
Hickory Tussock Moth	L	Larvae feed on leaves.	Sevin, Carbaryl, Malathion, Dylox, Dimilin, Conserve SC, Entrust SC, Acelepryn, Talstar, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others), Tempo, Decathloon, Scimitar, Provaunt, Mainspring GNL, Intrepid 2F	May, August
HOLLY				
Holly Leafminer	A & L	upper and undersides of leaves on American, English holly (see native holly leafminer)	Merit, Discus L, Marathon, TriStar, Orthene, Dimethoate, MSR Spray Concentrate, Mainspring GNL	May Don't use Dimethoate on Burford holly.
Holly Scale (an armored scale)	N	leaves and twigs of hollies	horticultural oil, Safari, Zylam Liquid, TriStar, Distance, Talus, Fulcrum, Aria, Kontos	April-May

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Native Holly Leafminer	A & L	foliage of American holly	Orthene, Dimethoate, Merit, Marathon, Discus L, TriStar, Mainspring GNL	May-July Don't use Dimethoate on Burford holly. Use Merit, Marathon, MSR Spray Concentrate, Orthene, or Dimethoate for control of mining larvae.
Mulberry Whitefly	N, A	Underside of foliage - the pupa is shiny black with a fringe of cottony, white wax filaments.	horticultural oil, Mavrik Aquaflow, Merit, Discus L, Tempo, Marathon, Tempo SC Ultra, insecticidal soap, Decathlon, Azatin, Ornazin, Endeavor, Flagship, TriStar, Safari, Zylam Liquid, Meridian, Endeavor, Arena, Talus, Distance, Fulcrum, Aria, Magus, Sanmite, Forbid, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	Spring and Summer
Two-lined Spittlebug	N	Thatch control is important in preventing and controlling spittlebugs on lawns. Proper dethatching and fertilization practices can disrupt the humid conditions essential for spittlebugs. Mow and then irrigate several hours before making an insecticide application to turf.	Diazinon, Dursban, Orthene, Sevin, Mavrik Aquaflow, Talstar	May-September on turfgrass
	A	Foliage	Orthene, Dursban, Tempo, Decathlon, Tempo SC Ultra	June-September on holly foliage
Cottony Camellia Scale	A E N A	Primarily on underside of leaves.	dormant oil horticultural oil, Sevin, Carbaryl, Tempo, Decathlon, Dursban, Diazinon, Malathion, Merit, Marathon, Discus L, Flagship, Safari, Zylam Liquid, TriStar, Distance, Arena, Talus, Meridian, Fulcrum, Aria, Kontos, Mainspring GNL	February-March May-June
Indian Wax Scale	A C N		dormant oil Merit, Marathon, Discus L, Dursban, Orthene, Dimethoate, Flagship, Talus, Safari, Zylam Liquid, TriStar, Distance, Meridian, Fulcrum, Aria, Kontos	February-March Applications of systemic insecticides should be made in late April. Wait until mid-May to make foliar applications of other listed insecticides. A second foliar application should be made 10-14 days after the first application. Since there are 2-3 generations per year, spray again with the two spray regiment whenever crawlers are seen emerging. Don't use Dimethoate on Burford holly.
Southern Red Mite	E L N A	Undersides of leaves of *Ilex* , especially *convexa* . Also other broadleafed evergreens.	dormant oil Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Azatrol EC insecticide, Ancora	February-March April-May, August-October Two sprays made one week apart. Hexygon should only be used once per crop cycle or once per year and since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan in combination with a registered contact adult miticide. Hexygon DF, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
HONEYLOCUST				
Mimosa Webworm	L	Leaves webbed together and skeletonized.	Dursban, Sevin, Carbaryl, Malathion, Dylox, Dimilin, Conserve SC, Entrust SC, Acelepryn, Talstar, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others), Tempo, Decathlon, Scimitar, Provaunt, Mainspring GNL	June-July August-September
Honeylocust Plant Bug	N	Examine expanding leaflets for the small, green nymphs and treat before distortion, stunting and discoloration of foliage occurs.	insecticidal soap, horticultural oil, Sevin, Carbaryl, Dursban, Tempo, Decathlon, Talstar, TriStar, Tempo SC Ultra, Scimitar, Flagship, Aria, BotaniGard, Altus, Ancora	April
Honeylocust Pod Gall Midge	L	Leaves. Causes leaf galls.	Sevin, Carbaryl, Conserve SC, Entrust SC, Meridian, Flagship	Treat growing tips as soon as growth starts in the spring. Re-treat at 10-day intervals until infestation is cleaned up.
Honeylocust Spider Mite	E L N A	Foliage	Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Azatrol EC insecticide, Ancora	April-September Two to three sprays made 7 days apart. Hexygon should only be used once per crop cycle or once per year and since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan 5 WDG in combination with a registered contact adult miticide. Hexygon DF, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.
JUNIPER				
Bagworm	L	Foliage	Dimethoate, Talstar, Tempo, Decathlon, Mavrik Aquaflow, Orthene, Tempo SC Ultra, Diazinon, Sevin, Carbaryl, Dylox, Malathion, Dursban, Conserve SC, Bt (Dipel, Javelin, and others), Entrust SC, Acelepryn, Provaunt, Mainspring GNL, Intrepid 2F	late May-June
Juniper Scale (an armored scale)	All	Leaves and stems	Dormant oil horticultural oil, Sevin, Malathion, Talus, Dursban, Orthene, Safari, Zylam Liquid, Distance, TriStar, Fulcrum, Aria, Kontos, Intrepid 2F	February – March late April-May
Juniper Webworm	L	Foliage of juniper, grayish when covered	Dursban, Orthene, Acelepryn, Talstar, Onyx, Onyx Pro, Tempo, permethrin (Astro, Perm-Up and others), Decathlon, Scimitar, Provaunt, Mainspring GNL	March-April, August
Spruce Mite	E, N, A	Foliage, especially inner foliage	dormant oil Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Azatrol EC insecticide, Ancora	Februay-March April, October Two sprays made one week apart. Hexygon should only be used once per crop cycle or once per year and since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan 5 WDG in combination with a registered contact adult miticide. Hexygon DF, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Lilac Borer	L	Bark of trunk and larger branches, especially around wounds of lilac	Dursban, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	Mid-April and mid-June for lilac and privet. Entomopathogenic nematodes can be applied to the trunk from May to September to control borers in an infested tree or shrub. Dursban or permethrin can be used 2 weeks after using entomopathogenic nematodes.
Lilac Leafminer	L	Leaves mined and rolled, defoliation occurs	Orthene, Talstar, Mavrik Aquaflow, Dursban, Merit, Marathon, TriStar, Mainspring GNL	April-July
Two-banded Japanese Weevil	L A	Roots, new leaves, shoots, inner foliage. Adult weevils notch leaves, eventually leaving only the petiole.	Orthene, Talstar, Onyx, Onyx Pro, BotaniGard	April-September
LOCUST				
Locust Borer	L A	Mine in sapwood, heartwood.	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to trunk sprays. Dursban, permethrin (Astro, Perm-Up and others)	June August-September
Locust Leafminer	L A	Leaves. Mine in leaves.	Malathion, Merit, Marathon, Carbaryl, Discus L, Sevin, Diazinon, TriStar, Orthene, Conserve SC, Entrust SC, Mainspring GNL	May, June, July
Blister Beetle	A	Foliage	Sevin, Carbaryl, Mainspring GNL	June-September
MAGNOLIA				
Yellow Poplar Weevil	L A	Leaves. Adults feed on leaves in April and again in May to early June. Larvae mine in leaves in April.	Sevin, Carbaryl, Talstar, Dursban, Scimitar, Orthene, Tempo, Decathlon, Tempo SC Ultra, BotaniGard	April, May to early June
Magnolia Borer	E L A	Burrow in trunk near base of tree. Two generations per year.	Dursban, permethrin (Astro, Perm-Up and others), Onyx, Onyx Pro	Early May, early September
MAPLE				
Aphids - numerous species infest maple	E N A	Undersides of leaves, stems and on trunk; honeydew dripping is a nuisance.	Diazinon, Discus L, Merit, Marathon, Malathion, Meridian, Arena, MSR Spray Concentrate, Endeavor, Flagship, TriStar, Safari, Zylam Liquid, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April-September
Woolly Alder Aphid	E N A	Curled leaf encloses cottony mass often in thread-like tufts and blue-black aphids.	Diazinon, Meridian, Malathion, Discus L, Merit, Marathon, Endeavor, MSR Spray Concentrate, Flagship, TriStar, Safari, Zylam Liquid, Arena, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April-July
Norway Maple Aphid	E N A	Often defoliates Norway and sugar maple. Large, hairy green to brown aphid.	horticultural oil, Diazinon, Merit, Marathon, Discus L, Malathion, MSR Spray Concentrate, Endeavor, Flagship, TriStar, Safari, Zylam Liquid, Arena, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April, May, June Note: some varieties of maple are oil sensitive
Giant Bark Aphid (Hickory Aphid)		See under CHESTNUT.		
Sugar Maple Borer (Roundheaded borer pest of sugar maple)	E L A	Presence of transverse ridges or elevations on large limbs or trunk with sawdust-like frass and moisture with rough cracked bark	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to trunk sprays. Dursban, permethrin (Astro, Perm-Up and others)	Late April Late May, mid-July
Maple Callus Borer	E L A	Rough places or wounds on trunk. Larvae bore into sapwood.	Remove larvae from beneath bark in Spring. Dursban, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	Early May, late June. Entomopathogenic nematodes can be applied to the trunk from late May to September to control borers in an infested tree or shrub. Dursban or permethrin can be used 2 weeks after using entomopathogenic nematodes.

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Maple Spider Mite	E N A	Foliage	Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Azatrol EC insecticide, Ancora	May-September Two sprays made one week apart. Hexygon should only be used once per crop cycle or once per year and since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan 5 WDG in combination with a registered contact adult miticide. Hexygon DF, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.
Shoot Boring Caterpillar	E L P A	Small larvae bore into new shoots; leaves wilt and turn black. Spray to control larvae that will be entering terminal twigs. More of a problem on red maple.	Talstar, Onyx, Onyx Pro	Apply a foliar treatment anytime from bud break to when the first two pair of leaves have come out (usually in mid to late April). July-August Other species feed on and web small leaves together. Chemical control is often not needed. Spray at first sign of damage.
Gall-Making Maple Borer	L E P A	Base of small dead twigs on trunk, sapwood and heartwood of trunk; swellings or galls develop over wounds.	Dursban, permethrin (Astro, Perm-Up and others)	April, May, July, August
Leopard Moth	E L P A	Larvae bore into branches and trunk, feed in heartwood; frass or sawdust extruded through holes.	Dursban, permethrin (Astro, Perm-Up and others)	April-August
Petiole Borer	E L	Small sawflies tunnel in leaf petioles; one third of leaves drop.	Diazinon, Scimitar, Talstar, Tempo, Decathlon, Tempo SC Ultra, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	Leaf drop will not damage tree. Control recommendations are usually not warranted. Some of the maple petiole borer damage may be prevented by applying insecticide sprays to the trees in mid-April.
Fall Cankerworm	E L A	Leaves skeletonized at tips of branches, leaves completely eaten except for veins by older larvae. Larvae appear as foliage develops in the spring. Slender, green, striped, looping caterpillars. Adults emerge to lay eggs in December.	dormant oil Sevin, Carbaryl, Talstar, Bt (Dipel, Javelin and others), Tempo, Scimitar, Decathlon, Tempo SC Ultra, Conserve SC, Entrust SC, Onyx, Acelepryn, Onyx Pro, permethrin (Astro, Perm-Up and others), Provaunt, Mainspring GNL, Intrepid 2F Trap the emerging adult females crawling up the trunk to lay eggs with a sticky adhesive band of Tanglefoot.	February-March April
Spring Cankerworm	E L A	Twigs of maple, elm, oak, beech, linden, others. Inchworm like caterpillars are gray to brown with faint yellow stripes. They appear as foliage develops and can defoliate trees. Adults emerge to lay eggs in late February and March. Can defoliate trees.	dormant oil Sevin, Carbaryl, Talstar, Tempo, Bt (Dipel, Javelin, and others), Scimitar, Decathlon, Tempo SC Ultra, permethrin (Astro, Perm-Up and others), Conserve SC, Entrust SC, Acelepryn, Onyx, Onyx Pro, Provaunt, Mainspring GNL, Intrepid 2F Trap the emerging adult females crawling up the trunk to lay eggs with a sticky adhesive band of Tanglefoot.	Mid-to-late March April

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Cottony Maple Scale	A E N	Twigs of silver and other maples.	dormant oil horticultural oil Sevin, Carbaryl, Tempo, Decathlon, Malathion, Diazinon, horticultural oil, Dursban, TriStar, Tempo SC Ultra, Merit, Marathon, Discus L, Flagship, Safari, Zylam Liquid, Arena, Talus, Meridian, Distance,	February-March May - June June - July Note: Some varieties of maple are oil sensitive.
Maple Mealybug	E N A	Bark and twigs of maple.	dormant oil Sevin, Carbaryl, Tempo, Malathion, Diazinon, horticultural oil, Dursban, Merit, Marathon, Discus L, Flagship, TriStar, Safari, Zylam Liquid, Meridian, Arena, Talus, Aria,	February-March April, May, June, August Note: Some varieties of maple are oil sensitive.
Lecanium Scales	E N A	Dark to reddish-brown circular to oval, strongly convex.	dormant oil Sevin, Carbaryl, horticultural oil, Malathion, Dursban, Merit, Marathon, Discus L, Flagship, Safari, Zylam Liquid, TriStar, Distance, Arena, Talus, Meridian, Fulcrum, Aria, Kontos, Mainspring GNL	February-March June-August Note: Some varieties of maple are oil sensitive. Use Merit or Marathon in May if applying to the root zone.
Oystershell Scale (an armored scale)	E N A	Scales resemble miniature oysters on limbs, twigs, trunk.	dormant oil horticultural oil, Safari, Zylam Liquid, TriStar, Distance, Talus, Fulcrum, Aria, Kontos	February-March June Note: Some varieties of maple are oil sensitive.
Japanese Maple Scale (an armored scale)	E N A	Oyster-shell shaped overlain by grayish white wax.	dormant oil horticultural oil, Merit, Marathon, Discus L, Safari, Zylam Liquid, TriStar, Distance, Talus, Arena, Fulcrum, Aria, Kontos	February-March Mid-May–Mid-July, August-October Note: Some varieties of maple are oil sensitive.
Cottony Cushion Scale	E N A	Brown scales, large white cottony fluted mass with 600 red eggs.	dormant oil Sevin, Carbaryl, horticultural oil, Malathion, Dursban, Merit, Marathon, Discus L, Flagship, Safari, Zylam Liquid, TriStar, Distance, Talus, Meridian, Fulcrum, Aria, Kontos, Mainspring GNL	February-March April, May, June, August Note: Some varieties of maple are oil sensitive.
Potato Leafhopper	N A	Treat foliage for these tiny, light green nymphs and adults. Only the adults can fly.	Sevin, Carbaryl, Diazinon, Dursban, Talstar, Tempo, Decathlon, Scimitar, Tempo SC Ultra, Flagship, Discus L, Marathon, Merit, TriStar, Arena, Safari, Zylam Liquid, Talus, Aria, Kontos, BotaniGard, Sanmite, Provaunt, Altus	Throughout late spring and summer to prevent hopperburn to leaves.
Fall Webworm	E L	Dirty web encloses end of branches.	Malathion, Sevin, Carbaryl, Diazinon, Bt (Dipel, Javelin & others), Dursban, Conserve SC, Entrust SC, Onyx Acelepryn, Talstar, Onyx Pro, Tempo, Scimitar, Decathlon, permethrin (Astro, Perm-Up and others), Provaunt, Mainspring GNL, Intrepid 2F	May, June, August, September
Greenstriped Mapleworm	E L	Foliage of maple yellowish-green larvae marked above with 8 light- and 7 dark-green stripes. Two generations per year.	Sevin, Carbaryl, Mavrik Aquaflow, Azatin, Tempo, Decathlon, Onyx, Tempo SC Ultra, Bt (Dipel, Javelin, and others), Talstar, Acelepryn, Scimitar, Onyx Pro, permethrin (Astro, Perm-Up and others), Provaunt, Mainspring GNL, Intrepid 2F	May-June, July-August
Maple Pouch Galls (Maple bladder gall) (Maple spindle or finger gall)	E N A	Green, red, black galls on upper leaf surface. No appreciable damage to tree vigor. Green to red spindle shape or fingerlike leaf galls.	dormant oil, Sevin, Carbaryl, insecticidal soap, horticultural oil, Savate, Forbid, Avid, Akari, Kontos	Note: Some varieties of maple are oil sensitive. Spray bark in early spring before leaf buds break with dormant oil. Apply any of the other listed insecticides when first leaves are 1/4 expanded and again in 10 days.
Maple Trumpet Skeletonizer	E L P	Undersides of leaves, larvae spin a long trumpet-like tube of silk and frass, leaves fold around tube.	Sevin, Carbaryl, Mavrik Aquaflow, Azatin, Tempo, Decathlon, Onyx, Tempo SC Ultra, Bt (Dipel, Javelin, and others), Talstar, Acelepryn, Scimitar, Onyx Pro, permethrin (Astro, Perm-Up and others), Provaunt, Mainspring GNL, Intrepid 2F	May-June-July

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Forest Tent Caterpillar	L P	Larvae live in colony on silken net on trunks or large limbs; bluish caterpillar with black dots; diamond and white dots alternate on back.	Sevin, Carbaryl, Decathlon, Bt (Dipel, Javelin, and others), Onyx, Dursban, Dimilin, Conserve SC, Entrust SC Acelepryn, Talstar, Scimitar, Tempo, Onyx Pro, Provaunt, Mainspring GNL, Intrepid 2F	April, May, June
Flatheaded Appletree Borer	All	Larvae bore into trunk and feed in phloem and outer sapwood. Newly transplanted trees are very susceptible.	Marathon, Discus L, or Merit drench around the base of the tree as an alternative to trunk sprays Dursban, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	February to mid-April Early-May, mid-June
MIMOSA				
Mimosa Webworm	L	Leaves webbed together and skeletonized.	Sevin, Carbaryl, Dylox, Dursban, Onyx, Talstar, Tempo, Decathlon, Tempo SC Ultra, Scimitar, Onyx Pro, Acelepryn, Provaunt, Mainspring GNL, Intrepid 2F	June, July, August
OAK				
Aphids	All	Undersides of leaves discolored, distorted, cupped, covered with honeydew.	Merit, Marathon, Discus L, insecticidal soap, horticultural oil, Arena, Orthene, Malathion, Diazinon, Endeavor, Flagship, TriStar, Safari, Zylam Liquid, Meridian, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April, May, June-September
Giant Bark Aphid	All	See under CHESTNUT.		
Red Oak Borer (roundheaded borer)	E L P A	Larvae bore into inner bark and sapwood, tunnels extend into near the center of the trunk.	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to trunk sprays. Fertilize trees to maintain vigor. Remove "brood" trees in young timber stands. Dursban, permethrin (Astro, Perm-Up and others)	Early May Early June, mid-July
White Oak Borer (roundheaded borer)	E L P A	Larvae bore into sapwood and heartwood; frass or sawdust is extruded from the borer hole; adults emerge through round holes in the	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to trunk sprays. Dursban, permethrin (Astro, Perm-Up and others)	Early April Early May, June
Columbian Timber Beetle		See under POPLAR.		
Carpenterworm	E L P A	Eggs laid in bark crevices or wound; larvae bore into sapwood and heartwood; large winding tunnels weaken tree.	Dursban, permethrin (Astro,Perm-Up and others)	Mid to late April Spraying oak should coincide with leafing out and flowering of pecan.
Twig Girdler Twig Pruner	L	See under CHESTNUT. Twig girdler - female lays eggs in twig before chewing a notch around the twig that then falls to the ground.	Chemical control is not practical.	Pick up and burn the fallen twigs.
Flatheaded Appletree Borer	All	Larvae bore into trunk and feed in pholem and outer sapwood. Newly transplanted trees are very susceptible.	Marathon, Discus L, or Merit Drench around the base of the tree as an alternative to trunk sprays. Dursban, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	February to mid-April Early-May, mid-June
Twolined Chestnut borer (flatheaded borer)	All	Larvae bore into trunk and feed in phloem and outer sapwood. Newly transplanted trees are very susceptible. Oaks growing	Marathon, Discus L, or Merit drench around the base of the tree as an alternative to trunk sprays. Dursban, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	February to mid-April Early-May, mid-June
Oak Bark Scarver (roundheaded borer)	All	Larvae feed in bark and pupate in outer sapwood; scars result from feeding.	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to trunk sprays. Dursban, permethrin (Astro, Perm-Up and others)	April May, early July Apply first spray when chestnut and chinkapin are in full bloom.

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Asiatic Oak Weevil	A	foliage	Talstar, Sevin, Carbaryl, Dursban, BotaniGard, permethrin (Astro, Perm-Up and others)	late June to late August
Oak Sapling Borer (roundheaded borer)	E L P A	Base and roots of oak saplings; base of tree may be hollowed out, causing death of tree or bulb-like swellings at base	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to trunk sprays. Dursban, permethrin (Astro, Perm-Up and others)	Early April Early May, mid-June
Oak Branch Borer (roundheaded borer)	E L P A	Larvae feeding in small branches cause gall-like swellings.	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to trunk sprays. Dursban, permethrin (Astro, Perm-Up and others)	Mid-April Mid-May
Ivory Marked Beetle (roundheaded borer)	E L P A	Larvae enter through scars on bark; feed in heartwood.	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to trunk sprays. Dursban, permethrin (Astro, Perm-Up and others)	April May, mid-June
Chestnut Bark Borer (roundheaded borer)	E L P A	Larvae feed in thick moist bark in crotches and at base of tree.	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to trunk sprays. Dursban, permethrin (Astro, Perm-Up and others)	April May, mid-June
An Oak Borer (clearwing moth)	L	Bark of trunk	Dursban, Onyx, permethrin (Astro and others)	Early June, July 1
Oak Treehopper	N A	Egg laying slits in bark can kill small branches. Two generations per year.	Sevin, Carbaryl, Orthene	May-June, August
Oak Sawflies	L	Foliage. They skeletonize the leaves.	Sevin, Carbaryl, Dursban, Orthene, Malathion, Diazinon, Merit, Marathon, Discus L, Conserve SC, Entrust SC, Onyx, Onyx Pro, Scimitar, Meridian	May-September
Orangestriped Oakworm	L	Black caterpillars with eight longitudinal orange-yellow stripes on back and sides; larvae feed in groups.	Sevin, Carbaryl, Conserve SC, Dursban, Bt (Dipel, Javelin, and others), Entrust SC, Decathlon, Tempo, Tempo SC Ultra, Talstar, Scimitar, Acelepryn, Onyx, Onyx Pro, Provaunt, Mainspring GNL, Intrepid 2F	June, August
Redhumped Oakworm	L	Larvae skeletonize leaves feeding in groups. Later entire leaf is eaten.	Sevin, Carbaryl, Conserve SC, Entrust SC, Bt (Dipel, Javelin, and others), Dursban, Decathlon, Tempo, Tempo SC Ultra, Talstar, Scimitar, Provaunt, Mainspring GNL, Intrepid 2F	May, August
Saddled Prominent	L	Young larvae skeletonize upper leaf surface; older larvae eat entire leaf; trees defoliated.	Sevin, Carbaryl, Dursban, Bt (Dipel, Javelin, and others), Conserve SC, Entrust SC, Decatholon, Tempo, Tempo SC Ultra, Talstar, Scimitar, Acelepryn, Onyx, Onyx Pro, Provaunt, Mainspring GNL, Intrepid 2F	June-July
Variable Oakleaf Caterpillar	A L	Larvae skeletonize lower leaf surface and later eat entire leaf.	Sevin, Carbaryl, Dursban, Bt (Dipel, Javelin, and others), Conserve SC, Entrust SC, Decathlon, Tempo, Tempo SC Ultra, Talstar, Scimitar, Acelepryn, Onyx, Onyx Pro, Provaunt, Mainspring GNL, Intrepid 2F	May-June, August-September
Yellownecked Caterpillar	L	Foliage of oak and other hardwoods such as maple, hickory, birch, crabapple, quince, elm, butternut, walnut and locust.	Sevin, Carbaryl, Bt (Dipel, Javelin and others), Dursban, Conserve SC, Entrust SC, Decathlon, Tempo, Tempo SC Ultra, Talstar, Scimitar, Acelepryn, Onyx, Onyx Pro, Provaunt, Mainspring GNL, Intrepid 2F	July-August
Gypsy Moth	L	Foliage of oak and other hardwoods; young larvae feed on leaf base or leaf surface; older larvae feed from edge of leaf at night.	Sevin, Carbaryl, Bt (Dipel, Javelin, and others), Dimilin, Dursban, Talstar, Tempo, Decathlon, Tempo SC Ultra, Orthene, Conserve SC, Entrust SC, Onyx, Acelepryn, Onyx Pro, Provaunt, Mainspring GNL, Intrepid 2F	April-early June

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Obscure Scale (an armored scale)	N C	The scale are a mottled gray that looks like the bark. Scrape the bark to reveal the lighter color on the underside of the scale cover.	dormant oil horticultural oil, Safari, Zylam Liquid, Talus, Distance, TriStar, Arena, Fulcrum, Aria, Kontos	February-March Mid-July and again on August 1. Treat when crawlers emerge. This may be earlier than mid- July.
Oak Lecanium Scale	N C	Crawlers emerge in June and migrate to leaves. They migrate back to the branches in August to overwinter as second-instar nymphs.	dormant oil horticultural oil, Sevin, Carbaryl, Tempo, Decathlon, Tempo SC Ultra, Malathion, Diazinon, Merit, Marathon , Discus L, Fulcrum, Flagship, Safari, Zylam Liquid, TriStar, Distance, Arena, Meridian, Talus, Fulcrum, Aria, Kontos, Mainspring GNL	February-March June-July A couple sprays about 14 days apart may be needed.
Oak Spider Mite	E E L N A	Found on the upper leaf surface of oak, birch, elm chestnut, beech, and hickory.	dormant oil Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Azatrol EC insecticide, Ancora	Early spring before leaf buds break. May-September Two to three sprays made 5 days apart. Do not use horticultural oil more than once per week. Hexygon should only be used once per crop cycle or once per year and since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan 5 WDG in combination with a registered contact adult miticide. Hexygon DF, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.
Oak Galls		Numerous galls or growths occur on leaves, stems, buds, twigs and leaf petioles of many plants. Wasps, flies, aphids and mites are the principal gall makers. Most galls do not damage plants except for disfiguring the plant parts. Once formed and developed, there is little stress on the plants. By sheer numbers and deformed growth, some galls interfere with normal plant functions. Leaf galls and twig galls do cause damage in some infestations. Twig galls can cause severe damage or the death of trees. Identity of a gall has to be determined and the life cycle understood before effective control measures can be applied. Send gall specimens to your local county Extension office for identification in the event of a heavy infestation.		No controls are needed in many cases. To be effective, insecticides such as Diazinon, Malathion, Dimethoate, or Sevin must be applied just prior to the time of egg laying and the initial stages of gall development. Some galls can be controlled during the early development stage.
Oak Phylloxera	E N A	Bark of trunk and branches. Foliage	dormant oil Sevin, Carbaryl, Dursban, Tempo, Decathlon, horticultural oil, Merit, insecticidal soap, Discus L, Marathon	February- March Treat when nymphs first appear in April-May.
Gouty Oak Gall	E L A	Twigs, irregular, globose, 1 1/2 inches in diameter, frequently confluent, length to 5 inches, surface with round exit holes.	No satisfactory chemical controls.	April - leaf galls Summer - gouty oak gall on twigs and branches
Horned Oak Gall	E A	Twigs. Tubes project like horns. Globose, irregular, woody, variable in size with many horn-like projections.	No satisfactory chemical controls.	April - leaf galls summer - horned oak gall on twigs and branches
Succulent Oak Gall	E L A	Globular gall, succulent, hollow leaf, bud and catkin gall containing a white, free globular kernel, green, sometimes red tinged, diameter 1/4 to 1/2 inch. Spring.	Diazinon, Malathion, Dimethoate, Sevin, Carbaryl	March, April
Wool Sower Gall	E L A	Globular, white, pinkish-marked, woolly growth with seed-like grains on twigs in June, diameter 1 1/2 to 2 inches.	No control needed.	April
PINE				
Bagworm	L	Foliage of many trees. Feed on bark and needles from mid- May through August.	Bt (Dipel, Javelin, and others), Malathion, Diazinon, Orthene, Dursban, Sevin, Tempo, Decathlon, Tempo SC Ultra, Mavrik Aquaflow, Dylox, Conserve SC, Entrust SC, Acelepryn, Onyx, Onyx Pro, Provaunt, Mainspring GNL	mid-May through August Best control on young larvae from mid-May to mid-June

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
European Pine Shoot Moth	L	Small area between buds on terminals and laterals; foliage and bark of twigs on Scotch, Mugho, Japanese black pine.	Prune or shear off infested terminals before June. Dylox, Diazinon, Dimethoate, Orthene, Dimilin, Scimitar, permethrin (Astro, Perm-Up and others), Asana XL, Acelepryn, Onyx, Onyx Pro, Provaunt, Mainspring GNL, Intrepid 2F	Early April, June
Nantucket Pine Tip Moth	L P	Tunnel in buds and twigs of young trees up to 10 feet tall. (three generations; use pheromone traps to better time sprays)	Dylox, Dimethoate, Orthene, Dimilin, Scimitar, permethrin (Astro, Perm-Up and others), Acelepryn, Onyx, Onyx Pro, Provaunt, Mainspring GNL, Intrepid 2F	April-August
Pine Bark Adelgid	N	Bark of trunk, branches, and twigs on white pine; also Scotch and Austrian pine.	dormant oil horticultural oil, Dursban, Meridian, Merit, Marathon, Discus L, insecticidal soap, Flagship, TriStar, Kontos, Mainspring GNL	February-March April-July
Loblolly Pine Sawfly	L	Feed in groups on needles. Red-brown head, dull green body with gray stripes. One inch long. Eats last year's needles only. Trees not killed.	Malathion, Tempo, Decathlon, Tempo SC Ultra, Orthene, Sevin, Carbaryl, Scimitar, Talstar, Marathon, Conserve SC, Entrust SC, Merit, Discus L, Onyx, Onyx Pro, Meridian	March-May
Pine Sawflies	L	Larvae feed in groups on needles. Olive green or tan with glossy black head. Some have two longitudinal black stripes on back or a row of black spots on each side or a large black spot on last segment. Sawflies usually have 8 pair of fleshy prolegs that lack tiny hooks called crochets. Needles of most conifers especially red, Scotch, white pine and spruce	Malathion, Dursban, Orthene, Sevin, Carbaryl, Scimitar, Talstar, Tempo, Decathlon, Tempo SC Ultra, Conserve SC, Entrust SC, Merit, Marathon, Discus L, Onyx, Onyx Pro, Meridian *Provaunt is labeled for European Pine Sawfly	March-October
Red-Headed Pine Sawfly	L	Thorough wetting of needles. Broods may occur throughout the season.	Scimitar, Malathion, Talstar, Dursban, Tempo, Decathlon, Tempo SC Ultra, Orthene, Sevin, Carbaryl, Marathon, Conserve SC, Entrust SC, Merit, Discus L, Onyx, Onyx Pro, Meridian	May-September
Virginia Pine Sawfly	L	Feed in groups on needles; green body with black spots or stripes, black head; one generation.	Scimitar, Malathion, Talstar, Dursban, Tempo, Decathlon, Tempo SC Ultra, Orthene, Conserve SC, Entrust SC, Merit, Marathon, Discus L, Onyx, Onyx Pro, Meridian	March-May
Pine Needle Scale (an armored scale)	E C N	Needles of white, red, Scotch, Austrian, Mugho pine, spruce.	dormant oil Sevin, Carbaryl, Malathion, Orthene, horticultural oil, Dursban, insecticidal soap, MSR spray concentrate, Safari, Zylam Liquid, TriStar, Distance, Talus, Fulcrum, Aria, Kontos	February-March April, July-August when crawlers are emerging.
Pine Needle Miner	A	Foliage of pitch and jack pine.	Orthene, Discus L, Dimethoate, Merit, Marathon, Arena, TriStar, Safari, Zylam Liquid, Conserve SC, Flagship, Meridian, Azatin XL, Acelepryn, Distance, Fulcrum, Dimilin	May-June
Pine Spittlebug	N A	Foliage (needles), need long residual, especially white pine, also Scotch, red, Japanese.	Malathion, Orthene, Tempo, Decathlon, Tempo SC Ultra	May, July-August
Pine Webworm	L	Foliage (needles) on red, pitch, white pine, usually on seedlings and in plantations.	Scimitar, Malathion, Talstar, Dursban, Tempo, Decathlon, Tempo SC Ultra, Conserve SC, Entrust SC, Onyx, Onyx Pro, Sevin, Carbaryl, Orthene, Mainspring GNL, Provaunt. In the landscape, manual removal of the messy nests on the ends of branches is an alternative to spraying.	June-early September
White Pine Aphid	E N A	Needles of white pine; twigs and small branches of white pine, 1/8" with white marking.	dormant oil Orthene, Malathion, Merit, Marathon, Discus L, Diazinon,Tempo, Decathlon, Tempo SC Ultra, Arena, Dibrom, insecticidal soap, horticultural oil, Dursban, Dimethoate, Endeavor, Flagship, TriStar, Safari, Zylam Liquid, Aria, Kontos, BotaniGard, Mainspring GNL, Ancora	February-March April-September

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Pine Tortoise Scale	N C		dormant oil Marathon, Discus L, Merit, Sevin, Carbaryl, Malathion, Orthene, TriStar, horticultural oil, Dursban, insecticidal soap, Safari, Zylam Liquid, Distance, Arena, Talus, Meridian, Fulcrum, Aria, Kontos, Mainspring GNL	February-March early June-July when crawlers are emerging
Pine Tube Moth	L	Needles webbed into tube.	Control rarely warranted. In the landscape, handpick and dispose of pine tubes. Scimitar, Malathion, Talstar, Dursban, Tempo, Decathlon, Tempo SC Ultra, Orthene, Conserve SC, Entrust SC, Onyx, Onyx Pro, Mainspring GNL, Intrepid 2F	May, July
Eriophyid Mites (Rust Mites)	E E N A	Needles discolor and become chlorotic. Rust mites taper from head to tail. They are smaller than spider mites.	dormant oil horticultural oil, Dimethoate, Avid, Sevin, Carbaryl, Savate, Forbid, Akari, Kontos	February-March April-October Two sprays made one week apart. First treat when new growth is 3-5 inches long.
Black Turpentine Beetle	A	One-third to one-fourth inch long, bore vertical tunnel in cambium; larvae bore large gallery adjacent to vertical tunnel; pitch tubes on lower trunk and roots.	Dursban, permethrin (Astro, Perm-Up and others), Onyx, Onyx Pro	April-September
Ips Engraver Beetles	A	One-eighth inch long, crown and upper trunk.	Dursban, permethrin (Astro, Perm-Up and others), Onyx, Onyx Pro	March-September
Southern Pine Engraver	A	Trunk-(mid and lower), 3/16 inch long.	Dursban, permethrin (Astro, Perm-Up and others), Onyx, Onyx Pro	March-September
Eastern Fivespined Ips	A	Trunk--mid and lower, 1/4 inch long; bark with shot holes and pitch tubes; Y- or H-shaped galleries with short lateral to either side in inner bark.	Dursban, permethrin (Astro, Perm-Up and others), Onyx, Onyx Pro	March-September
Southern Pine Beetle	A	S-shaped tunnels in inner bark.	Dursban, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	April-October Cut and let lie or remove dying trees
Pales Weevil	L	Stump treatment: Pull and destroy stumps before June or treat stumps in March-early April or after trees are cut and the temperature is above 50 F.	Asana XL (Christmas tree plantings, forest tree nurseries, conifer seed orchards only, stump only), Dursban, Lorsban	
	A	Foliar treatment: The tender bark of seedling conifers and the young twigs of larger conifers can be protected by spraying in early to late April and again in August.	Dursban, Onyx, Onyx Pro, BotaniGard, permethrin (Astro, Perm-Up and others.)	
Pine Root Collar Weevil	A L	Bark at base of trunk and soil surface 8 inches out from trunk of Scotch, red pine and Austrian pine.	Dursban, Onyx, Onyx Pro, BotaniGard permethrin (Astro, Perm-Up and others)	early April
White Pine Weevil	A	Thorough coverage on terminals of white pine, Norway and white spruce, Scotch pine and Japanese black pine.	Dursban, MSR Spray Concentrate, Dimethoate, permethrin (Astro, Perm-Up and others), Talstar, Onyx, Tempo, Scimitar, Decathlon, BotaniGard	For Christmas tree growers, spray with MSR Spray Concentrate or Dimethoate 7-10 days after forsythia full bloom and a second application three weeks later. Another option is an application of Talstar or Decathlon when forsythia is in full bloom and again three weeks later. In the landscape, spray with Onyx, Talstar, Tempo, Scimitar, permethrin (Astro, Perm-Up and others) when forsythia is in full bloom. Repeat three weeks later.
			Merit, Marathon, Discus L	Apply as a soil drench in October or November to prevent damage the following Spring.

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Southern Pine Sawyer (roundheaded borer)	A	Trunk At least two generations per year with overlapping broods.	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to trunk sprays. Dursban, permethrin (Astro, Perm-Up and others)	Late March Late April-early May, mid-July
POPLAR, YELLOW OR TULIPTREE				
Tuliptree Aphid	E N A	Pale green aphids on underside of leaves; leaves become pale and fall prematurely.	horticultural oil, insecticidal soap, MSR Spray Concentrate, Diazinon, Arena, Malathion, Orthene, Discus L, Merit, Marathon, Endeavor, Flagship, TriStar, Safari, Zylam Liquid, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April, May, June
Root Collar Borer	E L A	Burrow in trunk near base of tree. Two generations per year.	Dursban, Onyx, Onyx Pro permethrin (Astro, Perm-Up and others)	Early May, early September
Tuliptree Scale	E N A	Twigs and stems.	dormant oil Sevin, Carbaryl, insecticidal soap, Orthene, horticultural oil, Diazinon, Dursban, Discus L, Merit, Marathon, Flagship, Safari, Zylam Liquid, TriStar, Distance, Arena, Talus, Meridian, Fulcrum, Aria, Kontos, Mainspring GNL	February-March Treating in May with Orthene or Merit may aid in control but a follow up treatment of the crawlers in September-early October is required for more complete control.
Columbian Timber Beetle	E L P A	Sapwood of trunk under bark; white dust collects at borer hole; later a sap-soaked area may develop around the hole.	Dursban, permethrin (Astro, Perm-Up and others)	May-June-October
Yellow Poplar Weevil	L A	Leaves; mine in leaves side by side.	Sevin, Carbaryl, Scimitar, Dursban, Orthene, Tempo, Decathlon, Talstar, Tempo SC Ultra, Onyx, Onyx Pro, BotaniGard	April, late May-early June
PRIVET				
Privet Aphid	All	New leaves curled lengthwise	Merit, Marathon, Orthene, Discus L, Dursban, insecticidal soap, TriStar, horticultural oil, Flagship, Safari, Zylam Liquid, Arena, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April-May September
Privet Aphid	All	New leaves curled lengthwise	Merit, Marathon, Orthene, Discus L, Dursban, insecticidal soap, TriStar, horticultural oil, Flagship, Safari, Zylam Liquid, Arena, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April-May September
Lilac Borer	L	Trunk	See under LILAC	
Lilac Leafminer	L	Leaves	See under LILAC	
European Hornet	A	Bark	See under BOXWOOD	
Mealybugs		Stems and leaves	Merit, Marathon, Discus L, Diazinon, Dursban, Arena, Orthene, Flagship, TriStar, Talus, Aria, Kontos, BotaniGard, Ancora	April-June
Privet Rust Mite	All	Leaves and stems	Avid, horticultural oil, Sevin, Carbaryl, Savate, Forbid, Akari, Kontos	April-June Two sprays made one week apart.
Southern Red Mite	E, N, & A	Lower leaf surfaces	Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Azatrol EC insecticide, Ancora	May-June September-October Two sprays made one week apart. Hexygon should only be used once per crop cycle or once per year and since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan 5 WDG in combination with a registered contact adult miticide. Hexygon DF, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
White Peach Scale (an armored scale)	All, E, N & A	Bark of trunk, branches, and twigs or ornamental stone fruits, privet and lilac	Sevin, Carbaryl, Malathion, Dursban, Orthene, horticultural oil, Safari, Zylam Liquid, TriStar, Distance, Talus, Fulcrum, Aria, Kontos	April-September
Two-banded Japanese Weevil		Roots, new leaves, shoots, inner foliage. Adults notch leaves, eventually leaving only petiole.	Talstar, Orthene, Onyx, Onyx Pro, BotaniGard, Mainspring GNL	April-September
Pyracantha				
Apple and Rose Aphids	All, E, N & A	Terminal stems and leaves, undersides of leaves	Merit, Marathon, Discus L, Malathion, Orthene, Dursban, Arena, insecticidal soap, horticultural oil, Endeavor, Flagship, TriStar, Safari, Zylam Liquid, Meridian, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April-September
Hawthorn Lace Bug	All, E, N & A	Undersides of pyracantha, cotoneaseter or hawthorn leaves	Orthene, Discus L, Dursban, Merit, Marathon, Diazinon, Tempo, Tempo SC Ultra, Decathlon, horticultural oil, Flagship, Acelepryn, BotaniGard, Mainspring GNL, Altus	mid-May to October
Southern Red Mite	All	Upper and lower leaf surfaces, leaves turn gray or brown	Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Azatrol EC insecticide, Ancora	April-May September-October Two sprays made one week apart. Hexygon should only be used once per crop cycle or once per year and since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan 5 WDG in combination with a registered contact adult miticide. Hexygon DF, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.
San Jose Scale (an armored scale)	All	Stems and leaves	dormant oil Sevin, Carbaryl, Malathion, Orthene, Dursban, Safari, Zylam Liquid, TriStar, Distance, Talus, Fulcrum, Aria, Kontos	February-March April-June August
Webworms	L	Leaves webbed together and turn brown	Bt (Dipel, Javelin & others), Dursban, Sevin, Carbaryl, Malathion, Dylox, Scimitar, Onyx, Onyx Pro, Acelepryn, Provaunt, Mainspring GNL	June-September
RHODODENDRON				
Black Vine Weevil	L A	Roots Foliage, roots. Adults notch the edges of leaves.	G, Merit, Marathon, entomopathogenic nematodes, Ancora Orthene, Talstar, Meridian, Mavrik Aquaflow, Diazinon, Scimitar, Dursban, Tempo, Decathlon, Tempo SC Ultra, Onyx, Onyx Pro, BotaniGard	May-September May-September Treat every three weeks until no adults are found. If adults can overwinter in container plants in polyhouses, begin treatment in March-April.
Rhododendron Borer		Trunk and branches	Dursban 50W, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others)	Mid-May and late June
Rhododendron Gall Midge (Rhododendron Tip Midge)	L P A	Tender, new leaves	A soil drench with Diazinon or Dursban from late fall to early spring is directed at controlling the overwintering larvae and pupae. One or two additional soil drenches can be made in season between growth flushes in conjunction with the use of Orthene foliar sprays timed to protect each flush of new growth.	April-September
Rhododendron Lace Bug	N A	Underside of leaves	Orthene, Discus L, Diazinon, Tempo, Decathlon, Merit, Marathon, Dursban 50W, Tempo SC Ultra, Flagship, Acelepryn, BotaniGard, Mainspring GNL, Altus	April-October

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Rhododendron Stem Borer	L,A	The primary control is to prune out and destroy wilted branches where eggs have been laid in June to mid- July. Prune below the lower of two	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to bark sprays. Rhododendron borer sprays should also help control this pest.	April May and July sprays. Prune in the summer.
Cranberry Rootworm	A	Foliage	Dursban, Mainspring GNL	May Spray at first sign of serpentine leaf feeding. Make a second spray 7-10 days later.
ROSE				
Rose Chafer	A	Thoroughly wet foliage with a residual spray	Sevin, Carbaryl, Dursban, Scimitar, permethrin (Astro, Perm-Up and others), Onyx, Onyx Pro, Talstar, Mainspring GNL	May-July
Rose Sawfly	L	Upper and lower surface of foliage, especially on rambler rose	Diazinon, Malathion, Dursban, Orthene, Conserve SC, Entrust SC, Merit, Talstar, Marathon, Discus L, Scimitar, permethrin (Astro, Perm-Up and others), Onyx, Onyx Pro, Meridian	May-July
Thrips	N & A	Buds and flowers, base of petals	Diazinon, Dimethoate, Dursban, Dylox, Conserve SC, Merit, Marathon, Aria, Kontos, BotaniGard, Mainspring GNL, Altus, Ancora	April-September
Japanese beetle	A	The beetles are 3/8 inches long, metallic green with coppery wing covers	Sevin, Carbaryl, Scimitar, Onyx, Onyx Pro, Talstar, TriStar, Mainspring GNL	June, July & early August (spray weekly)
Twospotted Spider Mites	N & A	foliage	Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Notavo, Azatrol EC insecticide, Ancora	April-September Hexygon DF, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.
SPRUCE				
Spruce Mite	E N A	Needles turn yellow, webbing between leaves	dormant oil Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Azatrol EC insecticide, Ancora	February-March April, September-October Two sprays made one week apart. Hexagon should only be used once per crop cycle or once per year and since it is mostly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan 5 WDG in combination with a registered contact adult miticide. Hexygon DF, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying.
Hemlock Eriophyid Mite (Rust Mites)	E N A	Needles with grayish cast, feed on upper and lower needle surfaces.	dormant oil horticultural oil, Sevin, Carbaryl, Avid, Dimethoate, Savate, Forbid, Akari	February-March April-May Two sprays made one week apart.
Hemlock Scale (an armored scale)	C E N A	Nearly black, undersides of needles; needles drop prematurely.	horticultural oil, Diazinon, Sevin, Carbaryl, Malathion, Safari, Zylam Liquid, TriStar, Distance, Talus, Fulcrum, Aria, Kontos	April, May, August
Pine Needle Scale (an armored scale)	E C N	Needles	dormant oil Sevin, Carbaryl, Malathion, Orthene, horticultural oil, Dursban, insecticidal soap, MSR spray concentrate, Safari, Zylam Liquid, TriStar, Distance, Talus, Fulcrum, Aria, Kontos	February-March April, July-August when crawlers are emerging.

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Pine Bark Adelgid	A E N A	Bark of trunk, branches, and twigs	dormant oil horticultural oil, Diazinon, Dursban, Merit, Marathon, insecticidal soap, Discus L, Flagship, Meridian, Kontos, Mainspring GNL	February-March April-July
Pine Spittlebug	N A	Foliage (needles), need long residual	Diazinon, Malathion, Orthene, Tempo, Decathlon, Tempo SC Ultra	May, July-August
Bagworm	L	Foliage of many trees. Feed on bark and needles from mid-May through August.	Bt (Dipel, Javelin, and others), Malathion, Diazinon, Orthene, Dursban, Sevin, Tempo, Decathlon, Tempo SC Ultra, Mavrik Aquaflow, Dylox, Conserve SC, Entrust SC, Acelepryn, Scimitar, Onyx, Onyx Pro, Provaunt, Mainspring GNL	Mid-May-August Best control on young larvae from mid-May to mid June
Sawflies	L	Larvae feed in groups on needles. Sawflies usually have 8 pair of fleshy prolegs that lack tiny hooks called crochets. Needles of most conifers.	Malathion, Diazinon, Dursban, Orthene, Sevin, Carbaryl, Scimitar, Talstar, Tempo, Decathlon, Tempo SC Ultra, Conserve SC, Entrust SC, Merit, Marathon, Discus L, Scimitar, Onyx, Onyx Pro, Meridian	March-October
Ips Engraver Beetles White Pine Weevil	A A	One-eighth inch long, crown and upper trunk. Thorough coverage on terminals of Norway and white spruce.	Dursban, permethrin (Astro, Perm-Up and others) Dursban, MSR Spray Concentrate, Dimethoate, Permethrin (Astro, Perm-Up and others), Talstar, Onyx, Onyx Pro, Tempo, Decathlon, Scimitar, Merit, Marathon	March-September For Christmas tree growers, spray with MSR Spray Concentrate or Dimethoate 7-10 days after forsythia full bloom and a second application three weeks later. Another option is an application of Talstar or Decathlon when forsythia is in full bloom and again three weeks later. In the landscape, spray with Onyx, Talstar, Tempo, Scimitar, permethrin (Astro, Perm-Up and others) when forsythia is in full bloom. Repeat three weeks later. Apply as a soil drench in October or November to prevent damage the following Spring.
Pales Weevil	L A	Stump treatment: Pull and destroy stumps before June or treat stumps in March-early April or after trees are cut and the temperature is above 50 F. Foliar treatment: The tender bark of seedling conifers and the young twigs of larger conifers can be protected by spraying in early to late April and again in August.	Asana XL (Christmas tree plantings, forest tree nurseries, conifer seed orchards only, stump only), Dursban, Lorsban Dursban, Onyx, Onyx Pro	
SWEET GUM				
Fall Webworm		See under CHESTNUT.		
Terrapin Scale	A	Twigs and stems.	dormant oil	February-March
	All		Diazinon, Malathion, Sevin, Carbaryl, Dursban, Orthene, Merit, Discus L, Marathon, Flagship, TriStar, Talus, Distance, Safari, Zylam Liquid, Arena, Meridian, Fulcrum, Aria, Kontos, Mainspring GNL	June, July
Sweetgum Scale (an armored scale)	A All	Pit on underside of leaf; small discolored galls occur on upper surface.	dormant oil Malathion, Sevin, Carbaryl, Dursban, Orthene, TriStar, Distance, Safari, Zylam Liquid, Talus, Fulcrum, Aria, Kontos	February-March May-June, August

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
SYCAMORE				
Fall Webworm		See under CHESTNUT.		
Sycamore Lace Bug	N A	Underside of leaves; foliage stippled, turns white, drops prematurely.	Malathion, Sevin, Carbaryl, Discus L, Marathon, Merit, Flagship, Acelepryn, BotaniGard, Mainspring GNL, Altus	May, September
VIBURNUM				
Snowball Aphid	N & A	Foliage of Viburnum	Merit, Marathon, Orthene, Dursban, Endeavor, Flagship, TriStar, Safari, Zylam Liquid, Discus L, Arena, Aria, Kontos, BotaniGard, Mainspring GNL, Ancora	April-May
WALNUT				
Giant Bark Aphid		See under CHESTNUT.		
Fall Webworm		See under CHESTNUT.		
Walnut Caterpillar	E L	Larvae feed in colonies.	Bt (Dipel, Javelin and others), Malation, Diazinon, Orthene, Dursban, Sevin, Tempo, Decathlon, Tempo SC Ultra, Mavrik Aquaflow, Dylox, Conserve SC, Entrust SC, Onyx, Acelepryn, Scimitar, Onyx Pro, Carbaryl, Talstar, Provaunt, Mainspring GNL, Intrepid 2F	May, June, August, September
Walnut Petiole Gall Mite	E N A	Twigs and bark before new growth begins. Large, deformed, hairy growths on leaf petiole.	Sevin, Carbaryl, Avid, Akari, Kontos	April-May
Butternut Gall Mite	All	Twigs and bark before new growth begins.	Sevin, Carbaryl, Avid, Akari, Kontos	April, May
WILLOW and POPLAR				
Giant Bark Aphid		See under CHESTNUT.		
Cottonwood Leaf Beetle Imported Willow Leaf Beetle	L P A	Larvae feed in groups; leaves skeletonized by young larvae. Older larvae consume entire leaf except veins.	Orthene, Sevin, Carbaryl, Talstar, Dursban, Conserve SC, Entrust SC, Merit, Marathon, Discus L, BotaniGard, Mainspring GNL	April, May, September
Twospotted Spider Mite	E N A	Heavy infestation causes browning and cupping of undersides of leaves.	Hexygon DF, Avid, Lucid, Ultiflora, horticultural oil, Savate, Forbid, Shuttle O, Shuttle 15 SC, Akari 5 SC, Magus, Sanmite, insecticidal soap, BotaniGard, MSR Spray Concentrate, Floramite SC, Floramite SC/LS, Kontos, TetraSan 5 WDG, Sirocco, Pre-Am Ultra, Aracinate TM, Sultan, Notavo, Azatrol EC insecticide, Ancora	May-September Two to three sprays made 5 days apart. Do not use horticultural oil more than once per week. Hexygon should only be used once per crop cycle or once per year and since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan 5 WDG in combination with a registered contact adult miticide. Hexygon DF, Notavo, Azatrol EC insecticide, Kontos, and TetraSan 5 WDG are most effective when applied at the first sign of mite activity and egg laying. Two to three sprays made 5 days apart. Do not use horticultural oil more than once per week. Hexygon should only be used once per crop cycle or once per year and since it is predominantly ovicidal/larvicidal, it should be applied prior to adult mite buildup. If adult mites are present in medium to high populations or if all life stages are present, apply Hexygon or TetraSan in combination with a registered contact adult miticide.

Table 1. Ornamental Pests

Host & Pest	Stage	Where to Treat	What to Use	When to Treat
Willow Sawfly	E L A	Young larvae feed in colonies; entire leaf eaten.	Diazinon, Malathion, Talstar, Tempo, Tempo SC Ultra, Decathlon, Conserve SC, Entrust SC, Orthene, Merit, Marathon, Discus L, Onyx, Onyx Pro, Scimitar, Meridian	May-September
Elm Sawfly	L A	Feed on bark of small twigs and leaves.	Malathion, Diazinon, Talstar, Tempo, Tempo SC Ultra, Decathlon, Conserve SC, Entrust SC, Orthene, Merit, Marathon, Discus L, Onyx, Onyx Pro, Scimitar, Meridian, Provaunt	May, August
Willow Shoot Sawfly	E L A	Larvae bore in pith killing shoots.	Diazinon, Talstar, Tempo, Tempo SC Ultra, Decathlon, Conserve SC, Entrust SC, Orthene, Merit, Marathon, Discus L, Onyx, Onyx Pro, Scimitar, Meridian	May, June
Poplar Tentmaker	L	Feed on the foliage of poplar and willow. They make a protective nest out of leaves and silk.	Dursban, Othene, Sevin, Carbaryl, Bt (Dipel, Javelin and others), Malathion, Diazinon, Tempo, Decathlon, Talstar, Scimitar, permethrin (Astro, Perm-Up and others), Tempo SC Ultra, Acelepryn, Onyx, Onyx Pro, Provaunt, Mainspring GNL, Intrepid 2F	May-October
Cottonwood Borer (roundheaded borer)	A L	Base of trunk under bark; base of tree riddled by tunnels.	Marathon, Discus L, or Merit, drench around the base of the tree as an alternative to trunk sprays.	Early May
			Dursban, permethrin (Astro, Perm-Up and others)	Early June, mid-July
YEW				
Asiatic Garden Beetle	L & A	Foliage stripped off at night by adult, roots cut by white grub.	Sevin, Orthene, Dursban, Mainspring GNL	May-July
Taxus Mealybug	N N	Bark of trunk and large branches Bark of small branches and twigs	dormant oil Orthene, Malathion, Sevin, Carbaryl, Diazinon, Merit, Discus L, Marathon, Flagship, TriStar, Safari, Zylam Liquid, Arena, Talus, Aria, Kontos, BotaniGard, Altus, Ancora	February-March May, July
Cottony Taxus Scale (cottony camellia scale)	N N	Bark of twigs and branches of taxus Same as above	dormant oil Sevin, Carbaryl, Dursban, Tempo, Decathlon, Merit, Marathon, horticultural oil, Tempo SC Ultra, Flagship, Safari, Zylam Liquid, TriStar, Distance, Discus L, Arena, Talus, Meridian, Fulcrum, Aria, Kontos, Mainspring GNL	February-March May-June
Taxus Weevil (Black Vine Weevil)	A L	Foliage, bark of trunk and branches, and the surfaces of ground beneath where beetles walk after emerging. Adults notch the edges of leaves. Roots	Tempo, Decathlon, Diazinon, Orthene, Dursban, Talstar, Tempo SC Ultra, Mavrik Aquaflow, Meridian, Kontos Merit, Marathon, Discus L, entomopathogenic nematodes, Kontos, Ancora	May-September Treat every three weeks until no adults are found. If adults can overwinter in container plants in polyhouses begin treatments in March-April. May-September
Fletcher Scale	N C	See under ARBORAVITAE See under ARBORAVITAE	see under ARBORAVITAE see under ARBORAVITAE	
YUCCA				
Termites	N & A	Roots, lower trunk	Merit, Marathon, Discus L (soil drench)	April
Yucca Plant Bug	E, N & A	Leaves and stems	Orthene, Sevin, Carbaryl, Decathlon, Tempo, Talstar, Onyx, Onyx Pro, Discus L, permethrin (Astro, Perm-Up and others), Scimitar, Aria, BotaniGard, Altus	May-October
Stalk Borer	L	Tunnels in the stems, wilted plants have a hole in stem from which frass has been extruded	Diazinon, Dursban, Talstar, Tempo, Decathlon, Tempo SC Ultra, Onyx, Onyx Pro, permethrin (Astro, Perm-Up and others), Scimitar, Mainspring GNL, Intrepid 2F	May-June
Scale	C	Stems and leaves	Sevin, Carbaryl, Malathion, Dursban, Orthene, horticultural oil, Safari, Zylam Liquid, Talus, TriStar, Distance, Discus L, Fulcrum, Aria, Kontos, (Meridian and Mainspring GNL for soft scale only)	April-June August

Table 2. Insect and Mite Control Recommendations for Flowers

Listed Insecticides can be easily measured and/or mixed in amounts sufficient to treat small to medium size areas

Pest	Insecticide Formulations	Amount to use per gallon	Precautions and Remarks
IMPORTED FIRE ANTS	Various baits		A general area treatment is best. Slow acting insecticide baits are recommended for certain ants including imported fire ants. See Commercial Turfgrass Insect Control, PB 1342 and https://ag.tennessee.edu/EPP/Redbook/2014InsectControlHomeLawn.pdf
APHIDS	Orthene T, T&O 75WSP	see label	Repeat applications are usually needed. Use Orthene with caution on Gloxinia, Philodendron and Salvia when repeated applications are needed. Dimethoate should not be applied to chrysanthemums or any other plant not on the label. Dimethoate is for commercial ornamental (nursery) use. Dimethoate for use on poinsettia, roses, iris, honeysuckle, gladiolus, gardenias, gerberas, carnations, daylilies, azaleas and camellias.
	Dimethoate 4E 4 lb/gal EC	see label	
	horticultural oil (Ultra-Pure Oil)	2.5-5 Tbs	
	Marathon 60% WP	see label	
	Merit 75% WSP	0.25 tsp/2.5 gal	
	Merit 2 lb/gal F	0.46-0.6 fl oz per 1000 sq ft	
	Discus N/G	see label	
	insecticidal soap (M-Pede)	5 Tbs	
	Marathon II	see label	
ARMYWORMS	Conserve 1 lb/gal SC	0.06 fl oz (2 ml)	Spray when insects are present or when feeding injury is first noticed.
	Sevin SL	see label	Sevin injures Boston ivy, Virginia creeper and maidenhair ferns.
BLISTER BEETLE JUNE BEETLE JAPANESE BEETLE FLEA BEETLE	Sevin SL	see label	
	Scimitar GC	see label	
CABBAGE LOOPER	Bacillus thuringiensis, Bt (Dipel Pro DF)	Follow label	Spray when worms are 1/8 to 1/4 inch long. Mature worms 1/2 to 1 inch long are difficult to control. Hand pick and destroy to protect flowers.
	Conserve 1 lb/gal SC	0.06 fl oz (2 ml)	
	Tempo SC Ultra	see label	
	Astro 3.2 EC Perm-Up 3.2 EC	see label	
	Scimitar GC	see label	

Table 2. Insect and Mite Control Recommendations for Flowers

Pest	Insecticide Formulations	Amount to use per gallon	Precautions and Remarks
CANNA LEAF ROLLER	Conserve 1 lb/gal SC	0.06 fl oz (2 ml)	
	SEE CABBAGE LOOPER RECCOMENDATIONS FOR ADDITIONAL INSECTICIDES		
CORN EARWORM	Conserve 1 lb/gal SC	0.06 fl oz (2 ml)	
	Sevin SL	see label	Spray thoroughly and repeat as needed.
	Tempo SC Ultra	see label	
	Astro 3.2 EC Perm-Up 3.2 EC	see label see label	
	Scimitar GC	see label	
EUROPEAN CORN BORER	Conserve 1 lb/gal SC	0.06 fl oz (2 ml)	
	Sevin SL	see label	Spray thoroughly
	Tempo SC Ultra	see label	
	Astro 3.2 EC Perm-Up 3.2 EC	see label see label	
	Scimitar GC	see label	
IRIS BORER	Dimethoate 4E 4 lb/gal EC	see label	Apply to foliage in early spring when leaf fans are about 6 inches tall. Repeat in 10 to 14 days. Rogue infested, decaying tubers from bed and destroy. Remove leaf litter and plant debris from bed in late fall.
LEAFHOPPER	Dimethoate 4E 4 lb/gal EC	see label	Apply to foliage as needed. See precautions under aphids. Dimethoate for use on poinsettia, iris, roses, honeysuckle, gladiolus, gardenias, gerberas, carnations, daylilies, azaleas and camellias.
	Scimitar GC	See label	
	Marathon 60% WP	see label	
	Merit 75% WSP	0.25 tsp/2.5 gal	
	Merit 2 lb/gal F	0.46-0.6 fl oz per 1000 sq ft	
	Marathon II	see label	
	Discus N/G	see label	
LEAFMINERS	Dimethoate 4E 4lb/gal EC	see label	Apply to foliage thoroughly - kills larvae in leaves. Only use Dimethoate on plants listed on the label. Dimethoate is for commercial ornamental (nursery) use.
	Marathon 60% WP	see label	
	Merit 75% WSP	0.25 tsp/2.5 gal	
	Merit 2 lb/gal F	0.46-0.6 fl oz per 1000 sq ft	
	Marathon II	see label	
	Discus N/G	see label	

Table 2. Insect and Mite Control Recommendations for Flowers

Pest	Insecticide Formulations	Amount to use per gallon	Precautions and Remarks
PLANT BUGS	Sevin SL	see label	Apply to foliage as needed.
	Scimitar GC	see label	
SLUGS AND SNAILS	Metaldehyde + Sevin B	Follow label directions	Apply baits around plant bed borders in early evening. Moisten bait with a mist spray. Remove boards, plant debris and leaf litter from area to permit soil to dry and to reduce shelter for pests.
	Mesurol 75- W	see label	
SOWBUG, PILLBUGS AND MILLIPEDE	Sevin SL	see label	Spray or dust flower beds, leaf litter, lawn areas around house and flower beds.
SPIDER MITES	horticultural oil (Ultra-Pure Oil)	2.5-5 Tbs	Spray foliage thoroughly when infestation appears. Two to three sprays made 5 days apart. Do not use horticultural oil more than once per week.
	Avid 0.15 lb/gal EC	0.24 tsp	
	Floramite 50% WP	1/3-2/3 tsp.	
	insecticidal soap (M-Pede)	5 Tbs	
	Ovation SC	see label	
SCALE INSECTS	horticultural oil (Ultra-Pure Oil)	2.5-5 Tbs	Spray when infestation occurs. Spray when scale crawlers are migrating on plants.
	insecticidal soap (M-Pede)	5 Tbs	
	Marathon 60% WP	see label	
	Marathon II	see label	
	Merit 75% WSP	0.25 tsp/2.5 gal	
	Merit 2 lb/gal F	0.46-0.6 fl oz per 1000 sq ft	
	Discus N/G	see label	
SPITTLEBUGS	Merit 75% WSP	see label	
	Merit 2 lb/gal F	see label	
	Discus N/G	see label	

Table 2. Insect and Mite Control Recommendations for Flowers

Pest	Insecticide Formulations	Amount to use per gallon	Precautions and Remarks
MEALYBUGS	horticultural oil (Ultra-Pure Oil)	2.5-5 Tbs	
	insecticidal soap (M-Pede)	5 Tbs	
	Orthene T, T&O 75WSP	see label	
	Marathon 60% WP	see label	
	Marathon II	see label	
	Merit 75% WP	0.25 tsp/2.5 gal	
	Merit 2 lb/gal F	0.46-0.6 fl oz per 1000 sq ft	
NARCISSUS BULB FLIES	Dylox 420 SL	see label	
THRIPS	Mesurol 75-W	see label	Spray foliage and buds when pest occurs. Repeat sprays will be needed. Only use Dimethoate on plants listed on the label. Dimethoate is for commercial (nursery) use. Dimethoate for use on poinsettia, iris, roses, honeysuckle, gladiolus, gardenias, gerberas, carnations, daylilies, azaleas and camellias.
	Dimethoate E 4 lb/gal EC	see label	
	Conserve 1 lb/gal SC	0.06 fl oz (2 ml)	
WHITEFLIES	Orthene T, T&O 75WSP	1 Tbs	Spray underside of leaves when pests appear. Repeat when infestation occurs throughout season. Only use Dimethoate on plants listed on the label. Dimethoate is for commercial (nursery) use. Dimethoate for use on poinsettia, iris, roses, honeysuckle, gladiolus, gardenias, gerberas, carnations, daylilies, azaleas and camellias.
	Dibrom 8 lb/gal EC	2 tsp	
	Dimethoate 4E 4 lb/gal EC	see label	
	Azatin XL 3% EC	see label	
	horticultural oil (Ultra-Pure Oil)	2.5-5 Tbs	
	insecticidal soap (M-Pede)	5 Tbs	
	Marathon 60% WP	see label	
	Marathon II	see label	
	Merit 75% WSP	0.25 tsp/2.5 gal	
	Merit 2 lb/gal F	0.46-0.6 fl oz per 1000 sq ft	
	Discus N/G	see label	

Preparing A Spray

Pesticides are formulated as emulsifiable concentrates or wettable powders for dilution in water or as granules to be applied on or in the soil. Accurately measure the amount recommended for the volume of dilute spray you need. The concentrates may contain either one, two, three, four or seven pounds per gallon of the active insecticidal ingredient. The safety margin is reduced considerably when too much insecticide is added to the dilute spray. Injury to plants and overexposure to the home gardener frequently results from using too much insecticide.

Read the label thoroughly before you mix a spray. The four most important minutes in any pest control project are the time required to read and understand the label.

Overexposure to insecticides can result from oral ingestion, inhalation or absorption through the skin. The amount any one individual can tolerate without becoming ill may vary according to age, weight, sex and health. The potential toxicity is based on test results with experimental animals. The insecticides Di-Syston, Metasystox-R2 and Diazinon have a high dermal absorption potential. The oral poisoning potential for these insecticides is extremely high. Observe the caution and warning statements on all insecticide labels. Wear the prescribed protective equipment and apply the insecticides in recommended situations according to label directions.

The potential toxicity is increased many times when the amount recommended for a spray application is doubled. Mixing two or more insecticides together can also greatly increase the potential toxicity of a spray.

Table 3. Spray Estimate Chart

Estimate the amount of dilute spray material required to thoroughly cover your infested plants to the point of run-off. When the spray begins to drip off, you have applied a sufficient amount. A fine-mist spray will give a better, more uniform coverage to the plant.

Spraying Trees or Shrubs	Height of Plant (Feet)	Spread of Plant	Square Feet of Bark Surface	Volume Needed (Gallons)
Foliage Spray	50	60		25
Dilute Spray	30	35		20
Fine-Mist Spray	25	30		15
	19	26		14
	16	24		13
	13	20		12
	10	16		8
	8	12		6
	6	8		4
	4	3		1/2
Bark Spray			80-125	1 pint
Borers	Trunk up to and including lower limbs of scaffold		80-125	1 pint

Table 4. Pesticide Formulations

Common Name	Class	Brand Names	Formulations
acephate	OP	Orthene Turf, Tree & Ornamental Spray	75% SP
		Lepitect	97.4%
acequinocyl	ND	Shuttle 15 SC	15.8% SC
		Shuttle O	15.8% SC
acetamiprid	CN	TriStar 8.5 SL	8.5% SL
abamectin	B	Avid Abacide 2	0.15% EC 1.9% EC
azadirachtin	BOT	Azatin O Ornazin 3% EC OHP Azatin XL Azatrol EC Insecticide TreeAzin	4.5% 3% EC 3% EC 1.2% EC 5%
Bacillus thuringiensis subsp. *aizawai*		XenTari	54% DF
Bacillus thuringiensis subsp. *galleriae*		GrubGone! G	9% W/w
Bacillus thuringiensis subsp. *israelensis*		Gnatrol WDG	37.4% WDG
Bacillus thuringiensis subsp. *kurstaki*	B	Dipel Pro DF	54% DF
bifenazate	CBZ	Floramite	50% WP
bifenthrin	P	Talstar F	7.9% F
		Talstar One	7.9% F
		Talstar Nursery	7.9% F
		Onyx, Onyx Pro	23.4%
carbaryl	Car	Carbaryl Sevin	80% S 4 lb/gal SL
chlorantraniliprole	AD	Acelepryn	1.67 SC
chlorpyrifos	OP	Chlorpyrifos 4E AG	4 lb/gal EC
		Dursban 50 W	50% WSP
		DuraGuard ME	20% ME
		Lorsban 4E (for Christmas tree plantations)	4 lb/gal EC

Common Name	Class	Brand Names	Formulations
clofentezine		Ovation SC	4 lb/gal SC
clothianidin	CN	Arena 50 WDG	50 % WDG
beta-cyfluthrin	P	Tempo SC Ultra	1 lb/gal SC
cyfluthrin	P	Tempo 20 WP Decathlon 20WP	20% WP 20% WP
deltamethrin	P	DeltaGard G	0.1% G
diazinon	OP	D-264 4EC Diazinon Insecticide	4 lb/gal EC
diflubenzuron	IGR	Dimilin	25 W 4 L
dicofol	CH	Kelthane	50% WSP
dinotefuran	CN	Safari	20 SG
dimethoate	OP	Dimethoate 4 EC, 4E	4 lb/gal EC
dormant oil	misc.	Volck-Saybolt reading of 90-150 sec. (viscosity test 60 cc through standard opening at 100^0 F.) 90-92% unsulfonated residue = Superior; 60-85% = Regular	70-90 sec. 80-90 % oil + emulsifier
esfenvalerate	P	Asana XL	0.66 lb/gal EC
etoxazole	IGR	TetraSan 5 WPG	5% WDG
fenbutatin-oxide	OG	Promite 50 WP Meraz	50 WSP 50 WSP
fenpropathrin	P	Tame 2.4 EC	2.4 lb/gal EC
tau-fluvalinate	P	Mavrik Aquaflow	22.3% F
hexythiazox	Thia	Hexygon	50% WP
horticultural oil	misc.	Ultra - Pure Oil 99% unsulfonated residue Horticultural oil is often made of mineral oil and detergent/emulsifier. These oils have a high content of parafinic hydrocarbons with relatively small amounts of aromatic or naphthalenic constituents. These oils are less phytotoxic than the aromatic or naphthalenic oils.	98.0% oil + emulsifier

Common Name	Class	Brand Names	Formulations
imidacloprid	CN	Merit 2	2 lb/gal F
		Merit 75 WP Marathon 1%Granular Marathon 60WP	75% WP 1% G 60% WSP
imidacloprid plus bifenthrin	CN	Allectus SC	5.0% SC 4.0% SC
imidacloprid plus cyfluthrin	CN P	Discus	2.94% L 0.70% L
insecticidal soap	misc.	M-Pede	49% a.i.
		Insecticidal Soap	49.52% CF
		Safer Insecticidal Soap	49% a.i.
insecticidal soap lambda-cyhalothrin	misc. P	M-Pede	49% a.i.
		Insecticidal Soap	49.52% CF
		Safer Insecticidal Soap	49% a.i.
		Scimitar Scimitar CS Scimitar GC	10% WP 9.7% CS 9.7% GC
malathion	OP	Malathion	57% EC 50% EC
methiocarb	CAR	Mesurol	75% WP
naled	OP	Dibrom 8 Emulsive	8 lb/gal EC
parasitic nematode	B	Guardian Nemasys H	*Steinernema* spp. *Heterorhabditis megidis*
permethrin	P	Astro T & O, Pounce, Ambush, Dragnet, Perm-UP	25% WP 3.2 lb/gal EC
phosmet	OP	Imidan	70% WSB
propargite	misc.	Ornamite	30% WSB
pymetrozine	PYAZ	Endeavor	50% WDG
pyrethrins	BOT	Pyrenone	6% Pyrethrin plus 60% PBO EC
spinosad	spin	Conserve SC	1 lb/gal SC
		Entrust SC	2 lb/gal SC

Common Name	Class	Brand Names	Formulations
spiromesifen	tet	Judo, Forbid 4F	4 lb/gal F
tebufenozide	IGR	Confrim 2F (for Christmas trees)	2lb/gal water-based flowable
thiamethoxam	CN	Flagship 25WG	25% WG
		Flagship	0.22 G
		Meridian	25% WG
		Meridian	0.33 G
trichlorfon	OP	Dylox 80	80% SP

AD - Anthranilic diamide
OP - Organophosphate
P - Pyrethroid
IGR - Insect Growth Regulator
B - Biological agent
Misc. - Miscellaneous
PYAZ - Pyridine azomethine
OG - Organotin
tet - tetronic acid derivative
CH - Chlorinated Hydrocarbon
Bot - Botanical
Car - Carbamate
CN - Chloro-nicotinyl
CBZ - Carbazate
Spin - Spinosyn
Thia - thiazolidinone

Dilution Tables - a Guide to Accurate Measures

Wettable Powders

Number of ounces of wettable powder to use in small sprayers when amount per 100 gallons is known.

100 Gals.	10 Gals.	5 Gals.	2 Gals.	1 Gals.
0.5 lb.	0.8	0.4	0.2	0.1
1 lb.	1.6	0.8	0.3	0.2
2 lbs.	3.2	1.6	0.6	0.3
3 lbs.	4.8	2.4	1.0	0.5
4 lbs.	6.4	3.2	1.3	0.6
5 lbs.	8.0	4.0	1.6	0.8

Emulsifiable Concentrates
Number of fluid ounces of emulsifiable concentrate to use in small sprayers when amount per 100 gallons is known.

100 Gals.	10 Gals.	5 Gals.	2 Gals.	1 Gal.
1 pt.	1.6	0.8	0.3	0.2
1 qt.	3.2	1.6	0.7	0.3
2 qts.	6.4	3.2	1.3	0.6
1 gal.	12.8	6.4	2.6	1.3

Mist Blower
Quantity of emulsifiable concentrate (EC)
needed to make a 25X concentration

If Amount per 100 Gals. for a High Volume Spray is:	Use This Amount in a Mist Blower for:			
	25 Gals	10 Gals	2 Gals.	1 Gal.
1 pt.	6.25 pts.	2.5 pts.	8 fl. ozs.	4 fl. ozs.
1 qt.	6.25 qts.	5.0 pts.	1 pt.	8 fl. ozs.
2 qts.	3.13 gals.	5.0 qts.	1 qt.	1 pt.
1 gal.	6.25 gals.	2.5 gals.	2 qts.	1 qt.

Table of Measures

Liquids
1 level tablespoonful = 3 level teaspoonfuls
1 fluid ounce = 2 tablespoonfuls = 29.57 milliliters
1 cupful = 8 fluid ounces
1 pint = 2 cupfuls = 16 fluid ounces
1 quart = 2 pints = 32 ounces
1 gallon = 4 quarts = 128 fluid ounces

Weights
1 ounce = 28.3 grams
1 lb. = 16 ounces = 454 grams
1 ton = 2,000 pounds

Rates to Use to Treat One Acre

Pounds Actual Pesticide Per Gallon of Liquid Concentrate	Pounds Actual of Pesticide Needed						
	1/4	1/2	3/4	1	2	3	4
	Pints of Liquid Concentrate to User Per Acre						
1	2	4	6	8	16	24	32
1 1/2	1.3	2.6	4	5.3	10.6	16	21.3
2	1	2	3	4	8	12	16
4	0.5	1	1.5	2	4	6	8

Rates to Use to Treat One Acre

Percent Formulation of Wettable Powder	Pounds Actual of Pesticide Needed						
	1/4	1/2	3/4	1	2	3	4
	Pints of Liquid Concentrate to User Per Acre						
15%	1.75	3.33	5	6.5	13	20	26.5
25%	1	2	3	4	8	12	16
40%	0.6	1.25	1.75	2.5	5	7.5	10
50%	0.5	1	1.5	2	4	6	8
75%	0.4	0.7	1	1.3	2.66	4	5.33

Rates to Use to Treat One Acre

Percent Formulation of Dust or Granules	Pounds Actual of Pesticide Needed						
	1/4	1/2	3/4	1	2	3	4
	Pounds of Dust or Granules to Use Per Acre						
2 1/2%	10	20	30	40	80	120	160
5%	5	10	15	20	40	60	80
10%	2.5	5	7.5	10	20	30	40
20%	1.25	2.5	3.75	5	10	15	20
25%	1	2	3	4	8	12	16

Small Gallonage Rates

If an insecticide recommendation is given on the basis of 100 gallons of finished spray but only 1 gallon is wanted, follow this general rule to prepare that 1 gallon of spray.

Dry Formulations -
For each 1 pound of powder that is recommended per 100 gallons of water, use 1 level tablespoonful (Tbs) per 1 gallon of spray.

Liquid Formulations - For each 1 pint that is recommended per 100 gallons of water, use 1 teaspoonful (tsp) per gallon of spray.

Table 5. Information about Insecticides/Miticides

Revised 3/15

Pesticide (Common Chemical Name)	Trade Name(s)	Classification	Oral LD 50 (mg/kg)[2]	Dermal LD 50 (mg/kg)[2]	Manufacturer
abamectin	Avid	microbial toxins	650	>2000	Syngenta
acephate	Orthene	organophosphate	980	10,250	Valent, Ortho
acequinocyl	Shuttle O	Napthoquinone derivatives	> 2,000 (bobwhite quail)	>2,000 (rats)	OHP
actetamiprid	TriStar	chloronicotinyl	1,064	>2000	Cleary
azadiractin (=neem, azatin)	Bioneem, Azatin XL	botanical	4,242	>2000	Safer, OHP
Bacillus thuringiensis var. kurstaki	Dipel, and possibly others	spores + crystalline delta-endotoxin, microbial	none	none	Valent, Syngenta
bifenazate	Floramite	carbazate	---	---	Chemtura Corp.
bifenthrin	Talstar, Onyx	pyrethroid	375	>2000	FMC
buprofezin	Talus	insect growth regulator (inhibit chitin biosynthesis - type 1)	>5,000 (rat)	>2,000 (rat)	SePro
carbaryl	Carbaryl, Sevin	carbamate	246	>4000	Bayer, Drexel
chlorantraniliprole	Acelepryn	anthranilic diamide	>5,000 (rat)	>5,000 (rat)	DuPont
chloryrifos	Dursban, Lorsban	organophosphate	270	2000	Dow AgroSciences
cryolite	Kryocide	inorganic fluroine	practically nontoxic		Atochem
cyfluthrin	Decathlon, Tempo	pyrethroid	826	>2000	Dow AgroSciences
deltamethrin	DeltaGard G	pyrethroid	128.5 to >5,000	>2000	Aventis
diazinon	Diazinon, Spectracide	organophosphate	400	3600	Drexel, Syngenta
dicrotophos	INJECT-A-CIDE B	organophosphate	17	224	DuPont, Mauget
diflubenzuron	Dimilin	insect growth regulator	>4640	>10,000	Chemtura Corp.
dimethoate	Dimethoate	organophosphate	235	>400	Platte, Loveland
dinotefuran	Safari	chloronicotinyl	>2000	>2000	Valent
esfenvalerate	Asana XL	pyrethroid	458	>2000	DuPont
etoxazole	TetraSan 5DG	insect growth regulator	4,500 (male rat) 2,600 (female rat)	>5,000	Valent
fenetrothion	Pestroy	organophosphate	800	1300	PBI-Gordon

Pesticide (Common Chemical Name)	Trade Name(s)	Classification	Oral LD 50 (mg/kg)[2]	Dermal LD 50 (mg/kg)[2]	Manufacturer
fenpyroximate	Akari 5SC	Mitochondrial electron transport inhibitor (METI)	810 (male rat) 600 (female rat)	2 (rat)	SePro
fluvalinate	Mavrik Aquaflow	pyrethroid	282	20,000	Syngenta
hexythiazox	Hexygon	carboxamide	5,000	>5,000	Gowan
imidacloprid	Marathon, Merit	chloronicotinyl	2591	>2000	Bayer, OHP
imadacloprid plus cyfluthrin	Discus N/G	chloronicotinyl plus pyrethroid	>5,000	>5,030	OHP
lambda-cyhalothrin	Scimitar	pyrethroid	79	632	Syngenta
malathion	Cythion, Malathion	organophosphate	1000	4100	Setre, Drexel, UAP
metaldehyde	Bug-Geta, Deadline, Slug-Geta	metacetaldehyde	360	---	Valent
methiocarb	Mesurol	carbamate	20	>5000	Gowan
naled	Dibrom	organophosphate	272	1100	Valent
oxydemeton-methyl	Harpoon, MSR Spray Concentrate	organophosphate	48	112	Gowan
permethrin	Ambush, Pounce, Astro, Perm-Up	pyrethroid	4000	>4000	FMC, Syngenta, United Phosphorus
petroleum oils	Dormant, Summer, Superior Oils, etc.	hydrocarbon oils	exempt		numerous
phosmet	Imidan	organophosphate	147	>4640	Gowan, Florida Silvics, Inc.
propargite	Ornamite	sulfite ester	4029	2940	Chemtura Corp.
pyrethrum	Pyrethrin, Pyrellin, Pyrenone, etc.	botanical	1500	1800	Fairfield, Prentiss, etc.
rotenone, cube=	Prentox, Rotenone	botanical	1500	---	Fairfield, Prentiss
spinosad	Conserve SC, Entrust 2 SC	spinosyn	>5000	---	Dow Agro Sciences
soaps, pesticidal	Aphid-Mite Attack, Insecticidal Soap, M-Pede, etc.	Fatty acid salts	practically nontoxic		Mycogen, Ringer
tebufenozide	Confirm 2F, Mimic 2LV	insect growth regulator (benzoic acid hydrazide)	>2150	---	Dow AgroSciences
thiamethoxam	Flagship, Meridian	neonicotinoid	>5000	>2000	Syngenta
trichlorfon	Dylox	organophosphate	250	>2100	Bayer
spiromesifen	Judo, Forbid	Tetronic acid derrivatives	>2000	>2000	Bayer, OHP

[1]Farm Chemicals Handbook '93 (Meister Publishing Co., Willoughby, OH), and technical data information where available.
[2]Equals milligrams per kilogram of body weight applied orally or dermally. (1 milligram = 1/1,000 of a gram, 454 grams = 1 lb.)

PRODUCTS LISTED IN TABLES AND TYPE OF REGISTRATION [a]

Acelepryn
Akari 5 SC
Allectus SC
Arena 0.25 G
Asana XL (**H**)
Avid (*)
Bioneem
"Bt" (kurstaki)
Bug-Geta
Carbaryl 5D
Carbaryl 10D
Carbaryl 4L
Carbaryl 50WP (*)
Chlorpyrifos Pro 4 (@)
Chlorpyrifos Pro 2 (@)
Conserve 1 SC
Cythion 5EC
Cythion 8EC
Deadline Bullets
Deadline Granules
Decathlon 20% WP (*)
DeltaGard G (&)
Dendrex
Diazinon 50W (*)
Diazinon 2E
Diazinon 4E & AG500 (*)
Discus (*)
Dicofol 4EC
Dibrom 8 Emulsive
Dimethoate 400
Dimilin 4L (**H**)
Dimilin 25W (**H**)
Dursban Pro (**H**)
Dursban 50W (**H**)
Dursban TNP (@)
Dylox 420 SL(*)
Entrust 2SC
Flagship 25WG
Floramite
Forbid 4F
Furadan 4F (**H**)
Guthion 2S (**H**)
Harpoon (**H**)
Hexygon 50-WP (*)
Imidan 70-WSB (*)
Inject-A-Cide (**H**)
Inject-A-Cide B (**H**)
Judo 4F
Kelthane 50 WSP (*)
Kryocide 96% WP
Lorsban 4E
Malathion 50
Malathion 57
Marathon 1% Granular
Marathon 60 WP
Mavrik Aquaflow
Meridian 25 WG
Merit 75WP
Merit 2
Merit 0.5G
Mesurol 75% WP
MSR Spray Concentrate (**H**)
Oils
Onyx (&)
Onyx Pro (**H**)
Ornamite
Orthene 75% SP
Orthene 9.4%EC
Ovation SC
Pestroy 4EC
Pounce 3.2EC (**H**)
Pounce 25WP (**H**)
Pyrethrin (+PBO)
Resmethrin EC26
Rotenone + Pyrethrin
Rockland Shade Tree Insect Spray
Scimitar WP (*)
Sevin Liquid 2F
Sevin 50W
Sevin 5 Dust
Shuttle O
Slug-Geta
Soaps (insecticidal)
Spectracide 25% EC
Steinernema spp.-entomopathogenic nematodes
Talstar T&O (*)
Talstar 10WP (*)
Talus 40SC
Tempo 2
Tempo 20WP
TetraSan 5WDG
Thiodan 50WP (*)
Thiodan 3EC (*)
TriStar 30 SG

\[a] Products without symbols are general use products.

Products with (*) are designated on labels as "Commercial or Agricultural Use Only"

Products with (**H**) are designated on labels as "Restricted Use Pesticide"

Products with (#) are designated on labels as for use by individuals/firms licensed or registered by state to apply termiticide products.

Products with (@) are to be applied only by or under the direct supervision of trained applicators responsible for insect control programs.

Products with (&) are for sale to, use and storage by commercial applicators only.

Products with (%) are intended for use by commercial applicators only.

Disclaimer

This publication contains pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. The label always takes precedence over the recommendations found in this publication.

Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others that may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product. The author(s), the University of Tennessee Institute of Agriculture and University of Tennessee Extension assume no liability resulting from the use of these recommendations.

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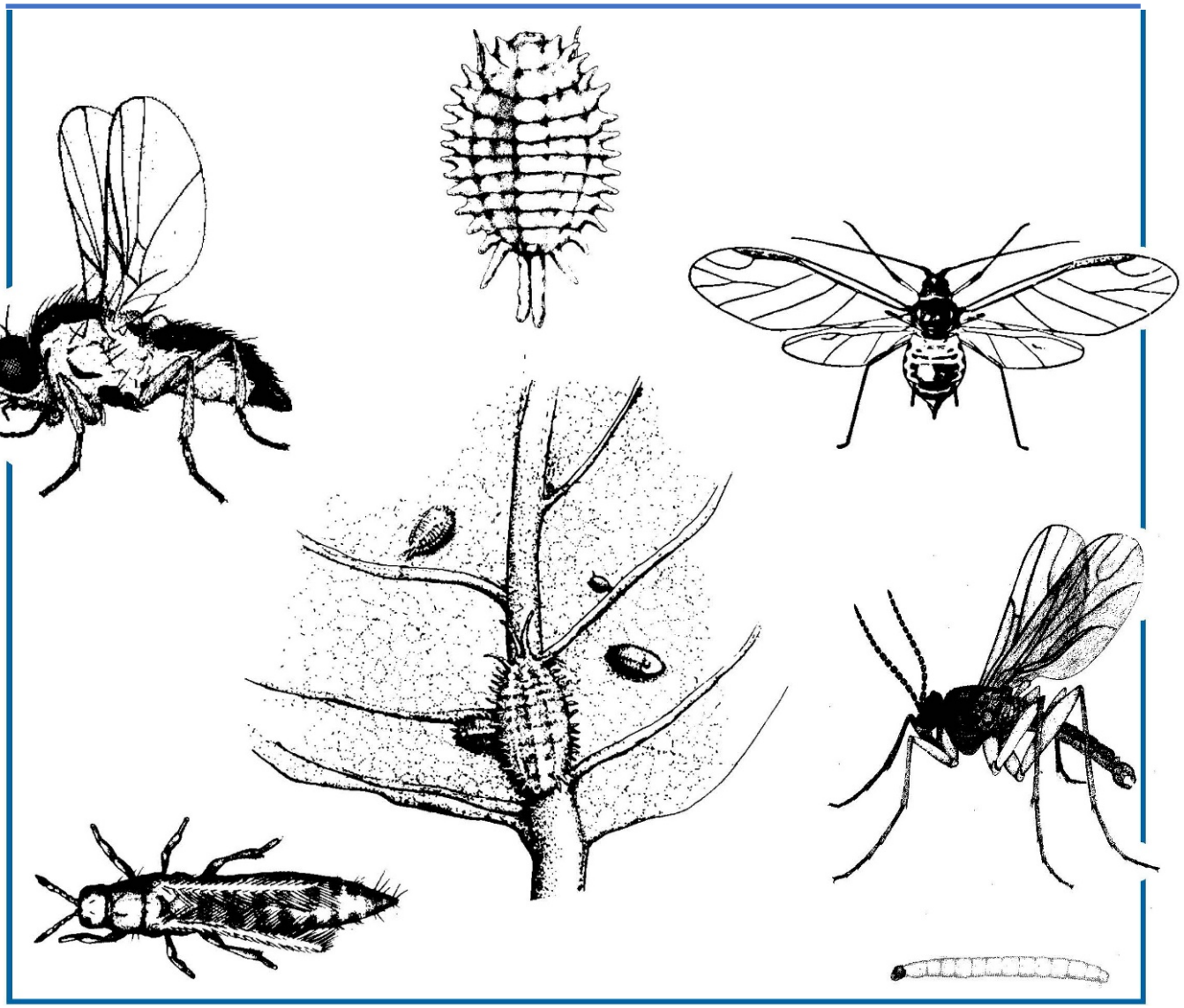
PB 1594

Insect and Mite Management in Greenhouses

2018



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Insect and Mite Management in Greenhouses

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Pest Management

Integrated Pest Management (IPM) is a term which refers to the use of various strategies to manage greenhouse insect and mite pests. The focus of IPM is to use a variety of management strategies to deal with existing pest problems, rather than relying solely on pest control materials such as insecticides and/or miticides. IPM involves the use of cultural, physical, biological, and/or pesticidal management strategies.

IPM programs typically require producers to be proactive rather than reactive. An effective IPM program begins by regularly scouting the greenhouse crop for insect and mite pests. An IPM program may include establishing action thresholds for specific insect and/or mite pests and then implementing a pest management strategy once a threshold has been reached. Greenhouse producers who have successfully implemented IPM programs indicated that they have reduced costs and increased worker safety. As a result, employees often respond to IPM programs with increased enthusiasm. The objective of this publication is to assist greenhouse producers in starting an IPM program.

Pest Management Basics

Identification

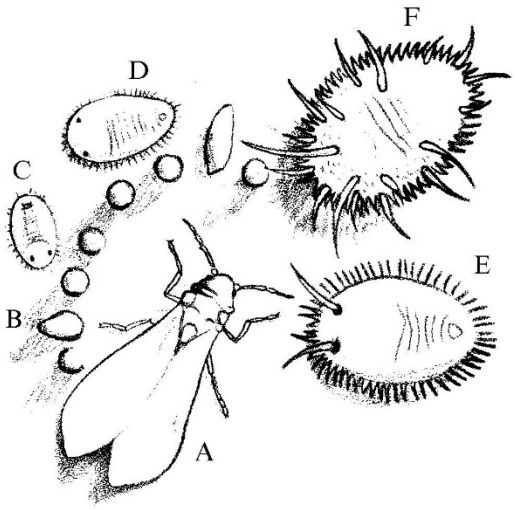
Identifying insect or mite pests and the number of each species in a greenhouse requires diligence, but this information is critical in order for greenhouse producers to avoid spraying an inappropriate pest control material such as an insecticide or miticide. When greenhouse producers know exactly what pests are present and the plants they are present on, then the appropriate insecticide or miticide can be applied. A valuable pictorial guide for pest identification is *Identification of Insects and Related Pests of Horticultural Plants* by R.K. Lindquist and R.A. Cloyd which is published by O.F.A. Services, Inc. The University of Tennessee Soil, Plant and Pest Center in Nashville is another valuable resource.

Sanitation

Clean greenhouses provide fewer opportunities for insect and mite pests to establish and thrive. Weeds in pots or underneath benches serve as reservoirs for many greenhouse insect and mite pests. Weeds underneath benches are not typically sprayed with insecticides and miticides. In addition, many weeds serve as a source for viruses transmitted by insects such as the western flower thrips (*Frankliniella occidentalis)*. Avoid standing water and allow water to properly drain away from the greenhouse since excess water provides an ideal breeding environment for fungus gnats and shore flies. Remove plant

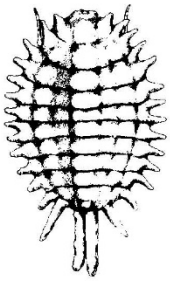
debris and old stock plants from the greenhouse or place into containers with tight-sealing lids because winged adult insects will abandon desiccating plant material and migrate onto the main crop.

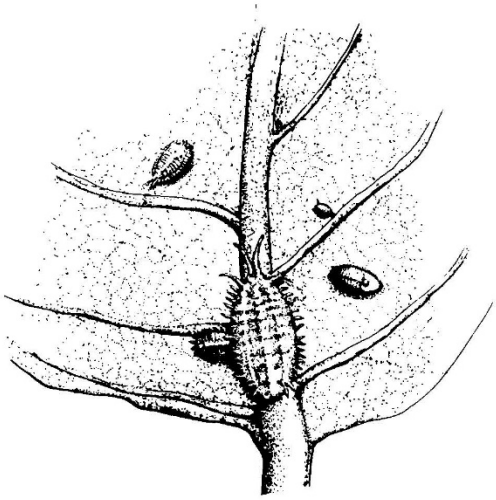
llustrations of Common Insect and Mite Pests of Greenhouse Crops

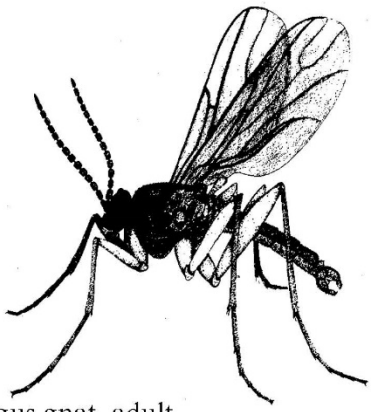


Greenhouse whitefly. A, Adult. B, Eggs. C - E, Nymphs. F, Pupa

Mealybug, adult female



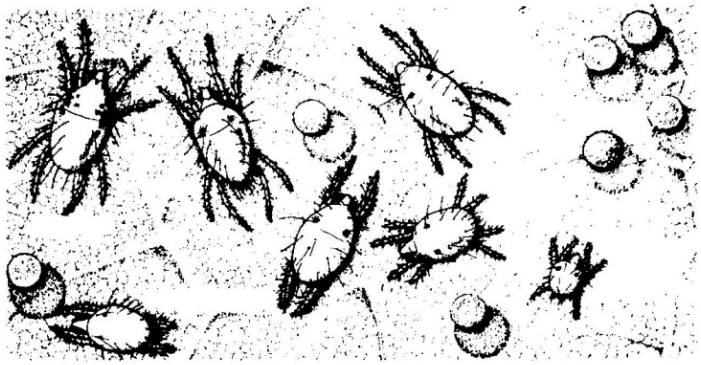




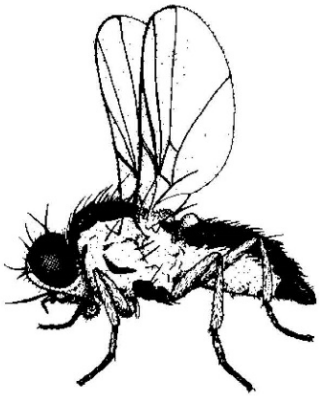
Fungus gnat, adult

Fungus gnat, larva

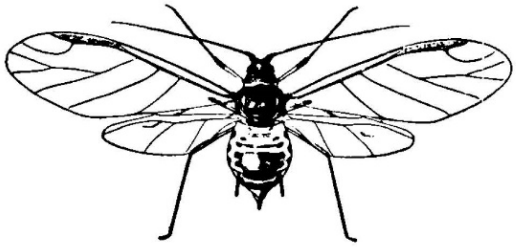
Drawings do not indicate the relative size of the pest; e.g., thrips are much smaller than aphids.



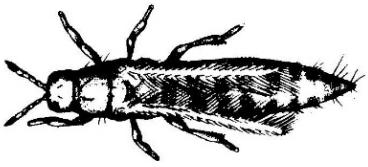
Spider mites



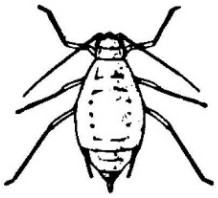
Leafminer, adult



Aphid, winged



Thrips, adult



Aphid

Drawings do not indicate the relative size of the pest; e.g., thrips are much smaller than aphids.

Exclusion

Preventing insect or mite pests from entering the greenhouse is easier than attempting to kill them after they have entered the greenhouse. Many greenhouse producers introduce insect and mite pests into greenhouses when they receive shipments of infested plant material from another source. Carefully inspecting new plants before placing them into a greenhouse can minimize problems with insect and mite pests. Exclusion can also be achieved by screening greenhouse openings, including side and ridge vents with specially designed screening material. Refer to the section entitled “Excluding Insect Pests Using Micro-Screening.”

Management

Once insect or mite pest populations are at or above an action threshold, the application of an insecticide or miticide may be warranted. Insecticides and miticides are expensive, so it is important to select the appropriate product and follow proper application procedures (refer to label). There has been an increase in the use of alternative pest control materials. These materials have relatively low mammalian toxicity and are generally less harmful to biological control agents or natural enemies than most conventional pest control materials. Biological control is the use of natural enemies such as predators, parasitoids and/or pathogens to manage insect or mite pests. Predators consume their prey (host) either partially or entirely while parasitoids lay their eggs inside or on their prey. The immature parasitoid then feeds on the internal contents of the prey. Eventually, the parasitoid matures and the adult either emerges near the dead host or exits from a chewed hole. Pathogens including beneficial fungi and entomopathogenic nematodes work similar to parasitoids since they also consume the inside of a target insect host. Biological control requires considerable management skill and education in order to be successful in commercial greenhouse production systems.

Scouting for Insect and Mite Pests in the Greenhouse

Scouting is a key component in developing a successful IPM program. It is not possible to make pest management decisions without routinely examining sticky cards or visually inspecting plants for the presence of insect and mite pests and determine their numbers. Detecting insect and mite pests when populations are low allows for flexibility in selecting pest management strategies such as removing infested plants or plant parts, using reduced risk insecticides or miticides, and making spot applications to infested plants containing high numbers of insect and mite pests. The following information provides guidance for developing an insect and mite pest scouting program. Line drawings of the key greenhouse insect and mite pests are presented in this publication.

What should be inspected while scouting for pests:

1) Sticky cards

2) Above-ground plant parts such as leaves, stems, and flowers

3) Roots

Sticky Cards

- Place sticky cards just above the plant canopy. Use sticky cards that are 3-by-5 inches.
- Thrips may be more attracted to blue cards; however, yellow sticky cards capture a variety of insect pests including winged aphids, whiteflies, leafminers, fungus gnats and shore flies.
- When scouting for fungus gnat adults, place sticky cards horizontally on pots or on the growing medium surface.
- It is not necessary to count all insects on a sticky card. Select a 1-inch vertical column (not horizontal) and be consistent each time sticky cards are monitored. In addition, one side of a sticky card may be used.
- Place one sticky card per 500 to 1,000 square feet of greenhouse space unless the situation requires the need for more, which will depend on crops grown and virus susceptibility.
- Scout sticky cards weekly, identifying all the insects on sticky cards with a 10X hand lens. Record insect numbers on a worksheet that allows you to monitor changes in populations of individual pest numbers and determine changes in insect and mite pest populations at each location through time.
- Replace sticky cards every week or if they become full of insects, which will make identification difficult.
- Insect pests that may be captured on sticky cards:
    - Whitefly adults
    - Leafminer adults
    - Thrips adults
    - Scale and mealybug adult males
    - Fungus gnat adults
    - Winged adult aphids
    - Shore fly adults
- Insect and mite pests not captured on sticky cards:
    - Non-winged aphids
    - Mites including twospotted spider mite, broad mite and cyclamen mite
    - Mealybug immatures and adult females
    - Scale immatures and adult females
    - Egg, larva/nymph and pupa stages of many greenhouse insect and mite pests

Above-ground Plant Parts and Roots

- Randomly examine plants over an area represented by a sticky card. Pay particular attention to specific plant varieties that are more susceptible to certain insect and mite pests.
- Examine leaf undersides, especially young leaves, for the life stages of whiteflies, mealybugs, aphids, spider mites, and scales.
- Examine the upperside of leaves for:
    - Leafminer tunnels
    - Distortion and discoloration resulting from feeding by thrips, aphids, whiteflies, spider
    - mites, scales, and mealybugs or egg-laying damage from leafminer females.
    - Honeydew a sticky, clear substance excreted by aphids, soft scales, whiteflies and mealybugs.
    - Sooty mold — a dark fungal growth that uses honeydew as a food source.
- Examine terminal growth for immature thrips and aphids.

- Examine open flowers for thrips larvae and adults.
- Examine the main plant stem for scales and mealybugs.
- Look at the base of stems, leaves and other protected crevices for mealybug life stages and immature thrips.
- Examine plant roots for the presence of fungus gnat larvae and root mealybugs.

Pest Thresholds

One principle of IPM is that insect and/or mite pest must be present in numbers that will cause unacceptable crop damage before action should be taken to control the designated insect or mite pest(s). Currently, there are no discreet action thresholds for greenhouse insect and mite pests. However, greenhouse producers usually establish a threshold number based on past experience. Information obtained from scouting records maintained in previous years may help to determine action thresholds for the next season. For example, a greenhouse producer may determine that five adult whiteflies per sticky card per week are acceptable. Therefore, whenever more than five adult whiteflies, on average, are detected on a sticky card for one week, a management strategy should be initiated.

Excluding Insect Pests Using Micro-Screening

Pests can be excluded from greenhouses by placing screens on greenhouse openings including side and ridge vents. The size of the screen mesh is determined by the pests to be excluded. For example, leafminers can be excluded with 0.025-inch mesh screen, whereas western flower thrips require a 0.0075 inch mesh screen.

The two major problems with screening are (1) increased resistance to air flow, which results in reduced cooling capacity in the greenhouse, and (2) protecting the screen from accidental damage by greenhouse equipment or employees.

Placing a screen over greenhouse vents will restrict air movement into the greenhouse, thus reducing the effectiveness of the fans at pulling air through the greenhouse. Properly designed screening is necessary to reduce the effect of the screen on greenhouse cooling. UT Extension faculty can assist you in designing a proper insect screening system. To do so, the following information is required:

Exhaust Fan Information:

Manufacturer

Model No.

Fan Diameter

Power (horsepower)

Number of Exhaust Fans

Greenhouse Floor Area (square feet)

Area of the Vent Opening (square feet)

Extension faculty may need to visit your facility to measure the pressure drop when the fans are turned on. This procedure takes only 30 minutes. With this information, we can determine the area of screen

necessary to avoid severe reduction in the greenhouse cooling capacity, and the possibility of burning out greenhouse fan motors.

Management of Insects and Mite Pests of Greenhouse Crops

Biological Control

Biological control is the use of living organisms to reduce the population levels of insect and mite pests. Biological control agents (natural enemies or beneficials) typically will not entirely eliminate the target insect or mite pest. Some beneficials are capable of surviving on alternate food sources such as pollen, nectar, or other insects and/or mite pests when populations of the target pests are too low to support continued reproduction of the given natural enemy.

A biological control program must be designed for each greenhouse operation based on trial and error. A major challenge is to integrate natural enemies into a pest management program that includes pest control material treatments, which may be harmful to natural enemies. Alternative insecticide and miticides and application techniques are available that are less likely to have detrimental effects on natural enemies. Biological control is more successful when implemented prior to insect and/or mite pest populations having reached damaging levels. As a result, greenhouse personnel must systematically scout for insect and mite pests on a regular basis in order to prevent insect and mite pest populations from reaching damaging levels. Identification and early detection of insect and/or mite pests is important to determine the type of natural enemy or enemies needed and when releases should be implemented in order to maximize effectiveness. Biological control is not a quick fix for control of existing insect and mite pest problems but can be an effective part of a pest management program in which the goal is to reduce reliance on insecticides and miticides.

Types of Commercially Available Biological Control Agents

The larvae and/or adults of predators including the ladybird beetle, green lacewing, and minute pirate bug have a particular prey preference and require certain environmental conditions such as temperature and relative humidity to be successful (see Table 1). Parasitic wasps or parasitoids are host-specific and in general they tend to attack only one type of insect pest or life stage. In addition, they may be stage-specific meaning that parasitoids will insert their eggs into the eggs or other life stages such as larvae or adults of certain insect pests. Immature parasitoids feed in or on the host, eventually killing it. Entomopathogenic nematodes are soil-dwelling, microscopic roundworms that enter insect hosts can emit a bacterium lethal to insect hosts; killing them within 48 hours.

The entomopathogenic nematodes enter an insect through natural openings such as the mouth, anus, or spiracles (breathing pores), and regurgitate bacteria which paralyze and kill the insect host. The entomopathogenic nematodes feed on the reproducing bacteria and continue to multiply in the insect carcass, eventually exiting to find a new host after the food source dissipates.

Table 1. Biological Control Agents of Insect and Mite Pests of Greenhouses

Pests	Predators	Comments	Parasitoids and Entomopathogenic Nematode	Comments
Aphids	Lacewings, *Chrysoperla* spp. and *Chrysopa* spp.	Release as eggs or larvae. Feed on several different insect and mite pests in the absence of aphids.	Parasitoid, *Aphidius colemani*	Effective against green peach and melon aphid.
	Aphid midge, *Aphidoletes aphidimyza*	Adults do not feed. Only the larvae are predacious. Inactive during short days unless light is provided.	Parasitoid, *Aphelinus abdomalis*	Effective against potato aphid.
	Ladybird beetle, *Hippodamia convergens*	Adults and larvae are predacious. Feed on different aphid species.	Parasitoid, *Aphidius ervi*	Effective against potato and foxglove aphid.
Fungus gnat larvae	Predatory mite, *Stratiolaelaps scimitus* (formerly *Hypoaspis miles*)	Soil predatory mite that resides in growing medium. Seven to 11 day life cycle. Can incorporate into growing media before filling containers. May be used in conjuction with *Bacillus thuringiensis* subsp. *israelensis*, and entomopathogenic nematodes.	Entomopathogenic nematode *Steinernema feltiae* (Scanmask, Entonem, Nemasys, and NemaShield)	Attacks fungus gnat larvae.
	Rove beetle, *Dalotia coriaria*	Both adult and larvae are predacious. Feed on fungus gnats larvae and western flower thrips pupae.		
Leafminer larvae			Parasitoids: *Dacnusa sibirica* and *Diglyphus isaea*	Parasitoid larvae complete development inside or outside leafminer larvae. Optimial temperatures for development vary between the two parasitoids.
Mealybugs	Mealybug destroyer, *Cryptolaemus montrouzieri*	Feeds on all mealybug life stages. Primarily effective when mealybug populations are high. Less effective when exposed to low light conditions.		

Pests	Predators	Comments	Parasitoids and Entomopathogenic Nematode	Comments
Mites	Predatory mite, *Phytoseiulus persimilis*	Requires temperature <80ºF and relative humidity between 60% to 80%. Only feeds on twospotted spider mite.		
	Predatory mite, *Mesoseiulus longipes* (formerly *Phytoseiulus longipes*)	Tolerates warmer temperatures and a lower relative humidity than *P. persimilis.* Used for regulation of twospotted spider mite populations.		
	Predatory mite, *Neoseiulus* (formerly *l s i s*) *californicus*	Survives longer without prey than *P. persimilis* . Used for regulation of twospotted spider mite, broad mite and cyclamen mite.		
	Predatory midge, *Feltiella acarisuga*	Feeds on twospotted spider mites. Only larvae are predaceous as adults do not feed.		
	Predatory mite, *Neoseiulus* (formerly *Amblyseius*) *fallacis*	Effective against twospotted spider mite		
	Galendromus (formerly *Metaseiulus*) *occidentalis*	Effective against twospotted spider mite, broad mite, cyclamen mite, and tomato russet mite		
	Amblyseius andersoni	Effective against twospotted spider mite, tomato russet mite, and broad mite		
Scales	Ladybird beetle, *Lindorus or Rhyzobius lophanthae*	The adult and larva attack hard (armored) and soft scales.	Parasitoid, *Aphytis melinus*	Only attacks certain hard (armored) scales.

Pests	Predators	Comments	Parasitoids and Entomopathogenic Nematode	Comments
			Parasitoid, *Metaphycus helvolus*	Only attacks certain soft scales such as brown soft scale. However, brown soft scale can encapsulate eggs.
Thrips	Predatory Mite, *Amblydromalus limonicus*	Effective against thrips larvae as well as whitefly eggs and larvae.		
	Predatory Mite, *Neoseiulus* (formerly *l s i s*) *cucumeris*	Only attacks first instar larvae. Can survive on pollen in the absence of prey.		
	Predatory Mite, *Stratiolaelaps scimitus* (formerly *Hypoaspis miles*)	May feed on western flower thrips pupae in growing media. Can be incorporated into growing media.		
	Insidious flower bug, *Orius insidiosus*	The adult and nymphal stages are predacious. Survives on pollen in the absence of prey. Also feed on aphids, spider mites, and whiteflies.		
	Predatory Mite, *Amblyseius swirskii*	Effective against western flower thrips and whiteflies.		
Whiteflies	Ladybird beetle, *Delphastus catalinae*	Both adult and larvae feed on eggs and nymphs. Requires 'high' whitefly populations for survival.	Parasitoid, *Encarsia formosa*	Primarly used against greenhouse whitefly. Prefers temperatures >72 F. Adults lay eggs in second instar nymphs and feed on third instar nymphs.

	Predators	Comments	Parasitoids and Entomopathogenic Nematode	Comments
			Parasitoid, *Eretmocerus eremicus*	Primarily used against sweet potato whitefly.
	Predatory Mite, *Amblydromalus limonicus*	Effective against whitefly eggs and larvae as well as thrips larvae.		
	Predatory Mite, *Amblyseius swirskii*	Effective against whiteflies and western flower thrips.		

Alternative Pest Control Materials

Alternative pest control materials, in this case insecticides and miticides, are those that, in general, have activity on specific target insect or mite pests while being less harmful to natural enemies. Proper timing of applications is important in order to control specific insect or mite pests.

Insect growth regulators

Insect growth regulators or IGRs are used to kill the young (immature) stages of plant feeding insects including mealybugs, scales, and whiteflies. Insect growth regulators regulate insect development and are typically placed into three general categories: juvenile hormone mimics or analogs; ecdysone antagonists; and chitin synthesis inhibitors. Juvenile hormone mimics or analogs inhibit development and cause insects to remain in an immature stage thus preventing insects from completing their life cycle. Ecdysone antagonists disrupt the molting process of insects by inhibiting metabolism of the molting hormone ecdysone. Chitin synthesis inhibitors interfere with enzymes during the molting process that stimulate the synthesis and formation of chitin, an essential component of an insect's exoskeleton. As a result, insects fail to reach adulthood because they die in an immature stage, or they mature into sterile adult females.

Microbials

These are insecticides containing microorganisms such as bacteria or fungi which cause diseases of insects. They are usually very specific for the targeted insect pest and are slow-acting typically requiring repeat applications. *Bacillus thuringiensis* (Bt) is an example of a toxin-producing bacteria used against the larval stage of moths (caterpillars) and fungus gnats. *Beauvaria bassiana* is a fungal pathogen or entomopathogenic fungus used against aphids, mites, thrips, and whiteflies. Spores (conidia) of the fungus germinate on the surface of the insect and hyphae penetrate the cuticle. Similar to parasitoids, the fungus consumes the internal contents of the host. In addition, the insect dies from a toxin produced by the fungus.

Neem products

These insecticides are based on extracts from the tropical and subtropical neem tree, *Azadirachta indica*. Azadirachtin, the most commonly used material is derived from the oil of neem tree seeds. It acts as an insect growth regulator, insect feeding deterrent, repellent, oviposition inhibitor, sterilant, and/or direct toxin. The other material derived is the clarified hydrophobic extract of neem oil, which suffocates and desiccates insect and mite pests. Neem oil has contact activity only so thorough coverage of all plant parts is important.

Horticultural oils

These are petroleum or plant-based materials that suffocate insect and mite pests by blocking the breathing pores (spiracles) and disrupting cell membranes. Horticultural oils have short residual activity.

Insecticidal soaps

These are derivatives of potassium salts of fatty acid chains that act by disrupting insect cell membranes. Insecticidal soaps have a short residual activity.

Selective feeding blockers

These materials inhibit the feeding behavior of insects by interfering with neural regulation of fluid intake through the mouthparts. Insects starve to death within 48 hours.

Conventional Pest Control Materials

Selecting a Pest Control Material

Once a perceived pest threshold has reached, then pest control material (insecticide or miticide) applications may be initiated. A pest control material choice is dictated by:

- Effectiveness on the existing insect or mite pest(s)
- Mode of action
- Application method
- Human toxicity
- Potential phytotoxicity
- Potential impact on non-target organisms including natural enemies
- Cost
- Restricted entry interval (REI)

Table 2 lists insecticides and miticides labeled for control of insect and mite pests in greenhouses.

Table 2. Pest Control Materials Labeled for Use in Greenhouses for Control of Insect and Mite Pests

PESTICIDE	APHIDS	LEAFMINERS	FUNGUS GNATS	WHITEFLIES	MITES	THRIPS	SCALE	CATERPILLARS	MEALYBUGS	CLASS	REI (hr)	IRAC*	COMMENTS
Adept (diflubenzuron)		X	X	X				X		IGR	12	15	Primarily active on immature stages with long residual activity. Can be applied as a spray or drench. For lepidoptera leafminers, not diptera leafminers.
Akari 5SC (fenpyroximate)					X					PP	12	21A	Primarily active on larval stages. Provides up to 21 days of residual activity. Does not have translaminar properties.
Altus (flupyradifurone)	X			X		X			X	BU	4 (12 for CA)	4D	Provides suppression of citrus leafminer and scale.
Ancora *(Isaria fumosorosea Apopka Strain 97, ATCC 20874)*	X	X		X	X	X			X	MI	4	Unclassified	Insect-killling fungus. Contact activity only so thorough coverage of all plant parts is important. Make applications in the evening.
Aria (flonicamid)	X			X					X	OR	12	29	Selective feeding blocker that prevents insects from feeding. Systemic insecticide with translaminar activity.
Attain (bifenthrin)	X		X	X	X		X	X		PY	12	3A	Thorough coverage is necessary to contact insect and mite pests. Treat late in day and vent before entry.
Avid (abamectin)	X	X		X	X	X				ML	12	6	Do not apply to ferns or Shasta daisy. Insecticide/miticide derived from soil microorganisms, with translaminar activity.
Azatin (azadirachtin)	X		X	X				X		BO	4	Unknown	Insect growth regulator so only active on immature stages of most insect pests. Has multiple modes of action. Slow acting. Repeat applications may be needed after 7 to 10 days.

PESTICIDE	APHIDS	LEAFMINERS	FUNGUS GNATS	WHITEFLIES	MITES	THRIPS	SCALE	CATERPILLARS	MEALYBUGS	CLASS	REI (hr)	IRAC*	COMMENTS
Azatrol (azadirachtin)	X		X	X		X	X	X	X	BO	4	Unknown	Insect growth regulator so only active on immature stages of most insect pests. Repeat applications may be needed after 7 to 10 days. May be tank-mixed with other insecticides.
BotaniGard ES, 22WP (*Beauveria bassiana*)	X			X		X				MI	4	Unclassified	Insect-killing fungus. Need to apply before insect populations reach outbreak levels. Requires relative humidity >65%. Do not use thermal pulse fogger for low volume applications. Thorough coverage of all plant parts is important. Make applications in the evening.
Citation (cyromazine)		X	X							IGR	4	17	Insect growth regulator so only active on immature stages. Labeled for use against diptera leafminer, and fungus gnat and shorefly larvae.
Conserve (spinosad)		X				X		X		MI + SP	4	5	Provides rapid knockdown of thrips populations. Rotate with other insecticides with different modes of action to avoid resistance. Also labeled for use against leafminers and caterpillars.
Decathlon (cyfluthrin)	X		X	X		X	X	X	X	PY	12	3A	Has contact activity only so thorough coverage of plant parts is important. May be directly harmful to natural enemies.
Dibrom 8 (naled)	X			X	X		X	X		OP	24	1B	Avoid making applications to wandering jew, poinsettia, Dutchmans Pipe, and chrysanthemums due to potential for plant injury (phytotoxicity).

PESTICIDE	APHIDS	LEAFMINERS	FUNGUS GNATS	WHITEFLIES	MITES	THRIPS	SCALE	CATERPILLARS	MEALYBUGS	CLASS	REI (hr)	IRAC*	COMMENTS
Dipel Pro DF (*Bacillus thuringiensis* subsp. *kurstaki*)								X		MI	4	11A	Target insect must ingest this material in order to be killed. Feeding stops immediately with death occurring in 2 to 3 days. Thorough coverage of all plant parts is important. Not directly harmful to most natural enemies.
Discus L (imidacloprid + cyfluthrin)	X	X	X	X		X	X	X	X	NN+PY	12	4A + 3A	Fungus gnat larvae in the growing medium/soil will be controlled by drench applications or growing medium. Thrips suppression on foliage only. Effective on soft scales with suppression only for hard (armored) scales. Target scale crawlers when making foliar applications. Caterpillar control when applied to foliage.
Distance IGR, Fulcrum (pyriproxyfen)			X	X			X			IGR	12	7C	Has translaminar activity. Do not apply to poinsettia after bract development. May be effective against western flower thrips pupae when applied as a drench to the growing medium/soil.
DuraGuard (chlorpyrifos)	X		X			X	X	X		OP	24	1B	Micro-encapsulated formulation. May be applied as a spray or drench to the growing medium/soil. Through coverage of all plant parts is important when applied to the foliage.
Duraplex (chlorpyrifos + cyfluthrin)	X		X	X		X		X		OP+PY	24	1B + 3A	Controls fungus gnat adults and is most effective against insect pests when plants are small.
Endeavor (pymetrozine)	X			X						PDZ	12	9B	Selective feeding blocker that prevents insects from feeding. Has both systemic and translaminar activity. Not directly harmful to most natural enemies.

PESTICIDE	APHIDS	LEAFMINERS	FUNGUS GNATS	WHITEFLIES	MITES	THRIPS	SCALE	CATERPILLARS	MEALYBUGS	CLASS	REI (hr)	IRAC*	COMMENTS
Enstar AQ (kinoprene)	X		X	X		X	X		X	IGR	4	7A	Insect growth regulator so most active on immature stages of certain insects. Slow acting so repeat applications will be needed.
Flagship 25 WG (thiamethoxam)	X	X		X			X		X	NN	12	4A	Systemic insecticide with translaminar properties. Has extended residual activity. Only effective on soft scales, not hard (armored) scales.
Floramite SC (bifenazate)					X					CARB	4	20D	Only active on spider mites. Contact activity only so thorough coverage of plant parts is important. Provides up to four weeks of residual activity. Minimal direct effect on most predatory mites.
Gnatrol (*Bacillus thuringiensis* subsp. *israelensis)*			X							MI	4	11A	Larvae must ingest material to be killed. Feeding stops immediately with death occurring in 3 to 5 days. Works best on the early larval instars. Not directly harmful to most natural enemies.
Hachi-Hachi SC (tolfenpyrad)	X			X		X	X			CBOX	12	21A	Contact activity only so thorough coverage of all plant parts is important. Does not have translaminar properties.
Hexygon (hexythiazox)					X					CBOX	12	10A	Provides up to 30 days of residual activity. Only kills the egg and larval stages with no effects on adult spider mites. Only one application is allowed per cropping cycle to avoid resistance issues.

PESTICIDE	APHIDS	LEAFMINERS	FUNGUS GNATS	WHITEFLIES	MITES	THRIPS	SCALE	CATERPILLARS	MEALYBUGS	CLASS	REI (hr)	IRAC*	COMMENTS
Insecticidal Soap (potassium salts of fatty acids)	X			X	X	X	X		X	SO	4	Unclassified	Contact activity only so thorough coverage of all plant parts is important. Avoid applying more than three times in succession or plant injury (phytotoxicity) may result. Has short residual activity so repeat applications will be needed.
Intrepid 2F (methoxyfenozide)								X		IGR	4	18	
Kontos (spirotetramat)	X			X	X	X			X	TA	24	23	Has systemic activity against mites when used preventatively.
Magus (fenazaquin)				X	X					QUIN	12	21A	Contact activity only so thorough coverage of all plant parts is important. Does not have translaminar properties.
Mainspring, Mainspring GNL (cyantraniliprole)				X		X	X	X		AD	4	28	Has systemic activity. For soft scale only. Aphids on Mainspring GNL label only, not Mainspring label.
Marathon (imidacloprid)	X	X	X	X		X	X		X	NN	12	4A	Systemic insecticide with translaminar properties. Has extended residual activity. Effective on soft scales but not hard (armored) scales.
Mavrik Aquaflow (fluvalinate)	X			X	X	X	X	X		PY	12	3A	Contact activity only so thorough coverage of all plant parts is important. May cause respiratory allergic response.
Mesurol (methiocarb)	X					X				CA	24	1A	Thorough coverage of plant parts is important. Can also be used for control of slugs and snails. May leave distinct residues on plant leaves.
Met52 EC (*ta i i a iso lia* strain F52)				X	X	X				MI	0 for soil incorporated mechanically, 4 for all other uses	Unclassified	Insect killing fungus. Thorough coverage of all plant parts is important

PESTICIDE	APHIDS	LEAFMINERS	FUNGUS GNATS	WHITEFLIES	MITES	THRIPS	SCALE	CATERPILLARS	MEALYBUGS	CLASS	REI (hr)	IRAC*	COMMENTS
Molt-X (azadirachtin)	X		X	X		X	X	X	X	BO	4	Unknown	Insect growth regulator so only active on immature stages of most insect pests. Slow acting. Make repeat applications after 7 to 10 days. Can be tank-mixed with other insecticides.
M-Pede (potassium salts of fatty acids)	X			X	X	X	X		X	SO	12	Unclassified	Contact activity only so thorough coverage of all plant parts is important. Has short residual activity so repeat applications will be needed. However, do not apply more than twice in succession to avoid foliar discoloration.
Nemasys, ScanMask, Entonem, NemaShield (*Steinernema feltiae*)			X							B	0	Unclassified	Only active on fungus gnat larvae. Apply before fungus gnat larval populations reach outbreak levels. Two to three applications may be needed.
NoFly WP (*sa ia fumosoroseus)*	X			X		X			X	MI	4	Unclassified	Insect killing fungus. Contact activity only so thorough coverage of all plant parts is important. Apply before pest populations reach outbreak levels.
Novato (Ovation/Applause) (clofentezine)					X					TET	12	10A	Only active on spider mite eggs and early mite life stages. Can only use once per cropping cycle. Most effective when applied at the first sign of mite activity and when females are laying eggs.
Ornazin (azadirachtin)	X		X	X				X		IGR	12	Unknown	Insect growth regulator so most active on immature stages. Slow acting so repeat applications will be needed. Requires a spray solution pH between 4 and 8.

PESTICIDE	APHIDS	LEAFMINERS	FUNGUS GNATS	WHITEFLIES	MITES	THRIPS	SCALE	CATERPILLARS	MEALYBUGS	CLASS	REI (hr)	IRAC*	COMMENTS
Orthene (acephate)	X	X		X		X	X	X	X	OP	12	1B	Has systemic and translaminar activity. May be harmful (phytotoxic) to certain plants, including chrysanthemum cultivars. Wait two weeks for symptoms to appear. Can be tank mixed with fenpropathrin (Tame) to enhance control of thrips.
Orthene 1300 (acephate)	X	X	X	X		X	X	X	X	OP	24	1B	Has translaminar activity. May be harmful (phytotoxic) to certain plants, including chrysanthemum cultivars. Wait two weeks for symptoms to appear. Treat as late in day as possible and vent before reentry.
Overture (pyridalyl)						X		X		Unclass-ified	12	Unknown	Has contact and translaminar activity. May take up to 10 days to effectively suppress thrips populations.
Pedestal (novaluron)		X		X		X		X		IGR	12	15	Insect growth regulator so only active on immature stages. May sterilize adult female whiteflies. Only provides uppression of leafminers.

PESTICIDE	APHIDS	LEAFMINERS	FUNGUS GNATS	WHITEFLIES	MITES	THRIPS	SCALE	CATERPILLARS	MEALYBUGS	CLASS	REI (hr)	IRAC*	COMMENTS
Perm-Up (permethrin)	X	X	X	X			X	X		PY	24	3A	Contact activity only so thorough coverage of all plant parts is important. May be harmful (phytotoxic) to *Salvia* spp. with marginal leaf burn and necrosis of open petals. Used primarily for control of leafminer adults.
Precision (fenoxycarb)	X	X	X				X			IGR + CA	12	7B	Insect growth regulator so only active on immature stages. Repeat applications will be needed. For caterpillar leafminers, not fly leafminers.
Preclude (fenoxycarb)	X			X		X	X			IGR + CA	12	7B	Insect growth regulator so only active on immature stages. Treat as late in day as possible and vent before reentry.
Pylon (chlorfenapyr)			X		X	X				PL	12	13	Has translaminar activity with extended residual activity. Avoid spraying plants in bloom. Also labeled for control of broad and cyclamen mite. Effective against western flower thrips adults and larvae as a foliar spray, and drench applications are effective against fungus gnat larvae in the growing medium.
Pyreth-It (pyrethrins plus PBO)	X		X	X			X	X		BO	12	3A + 27A	Contact activity only so thorough coverage of all plant parts is important. Has short residual activity.
Pyrethrum TR (pyrethrins plus PBO)	X		X	X	X		X			BO	12	3A + 27A	Contact activity only so thorough coverage of all plant parts is important. Has short residual activity. Not recommended for use on plants in bloom or poinsettia bracts displaying color. Make applications as late in day as possible and vent before reentry.
Rycar (pyrifluquinazon)	X			X		X			X	PDZ	12	9B	Has both contact and translaminar properties.
Safari (dinotefuran)	X	X	X	X		X	X		X	NN	12	4A	Systemic insecticide with translaminar properties. Has extended residual activity. Very water-soluble. Can be applied as a spray or drench. Labeled for use against leafminers, aphids, whiteflies, and thrips. However, only provides thrips suppression.

PESTICIDE	APHIDS	LEAFMINERS	FUNGUS GNATS	WHITEFLIES	MITES	THRIPS	SCALE	CATERPILLARS	MEALYBUGS	CLASS	REI (hr)	IRAC*	COMMENTS
Sanmite (pyridaben)				X	X					PD	12	21A	Contact activity only so thorough coverage of plant parts is important. Provides extended residual activity. Labeled for control of broad mite.
Savate (Judo) (spiromesifen)				X	X					TA	12	23	Has translaminar properties. Provides up to 28 days of residual activity. More effective on larvae and nymphs than adults. Not directly harmful to most predatory mites.

PESTICIDE	APHIDS	LEAFMINERS	FUNGUS GNATS	WHITEFLIES	MITES	THRIPS	SCALE	CATERPILLARS	MEALYBUGS	CLASS	REI (hr)	IRAC*	COMMENTS
Scimitar (lambda-cyhalothrin)	X	X		X		X		X		PY	24	3A	Contact activity only so thorough coverage of plant parts is important. Primarily used for control of leafminer adults. May be directly harmful to natural enemies.
Shuttle O (acequinocyl)					X					ND	12	20B	Contact activity only so thorough coverage of all plant parts is important. Do not use in successive with other miticides with similar modes of action. Does not have translaminar activity.
Sirocco (abamectin and bifenazate)	X			X	X	X				ML and CARB	12	6 + 20D	Contains two miticides with different modes of action. Has translaminar properties.
SuffOil-X (mineral oil)	X		X	X	X	X	X		X	OR	4	Unclassified	Contact activity only so thorough coverage of all plant parts is required. Active on most life stages of insect and mite pests. Do not spray when relative humidity is >80%.
Sultan (cyflumetofen)					X					BK	12	25A	Not effective against broad mite, bulb mite, cyclamen mite, flat mite or rust mite. Contact activity only so thorough coverage of plant parts is important.
Talstar (bifenthrin)	X	X	X	X	X	X	X	X	X	PY	12	3A	Contact activity only so thorough coverage of all plant parts is important. Also labeled for control of broad mite. Primarily used for control of leafminer adults.
Talus (buprofezin)				X			X		X	IGR	12	16	Insect growth regulator so only active on immature stages. May sterilize adult female whiteflies.

PESTICIDE	APHIDS	LEAFMINERS	FUNGUS GNATS	WHITEFLIES	MITES	THRIPS	SCALE	CATERPILLARS	MEALYBUGS	CLASS	REI (hr)	IRAC*	COMMENTS
Tame (fenpropathrin)	X			X	X		X	X	X	PY	24	3A	Contact activity only so thorough coverage of all plant parts is important. Can be mixed with acephate (Orthene) to enhance control of thrips.
TetraSan 5 WDG, Beethoven TR (etoxazole)					X					IGR	12	3A	Mite growth regulator with activity on eggs, larvae, and nymphs with no activity on adults. Has translaminar properties.
Triact 70 (clarified hydrophobic extract of neem oil)	X			X	X		X			BO	4	Unclassified	Contact activity only so through coverage of plant parts is important. Effective against eggs, larvae (nymphs), and adults. Apply early morning or late evening. Has short residual activity. Do not apply to certain plants in bloom including: impatiens, fuschia, hibiscus, ornamental olive trees, and some carnation varieties without prior testing. Cannot be used on roses. Only labeled for use on a limited number of plants.
TriStar 8.5SL (acetamiprid)	X	X		X		X	X		X	NN	12	4A	Systemic insecticide with translaminar properties. Has extended residual activity. Can only be applied as a foliar spray. Not labeled for drench applications.
Ultra-Pure Oil (mineral oil)	X		X	X	X	X	X		X	OR	4	Unclassified	Contact activity only so thorough coverage of all plant parts is important. Active on most life stages of insect and mite pests. Do not spray when the relative humidity is >80%.

Rate or dosage

Most insecticide or miticide labels contain a range of rates that may be used. The low rate is often considered the *preventative rate*, while the high rate is considered the *curative rate*. If the insect or mite pest population is excessive, then the curative rate should be used; however, if the insect or mite population is relatively low the preventative rate may be used.

Application frequency

Application frequency is a very important and often overlooked factor in determining the effectiveness of an insecticide or miticide. Many insecticides and miticides have short residual activity. As such these materials, in general, need to come into direct contact with insect or mite pests to be effective. Most insecticides and miticides are effective on certain life stages (e.g., larva, nymph, and adult). For example, *Bacillus thuringiensis* subsp. *israelensis* (sold as Gnatrol) only kills the larval stage of fungus gnats, whereas the eggs, pupae, and adults are not affected. A second application needs to be applied later as the eggs hatch into larvae. Meanwhile unaffected adults lay additional eggs, which mean another application is warranted in order to control the next generation of larvae. An application of an adulticide will kill fungus gnat adults, thus preventing egg-laying.

Phytotoxicity

Insecticides and miticides can cause plant injury if not used properly; according to label directions. It is important to consider the following prior to making an insecticide or miticide application:

1. Read the pest control material label to determine if there are precautionary statements indicating plant species that should not be treated.
2. Always test spray a small sample of the crop when applying an insecticide or miticide for the first time. Most symptoms will appear within 10 days following application.
3. Not all plant varieties respond the same. There are often specific varieties of a particular species that are more susceptible than others.
4. The higher the insecticide or miticide concentration used, the more potential for problems associated with phytotoxicity. Therefore, do not apply insecticides or miticides at concentrations higher than the recommended labeled rate.
5. Flowers and bracts are generally more sensitive than leaves; therefore, control insect and mite pests prior to plants flowering.
6. The spray solution should be agitated frequently; otherwise, the solution at the bottom of the tank may be at a higher concentration resulting in phytotoxicity.
7. Maintain records of observed phytotoxic symptoms for all plants.
8. Tank mixing two pest control materials may increase the possibility of phytotoxicity.
9. Do not use the same sprayer for herbicides, and insecticides or miticides. Always have a separate sprayer for each general type of pest control material.
10. Avoid making frequent applications of insecticidal soaps and horticultural oils as this may increase the risk of phytotoxicity.

Pest Control Materials Labeled for Use in Greenhouses for Control of Insect and Mite Pests

Abbreviations used in Table 2

CLASS: BO = botanical; CA = carbamate; CARB = carbazate; CBOX = carboxamide;

CH = chlorinated hydrocarbon; IGR = insect growth regulator; ND = napthoquinone derivative;

MI = microbial; ML = macrocyclic lactone; OP = organophosphate; OR = other; OT = organic tin compound; NN = neonicotinoid; PD = pyridazinone; PL = pyrrole; PP = phenyl pyrazole; PDZ = pyridine azomethine; PY = pyrethroid; SO = soap; SP = spinosyn; TA = tetronic acid; TET = tetrazine.

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Interiorscapes

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Interiorscapes or interior plantscapes refer to the use of plants indoors to make a pleasing interior landscape. There are special safety concerns when using any pesticide indoors. First, the pesticide label should state that the product can be used in interiorscapes, interior plantscapes or other similar language. There might also be special precautions that need to be followed to safely use a pesticide in an interiorscape. Systemic insecticides are used extensively in interiorscapes since they can be applied directly to the soil or planting media so that the product can be taken up by the roots. This is one of the safest ways to apply insecticides in an interiorscape. The insecticide or miticide, once inside the plant, primarily targets pests that are feeding on the plant. Other insecticides or miticides need to be sprayed on the infested plant parts. Whenever spraying is done, care should be taken to reduce drift to nearby floors, walls, ceilings, furniture or other indoor items. It is often advisable to use sheets or cardboard as a spray shield to reduce drift or place tarps over areas where you do not want pesticides drift to settle. Pesticide applications are best applied after hours when no one other than those applying the pesticide are present. Special care should be taken to fully read the pesticide label and to follow all directions, especially concerning the use of personal protective equipment and other safety issues.

Pest	Insecticide and Formulation
APHIDS	insecticidal soap (Safer Insecticidal Soap, M-Pede) horticultural oil (various brand names) S-kinoprene (Enstar AQ) imidacloprid (Merit 75WP, Marathon II) beta-cyfluthrin (Tempo Ultra WSP) cyfluthrin (Decathlon 20 WP) fluvalinate (Mavrik Aquaflow 22.3F) permethrin (Perm-Up 3.2EC) pymetrozine (Endeavor 50WDG) *Beauveria bassiana* (BotaniGard ES) thiamethoxam (Meridian 25 WG) abamectin plus bifenazate (Sirocco SC) for suppression only spirotetramat (Kontos 2 SC) pyriproxyfen (Distance Insect Growth Regulator, Fulcrum) - suppression cyantraniliprole (Mainspring GNL)
BROAD MITE	bifenthrin (Onyx Pro 23.4F) abamectin plus bifenazate (Sirocco SC) fenproximate (Akari 5SC) spirotetramat (Kontos 2 SC)

Pest	Insecticide and Formulation
CYCLAMEN MITE	fenproximate (Akari 5SC) abamectin plus bifenazate (Sirocco SC) spirotetramat (Kontos 2 SC)
FUNGUS GNATS ***For larval control, apply to soil medium**	**Bacillus thuringiensis* subsp. *israelensis* (Gnatrol) **Steinernema feltiae* – Entoneem, NemaSheild, Steinernema-System, Nemasys, entomopathogenic nematodes pyrethrins plus piperonyl butoxide (1600 X-clude A) *acetamiprid (TriStar 8.5 SL) *S-kinoprene (Enstar AQ) permethrin (Perm-Up 3.2EC, Permethrin Pro, Astro) beta-cyfluthrin (Tempo Ultra WSP) cyfluthrin (Decathlon 20 WP) *cyromazine (Citation 75WP) *clothianidin (Arena 0.25 G) *pyriproxyfen (Distance Insect Growth Regulator, Fulcrum) *dinotefuran (Safari 20 SG, Safari G) * azadirachtin (Azatin O, Azatin XL, Ornazin EC, Molt-X, Azatrol EC)
LEAFMINERS	cyromazine (Citation 75WP) permethrin (Astro 36.8EC) clothianidin (Arena 0.25 G) dinotefuran (Safari 20SG, Safari G) – for fly or midge leafminers pyriproxyfen (Distance Insect Growth Regulator, Fulcrum) – for lepidopterous leafminers cyantraniliprole (Mainspring GNL)
MEALYBUGS	insecticidal soap (Safer Insecticidal Soap, M-Pede) horticultural oil (various brand names) S-kinoprene (Enstar AQ) azadirachtin (Safer Bioneem, Azatin XL, Molt-X, Azatrol EC) imidacloprid (Merit 75WP, Marathon II) beta-cyfluthrin (Tempo Ultra WSP) cyfluthrin (Decathlon 20 WP) permethrin (Perm-Up 3.2EC) pyrethrins plus PBO (1600 X-clude A) clothianidin (Arena 0.25 G) thiamethoxam (Meridian 25 WG) spirotetramat (Kontos 2 SC) dinotefuran (Safari 20SG, Safari G) pyriproxyfen (Distance Insect Growth Regulator, Fulcrum) - suppression

Pest	Insecticide and Formulation
SCALE INSECTS	S-kinoprene (Enstar AQ) horticultural oil (various brand names) insecticidal soap (Safer Insecticidal Soap, M-Pede) beta-cyfluthrin (Tempo Ultra WSP) crawler stages cyfluthrin (Decathlon 20 WP) (crawler stages) pyrethrins plus PBO (1600 X-clude A) imidacloprid (Merit 75WP, Marathon II) pyriproxyfen (Distance Insect Growth Regulator, Fulcrum) clothianidin (Arena 0.25 G) for soft scales thiamethoxam (Meridian 25 WG) effective on soft scale dinotefuran (Safari 20SG, Safari G) cyantraniliprole (Mainspring GNL, Mainspring) for soft scales
SHORE FLIES Since they are algae feeders, find the source and control the algae.	pyrethrins plus, PBO (1600 X-clude A) cyromazine (Citation 75WP) fenoxycarb (Precision 25WP) pyriproxyfen (Distance Insect Growth Regulator, Fulcrum)
SPIDER MITES	*Beauveria bassiana* (BotaniGard ES) Insecticidal soap (Safer Insecticidal Soap, M-Pede) horticultural oil (various brand names) bifenazate (Floramite SC) fenproximate (Akari 5SC) etoxazole (TetraSan 5WDG) Not for residential use. abamectin plus bifenazate (Sirocco SC) acequinocyl (Shuttle 15 SC) fenazaquin (Magus) spirotetramat (Kontos) neem oil / Triact 70 cyflumetofen (Sultan miticide)
THRIPS	S-kinoprene (Enstar AQ) beta-cyfluthrin (Tempo Ultra WSP) cyfluthrin (Decathlon 20 WP) pyrethrins plus PBO (1600 X-clude A) azadirachtin (Safer Bioneem, Azatin XL, Azatin O, Molt-X, Azatrol EC) fluvalinate (Mavrik Aquaflow 22.3F) *Beauveria bassiana* (BotaniGard ES) abamectin plus bifenazate (Sirocco SC) for suppression only cyantraniliprole (Mainspring GNL, Mainspring) clothianidin (Arena 0.25 G)

Pest	Insecticide and Formulation
WHITEFLIES	S-kinoprene (Enstar AQ) horticultural oil (various brand names) insecticidal soap (Safer Insecticidal Soap, M-Pede) azadirachtin (Safer Bioneem, Azatin XL, Azatin O, Molt-X, Azatrol EC) permethrin (Perm-Up 3.2EC) cyfluthrin (Decathlon 20 WP) beta-cyfluthrin (Tempo Ultra WSP) fluvalinate (Mavrik Aquaflow 22.3F) pyrethrins plus PBO (1600 X-clude Formula 2A) imidacloprid (Merit 75WP, Marathon II) pymetrozine (Endeavor 50WDG) pryiproxyfen (Distance 0.86EC) *Beauveria bassiana* (BotaniGard ES) clothianidin (Arena 0.25 G) thiamethoxam (Meridian 25 WG) abamectin plus bifenazate (Sirocco SC) for suppression only spirotetramat (Kontos 2 SC) dinotefuran (Safari 20SG, Safari G) fenazaquin (Magus 18.79 SC) pyriproxyfen (Distance Insect Growth Regulator, Fulcrum) cyantraniliprole (Mainspring GNL, Mainspring)
CATERPILLARS	permethrin (Perm-Up 3.2EC) azadirachtin (Azatin XL, Azatin O, Molt-X, Azatrol EC) beta-cyfluthrin (Tempo Ultra WSP) cyfluthrin (Decathlon 20 WP) fluvalinate (Mavrik Aquaflow 22.3F) bifenthrin (Onyx Pro 23.4F) chlorantramiliprole (Acelepryn 1.67 SC) cyantraniliprole (Mainspring GNL, Mainspring)

Precautionary Statement

In order to protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store, or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label. Persons who do not obey the law will be subject to penalties.

Disclaimer Statement

Pesticides recommended in this publication were registered for the prescribed uses when printed. Pesticides registrations are continuously reviewed. Should registration of a recommended pesticide be canceled, it would no longer be recommended by the University of Tennessee. Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others which may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product.

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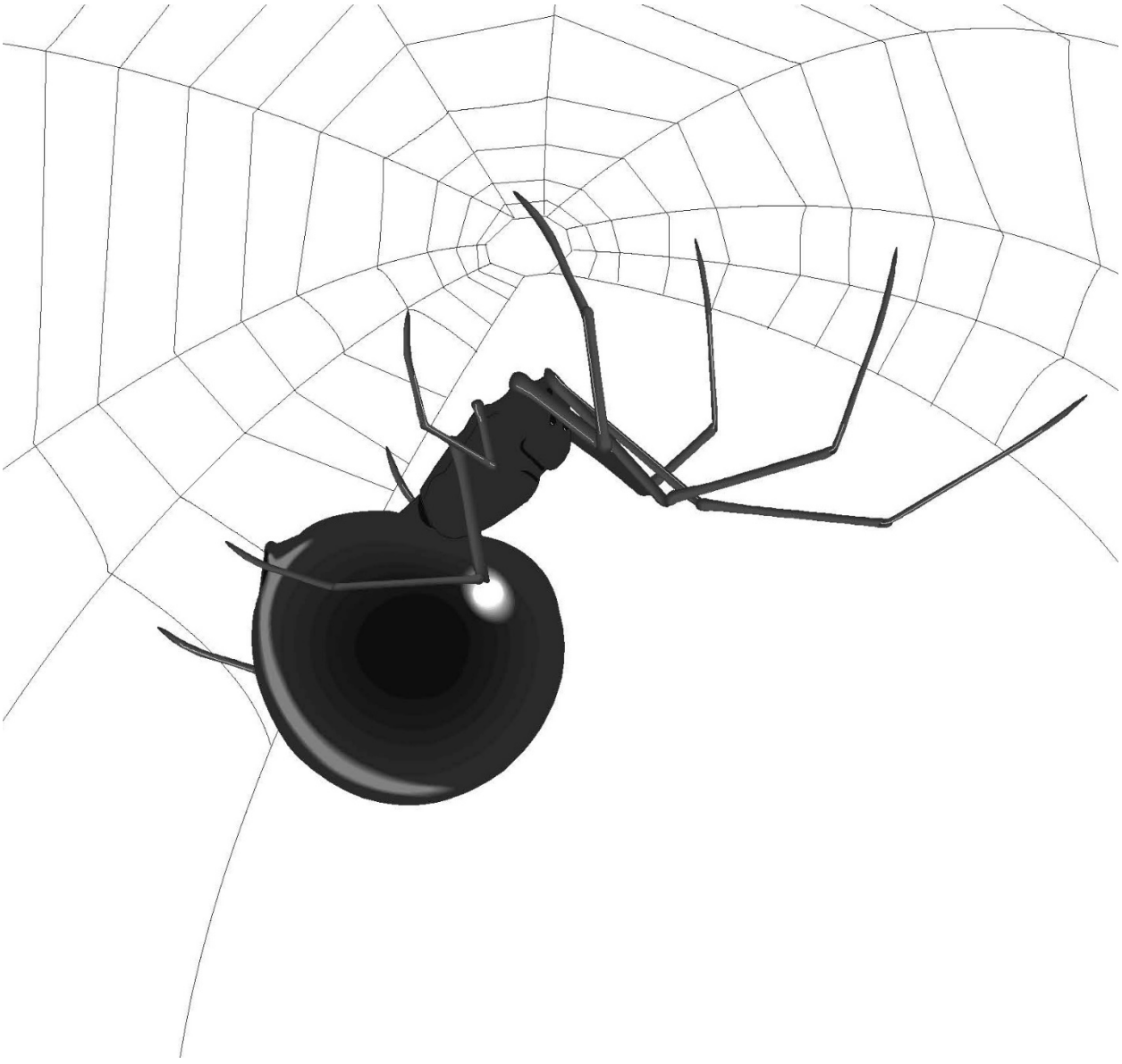
Managing Pests Around the Home
2018



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Managing Pests Around the Home

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What are household pests?
Most household pests are insects and are commonly called "bugs." Other organisms such as spiders, scorpions, centipedes, millipedes, ticks, sowbugs, pillbugs, mites, rats, mice, snakes, bats, squirrels, birds, molds and fungi may also enter homes. In Tennessee, one or more of 40 common pests are found in every home at one time or another. Even the most conscientious person cannot always avoid an occasional pest infestation.

Where are these pests found?
Under optimal conditions, large populations of an insect, rodent or other pest can occur in your yard, home, farm or neighborhood. Large numbers of a pest species can develop in trees, stumps, flower beds, mulch, leaf litter, garbage, wood piles, ditch banks, animal carcasses, stored products, spilled materials, sewer lines and other sites. Pests enter homes through openings in the walls, floors, around pipes or cracks, and under doors or windows. Pests seeking shelter build nests or hibernate within the walls, attic or in living quarters.

What attracts them to your home?
Pests are attracted by light, warm air, moisture and food. Odors from a dead bird, rodent, dead insects or nest in a wall, soured mop or spilled materials can also be attractive. They seek protection and shelter in dark cavities in walls or crawl spaces.

What can I do to prevent pest problems in my home?
Luckily, many pests are easily controlled. This publication will explain how to manage the most common household pests found in Tennessee. We have placed special importance on controlling pests by limiting their access to food, water and shelter. Control devices such as vacuums and traps are emphasized. Pesticides are used in a manner to reduce exposure to you, your property and the environment. Always read the entire pesticide label for directions on mixing, applying, safety precautions, storing and disposing of the product before using it. If you are unsure about how to control a household pest after reading this publication, ask your county Extension agent for additional assistance.

When should I contact a professional pest control company?
Some pests, such as termites, require the use of special equipment and knowledge to apply large volumes of insecticides to all possible entry points into the structure. Professionals have the proper equipment and the training, including safety training, to apply the large volumes of pesticides needed to rid your home of termites. Termites can also be managed with baits, but professional training in understanding the biology of the termite is essential to obtain control.

Quite often, professional pest control technicians have access to more effective active ingredients and formulations than the homeowner. The professional is trained in the life cycle, habits and preferences of the pest, as well as the safest and best techniques to control them. In Tennessee, pest control technicians are required to pass a test before they can apply pesticides in your home. Technicians should carry a commercial pesticide applicator certification card verifying they are approved by the Tennessee Department of

Agriculture. They need to attend training sessions to obtain points to keep the card valid. If they do not get enough points within three years, they have to take another test. Also, they must work for a licensed operator if they are charging you a fee. The charter number of their employer's business must appear on their vehicle.

When should you ask for professional help?

Of course that is a decision you as a homeowner must make for yourself. You may want to use a professional:

1) When treating for termites because special equipment and training are needed,
2) When treating for other wood-destroying insects and organisms (especially if you are concerned about reselling the home),
3) If the pest is found in difficult-to-reach locations and requires treatment with special equipment,
4) If you are concerned about pesticide exposure during mixing and applying,
5) If there is not enough time to do it yourself, or
6) If several attempts have failed to control the pest. Professionals need your help to manage pests too. Please perform all the sanitation and exclusion practices they recommend.

Managing Pests and Reducing the Risk of Pesticide Exposure

1. Inspecting and Monitoring

Household pests can be managed with a minimal amount of pesticides by using an integrated pest management (IPM) approach. In an IPM program, regularly scheduled (monthly, quarterly, etc.) inspections are encouraged instead of regularly scheduled pesticide applications. If pests are not present, in most cases, pesticide applications may not be necessary. A flashlight and screwdriver are usually sufficient to inspect a structure. Look for insect pests, signs of insect activity, possible food and water sources, as well as pest nesting or resting sites. Inspect for conditions favorable to insects and rodents: warm temperatures (75-85 F), condensation, moist wood, humid atmosphere, cracks or crevices where insects can hide, plumbing leaks, spilled materials and food left overnight in pet feeding dishes. Pest feces and webbing are often found in infested areas. Inspect for signs of rodent activity: rodent hair, fecal pellets, tracks, rub marks, and signs of gnawing and digging. Rodent urine will fluoresce under a blacklight. Monitoring devices such as glue boards and pheromone traps can be useful to detect insects that may have been previously overlooked. Glue boards are very effective in detecting the presence of cockroaches. These should be placed near edges of walls or cabinets near possible shelter, food or water. Glue boards can also be used for detection and control of rodents. Pheromone traps are available for most pantry or stored products insects.

Managing Pests and Reducing the Risk of Pesticide Exposure

1. Scheduled monitoring and inspecting — not scheduled sprays.
2. Identification of pest and damage.
3. Removing pests' access to food, water and shelter through sanitation and exclusion.
4. Use controls such as traps and vacuums. Reduce pesticide exposure to people and pets by using baits, insect growth regulators, dusts in voids and sprays in cracks and crevices.

2. Identification

After the pest is caught, it must be identified. If you cannot identify the specimen yourself, take it to your local county Extension agent. After the pest has been identified, you can determine where it lives, what it prefers to feed on, if it can cause structural damage or is a health threat, or just a nuisance. If it is determined that control is necessary, several approaches may be used, including sanitation and exclusion practices, vacuuming, trapping and the judicious use of pesticides.

3. Modifying the Environment

All pests need access to food, water, shelter and a suitable environment. By removing their access to these necessities, you can prevent or decrease pest populations dramatically. This can be achieved through sanitation and exclusion practices, as well as other modifications of the environment.

Remove Access to Food

Keep a building clean. Sweep or mop to remove spilled food and beverages. Clean soiled wool fabrics, furs and feathers before storing. Storage of items can also affect their vulnerability to pest attack. Date food packages being placed in storage. Use older food items first. Remove broken packages and sweep up spills as soon as possible. In storage areas, allow 18 inches of clearance between stacks (or the wall) and elevate items off the floor to permit inspection for pests, feces, broken packages, etc.

Sanitation is a key factor in controlling pests.

Figure 1. Pet food can be a food source for many pests. Train pets to eat food within 10 minutes of placement and then remove the food bowl.

Proper garbage disposal is also important to reduce pest populations. Use garbage cans with tight-fitting lids. Dispose of contents often, at least twice a week, to prevent fly larvae from crawling out of the can. Daily disposal of garbage would reduce the food available to many pests. Clean garbage containers to remove any remaining food materials. Although it is more convenient to place the dumpster or garbage can just outside the kitchen door, dumpsters and garbage cans should be placed away from the structure. For a commercial account, we suggest dumpsters be placed at least 50 feet, and preferably 100 feet, from the structure. In a home, garbage cans should be placed as far away as is practical. If placed too far from the home, residents may let garbage bags accumulate inside rather than walk the long distance to the outdoor receptacle.

Water and Moisture

Most pests can survive a long time without food, but most need to drink water within a few days or they will die (some exceptions include stored products insects and wood-boring insects). Access to water can be limited by fixing leaking plumbing or dripping faucets, sealing pipe penetrations or ventilating wet areas.

Drainage

Foundation drains should move water away from foundations. Drains should be perforated, plastic pipe embedded in coarse gravel at the footing level around the outside perimeter. Drains should empty into a solid pipe to carry water away from the structure.

Crawl Space Ventilation

Dry wood (10-12 percent moisture) is less susceptible to fungus infection, termites, powderpost beetle and carpenter ant infestation. When floor joists, subflooring and insulation are wet with condensate, a fan can be installed in a crawl space access opening as a temporary relief measure. Ventilation openings in foundation walls, beneath buildings with crawl spaces, should be large enough and equally distributed to prevent dead air pockets from forming. Such pockets can give rise to humid conditions conducive to termite activity, powderpost beetles, carpenter ants and wood decay. Openings placed within 3 to10 feet of corners of buildings usually give the best cross ventilation. Depending on the building code, suggestions for the number of vents in a crawl space are 1 square foot of vent space per 300-1,500 square feet of crawl space if a polyethylene vapor barrier is used. Vents are approximately 60 square inches, so approximately 2.5 vents equals 1 square foot of vent space. Cover 80 percent of the

soil surface in the crawl space area with a 4-6 mil polyethylene (plastic) layer. One way to do this is to cover all of the center of the crawl space area, leaving a 1-foot wide strip of bare soil around the foundation. (A 100 percent crawl space cover could dry hardwood flooring too much and lead to warping.) Moisture rising from the soil around the perimeter will be exhausted through the foundation vents. The plastic cover will prevent moisture rising from the soil from being absorbed by the floor joists, insulation and subfloor. The cross ventilation will lower the moisture content in the wood. If a plastic barrier is not used, it is suggested that 1 square feet of vent space be placed for every 150 square feet of crawl space. Because the plastic moisture barrier is inexpensive, it is more economical to use the plastic barrier than to install more vents for a crawl space without a plastic barrier.

Newer building codes allow for an unvented or enclosed crawl space to control moisture. In this instance, the crawl space is not exposed to the humid outdoor air. The earth is covered with a continuous vapor barrier that overlaps by 6 inches and is taped or otherwise sealed. Vapor barrier edges extend up the stem wall at least 6 inches and should be attached and sealed to the wall. Air is either mechanically vented out of or conditioned air supplied to the area under the floor, and an air pathway to the common area (duct or transfer grille) provided. The perimeter walls are insulated but a 6-inch insulation-free zone is recommended at the top of the foundation wall to allow for termite inspections. Various systems add other components such as dehumidifiers or concrete slabs. Research data indicate a drop in moisture and dewpoint in the crawl spaces using this system in the southern U.S. One concern of the pest control industry is the reduction in visible termite entry routes. These systems have been in place for years now and if issues with termite inspections are to become a reality, they should be evident soon.

Attic Ventilation

Ventilation of attic spaces and roof areas is important in minimizing water vapor or condensation to build up. Even with good ventilation, there is still a need for vapor barriers in ceiling areas. This is especially true of a flat or low slope roof where only a 1- to 3-inch space above the insulation might be available for ventilation. In houses with attic spaces, the use of both inlet and outlet ventilation is recommended. Place inlet ventilators in soffit or frieze board areas of the cornice. Outlet ventilators should be placed as near as possible or on the ridgeline. This placement of ventilators will assure air movement through a stack effect. A combination of attic ventilators may be installed in the gables, soffits, roof or roof ridge line to maintain a flow of air through an attic. Manufacturers' markings or literature tell the number of square inches of attic vents needed per square foot of attic space. It is important to place corrosion-resistant wire mesh with openings not more than ¼ inch in any direction behind all vents to aid in excluding pests.

Exclusion

Exclusion is another way to prevent pest populations with minimal pesticide use. Insect, rodent, bird and reptile pests may walk, crawl or fly into your home. Pests are also carried in bags, boxes or on clothing, so examine these items before bringing them into the structure. To prevent occasional invaders (lady beetles, boxelder bugs, centipedes, crickets, millipedes, sowbugs, pillbugs, mites, rats, mice, snakes, bats, squirrels and birds) from entering homes, use exclusion practices. Walk around the perimeter of your structure to determine possible pest entry points. Exclude pests with tight-fitting doors, windows and sealed walls. This may involve adding door sweeps, adding weather stripping to sliding glass doors and windows, caulking openings in window frames, repairing holes in screens, adding screens, etc. If you are unsure whether a door fits tightly, observe the door from outside when it is dark and an interior light is on. If light is seen around the edges of the door, then you don't have a good seal. Mice can enter openings about 1/4 inch, while rats need a 1/2-inch hole. Seal cracks, crevices and holes in the foundation. Screen vent openings in foundation walls and attic.

Figures 2a and 2b. Gaps around doors should be sealed.

Caulk or seal holes in outside walls, eaves and other external surfaces. Many pests use wires, pipes, tree limbs and other guidelines to help them move from one area to another. Voids around pipes can be sealed with steel wool or copper gauze (which won't rust) and expandable foam. Rodents will not chew the steel wool or mesh. If rats are entering the structure through the commode, install a "Rat Guard®" (J.T. Eaton) on sewer lines.

Landscaping Practices

Landscaping practices also influence pest populations. Trim branches away from buildings to prevent carpenter ants, roof rats and squirrels from gaining access. One landscaping practice that can dramatically reduce millipede, cricket, sowbug, pillbug and clover mite populations is a 12-to 18-inch bare zone around the base of the structure. The bare zone reduces moisture around the structure which many of these pests are seeking.

Termites need cellulose materials to feed on. Mulches placed over the termiticide-treated soil next to the foundation can give termites access to the structure without contacting the termiticide. This is another reason to keep a 12-to 18-inch bare zone next to the foundation. Landscape timbers will often provide food for termites or shelter for carpenter ants. Other landscaping materials for borders, such as concrete or vinyl, are available that will not degrade as quickly as wood and will not provide food for termites and shelter for other critters.

Figure 3. Holes in the foundation and around plumbing, conduit and wires should be sealed to prevent pest entry.

Construction and maintenance practices also affect a building's susceptibility to termites. In the final grading, allow at least 6 inches of clearance between the top of the soil and the top of the foundation. Foam board insulation and stucco that extend below grade are especially troublesome. When stucco separates from the foundation wall, termites can tube between the wall and stucco and enter the home undetected. If foam insulation is present below grade also, the termites chew through the insulation.

Moisture attracts termites to the home. The finished grade outside the building should slope away from the foundation so water will not collect under the house. Repair plumbing leaks and leaks

in roofs and around windows as quickly as possible. Clean leaves and debris from gutters. Downspouts should empty into drain pipes to conduct water away from structure.

Figure 4. Leave a 12-18-inch bare zone (i.e., pull back the mulch next to the foundation to prevent providing a bridge to subterranean termites over the termiticide-treated zone).

Remove debris (firewood, boards and other clutter) from the base of buildings to discourage rodents from nesting; this in turn could reduce snake and tick problems. Firewood can also harbor large cockroaches, carpenter ants, wood-boring beetles, termites and others. Reducing insect populations around or under structures should decrease their predators such as centipedes and scorpions.

Figure 5. Repair plumbing leaks as quickly as possible. Moisture attracts termites to the structure.

Lighting

Many insects are active at night and are attracted to lights. Sodium vapor lights are much less attractive to insects. Use yellow bug lights or sodium vapor lights near doorways, driveways and sidewalks. Use mercury vapor or incandescent lights around the perimeter of the property to lure insects away from buildings.

Exclusion practices are also important indoors. Caulk or seal the edges of wall outlets, fuse boxes, light switches, cabinet edges along walls, any gaps between cabinets, voids below cabinets, the linoleum/bathtub interface and plumbing penetrations to prevent pests from moving along guidelines (wires, pipes, edges of walls) from one area to another. Cockroaches prefer to feel a surface above and below them (space about 3/8 inches high or smaller), so areas where floor tile is loose, wallpaper or other surface is peeling, or Formica is loose on counterparts, all need to be resealed to reduce cockroach harborage.

4. Household Pest Control Measures to Supplement Prevention Measures

Sanitation and exclusion measures can be thought of as prevention. Even though diligent efforts have been applied to reducing pests' access to food, water and shelter, some pests may still occur.

Vacuuming

There are alternative control measures to pesticides. A vacuum can be used to remove occasional invaders. If a pesticide was sprayed, the dead pests would still need to be removed. A wet/dry vac with a soapy water solution may be more useful when pests are very abundant.

Vacuuming can also be used for initial control (cleanout) of cockroach infestations and is especially useful in sensitive environments such as schools and health care facilities. A HEPA or other filter that screens allergens should be used on the vacuum to prevent the allergens from becoming airborne. Vacuuming can also supplement other pest control efforts. Vacuuming areas frequented by pests prior to flea pesticide treatments can remove 60 percent of the flea eggs

and about 27 percent of the larvae. It also removes organic matter and fecal blood the larvae need to feed on to mature. Stimulus provided by the vacuum causes the adult to emerge from the cocoon, and, if not vacuumed, the adult which was protected in the cocoon will now be exposed to insecticide applications. It is important to dispose of the vacuum cleaner bag immediately after use in an outside garbage can with a tight-fitting lid to prevent reinfestation. Clean out bagless vacuums as instructed by the manufacturer.

Figure 6. Use a knee-high stocking over the end of the vacuum tube to catch bed bugs (and other pests) and prevent them from infesting the vacuum.

Traps

Many different types of traps are available to control vertebrate pests ranging from snap traps to multiple catch traps to other live traps (see Extension publication PB 1624). Mice and rats typically use the edges of the wall as guidelines. The trigger of the snap traps should be placed near the wall. Mouse traps should be placed 10-12 feet apart. Glue boards can also be used to trap and control rodent populations. Fly light traps with sticky boards placed 3-4 feet above corners or along walls where they will not compete with natural lighting are excellent monitoring tools and may also provide control.

Pesticides

Pesticides are often needed to supplement the above procedures. To reduce the risk of exposure from pesticides use baits, insect growth regulators, dusts in voids, and spray formulations in crack and crevices. Spot treatments should be used on a discretionary basis. The use of "foggers" or space sprays should be discouraged.

Baits are available in tamper-resistant bait stations, gels, pastes and granular formulations. These are very effective in reducing risk of exposure to pesticides for several reasons:

1) They are premixed or packaged, reducing the threat of exposure during mixing;
2) They are usually formulated at low concentrations;
3) Typically they contain slow-acting toxicants with caution signal words;
4) They are placed in cracks and crevices or other protected areas to increase exposure to the pest and to limit exposure to children, pets and other nontarget organisms; and
5) The toxicant is placed in a carrier that attracts the pest and often the pest transfers this bait to other members of a colony.

Why Isn't More Better?

Over-applying pesticides can:

- Damage the plants in the lawn, garden or the treatment site.
- Increase the possibility of exposure.
- Waste money.
- Hurt the environment.

Insect growth regulators (IGRs) are chemicals that either mimic the hormones that occur in insects or prevent the formation of chitin used in the insect's exoskeleton (outer shell). Examples of IGRs are hydroprene, methoprene and pyriproxyfen. Many products containing pyriproxyfen or methoprene have become available to consumers for flea control.

Dusts can be injected into walls and other closed spaces. It is important to apply only a light dusting. Too many puffs can result in a thick layer which could be repellent. Boric acid, silica aerogel and diatomaceous earth are examples of inorganic dusts. Other dusts include pyrethroids. It is important to wear proper safety equipment

when applying dusts. Always follow the label instructions for safety.

Microencapsulated or wettable powder formulations can be used in cracks and crevices. Crack-and-crevice applications can be performed by using a sprayer or aerosol with a plastic tip that fits on the end of the nozzle.

Exposure can be further minimized if the crack and crevice is sealed after the pesticide application. Many of the wettable powders and microencapsulated and newer formulations are available to professionals. Insecticides for homeowners' use are often available in other ready-to-use formulations such as aerosols and pumps.

Selecting the Best Formulation for a Site

Select pest control products that have detailed label directions and **always follow label directions**. Select recommended pesticide formulations and equipment to apply pesticide to the infested area. Select products and methods that are most closely tailored for the particular type of environment. For example, for long residual activity in a dry situation, use a dust or bait; for residual treatments on a porous surface, spray a microencapsulated or wettable powder. Use emulsifiable concentrates where appearance is important. Emulsifiable concentrates tend to penetrate porous surfaces and therefore do not leave much pesticide at the surface. Spot test a small area before applying a pesticide to determine any adverse effects. For a surface application of a residual insecticide where appearance is not too important, use a wettable powder or microencapsulated spray. Wettable powders may leave a white residue on surfaces. Keep solutions and mists away from open flames or sparks. Around electrical installation, use a dust or bait station. On or around plants, use a wettable powder or dust. Few wettable powders are available to consumers.

Ultrasonic Pest Control Devices

Ultrasonic sound waves have been tested extensively for pest control in the laboratory and field; most research results indicate these devices are not effective.

Safety Precautions

Pesticides are poisons, but they are safe to use when properly handled and applied.

Protect yourself when applying and mixing pesticides.

- Wear a hat, long-sleeved shirt, long pants or coveralls, unlined neoprene or rubber gloves (leather or cloth [including linings] absorb pesticides), socks and boots, especially in wet grass, because of increased chance the pesticide will contaminate footwear.
- Read label carefully to determine steps for mixing, applying and storing pesticides and to determine if other protective equipment such as goggles, rubber apron or a respirator is needed.
- Take extra precautions when mixing because the pesticide is more concentrated.
- Mix outdoors in good lighting and fresh air.
- Wash off at once any pesticide spilled on skin.
- Do not touch surfaces that have been sprayed with insecticides until they are dry.
- The pesticide label will recommend time to re-enter the treated site.
- To determine if carpets are dry before entering, place a paper towel on the carpet. With shoes on, step on the paper towel. If a wet spot appears, carpet is not dry. Repeat procedure a few hours later.
- Keep emergency response numbers, such as the National Poison Control Centers (800-222-1222) and medical emergency (911), nearby.
- Use protective gear when cleaning equipment.
- Store all pesticides in a safe place out of reach of children or irresponsible persons.

The following pages list recommended procedures and, if necessary, pesticides to use to control specific pests. Remember to reduce the pest's access to food, water and shelter. This may provide control by itself. If pesticides are needed, they are more likely to provide control if access to these necessities are limited. Pesticides to be used by professionals are printed in bold in this publication. They are not suggested for homeowner use, but are to act as a guide when receiving professional services. More information on pests can be found in the UT Extension publications (SPs, PBs, Ws) listed in the tables by visiting extension.tennessee.edu/Pages/default.aspx and entering the publication number in the search box.

Click on insect name for recommended procedures.

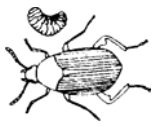
Ants
Fire Ants
Carpenter Ants
Bats
Bean Weevils
Book Lice
Bed Bugs
Boxelder Bugs
Carpenter Bees
Carpet Beetles
Centipedes
Chiggers
Clothes Moths
Clover Mites
Cockroaches
Crickets
Earwigs
Fleas
Flies
Fungus Gnats
Head Lice
Kudzu Bug
Mice
Millipedes
Mites, Bird or Rodent
Moles
Mosquitoes
Pantry Pests
Powderpost beetles
Rats
Silverfish and Firebrats
Skunks
Snails and Slugs
Snakes
Sowbugs or Pillbugs
Spiders or Scorpions
Springtails
Termites
Ticks
Wasps, Hornets, Yellowjackets

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
ANTS PB 1629 W 473  Argentine ant  Acrobat ant  Odorous house ant  Pavement ant  Pharaoh ant	Ants have elbowed antennae, a thread-like waist with one or two bumps. Unmated reproductives have wings, the front wings are larger than the hind wings. Workers ants are wingless. Ants are social insects. Colonies are usually established by a queen. Workers feed the queen, care for the brood and defend the nest. Workers travel along well-marked trails between the nest and food source.	Do not spray near baits!! Baits should contain slow-acting ingredients such as abamectin, hydramethylnon, dinotefuran, fipronil, indoxacarb, disodium octaborate tetrahydrate, boric acids, and borax so they are distributed well throughout the colony. Indoors: Baits: Most ants feed on sweets, but odorous house ants and Argentine ants don't feed on oils very often, so try Terro Ant Killer II (odorous, Argentine), Combat Ant Killing Gel (Argentine ants), Hot Shot Ultra Liquid Ant Bait (odorous, Argentine), as well as other sweet and protein baits for these ants. Myrmicine ants, such as Pharaoh ants, big-headed ants, little black ants and pavement ants feed on sweet liquid and gel baits listed above and other baits such as Hot Shot Maxattrax Ant Bait2, Raid Ant Baits, and Combat Ant Killing Bait Indoor and Outdoor Use bait stations. Outdoors: Baits: Spectracide Ant Shield Outdoor Killing Stakes Hot Shot Maxattrax Ant Bait2 Barrier Sprays: bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU beta-cyfluthrin RTU 0.05% gamma-cyhalothrin RTU 0.025%	Professionals have access to more baits and sprays than homeowners and professionals are trained to use them. Call a pest management professional if an ant problem persists. Follow good sanitary and exclusion practices. Exploit the worker caste by using baits. Find foragers and place bait near the foraging trails. Workers then bring the bait back to the nest where it is distributed among all members of the colony. You must kill queen(s) (and all the immatures for Pharaoh ants) to eliminate a colony. Spraying for ants indoors often worsens the problem by causing the colony to split into many smaller colonies. Do NOT spray for Pharaoh ants. If ants are foraging indoors from an outdoor nest, bait outdoors, exclude ants by sealing entry points such as window sills and door steps, and/or spray entry points (barrier spray) into the structure.

ANTS-FIRE

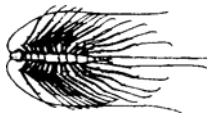
SP 419, PB 1739, PB 1158, PB 1788

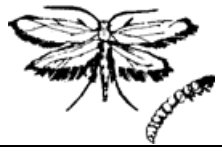
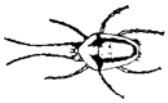
Fire ant infestations on home lawns are often managed with a two-step approach: 1. Broadcast a fire ant bait over the entire lawn or area to be managed first. IGR baits are distributed especially well because they don't affect the worker. 2. 7-10 days later, apply granules, a drench, dust, or fast-acting bait (hydramethylnon, indoxacarb, abamectin, or spinosad), to the individual mounds that are likely to be encountered by people. A more thorough discussion of IFA management options are provided in the publications listed above. A list of products labeled for fire ants are updated regularly and can be found at "Imported Fire Ants In Tennessee" (fireants.utk.edu) under "Resources" and "Updates." For a list of "homeowner" products by price and application type (broadcast vs. individual mound treatment) see aces.edu/pubs/docs/A/ANR-0175-A/ANR-0175-A.pdf.

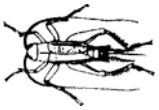
ANTS - CARPENTER PB 1599 	Large, black, red or red-and-black ants that usually nest in damp wood. Wingless workers 1/4 to 3/8 inch long. Winged male and female reproductives swarm from a colony. Carpenter ant workers (wingless ants in the colony) do not eat wood, but excavate smooth galleries in the wood to raise their young. Piles of coarse sawdust or splintered wood indicate a carpenter ant nest nearby. Dead insects falling from a wooden porch may indicate a carpenter ant nest above. Most often carpenter ants are located outdoors and foragers are entering the home in search of water or food. Trim branches away from structure. Seal possible entry points such as doors, windows and areas where pipes and wires enter the structure. If ants are nesting outdoors and foraging indoors, potential entry points can be sprayed.	Dusts: boric acid dusts deltamethrin 0.05% D Sprays: beta-cyfluthrin RTU 0.05% bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU Baits: Apply indoors or outdoors, according to label, where ants are seen. Terro Ant Killer II Combat® Source Kill Max A2 Raid® Ant Gel	**Because carpenter ants can cause structural damage, infestations are best treated by a professional**. Professionals have the knowledge, other pesticides and special equipment needed to successfully treat carpenter ant infestations. Correct moisture problems, repair leaks and ventilate. Find and treat nests in wood parts. Drilling into the wood may be necessary. Dust nests in wall voids. Do not apply sprays near electricity such as electrical outlets or fuse boxes. Some success has been found using ant baits for carpenter ant control, but it is not always a successful technique at this time. Professionals can place baits where ants are actively foraging. Do not spray ants or trails with fast-acting sprays (pyrethoids or insecticides ending in "thrin") if baiting because it will prevent the bait from being brought back to the nest.
BATS PB 1624 	Night-flying creatures invade attics and similar areas.	Treat area with insecticides to control external parasites, including bed bugs, bat bugs, fleas, mites and lice after bats excluded. See flea, bed bug and mites section.	Close entrance holes with wire screening to exclude bats after they have left the resting area. Seal opening with expandable foam.
BEAN WEEVILS 	Small, gray beetles and white worms cut round holes in dried beans and peas. May attack in field or in storage.		Non-chemical control: Either destroy the infested products or salvage them by super heating to 140 degrees F for 1/2 hour, or super cooling in a deep freeze at 0 degree F for at least 4 days. Store insect-free beans in containers with tight lids.

BED BUGS PB 1763 SP 761 	Flat, oval, reddish, wingless insects. Bloodsucking. Night feeders.	Foggers are ineffective. Use a duster to lightly apply silicon dioxide (diatomaceous earth) to cracks and crevices of bed frame and bedroom. **Dust should not be present in piles**. Garden Safe Crawling Insect Killer Harris Diatomaceous Earth Bed Bug Powder Hot Shot Bedbug Killer Dust with Diatomaceous Earth	**Very difficult to control. Use an experienced pest management professional**. If professional treatment is cost prohibitive, residents can help lower bed bug populations by using diatomaceous earth and nonchemical controls. Most of the insecticides available to residents are pyrethroids and there is widespread bed bug resistance to these chemicals. Practice prevention. Launder bedding and clothing (bed bugs must experience 122 F; dry clothing should reach these temps in a dryer in ~ 20 minutes). Bag clothing in sealed plastic bags after drying. Cover mattresses and boxsprings with bed bug proof encasements (Protecta-Bed, Mattress Safe, etc.). Vacuum all cracks and crevices (use knee-hi on end of tube prior to attachment placement to catch bugs, tie off knee-hi and discard in outdoors trash). Use bed bug monitors ClimbUp Insect Interceptors, BlackOut Bedbug Detectors, etc.) under bed legs and other places. Difficult-to-treat items (appliances, lamps, etc.) can be treated with Nuvan Prostrips (nuvanstrips.com) in bags but may not kill all bed bugs in protected locations. Infested items that can't be heated or otherwise treated, can be removed after wrapping in plastic. Reduce clutter and seal cracks and crevices to reduce hiding places for the bugs.
BOOK LICE 	Small, soft-bodied, cream-colored to grayish or light brown, wingless, fast moving. Feed on molds, fungi. Found in books, cereals, wallpaper, boxes. May damage products which contain starch.	Bengal Insecticide Concentrate	Large numbers of book lice develop under excessive humid conditions, moldy books, papers, bags or cereals. Dry out infested areas. Destroy infested material of little value.

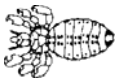
BOXELDERBUGS SP 341-H 	Flat, 1/2-inch long, 1/3-inch wide, dark brownish-black, with 3 lengthwise redstripes behind the head. Wings leathery at base. Membranous at tip with red veins; abdomen is red. Nymphs are smaller, wingless and bright red.	bifenthrin 0.05% & zeta-cypermethrin 0.0125% RTU beta-cyfluthrin RTU 0.05% gamma-cyhalothrin RTU 0.025%	These insects may be found on buildings in the spring and fall. Large numbers collect on siding, around doors, sunny walls and attics. Use exclusion practices before pests become apparent. Inside, vacuum into a dry vac. Avoid use of spacesprays if bugs found in wall voids. Dead bugs in wall voids could serve as carpet beetle food. Eliminate female (seedpod-bearing) boxelder trees. Outside: vacuum the bugs into water mixed with 1 teaspoon of a liquid detergent per gallon of water in wet/dry vacuum cleaner tank. Treat listed sites on label when bugs are first seen. Professionals have access to insecticides with longer residuals.
BROWN MARMORATED STINK BUG (BMSB) extension.tennessee.edu/publications/Pages/default.aspx	An invasive pest that feeds on many crops and ornamental plants during the growing season and then continues its pest status as it invades homes to overwinter. BMSB adults are shield shape, about 5/8 inches long, just about as long as wide, mottled brownish-grey with black antennae marked with a whitish band on the next to last segment, dark bands on the membranous part of the wings, and coppery or bluish metallic punctures (small, round depressions) on the head and pronotum). Abdominal segments protruding from the wings are marked with black-and-white bands. See eddmaps.org/bmsb/distribution.cfm?map=distribution for the latest brown marmorated stink bug distribution.	If exclusion methods aren't working completely, they may be supplemented with outdoor treatments. If perimeter treatments are applied, it is best to spray these in the fall before the bugs start aggregating on structures. Insecticides will have limited persistence outdoors in the sunlight and rain and may have limited effectiveness against preventing the brown marmorated stink bug from entering structures. Pyrethroid Perimeter Treatments Bayer Advanced Home Pest Control Indoor & Outdoor Insect Killer RTU Enforcer BugMax Home Pest Control Spectracide Bug Stop Home Barrier Indoor Plus Outdoor Insect Control	Pest-proof by late summer using techniques described in PB 1303. If supplemental pesticide applications are deemed necessary, make exterior spot, crack and crevice and/or void applications where these pests may harbor or hibernate, such as cracks and crevices, in weep holes, wall voids, around window and door frames, attic vents and behind siding, in late summer/early fall before the pests arrive. Pyrethroid labels are more restrictive so read label carefully. Indoor light traps may help reduce populations inside and are most effective late winter/early spring when the bugs are leaving the structure. Vacuum bugs found inside into knee-hi stocking placed on the end of the vacuum tube prior to attachment placement. After vacuuming, remove knee-hi, tie off, place in a sealed bag and in outside garbage can. If BMSB found on walls in large numbers, they can be removed by removing the top of a capless plastic soda bottle at the widest part of the neck, inverting it and placing back on the bottle to create a funnel trap. When the edge of the modified bottle is moved up the wall towards a BMSB aggregation, the bugs will drop into the trap. Soda bottles can be sealed in a plastic bag and placed in the freezer for a few days. Frozen or drown bugs can be disposed of outdoors in a garbage can or compost pile. Flushing BMSB down the toilet will waste water and is not recommended.

CARPENTERBEES 	1/2- to 4/5-inch long with a blue-black, green or purple metallic sheen. Color and size resemble a bumble bee, but the top of the abdomen is hairless. These bees chew a circular, 3/8-inch entrance hole into wood and nestinggallery 4-6 inches long at a right angle to the entrance hole. Galleries used for several years may extend 10 feet.	Apply Dusts into the gallery openings: Apicide (carbaryl 5%) deltamethrin 0.05% D Sprays: Bee/Wasp Killer Aerosols beta-cyfluthrin RTU 0.05% Ortho Home Defense Max Termite and Destructive Bug Killer Concentrate (bifenthrin) Foam: Spectracide Termite Killing Foam 2	Nonchemical or preventive controls include painting or varnishing wood surfaces. Use a straight wire to break up cells in tunnels. Individual bees can be killed with a badminton racquet. In the spring, puff insecticidal dusts into nest holes in the evening when the carpenter bees are at rest. Allow bees access to the nest for at least 24 hours. Seal the hole with 3/8-inch diameter dowel or cork and wood glue to prevent reinfestation. Carpenter bees overwinter in previously used galleries, so the structure should also be inspected in the fall. Repaint sealed area to possibly prevent woodpecker damage.
CARPET BEETLES SP 341-I **Black Carpet Beetle**  **Common; or Furniture; or Varied Carpet Beetles**	Adult 1/8 inch to 1/4 inch in length; black; brown legs. Larva 3/8 inch in length; carrot-shaped; covered with short hair and has long terminal bristles. Adults 1/8 inch long with white and orange; or yellow, white and black; or white, brown and yellow spots; larva with long black to brown hairs.	Apply spot treatments of insecticides to infested or suspect areas, but not to clothing. See precautionary statements about pesticides staining carpets. beta-cyfluthrin RTU 0.05%, bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU gamma-cyhalothrin RTU 0.025%	Carpet beetles infest carpeting, clothing, fur, upholstered furniture, books, bird nests, milk powders, articles of animal products, feathers, wool, silk and other materials of animal origin. Locate food source and remove, if possible. Use good housekeeping such as cleaning floor and carpets regularly. Dry clean clothes regularly. Stored materials subject to damage should be thoroughly cleaned and stored in tight container with moth crystals. Caution: moth crystals may stain clothing. Treat cracks, crevices and hidden area of walls, closets or stored materials, under carpets, etc.
CENTIPEDES 	Many long, slim legs, long antennae and fast-moving.	Indoors: beta-cyfluthrin RTU 0.05%, gamma-cyhalothrin RTU 0.025% Outside: beta-cyfluthrin RTU 0.05% bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU gamma-cyhalothrin RTU 0.025%	Feed on insects. Can bite. Usually not numerous. Active at night. Nonchemical control: leave a 12-18-inch bare zone next to foundation base. Move wood piles and other clutter away from structure. Spot-treat cracks and crevices, door thresholds and moldings where pest may crawl or as directed by label. Residuals may not provide total control. Treatments may need to come into direct contact with pest.

CHIGGERS	Very tiny mites that get on people and cause blotches and itching. Don't invade homes, but get in yards and wooded areas.	If needed, treat yard with a labeled insecticide every 4-6 weeks, or according to label. cyfluthrin Ready-to-spray 0.75% beta-cyfluthrin 0.05% G	Mow lawn regularly. Remove weeds and brambles from fence rows. Using commercial repellents around ankles and waist may provide personal protection. Apply deet repellent to skin and Permanone 0.5% spray to shoes, cuffs and socks 2 hours before.
CLOTHES MOTHS SP 341-J 	Brownish moths, wingspread 1/2" long. Larvae are 1/16-1/3" long. Gray silken cases or webbing over surface of fabric.	Brush and clean susceptible items periodically. Sweep or vacuum to remove dust or lint to prevent pests. Also vacuum prior to treatment. Dry clean and moth proof clothing with moth crystals in tight sealing container. Do not spray clothes. Any ready-to-use or concentrated liquid spray labeled for this pest. beta-cyfluthrin 0.05%	Adults are not attracted to light and will fly to a dark corner when disturbed. Usually found on infested materials, wool, fur, feathers, hair, upholstered furniture, nonsynthetic carpets, dust and lint. Apply sprays to cracks and crevices in closets and spot-treat other infested areas. See precautions on moth crystals about staining clothing.
CLOVER MITES 	Tiny (1/30 inch) mites, brown to olive green with pair of long front legs.	Household sprays control by contact in home: bifenthrin 0.05% & & Zeta-cypermethrin 0.0125% RTU gamma-cyhalothrin RTU 0.025% Outdoors use: bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU gamma-cyhalothrin RTU 0.025% (perimeter treatment)	Invade homes from the yard in great numbers in fall and leave in spring. Stain walls or fabrics reddish-brown when crushed. Keep grass and shrubs from direct contact with house. Good weed control in turf and a vegetation-free border of 12-18 inches around home will help. Apply sprays to points of entry such as foundations, windows and doors.
COCKROACHES PB 1024 German Cockroach Brown Banded or Furniture Cockroach Oriental Cockroach American Cockroach 	About 5/8" in length, pale brown or tan with 2 parallel dark streaks on pronotum. Usually most abundant in the kitchen and bathrooms. Most common home-infesting cockroach. 1/2" to 5/8" in length, dark brown with 2 pale bands traversing wings. Widely distributed throughout the house in walls, closets, furnishings and appliances, but abundant in kitchens. 1 1/4" in length, dark reddish-brown to black; wings do not surpass end of abdomen. Usually found in lower floors, outdoors or in crawl space. Frequents water meters, floor drains or moist, dark areas. 1 1/2" in length, reddish-brown with pale yellow band around pronotum. May be found throughout house, outdoors, in crawl spaces, sewers, water meters and garbage cans.	Baits in cracks and crevices: Combat Source Kill Max R3, Hot Shot Ultra Clear Roach & Ant Gel Bait Baits for small roaches: Combat Max 12 month Roach Killing Bait for Small Roaches (bait stations), Combat Roach Killing Bait Strips, Raid Double Control Small Roach Baits with Egg Stopper, HotShot Ultra Liquid Roach Bait, Bayer Advanced Home Pest Roach Killer Gel, others. Do not spray or dust near baits because cockroaches could be repelled. Lightly dust voids with insecticidal dusts containing boric acids. Sprays: beta-cyfluthrin RTU 0.05% bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU gamma-cyhalothrin RTU 0.025% Bengal Gold Roach Spray	Prevent access to food, water and shelter. Practice good sanitation in food handling, storage and eating areas. Control moisture, prevent leaks or condensation. Seal off harborage sites such as cracks and crevices with caulk, etc. Also use exclusion practices to prevent cockroach movement. Use glue boards or sticky traps placed along edges in dark places to locate and monitor cockroach populations. Baiting is the preferred method for cockroach control. Apply baits to cracks, crevices, pipes opening into walls, joints of furniture and cabinets, pipe conduits, and elsewhere as indicated by glue board catches. If you choose to spray, use precautions to keep chemicals out of food, spices and off dishes or eating utensils. Do not apply sprays where electrical shorts may occur; use baits or dusts in these areas. Do not use sprays when baiting because cockroaches will be repelled from the baits. Read label carefully; some products may not be labeled for food handling areas.

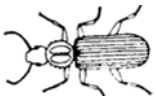
CRICKETS 	Black or beige jumping insects with long antennae. Cave or camel crickets are humped and brown.	Sprays beta-cyfluthrin RTU 0.05% gamma-cyhalothrin RTU 0.025%	May damage clothing. Repeat treatment as needed. Spray entry points into structure. Camel crickets infest damp basements, under slabs and crawl spaces. Ventilate or dry these areas. Active at night. Apply sprays into cracks and crevices where crickets dwell. Use exclusion practices. Glue boards can be used indoors around entry points and other places in basements, etc.
EARWIGS	Easily identified by pair of "pinchers" at end of abdomen.	Indoors: bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU gamma-cyhalothrin RTU 0.025% Outdoors: bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU gamma-cyhalothrin RTU 0.025%	Earwigs are incidental invaders into houses. They usually dwell in leaf litter, mulch and woodpiles and are common "hitchhikers" on vegetables harvested from the garden. Moving compost piles away from the house will aid pest control. Insecticidal control is usually unnecessary for this insect. If needed, spray possible entry points and mulched area around the house.
FLEAS PB 1596 	Small, 1/16" long, reddish-brown, wingless insect. Body compressed laterally (from the sides), legs long and adapted for jumping. Adult fleas prefer to feed on dogs, cats, opossums, foxes and sometimes rats and other urban animals. When pets are not available, humans are attacked. Larvae are worm-like and feed on blood and organic matter in house or yard.	On pet: **CATS, KITTENS, & PUPPIES ARE MORE SENSITIVE TO INSECTICIDES!!!!!!** **Consult a veterinarian and always read the label prior to treating a pet. Beware of imitation products.** Veterinarian supplied products - usually kill fleas within 12-36 hours or sooner and provides 90-95% control for about 30 days: see flea control pesticide recommendation at caes.uga.edu/content/dam/caes-website/departments/entomology/documents/ga-pest-management-handbook/2018-pmh/2017-homeowner/2018%20Animals.pdf for a thorough listing of veterinarian supplied on-pet products. Spot-treat infested areas and pet resting areas inside Insect Growth Regulators [and adulticides]: pyriproxyfen [and pyrethroid] Bengal Full Season Flea Killer Plus 2 Enforcer Flea Spray for Home Enforcer Flea Spray For Carpets & Furniture XX methoprene [and pyrethroid] Raid Flea Killer Plus Carpet and Room Spray Adulticides: pyrethrins bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU gamma-cyhalothrin RTU 0.025% Outdoor Premise Treatment (when specified on label): pyriproxyfen (Archer and others) gamma-cyhalothrin RTU 0.025%	**Step 1.** With veterinarian supplied products that are currently available, control of fleas in small- to moderate-sized infestations is likely to occur by using those pet treatment products alone. May take 2 months to completely break flea life cycle. If pet treatment alone does not provide sufficient control, initiate a complete control program by April. **Step 2.** Vacuum infested areas twice a week and prior to treatment to remove eggs, larvae, adults and organic matter. Dispose of the vacuum cleaner bag immediately after use in an outside garbage can with a tight-fitting lid to prevent reinfestation. Clean out bagless vacuums as instructed by the manufacturer. Steam-cleaning carpet may also reduce populations. Eliminate fleas from pets, bedding and premises before departing on vacation. **Step 3.** Treat pet resting areas indoors and clean or remove pet bedding on the same day. Insect growth regulators important to break flea life cycle. A combination of an insect growth regulator and an adulticide may be the most efficient formulation to use. **Step 4.** Mow grass, keep weeds down and trim shrubs to expose flea eggs and larvae to lethal dessication. Irrigating areas surrounding buildings, but not against building, may kill fleas by drowning. If fleas are surviving outdoors, apply insecticide to labeled areas. **Keep pets and people out of treated area (indoors and outdoors) until surface sprays dry**.

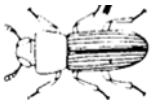
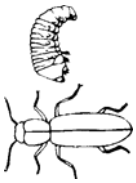
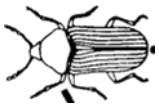
FLIES Face flies, small cluster flies and blue bottle flies	Adult flies of these three species hibernate in attics and wall voids. Cluster flies about 1/3-inch long, dark gray, with checkered black and silver abdomen, with gold hairs on thorax of newly emerged adults. Face fly similar in appearance to the house fly. Adult blue bottle flies have a dull gray thorax and a shiny blue abdomen.	Exclude flies in the fall by sealing entry points, screening behind all vents, sealing holes in walls and attics prior to pest entry in fall. Vacuum or use pyrethrin sprays to kill exposed flies. Use black light trap with sticky surface.	Cluster fly larvae are parasites of earthworms. Face fly larvae develop in cow patties. Adults hibernate in attics and wall voids. Blue bottle fly larvae develop in garbage, decaying meat, dead animals, fish and excrement.
House Flies	About 1/4" in length, dull gray color with 4 longitudinal dark stripes on the thorax.	**Remove larval food sources.** <u>For temporary relief of adult flies in homes</u> Victor Fly Catcher Sticky Tape Various light traps OrthoHome Defense Fly Bait Decal for Windows Use pyrethrin aerosol for temporary relief inside home. Apply residual sprays on outside locations where flies rest. beta-cyfluthrin RTU 0.05% gamma-cyhalothrin RTU 0.025%	Larvae develop in warm organic matter of animal or vegetable origin. Remove trash at least twice a week to reduce fly populations in homes. Screen windows and doors. Garbage cans should have tight-fitting lids. Use insect light traps indoors. Sanitation is very important.
Bottle Flies Green Bottle Fly Blue Bottle Fly Bronze Bottle Fly Black Bottle Fly	1/2" in length; green metallic color 1/2" in length; blue metallic color 1/2" in length; bronze metallic color 1/3" in length; shiny grey thorax and dull blue metallic abdomen.	**Remove larval food sources.** See house fly	Bottle flies indoors often indicate a dead mouse or other animal in wall voids, attic, basement, etc. Dispose of dead animal carcasses, animal excrement, etc. Garbage cans should have tight-fitting lids.
Fruit Fly or Vinegar Fly	1/8 inch long, red eyes, tan head and thorax, abdomen gray-black.	**Remove larval food source**. Traps may aid control. Pyrethrin aerosols for adults.	Egg to adult in 8-11 days. Larvae in decaying fruit, vegetables and garbage cans. Adults around larvae.
Moth Fly Sewer Fly	Small, scaly or hairy, long-legged moth-like flies.	Sanitation. Remove moist organic materials, clean drains with wire brush; and reduce organic matter lining drains by applying enzymatic or similar cleaners monthly.	Adults rest on walls or foliage. 3-4 weeks from egg to adult. Breed in drain pipes, sinks and very moist organic solids.

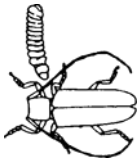
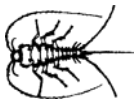
FUNGUS GNATS SP 341-C	Adults 1/8 to 1/4 inch long. Run rapidly over surfaces. Slender, gray larvae have shiny black head and white thread-like body.	Avoid over-watering plants; let soil dry out somewhat between waterings. Decoy pots of sprouting grain may be used to attract adult females, which lay their eggs in these pots. Remove and dispose of infested decoy pots every two weeks and replace with new decoy pots of sprouting grain. Flying insect sprays will kill adults but not solve problem.	Adults attracted to light. They are often found in windows and soil in potted plants.
HEAD LICE SP 341-S 	Tiny, flat insects found in human hair.	Permethrin (Nix); Pyrethrins 0.3% and piperonyl butoxide 3% (Rid, A-200, R & C, etc.)	Wash infested clothing and bedding with strong soap and very hot water; tumble dry on high heat. Do not share hair brushes, caps, etc. Use special combs to remove nits (eggs). Nits hatch by 10 days, so another application may be needed at this time. Follow label directions. Avoid group "selfies" when head lice present. See cdc.gov/parasites/lice/head/treatment.html for further details. If crawling lice are still seen after a full course of treatment contact your health care provider.
KUDZU BUG W 358	Adult is 1/5 inch mottled brown, pea-shaped bug. Seeks overwintering sites in the fall and is attracted to light-colored structures. Leaves protected sites in spring to feed primarily on kudzu. The next generation moves to soybean and other legumes and in the fall starts the invasion cycle over again. When crushed, kudzu bug can release offensive odor and stain surfaces in the home and can also cause skin irritation kudzubug.org/homeowner First found in TN in 2012. See kudzubug.org/distribution_map.cfm for updated distribution.	If exclusion methods aren't working completely, they may be supplemented with professionally applied outdoor treatments. Products containing indoxacarb, dinotefuran, pyrethroids (such as b-cyfluthrin, bifenthrin, cyfluthrin, deltamethrin and λ-cyhalothrin), or pyrethroids combined with neonicotinoids (imidacloprid, acetamiprid, or thiomathoxam) have been found to be effective against kudzu bug, but don't necessarily list this pest on the label. Insecticides should be applied around windows, doors and other entry points as is done for other occasional invaders. In general, pyrethroids are faster acting than other chemistries; however, new pesticide labels limit professionally applied pyrethroids to 1-inch bands around windows and doors when the surface is over a hardscape. Insecticides will have limited persistence outdoors in the sunlight and rain and may have limited effectiveness against preventing the kudzu bug from entering structures. Enforcer BugMax Home Pest Control Harris Home Pest Control Stink Bug Killer	Keep them out of the structure. Kudzu bugs can be difficult to keep out of homes as they are searching for an overwintering site. Mechanical exclusion is the most effective approach to provide long-term control. Think of all the places that kudzu bugs can enter the home and then deny them entry. Seal cracks around door frames (including crawl space entries), windows, utility penetrations, siding, and wood fascia and other openings with appropriate materials, such as quality silicone or silicone-latex caulk. Weather stripping may be needed around doors and windows to provide tighter seals. If light can be seen under a door, door sweeps may be needed. Repair screens on doors and windows. Screen behind crawl space, soffit and attic vents. Use chimney caps or screens when appropriate and remove window unit air conditioners, if possible, as this is a common entry point. Removal of kudzu bugs can be achieved with a vacuum cleaner, but be prepared for the smell if large numbers are vacuumed at once.

KUDZU BUG (cont'd)			Vacuum bugs found inside into knee-hi stocking placed on the end of the vacuum tube prior to attachment placement. After vacuuming, remove knee-hi, tie off, and dispose in soapy water. Indoor application of insecticides is discouraged for several reasons. Bugs that die may provide food for other pests such as carpet beetles which in turn could damage woolen clothing and dried, stored products. Foggers may kill bugs that are present at the time, but won't provide much control after the room is aerated. Misapplied foggers have resulted in fire or explosions. Sprays directed into cracks and crevices will still allow the bugs to emerge. Instead of treating indoor cracks and crevices where the bugs are emerging, seal them. Remove kudzu patches and plant legumes away from the structure to reduce outdoor kudzu bug populations nearby.
MICE PB 1624 	Adults weigh about 1/2 ounce. Dusky gray color, slender body, prominent ears, tail about as long as head and body. EPA's final risk mitigation decision requires that all rodenticide bait products for sale to consumers be in tamper-resistant bait stations. Loose bait such as pellets will be prohibited as a bait form.	Place snap traps, multiple catch traps and glue boards along paths traveled by mice. Traps or glue boards should be placed every 8-12 ft. Traps can be baited with: whole nuts, peanuts or peanut butter, dry rolled oatmeal, bacon squares, small wads of cotton or gumdrops. Baited traps should be set at right angles to rodent runs. Place trap at right angles to rodent pathway with trigger part of trap against the run.	Mice move in from outdoors in fall as temperatures decline. Exclusion practices needed – mice can fit through an opening 1/4 inch in diameter. Sanitation: remove access to food, water and shelter. Rodents use edges of walls, studs and pipes as guidelines. Remember to set traps where children and pets will not be hurt. Mice are curious and will normally approach traps the first night. If you don't catch a mouse in the first few nights, the trap is in the wrong location.
MILLIPEDES W 357 	Slender, brownish, multi-legged, hardshelled, 1-2 inches long. Two pair of legs per body segment. Invade home from outdoors. Harmless.	Outdoors: bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU beta-cyfluthrin RTU 0.05% gamma-cyhalothrin RTU 0.025%	Usually occasional invaders, but may invade in large numbers. Under these circumstances, nonchemical control may be more effective: remove mulch and other clutter from near the foundation, dethatch lawns and water in the morning. Prune tree limbs to dry their habitat. Use exclusion practices. Treat entry points into structure, shady areas, ivy beds, flower beds and rock walls, leaf-litter or as directed by label. Millipedes will die within 2-3 days after entering a dry structure. Vacuum millipedes found indoors. Millipedes are not insects, so insecticides not always effective. Best control obtained when pest comes in direct contact with the insecticide.

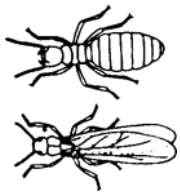
MITES, BIRD OR RODENT	Mites occasionally found indoors because of rodent or bird nest in, on or near structures. Some of these mites may bite people. They are small (about the size of a period), but can usually be seen with the naked eye.	If widespread, space sprays of pyrethrins may be necessary. Cimexa Dust into cracks and crevices. Mites are not usually listed on homeowner labels. Residuals such as those listed for fleas may also work. **Only apply products to areas listed on label as for other pests**. beta-cyfluthrin RTU 0.05% bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU For bird cages pyrethrin sprays such as UltraCare Mite and Lice Spray	The first step in controlling bird or rodent mites is to eliminate the host animals and remove their nesting sites. Often, the nests will be found in the attic, around the eaves and rafters or in the gutters or chimney. Gloves should be used when handling dead animals. A respirator should also be worn when removing nest materials to avoid inhaling fungal spores and other potential disease-producing organisms associated with the droppings. Spray crack and crevice around infested area. See chiggers for repellents. If mites entering from outside, place double-sided sticky tape around windows and other similar entry points.
MOLES PB 1624 	Small, furry animals that burrow and tunnel in soil, causing raised ridges in yards.	Use mole traps of choker or harpoon type. Grubs only make up a small amount of the mole's diet. Treating lawn for insects would reduce food available to moles, but probably would not lead to control.	Place trap in main runway. Tramp down runs in several spots. Spots re-raised are in main run. Other ways to identify main runway are to look for straight course for some distance; a runway connecting two mounds or other runways; one following a fence row, concrete path or other border; one that follows an edge of field or yard.
MOSQUITOES SP 503-B 	Delicate insects that bite humans and animals. Larvae and pupae found in water. Adults stay in shady protected locations such as shrubbery, crawl spaces, etc.	Treat larvae or wrigglers in standing water such as rain pools, intermittently flooded areas, stagnant water, etc. with: *Bacillus thuringiensis israeliensis* (Bti): Mosquito Bits Mosquito Dunks methoprene Pre-Strike Mosquito Torpedo Outside of buildings: use pyrethrin spray for temporary relief as aerosol or fogger; permethrin 0.15% in outdoor fogger. Residual barrier (malathion, permethrin, and other pyrethroids) can be applied to vegetation on perimeter of property that is prone to rapid infestation of mosquitoes. This kills adults feeding on nectar in day and some may act as a repellent. Spray other shady damp areas where mosquitoes rest. To protect pollinators, do not spray when plants in bloom and follow label carefully. If needed indoors use flying insect killers for temporary relief.	Eliminate larval sites (standing water) around structure by unclogging gutters, emptying bird baths, children's pools, pet bowls, flower pot saucers, old tires, and other containers around home twice a week. Drain or fill low areas where water collects. Easiest to control mosquitoes in immature stage because confined to water. If unable to remove standing water, treat standing water as allowed with labeled insecticide. Repair screens. Reduce the number of areas where adult mosquitoes can find shelter by cutting down weeds adjacent to the foundation and in yards, and mowing the lawn regularly. People should wear repellents when potentially exposed to mosquitoes. The CDC recommends repellents with these active ingredients: N,N-diethyl-m-toluamide (DEET)

MOSQUITOES (cont'd)			Picaridin IR3535 Oil of lemon eucalyptus (OLE) or para-methane-diol (PMD) 2-undecanone Do not use OLE or PMD on children under 3 years of age. Do not use repellents on babies younger than 2 months old. Mosquito netting can be used over infant carriers, cribs and strollers. Do not apply repellent to skin under clothing. If using sunscreen, apply sunscreen first and insect repellent second. More information on repellents and their safe use can be found at cdc.gov/westnile/prevention/index.html EPA's search tool (epa.gov/insect-repellents/find-repellent-right-you) helps you find suitable repellents.
MULTICOLORED ASIAN LADY BEETLE SP 503-C	Multicolored Asian Lady Beetles (MALB) start searching for overwintering sites, your home, on the first or second day in the fall when temperatures are greater than 65 F after a dramatic drop in temperature, usually to near freezing. This usually occurs about the third week in October.	Spray entry points the third week in September. If the beetles have not flown in 3 weeks, repeat spray if allowed by label. bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU gamma-cyhalothrin RTU 0.025% deltamethrin RTU 0.02% other pyrethroids	1. Pest-Proof: seal entry points before beetles arrive. 2. Treat roof lines or soffits, vertical contrast areas, and entry points (around the following outdoor items: windows, doors, vents, pipe penetrations) with pesticides before the beetles arrive. 3. Remove dead beetles as they pile up because they may cause other MALB to aggregate. 4. If the beetles make their way into the home, use HEPA filter vacuum or try a light trap.
PANTRY PESTS Saw-Toothed Grain Beetle  Cigarette Beetle	Reddish brown to brownish black, 1/8" long, flattened with 6 saw-tooth like projections on thorax. Feeds in a wide variety of stored products, cereals, nuts, dried fruit, cookies, candy, etc. 1/8" long, oval, reddish brown, head not visible from above, antennae saw-like. General feeder in tobacco, seasonings especially paprika, cereal, dried flowers, and a wide variety of stored foods.	Locate food source and discard. Place grains, flours, nuts and other stored products in insect-proof containers when they are brought home from store. Pheromone traps can indicate the presence of pests and may provide control without insecticides when populations are low and pests confined. Vacuum cracks and crevices and wipe down pantry to remove pests and food source. Often insecticide applications are NOT necessary.	To prevent infestations: 1) Inspect stored products periodically. 2) Practice good sanitation. 3) Rotate stored product use so older stores are used first and none remain in storage indefinitely. 4) Have adequate ventilation to prevent moisture buildup in storage areas. 5) Use insect-proof package or storage procedures wherever possible.

PANTRY PESTS (cont'd) Indian Meal Moth  Rice Weevil  Confused Flour Beetle  Red Flour Beetle	3/8" wing span, inner 2/3 of wing grayish, outer 1/3 of wing copper in color. Feeds in coarse grain products, chocolate, nuts, dried fruit. 1/8" long. Long snout on head, dark brown with 4 bright spots on wing cover. Feeds on grains. 1/8" long, reddish-brown convex, oval shape, antennae gradually enlarged to end in a club. Cannot fly. Feeds in flour and cereal products. 1/8" long, reddish-brown convex oval shape, antennae has a distinct 3-segmented club. Feeds in flour and cereal products.		6) Seal cracks and crevices to reduce pest hiding places in pantry. 7) Pheromone traps can indicate the presence of pests and are available for: Indian meal moth, saw-toothed grain beetle, confused and red flour beetle, cigarette beetle, drugstore beetle, clothes moths and others. See Bean Weevil for non-chemical control.
POWDERPOST AND OTHER WOOD-BORING BEETLES Lyctid powderpost beetle  Anobiid powderpost beetle  Roundheaded borers Old house borers	Shot-sized holes along with flour-like powder indicate these beetles. Attacks hardwoods such as oak, ash and hickory found in wood paneling, molding, window and door frames, plywood, hardwood floors and furniture. Antennae with 2-segmented club. Head protrudes forward. Reinfests seasoned wood. Attack hardwoods and softwoods. In addition to above, they also attack beams, rafters, joists, studs and other structural framing. Infestations found in moist, poorly ventilated areas such as crawl spaces, basements, etc. Head hidden by pronotum. Reinfest seasoned wood. Presence indicated by large hard-shelled beetles with long feelers. Broadly-oval 1/4" emergence hole made by old house borer. Larvae in tunnels packed with frass; 3 eye spots to left and right of mandibles. Beetle 3/4 inch long, dark brown/black with "V" or "W"-shaped markings on wing covers; 2 bumps on thorax. Reinfests seasoned softwoods (pine).	**We do not recommend that homeowners attempt wood-destroying beetle control themselves. Seek a professional!** See POWDERPOST AND OTHER WOOD-BORING BEETLES A Quick Reference Guide to Pesticides for Pest Management Professionals Working in and Around Structures for pesticide suggestions. Any wood-destroying beetle that has pupated prior to insecticide application may be unaffected and may continue to emerge. Insecticide applications should prevent reinfestation. If an anobiid infestation spread into walls or between floors fumigation may be needed. Fumigation is costly and should only be considered as a last resort. If only small articles infested such as furniture, antiques, etc., they can be fumigated at a lower cost. Only professional pest control operators licensed to fumigate can perform this operation. If all evidence indicates the infestation is localized, wood could be replaced. This is often the option used for lyctids. Watch for new holes in adjacent areas.	Determine extent of infestation. Signs for Lyctid powderpost beetles are: flour-like "frass" dropping from pinhead-sized or slightly larger holes, Anobiid frass is more gritty than Lyctid; adult beetles attracted to light may be found on window sills or foundation vents. Important to determine if infestation active or not. Mark or seal existing holes, vacuum existing sawdust, recheck wood for new holes in spring or early summer. These beetles damage wood slowly. If "frass" is yellow, caked or covered with dust or debris, that damage is probably old. Old house borers can be detected by hollow sound when wood tapped. Stethoscope can be used to hear large old house borer larvae chewing in spring and summer. Prevention: 1) Don't use old lumber from a barn or wood pile unless it has been treated or kiln-dried. (2) Don't use improperly dried or stored lumber. (3) Inspect firewood prior to bringing into structure. (4) Paint, varnish or otherwise seal wood to prevent exposed edges. (5) Seal previous emergence holes to prevent egg-laying sites.

POWDERPOST AND OTHER WOOD-BORING BEETLES (cont'd) Others 	Neat 1/2" holes may appear in walls where beetles emerge. Don't usually reinfest seasoned softwoods (pine).	If crawlspace wood infested with anobiids, decrease moisture in wood through ventilation and moisture barriers. Central heat and air may reduce wood moisture so there is insufficient moisture to support large infestations in living areas. Wood kept below 12 percent moisture should be unsuitable to Anobiid powder post beetle reinfestation. Professionals may have a moisture meter.	New houses usually infested by use of infested lumber. May also come from firewood. Alternative controls for powder post beetles: small items, such as picture frames, can be heated at 120 to 140 F for six hours to kill existing life stages. Freezing (0 F) infested wood for 72 hours will also kill all life stages.
RATS PB 1624 	Norway rat: 12-18 inches, tail shorter than head and body, body heavy and thick, ears small Roof rat: 12-17 inches, tail longer than head and body, body light and slender, ears larger. Roof rats becoming more common in Shelby County. Young rat : 6-7 inches, feet large, head large House mouse: 6-7 inches, feet small, head small Droppings identification: Roof rat: pointed, about ½ inch Norway rat: blunt, about 3/4 inch House mouse: pointed, about 1/8 inch	When rats are plentiful or where unsanitary conditions exist with shelter, poisoned baits are the best control method. Often community-wide control needed. EPA's final risk mitigation decision requires that all rodenticide bait products for sale to consumers be in tamper-resistant bait stations. Loose bait such as pellets will be prohibited as a bait form.	Exclusion practices needed. Rats can fit through an opening 1/2 inch in diameter. Locate entrance into structure and exclude. Use materials such as galvanized, stainless or other non-rusting metal such as 24-gauge sheet metal or 19-gauge hardware cloth with 1/4 inch or smaller opening; brick, concrete block, tile or glass; steel wool with expandable foam; and others. Remove debris such as piles of waste lumber or trash, used feed sacks, abandoned large appliances, and wood piles from next to structure. Store pet foods and seed in rodent-proof glass or metal containers. Place snap traps, multiple catch traps and glue boards along paths traveled by rats. Of the snap traps, the expanded trigger trap is the most versatile, since it can be baited. Rats are bait shy. Leave baits in place for at least a week before moving. Place trap 90 degrees to rodent pathway with trigger part of trap against the run. Rodents use edges of walls, studs and pipes as guidelines. Snap traps can be baited with whole nuts; raisins or grapes for roof rats; sardines packed in oil for Norway rats; peanuts or peanut butter; bacon squares; or small wads of cotton. **Area-wide effort may be needed if many rats present.**
SILVERFISH AND FIREBRATS SP 341-O 	Grayish, wingless, rapid-moving insects with 3 long tails. Feed on starchy materials such as bookbinding, wallpaper, cardboard, etc.	bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU beta-cyfluthrin RTU 0.05% gamma-cyhalothrin RTU 0.025%	Treat cracks and crevices where silverfish and firebrats may dwell. Attics many times source of infestation; treatment in attic often necessary.

SKUNKS PB 1624 	These animals many times live in the ground around or under homes.	Bac-Azap biological odor control or others can be sprayed to eliminate odors.	Trap and remove skunks from property. Seal the foundation to prevent entry under building.
SNAILS AND SLUGS 	Long, grayish, shiny, soft-bodied creatures. Will attack various plants. Leave slime trails on walks and walls.	Snail and slug killer baits containing metaldehyde or iron phosphate. Do not allow product to contact plant material.	Remove boards and plastic or plant debris and dry, damp areas adjacent to foundation.
SNAKES PB 1624 	Snakes of various kinds, den around or invade homes and other buildings.	Place a pile of cool, damp rags in building where snake was last seen. Snake will be attracted and can be removed. Large glue boards can trap snakes.	Mouse-proof building. Mow lawns and field to control grass, weeds and brush. Remove boards, flat rocks, trash piles and other debris that provide harborage for rodents.
SOWBUGS OR PILLBUGS	Grayish, hard-shelled, many-legged creatures appear on walks and patios. Roll up in ball when disturbed. Occasional invaders.	Chemical control usually not necessary for this pest. If needed, apply to infested areas outdoors around perimeter of structure. This stops any invasion into the house. bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU gamma-cyhalothrin RTU 0.025%	Remove leaf piles, grass clippings, old boards, wood piles and other debris from around foundation. Leave a 12-18-inch plant/mulch-free zone next to foundation base. Use exclusion practices: caulk cracks around foundation and screen vents in foundation. Drain and dry area around house.
SPIDERS or SCORPIONS PB 1193 PB 1191	Many kinds invade homes, basements and roof overhangs from outdoors. Two spider species most dangerous in Tennessee: **Black Widow**: dark black spider with red hour glass shape on bottom of abdomen. More of an outdoor pest along perimeter of buildings. Use outside perimeter treatment with residuals. **Brown Recluse:** light brown spider, with legs reaching to the size of a quarter or half dollar, dark violin shape on back of front portion of head, 3 pairs of eyes arranged in a semi-circle. **Quite often a professional pest management company should be used.**	Residual Sprays in cracks and crevices: bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU beta-cyfluthrin RTU 0.05% gamma-cyhalothrin RTU 0.025% Indoor cracks and voids Cimexa dust	Most other species are beneficial organisms because they feed on pest insects. They are occasional invaders that can be vacuumed or swept out the door. Remove wood or mulch piles away from house to lower abundance of their insect food source. Apply insecticides to cracks and crevices in crawl spaces, basements, attic, eaves and outdoor areas of home. Clean up debris where scorpions and spiders hide. Replace outdoor lights with yellow bug lights. Scorpions will fluoresce under a black light, so they and their breeding areas can easily be seen at night. Use glue boards to trap spiders and locate infested areas. Glue boards should be placed against walls and other guidelines where spiders are suspected. Efforts to control brown recluse will cause spiders to become more active. Prevent bites by checking shoes and clothing before wearing, by pulling beds away from walls, and preventing bed skirting and bedspreads from touching the floor.

SPRINGTAILS	Small, jumping insects with a forked spring mechanism	Treat entry areas, sills, foundations, soil and cracks where insects are found **(according to label for other perimeter pests):** bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU beta-cyfluthrin RTU 0.05% gamma-cyhalothrin RTU 0.025%	Usually found in moist, decaying vegetation and are incidental invaders into houses. There are a few reports of large populations entering homes. Dry out surrounding landscape, water only in morning, etc.
SUBTERRANEAN TERMITES PB 1344 	Termites invade and eat wood and other cellulose material, causing extensive damage in structural parts of a building. Their presence may not be discovered until they swarm, years after infesting a structure. Workers and soldiers: soft-bodied insects 1/8 to 3/16 inch long. Swarmers are honey-brown, dark brown or black with four nearly equal sized and shaped wings. Swarmers are easily distinguished from winged ants by termites straight antennae, broadly attached thorax to waist and four nearly equal wings. Inspect for signs of termite infestation: irregular earthen tubes constructed across walls, floors and foundation. Hammer or probe timbers with a sharp instrument. Damaged wood will be soft, channeled, unsound and may possibly reveal the termite infestation itself. Use a moisture meter. Active termites will increase moisture reading relative to uninfested areas. Termites commonly enter homes around doors, wooden steps and porches and unexcavated portions of structures. The easiest access points are where wood is in direct contact with the soil. Occasionally, moisture-damaged wood in roofs can support an aerial infestation. No mud tubes will reach to ground. Attic inspection is important, too.	We do not recommend that homeowners attempt termite control themselves. Seek a professional! See TERMITES, SUBTERRANEAN in A Quick Reference Guide to Pesticides for Pest Management in and Around Structures for pesticide suggestions for the professional to use. Soil treatment: Do not apply near (within 100 ft.) any body of water, cistern or well. Nonrepellents: Termites do not detect these insecticides and hence walk over the treated soil. Termiticide may be transferred back to colony. Pyrethroids: In general, this group tends to be repellent, thus treatments must be applied to create a continuous barrier. Wood treatment: Termite galleries and wall voids can be treated. May be used to supplement a soil treatment. Disodium octaborate tetrahydrate (DOT) can be applied by a professional as pretreatment barrier or as a second barrier (see labels for more details). Baits: Termites feed on bait and spread bait to rest of colony to eliminate or suppress it. Baits are used as standalone systems or with a termiticide spray application.	Follow correct construction practices. This is the best protection against a termite infestation:(1) Remove all wood materials from around and under the house; (2) Remove all form boards and construction stakes; (3) Construct a termite-proof foundation; (4) Have at least 30 in. of clearance under buildings; (5) Have proper ventilation and light under all parts of the building; (6) Use a moisture barrier in crawl spaces; (7) Drain water away from building; (8) Have no wood in contact with the ground, or treat those timbers that require ground contact with approved preservatives/borates; (9) Make periodic inspection of buildings. **Find a reputable professional to treat.** Collect some swarmers with wings for identification and vacuum the rest. Leave mud tubes in place until a professional pest control person arrives. Effective control measures for a soil treatment should include: 1) Inspect basement and underside of house thoroughly to determine the area and extent of infestation. 2) Inspect attic for termite tubes and damage to joists, rafters, flooring and stored materials. 3) Disrupt and block all termite tubes (unless baiting) 4) Ditch the entire foundation inside and out and treat the soil replaced in the trenches with chemicals. 5) Repair all foundation and basement floor and wall breaks with rich concrete. 6) Break all wood-soil contacts, treat such areas with chemicals. 7) Treat infested timbers and replace those which are badly infested. 8) Treat hollow spaces in the foundation-concrete blocks, piers, chimney bases, spaces behind brick veneer. Ditch and treat inside of porch foundations, under patios, under concrete slabs and the surface of ground under porches and similar dead places. 9) Provide ventilation and drainage beneath house and porches. 10) Remove all scrap wood from beneath house.

TICKS PB 726 	Grayish or brown, round, hard-shelled, 6- or 8-legged creatures that invade homes, yards and get on pets and people.	Insecticide applications are most effective when directed into areas where ticks and their animal hosts are likely to frequent. Pay particular attention to borders and fences between wooded or brushy areas and the lawn, around ornamental plantings, beside foot paths, house and dog house. Allow surface to dry before people or pets have access. bifenthrin 0.2% G beta-cyfluthrin 0.05% permethrin 0.5%G gamma-cyhalothrin RTU 0.025% and other synthetic pyrethroids. <u>Indoors for brown dog tick:</u> bifenthrin 0.05% & Zeta-cypermethrin 0.0125% RTU gamma-cyhalothrin RTU 0.025% other pyrethroids <u>Dogs:</u> BioSpot and other permethrin containing spot-ons fipronil (Front Line) spot-ons available from veterinarians collars containing amitraz (don't use around small children or dogs that may chew collar) see pesticide recommendations at caes.uga.edu/content/dam/caes-website/departments/entomology/documents/ga-pest-management-handbook/2018-pmh/2017-homeowner/2018%20Animals.pdf for a thorough listing of veterinarian supplied on-pet products.	Nonchemical methods for reducing tick problems include mowing the lawn and controlling weeds. This has three advantages – it lowers the moisture in the grass microclimate and allows sunlight to penetrate, which tends to cause ticks to dry out; it discourages rodents (which may serve as hosts) from nesting; and lastly, because there is less plant matter, less pesticide may be needed if a treatment is necessary. Also, removing debris, weeds or clutter from around the house discourages rodents from nesting. Repair entry points into the house to discourage possible tick hosts from entering. Cracks and crevices, both indoors and out, can be sealed to reduce hiding places for ticks. Inspect and clean pets and their bedding frequently. If bedding is infested, it can be cleaned or destroyed. In the home, ticks stay around baseboards and walls. Use insecticides in cracks and crevices in the home for brown dog tick.
WASPS, HORNETS, YELLOWJACKETS SP 290-A SP 341-M	Many types build paper and mud nests around homes, in ground or in shrubs.	Bee and wasp killer aerosols tetramethrin aerosols beta-cyfluthrin RTU 0.05% Dusts deltamethrin 0.05% D Apicide (carbaryl 5% D) Victor Yellow Jacket Trap	Wait until dark when wasps return to nest and are slow due to cooler temperatures. Apply insecticides to nest opening and seal nest opening if possible. Remove mud nests in winter to destroy overwintering forms. Traps can used to reduce foraging yellow jacket populations.

List of Products Sorted by Chemical Name Available to the General Public

Chemical Name	Trade Name	Website
avermectin (in bait) and hydroprene	Raid Double Control Small Roach Bait Plus Egg Stopper	S.C. Johnson https://www.raid.com/en-us/products
avermectin	Raid Ant Baits[III]	S.C. Johnson https://www.raid.com/en-us/products
acetamiprid	Ortho Home Defense Fly Bait Decal for Windows	The Ortho Group http://www.ortho.com
Bacillus thuringiensis israelensis	Mosquito Bits, Mosquito Dunks	Summit Chemical http://www.summitchemical.com
bifenthrin 0.2%	Hi-Yield Bug Blaster II	VPG http://www.fertilome.com/ProductFiles/33326%20Bug%20Blaster%20Approved%207-6-12.pdf
bifenthrin 2.4%	Ortho Home Defense Max Termite and Destructive Bug Killer Concentrate	The Ortho Group https://www.ortho.com/sites/g/files/oydgjc116/files/asset_files/T020001005_32600_LB7646_090916_cfl%20%281%29.pdf
bifenthrin 0.05% & zeta-cypermethrin 0.0125%	Ortho Home Defense Insect Killer for Indoor and Perimeter$_2$ RTU	The Ortho Group http://www.ortho.com
borax	Terro Ant Killer II	Senoret http://www.terro.com
carbaryl 5% D	Apicide	Mystic Chemical Company http://www.apicide.com
cyfluthrin Ready-to-Spray 0.75%	Bayer Advanced Vegetable & Garden Insect Spray Ready-to-Spray	Bayer http://www.bayeradvanced.com
beta-cyfluthrin RTU 0.05%	Bayer Advanced Home Pest Control, Indoor & Outdoor Insect Killer RTU	Bayer http://www.bayeradvanced.com
beta-cyfluthrin 0.05% G	Bayer Advanced Insect Killer for Lawns Granules	http://www.kellysolutions.com/erenewals/documentsubmit/KellyData%5COK/Pesticide/Product%20Label/72155/72155%2D35/BAYER%5FADVANCED%5FINSECT%5FKILLER%5FFOR%5FLAWNS%5FREADY%5FTO%5FSPREAD%5FGRANULES%5F6%5F3%5F2016%5F3%5F01%5F11%5FPM%2Epdf
deltamethrin 0.02% RTU	Bonide Household Insect Control	Bonide http://www.bonide.com/assets/Products/Labels/l527.pdf
deltamethirn 0.03% RTU	Enforcer BugMax Home Pest Control	Enforcer http://www.enforcer.com/products/spiders/bugmax-home-pest-control

deltamethirn 0.03% RTU	Harris Home Pest Control Stink Bug Killer	Harris https://pfharris.com/products/kudzu-bugs
deltamethrin 0.05% D	Enforcer BugMax Insect Powder	Zep http://www.kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/40849/1021-2617-40849/1021-2617-40849_Enforcer_BugMax_Insect_Powder___Waterproof_Dust_4_23_2015_4_00_22_PM.pdf
dinotefuran 0.05%	Hot Shot Ultra Clear Roach & Ant Gel Bait	Hot Shot http://www.hotshot.com
dinotefuran 0.05%	Hot Shot Ultra Liquid Ant Bait	Hot Shot http://www.hotshot.com
esfenvalerate	Bengal Insecticide Concentrate	http://www.kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/68543/1021%2D1641%2D68543/1021%2D1641%2D68543%5FBengal%5FInsecticide%5FConcentrate%5F5%5F23%5F2016%5F12%5F26%5F38%5FPM%2Epdf
fipronil	Combat bait stations Combat Max 12 Month Roach Killing Bait (bait station)	Combat Insect Control Systems http://www.combatbugs.com
fipronil 0.01%	Combat Roach Killing Bait Strips	Combat Insect Control Systems http://www.combatbugs.com
fipronil	Combat Source Kill Max R3 (Roach Killing Gel)	Combat Insect Control Systems http://www.combatbugs.com
fipronil	Combat Source Kill Max[A1] (Ant Gel)	Combat Insect Control Systems http://www.combatbugs.com
fipronil	Combat Source Kill Max[A2]	Combat Insect Control Systems http://www.combatbugs.com
fipronil	Combat Ant Killing Bait Strips	Combat Insect Control Systems http://www.combatbugs.com
gamma-cyhalothrin 0.025% RTU	Spectracide Bug Stop Home Barrier Indoor Plus Outdoor Insect Control	Spectrum Group, United Industries http://www.spectracide.com/Products-and-Solutions/Home-Insect-Killers/Spectracide-Bug-Stop-Home-Barrier-RTU.aspx
hydramethylnon	Combat Ant Killing Bait Indoor and Outdoor Use bait stations	http://www.kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/64240/64240%2D3/64240%2D3%5FCombat%5FAnt%5FKilling%5FBait%5F12%5F19%5F2017%5F6%5F55%5F24%5FPM%2Epdf
indoxacarb	HotShot MaxAttrax Ant Bait[2]	Hot Shot http://www.hotshot.com

indoxacarb	Spectracide Ant Shield Outdoor Killing Stakes	Spectracide http://www.spectracide.com
imidacloprid 2.15%	Bayer Advanced Home Pest Roach Killer Gel	Bayer https://www.bayeradvanced.com/find-a-product/insects-pests/home-pest-roach-killer-gel
lambda-cyhalothrin 0.16%	Cutter Backyard Bug Control Spray Concentrate	Cutter http://www.cutterinsectrepellent.com
methoprene	Pre-Strike Mosquito Torpedo	Starbar https://www.starbarproducts.com/products/commercial/pre-strike-mosquito-torpedo
permethrin 0.5% G	Hi-Yield Kill-A-Bug II Lawn Granules	VPG https://www.fertilome.com/product/kill-a-bug-ii-lawn-granules-20-lbs
0.15% permethrin 0.15% PBO	Black Flag Fogging Insecticide II	http://www.kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/53853/1021%2D1866%2D53853/1021%2D1866%2D53853%5FBlack%5FFlag%5FPropane%5FPowered%5FInsect%5FFogger%5F2%5F2%5F2009%5F3%5F44%5F45%5FPM%2Epdf
0.15% permethrin 0.15% PBO	Cutter Backyard Bug Control Fogging Insecticide	http://www.kellysolutions.com/erenewals/documentsubmit/KellyData/OK/pesticide/Product%20Label/53853/1021%2D1866%2D53853/1021%2D1866%2D53853%5FCutter%5FBackyard%5FBug%5FControl%5FFogging%5FInsecticide%5FFormula%5F5%5F22%5F2013%5F1%5F08%5F27%5FPM%2Epdf
2% permethrin 0.05% pyrirpoxyfen	Bengal Gold Roach Spray	Bengal http://www.bengal.com/gold_roach_spray.html
0.025% Prallethrin 0.010% Lambda-Cyhalothrin	Spectracide Terminate Termite Killing Foam$_2$	Spectrum Group, United Industries http://www.spectracide.com
0.01% pyriproxyfen (Nylar) 0.25% permethrin	Enforcer Flea Spray for Homes	Enforcer http://www.enforcer.com
0.015% pyriproxyfen 0.400% tetramethrin 0.300% phenothrin.	Enforcer Flea Spray For Carpets & Furniture XX (aerosol)	Enforcer http://www.enforcer.com
0.015% pyriproxyfen 0.4% tetramethrin 0.3% sumithrin	Bengal Full Season Flea Killer Plus 2	Bengal Products http://www.bengal.com
pyrethrins 0.03%	Ultra Care Mite and Lice Spray	http://www.kellysolutions.com/erenewals/documentsubmit/KellyData%5COK/Pesticide/Product%20Label/87703/87703%2D2/UltraCare%5FMite%5F%5F%5FLice%5FBird%5FSpray%5F3%5F16%5F2018%5F10%5F26%5F48%5FAM%2Epdf

0.14% pyrethrum 0.0664% tetramethrin 0.015% pyriproxyfen, others	Raid Flea Killer Plus Carpet and Room Spray	Raid, SC Johnson Brands https://www.raid.com/en-us
silicon dioxide 85%	Hot Shot Bedbug Killer Dust with Diatomaceous Earth	Hot Shot http://www.hotshot.com/Products/Bed-Bug-Control/Bedbug-Flea-Killing-Powder.aspx
silicon dioxide 85% from diatomaceous earth	Garden Safe Crawling Insect Killer	GardenSafe http://www.gardensafe.com
silicon dioxide 85% from diatomaceous earth	Harris Diatomaceous Earth Bed Bug Powder	Harris http://pfharris.com/bed-bugs.html
thiomethoxam	Raid Ant Gel	SC Johnson https://www.raid.com/en-us

Further References for Household Pest Identification:

Manuals*:*

Bennett, G.W., J.M. Owens, and R.M. Corrigan. 1997. **Truman's Scientific Guide to Pest Control Operations**. 5th edition. Edgell Communications, Duluth, MN

Mallis, A. 1997. **Handbook of Pest Control - the Behavior, Life History and Control of Household Pests**. 8th edition. Franzak and Foster Co. Cleveland, Ohio. (216)961-4130

Koehler, P. **Pests In and Around the Home**. IFAS Publications, P.O. Box 110011, University of Florida, Gainesville, FL 32611- 0011 or (352)392-1764 or if using the World Wide Web http://gnv.ifas.ufl.edu/~entweb/publicat.htm

Handbooks for identification and control of specific pests. These are inexpensive and very useful. Most pesticides mentioned are for professional use.

Hedges, S. Pest Control Technology Field Guide for the Management of Structure-Infesting Ants. Franzak and Foster Co., Cleveland, Ohio.

Hedges, S. Pest Control Technology Field Guide for the Management of Structure-Infesting Flies. Franzak and Foster Co., Cleveland, Ohio.

Hedges, S. Pest Control Technology Field Guide for the Management of Urban Spiders. Franzak and Foster Co., Cleveland, Ohio.

Hedges, S. and M. Lacey. Structure-Infesting Beetles. Volume 1: Hide and Carpet beetles/Wood- Boring Beetles .Franzak and Foster Co., Cleveland, Ohio.

Hedges, S. and M. Lacey. Structure-Infesting Beetles. Volume 2: Stored Product Beetles/Occasional and Overwintering Beetles. Stoy Franzak and Foster Co., Cleveland, Ohio.

Smith, E and R. Whitman. 1992. NPCA Field Guide to Structural Pests. NPCA, Dunn Loring, VA.

PRECAUTIONARY STATEMENT
To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store, or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

DISCLAIMER STATEMENT
This publication contains pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. The label takes precedence over the recommendations found in this publication. Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others which may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product. The author(s), The University of Tennessee Institute of Agriculture and the University of Tennessee Extension assume no liability resulting from the use of these recommendations.

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A Quick Reference Guide to Pesticides for Pest Management Professionals Working in and Around Structures 2018

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THE UNIVERSITY OF TENNESSEE

A Quick Reference Guide to Pesticides for Pest Management Professionals Working in and Around Structures

Karen Vail, Professor, and Jennifer Chandler, Research Specialist III,
Entomology and Plant Pathology

This publication provides a quick reference to pesticides and methods for the pest management professional to use in solving pest management problems in and around structures. A thorough description of pest identification including images, inspection and detection techniques, exclusion, sanitation, other environmental modifications, and pesticide formulations can be found in the following UT Extension publications (ag.tennessee.edu/PSEP/Pages/studymanuals.aspx):

Vail, K.M., G. Burgess, R. Gerhardt and C. Harper [eds.]. 2007. PB 1673 General Pest and Rodent Control Pesticide Applicator Licensing Manual (GRC). pp. 130.

Vail, K., G. Burgess, R. Gerhardt and C. Jones [eds.]. 2002. PB 1685 Public Health Mosquito Control: The Tennessee Mosquito Control Handbook (Pesticide Applicator Licensing Manual). pp. 54.

Vail, K., D. Hensley, G. Burgess, C. Pless and A. Taylor [eds.]. 2014. PB 1703 Wood-Destroying Organisms Licensing Manual. pp. 76.

Vail, K.M., E. Burgess, R. Gerhardt, and Craig Harper. 2006. PB 1732 Industrial, Institutional, Structural and Health Related Pest Management Certification Manual (Category 7). pp. 105.

Vail, K.M., E.E. Burgess, R. Gerhardt, C. Jones, J. Skinner and C. Harper. 2003. PB 1733. Public Health Pest Control (Category 8). pp. 99.

Further references for household pest identification:

Manuals:

Bennett, G.W., J.M. Owens, & R.M. Corrigan. 2011. Scientific Guide to Pest Management Operations, seventh edition Cleveland, OH: Questex Publishing.

Mallis, A. 2011. **Handbook of Pest Control - the Behavior, Life History and Control of Household Pests**. 10th edition. Mallis Handbook LLC.

Field Guides:

Hedges, S. 2010. **Pest Control Technology Field Guide for the Management of Structure-Infesting Ants, 3rd edition.** G.I.E. Inc. Publishers, Richfield, Ohio.

Hedges, S. 1995. **Pest Control Technology Field Guide for the Management of Structure-Infesting Flies.** Franzak and Foster Co., Cleveland, Ohio.

Hedges, S. 2012. **Pest Control Technology Field Guide for the Management of Urban Spiders**. Franzak and Foster Co., Cleveland, Ohio.

Hedges, S. and M. Lacey. **Structure-Infesting Beetles. Volume 1: Hide and Carpet Beetles/Wood-Boring Beetles.** Franzak and Foster Co., Cleveland, Ohio.

Hedges, S. and M. Lacey. **Structure-Infesting Beetles. Volume 2: Stored Product Beetles/Occasional and Overwintering Beetles**. Franzak and Foster Co.

Klotz, J., L. Hansen, R. Pospischil and M. Rust. 2008. **Urban Ants of North America and Europe: Identification, Biology and Management**. Comstock Publishing Associates, Cornell University Press, Ithaca, New York pp. 196

Smith, E and R. Whitman. 2007. **NPMA Field Guide to Structural Pests**. Second edition. http://npmapestworld.org/

General Identification Guides for Insects:

Peterson's Field Guides: Insects of North America # 19, Beetles of North America #29, Moths of Eastern North America #30

APPs:

NPMA Mobile Field Guide App is now available on iOS and Android devices, npmapestworld.org/technical-resources/npma-field-guide-app

The following tables list recommended procedures and, if necessary, pesticides to manage specific pests. Remember to reduce the pest's access to food, water and shelter. If pesticides are needed, they are more likely to provide control if access to these necessities are limited. In addition to the references provided above, more information can be found in the UT Extension publications (SPs, PBs and Ws) listed in the tables. Extension publications can be found by visiting extension.tennessee.edu/Pages/default.aspx and entering the publication number in the search box. Percentages that appear after the trade name indicate percentage of the active ingredient. Where no percentage is given, see the label for more details. SEE THE LABEL FOR ALL DIRECTIONS!

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
ANTS - ARGENTINE ANT, ODOROUS HOUSE ANT PB 1629 W 473	**ARGENTINE ANT** **Bump (Node) on waist:** one, obvious **Gaster tip:** no circular opening **Odor when crushed:** "disagreeable, rotten-coconut-like" with an additional faint musty odor **Color:** light to dark brown **ODOROUS HOUSE ANT** **Nodes on waist:** one, very flat, barely noticeable node hidden by the gaster **Gaster tip:** no circular opening **Odor when crushed:** "disagreeable, rotten-coconut-like" **Color:** brown to black **Both ant workers:** 1/8 inch The odorous house ant is the most common house-invading ant in TN. It nests in shady, moist areas such as under mulch, pine straw, stones, and logs. Moves indoors during periods of heavy rain and moves nests often. Winged male odorous house ants may be collected from lights from May through June. Argentine ant is not as common as the odorous house ant, but can build up larger populations. Behavior is similar for both species.	Perimeter Spray: Termidor SC 0.06% Arilon 0.05%, 0.10% Optigard Flex 0.1% (to perimeter and plants combined with Optigard Ant Gel Bait in outdoor stations) Outdoor Baiting: Advion Insect Granule (perimeter broadcast) Intice Thiquid 1% Maxforce Quantum Ant Bait MAXFORCE COMPLETE Brand Granular Insect Bait Maxforce Ant Killer Bait Gel (for Argentine ant) Niban FG, G baits Optigard Ant Gel Bait PT 388B Advance Ant Gel Bait Terro-PCO (1%) Indoor Crack and Crevice Spray and Outdoor Entry Points Phantom	Our best research results for odorous house ants have been a **0.06% fipronil (Termidor SC) spray** to entry points and 1 foot up and 1 foot out from the foundation base **COMBINED** with (1) a liquid or other bait placed in the landscape near/around the structure where ants are active **OR COMBINED** with (2) Phantom applied indoors as crack and crevice in areas of activity as well as at potential entry points. Gel baits may work longer outdoors when placed in stations. Baits listed under odorous house ant and outdoor baiting have eliminated small, laboratory-maintained odorous house ant colonies within 8 weeks of bait placement or have proven effective in field studies. Ants nesting in structures through the winter can be quite challenging to control and to the pest management professionals' reputation. Often the ant centers of activity are difficult to define because small numbers of ants are found in many different locations. You bait one area and activity ceases, only to be found in another area. It's worth exploring the use of placing Quantum or any other liquid/gel bait in indoor stations near ant activity where residents will not see the station or trailing ants. Moisture is fairly limiting this time of year when indoor heat is running longer because of low outdoor temperatures and liquid/gel bait in a station may serve as moisture source.
ANTS - CARPENTER PB 1599	Large, black, red, or red-and-black ants that nest in damp wood. Wingless workers 1/4 to 3/8 inch long with a one-segmented waist, circular opening at the end of the gaster and evenly rounded thorax when viewed from the side. Winged male and female reproductives will fly from a colony. Carpenter ants do not eat wood, but excavate smooth galleries in the wood to raise their young. Piles of coarse sawdust or splintered wood often mixed with insect parts may indicate a carpenter ant nest nearby.	Outdoor perimeter spray Termidor SC Arilon Transport GHP Demand CS Temprid SC Baits: Indoors in cracks and crevices where ants are seen: Advion Ant Bait Arena Advion Ant Gel Maxforce Carpenter Ant Bait Maxforce Fleet Niban FG, G	1. Correct moisture problem, repair leaks and ventilate. 2. If ants entering from or foraging outdoors, spray a slower acting, nonrepellent insecticide around the perimeter with an emphasis on areas where ants are entering the structure. 3. Place baits where ants are actively foraging. If baiting, do not spray ants, trails or baits with a fast-acting, repellent spray because it will kill ants too quickly and will stop them from feeding on the baits.

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
ANTS - CARPENTER CONT'D		Outdoors: Advion Ant Bait Arena Advion Ant Gel Maxforce Carpenter Ant Bait Gel Maxforce Fleet Maxforce Granular Bait Niban FG, G Optigard Ant Gel Bait Dusts: Deltadust Boric acid dusts Tempo 1D Sprays (or foam according to label): Talstar P, Tempo SC Ultra, Tempo Ultra WP, Cy-Kick, Transport, PT221L, Suspend SC, Bora-Care, Shell-guard, Tim-bor (dust, spray or foam), Armor-Guard (dust, spray or foam)	4. Find and treat (dust, spray or foam) nests in wood parts. Drilling into the wood may be necessary. Dust nests in wall voids. Do not apply sprays near electricity.
ANTS - PHARAOH also called "sugar ants" or "piss ants" PB 1629	**Nodes on waist:** two **Gaster tip:** sting (may not be visible or functional) **Worker size:** 1/16 inch **Antennae:** 12-segmented antennae with a three-segmented club **Color:** yellow or orange with the end of the abdomen darkened Nests rarely found outdoors; however, almost any indoor crack and crevice close to sources of warmth and water. These ants do not swarm. Colonies multiply by "budding," in which part of an existing colony migrates, carrying brood with or without a queen to a new nesting site. Hundreds of queens and 10,000 - 100,000s workers may be present.	Baits: Advion Ant Bait Arenas Maxforce FC Ant Bait Station Niban FG Indoor crack and crevice spray and entry points: Phantom SC Outdoor entry points and trails around structure: Termidor SC	Because Pharaoh ant colonies are hidden and can occur in virtually any crack or crevice, baiting is the best way to get an insecticide back to the colony. Give a taste test of baits. Prebait entire structure with honey. Place a bait wherever ants are found. All queen(s) and all immatures must be killed to eliminate a colony. Spraying fast-acting insecticides for Pharaoh ants indoors often worsens the problem by causing the colony to split into many smaller colonies. Apply slower-acting sprays (Phantom, Termidor) around entry points during warm weather when ants are foraging outdoors.
ANTS - FIRE **SP 419, PB 1739, PB 1158, PB 1788** Fire ant infestations on home lawns are often managed with a two step approach: 1. Broadcast a fire ant bait over the entire lawn or area to be managed first. IGR baits are distributed especially well because they don't affect the worker. 2. 7-10 days later, apply granules, a drench, dust, or fast-acting bait (hydramethylnon, indoxacarb, abamectin, or spinosad) to the individual mounds that are likely to be encountered by people. A more thorough discussion of IFA management options are provided in the publications listed above. A list of products labeled for fire ants is updated regularly and can be found at "Imported Fire Ants In Tennessee" (fireants.utk.edu) under "Resources" and "Updates." For a list of "homeowner" products by price and application type (broadcast vs. individual mound treatment) see aces.edu/pubs/docs/A/ANR-0175-A/ANR-0175-A.pdf.			

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
ASIAN NEEDLE ANT entomology.ces.ncsu.edu/asian-needle-ant	Both workers and winged females can sting, especially when trapped against clothing. Workers (1/5 inch) and queens (1/4 inch) are dark brown, with the legs, mandibles and outer antennal segments slightly lighter. Workers with a middle, side of thorax that is smooth and shiny, a large squarish node on the waist, and a large stinger.	MAXFORCE COMPLETE Brand Granular Insect Bait in stations or broadcast Advion Ant Gel Optigard Ant Gel Bait	This ant does not form strong foraging trials and does not group recruit. Workers may be seen carrying another ant to a food source.
ANTS - OTHER PB 1629	Ants have elbowed antennae, a thread-like waist with one or two bumps. Unmated reproductive ants may have wings. If so, the front wings are larger than the hind wings. Workers ants are wingless. Ants are social insects. Colonies are usually established by a queen. Workers feed the queen, care for the brood and defend the nest. Workers travel along well-marked trails between the nest and food.	Baits: Advion Ant Bait Arena Advion Ant Gel Gourmet Ant Bait Gel Stations Niban FG Optigard Ant Gel Bait PT Advance 375A Select Granular PT 388B Advance Ant Gel Bait Terro-PCO (1%) Liquid Baiting Systems: Terro-PCO(1%) Dominant 1% Liquid Ant Bait Pyrethroid Sprays: Talstar P, Tempo SC Ultra Tempo Ultra WP Transport Suspend SC Demand CS Temprid Slower-acting, non-repellent spray: Termidor SC 0.06% (outdoor perimeter) Phantom SC indoor crack and crevice, outdoor entry points	Follow good sanitary and exclusion practices. Exploit worker caste by using baits. Find foragers and place bait near foraging trail. Workers then bring the poisoned bait back to the nest where it is distributed among the members of the colony. If ants are foraging indoors from an outdoor nest, exclude ants by sealing entry points such as window sills and door frames, or spray entry points into the structure.
BATS PB 1624	Night-flying creatures invade attics and similar areas.	Treat area with insecticides to control external parasites including fleas, mites, and bat bugs after bats excluded. See bed bugs.	Close entrance holes with one-way excluders to prevent bats from returning after they have left the resting area. Seal opening once all bats excluded. Do not exclude bats when young bats present. See details in PB 1624.
BED BUGS PB 1763, PB 1807, SP 761, SP 788	Flat, wingless insects. Torpedo-shaped white eggs (1/25 inch) glued to surfaces to rough surfaces. Five beige to light-brown nymphal stages 1/25 – ¼ inch long. Red to black gut contents of nymph can be seen through cuticle. Adults ¼ - 1/3 inch reddish-brown insect either oval-shaped when unfed or torpedo-shaped when fed. Bloodsucking. Night feeders. Confirm identification. Bat bugs easily confused with bed bugs. Pronotal hairs longer than width of eye for bat bug. If bat bugs are feeding on people, control will not be achieved until bats are excluded and area treated for ectoparasites.	Detection Canine scent detection team especially helpful for inspecting large buildings or areas (check for third-party certification). Monitoring Devices CLIMBUP Insect interceptor, white or black, insect-interceptor.com (Place bed or furniture leg into center well to aid detection of new infestations and protect against re-infestation. Important to prevent other bed bug access to bed and refill wells with talc as needed.) CLIMBUPS helpful to determine efficacy of treatment when placed additionally in other places around room. Newer version does not require re-talcing.	Check every crack and crevice in bedroom and elsewhere, if needed. Do not spray sheets or blankets. Some PMPs will not treat mattresses with insecticides because of potential human exposure, while others will cover treated mattresses and boxsprings with a bedbug proof encasement after treatment. Others may physically remove bed bugs with vacuums and then cover with bed encasement specifically designed to prevent bed bugs from biting through or escaping (i.e., Protect-A-Bed with BugLock 3-sided zipper system and ALLERZIP seal, or Mattress Safe "Ultimate" zippered encasement - zipper must be kept closed). Some insecticides may need to contact bed bugs directly to be effective.

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
BED BUGS CONT'D		BlackOut Bed Bug Detector protectabed.com/lightsout-bed-bug-detector-trap.html. The SenSci Volcano, senscionline.com, is smaller with square base to better fit against walls. Many monitors, check for validity by comparing research results. Mattress and Boxspring encasements Protect-A-Bed (BugLock 3-sided zipper system and ALLERZIP seal), Mattress Safe "Ultimate" encasement Others, ensure bed bug proofed Mattress seams, folds & edges Phantom Aerosol Steri-Fab Bedlam Plus EcoRaider Bed Bug Killer Other cracks and crevices Phantom Aerosol Transport GHP Temprid SC, RTS Tandem Zenprox EC, Aerosol EcoRaider Bed Bug Killer Bed Bug Patrol Dust for Voids CimeXa Drione PT Tri-Die Pressurized Silica + Pyrethrin Alpine Heat treatment (all bed bug stages will die when exposed to 122 F). Equipment to heat rooms or buildings, trailers, tents and small chambers is expensive and often requires numerous circuits or generators. For whole room treatments, remote monitoring of temperatures using electronic sensors (minimum 5) AND overhead sprinkler disablement or protection that is compliant with fire safety regulations is recommended. A printed report should show that all sensors, including those in tight crevices, reached 122 F. Post-treatment should include an inspection and use of monitoring devices to determine efficacy, vacuuming dead bed bugs and a perimeter application of DE or silica (see dusts above). Chemical Fumigation (for licensees only) Vikane	Resistance to pyrethroid insecticides is widespread. Rotate chemicals used and do not rely on one type (use nonresiduals, residuals and dusts). Foggers are ineffective. Incorporating nonchemical controls including vacuuming, low moisture steaming (AmeriVap, Hi-Tec Cleaning Systems, etc.), laundering (dryer on high for 30 minutes for dry clothes), and removing infested items may be necessary to manage bed bugs and may be more important as resistant bed bug populations are encountered. Cold takes longer to kill bed bugs. Bed bugs need to be exposed to ~0 F for at least 4 days and up to 2 weeks for all stages to die. Reducing clutter will reduce callbacks. Heat or chemical fumigation can be conducted on entire buildings or certain materials, including box springs and mattresses, placed in a permanent or temporary chamber. Fumigation does not provide residual control. Whole heat treatments of rooms should include a perimeter insecticide treatment to prevent bed bugs from moving to surrounding rooms. Wrapping and taping mattresses in black plastic and placing in sun does NOT heat the mattress evenly and does NOT reach the bed bug's lethal thermal threshold on the underside. Difficult-to-treat items (appliances, lamps, etc.) can be treated with Nuvan Prostrips in bags but may not kill all bed bugs in protected locations. CIRKIL rag-in-a-bag technique (cirkil.com/rag) may be more thorough, but odors may linger. See UT Extension publication PB 1763 for more details on bed bug biology. For additional bed bug information and equipment see our *Bed Bugs in Tennessee* website at bedbugs.utk.edu The NPMA has released *Bed Bug Best Management Practices*, pestworld.org/media/562243/npma-bed-bug-bmps-approved-20160728-1.pdf

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
BOOK LICE	Small, soft-bodied, cream-colored to grayish or light brown, wingless, fast-moving. Feed on molds, fungi. Found in books, cereals, wallpaper, boxes. May damage starched items.	PT Microcare Pressurized Pyrethrum Capsule Suspension PT 565 Plus XLO PT 221L PT Cy-Kick CS Pressurized Crack & Crevice Residual PT Tri-Die Silica & Pyrethrum Dust PT Tri-Die Pressurized Silica & Pyrethrin Dust	Large numbers of book lice develop under excessive humid conditions, moldy books, papers, bags or cereals. **Dry out infested areas.** Destroy infested material of little value. Space sprays of pyrethrins may cause the book lice to scatter throughout structure.
BOXELDER BUGS SP 341-H	Flat, ½ inch long, 1/3 inch wide, dark brownish-black, with 3 lengthwise red stripes behind the head. Wings leathery at base. Membranous at tip with red veins; abdomen is red. Nymphs are smaller, wingless and bright red.	Treat listed sites on label when bugs are first seen. Tempo SC Ultra Tempo Ultra WP Demand CS Demon WP WSP TalstarP Suspend SC Deltadust	These insects are attracted to buildings in the spring and fall. Large numbers collect on siding, around doors, sunny walls and attics. Use exclusion practices before pests become apparent. Inside, vacuum into a dry vac. Avoid use of space sprays if bugs found in wall voids. Dead bugs in wall voids could serve as carpet beetle food. Eliminate female (seed-pod-bearing) boxelder. Outside: vacuum the bugs into water mixed with 1 teaspoon of a liquid detergent per gallon of water in wet/dry vacuum cleaner tank.
BROWN MARMORATED STINK BUG extension.tennessee.edu/publications/Pages/default.aspx	BMSB adults are shield shape, about 5/8 inches long, just about as long as wide, mottled brownish grey with black antennae marked with a whitish band on the next-to-last segment, dark bands on the membranous part of the wings, and coppery or bluish metallic punctures (small, round depressions on the head and pronotum). Abdominal segments protruding from the wings are marked with black-and-white bands. Serious agricultural pest that may overwinter in homes. See eddmaps.org/bmsb/distribution.cfm?map=distribution for latest brown marmorated stink bug distribution.	If exclusion methods aren't working completely, they may be supplemented with professionally applied outdoor treatments. Products containing pyrethroids (bifenthrin, beta-cyfluthrin, cyfluthrin and lambda cyhalothrin) and neonicotinoids (acetamiprid and thiomethoxam) have been found to be effective against brown marmorated stink bug. In general, pyrethroids are faster acting than other chemistries; however, new pesticide labels limit professionally applied pyrethroids to 1-inch bands around windows and doors when the surface is over a hardscape. Insecticides will have limited persistence outdoors in the sunlight and rain and may not prevent the brown marmorated stink bug from entering structures. Alpine WSG Talstar P Suspend Polyzone Other pyrethroids (check label)	Pest-proof by late summer using techniques described in PB 1303. If supplemental pesticide applications are deemed necessary, make exterior spot, crack and crevice, and/or void applications where these pests may harbor or hibernate, such as cracks and crevices, in weep holes, wall voids, around window and door frames, attic vents and behind siding, in late summer/early fall before the pests arrive. Pyrethroid labels are more restrictive so read label carefully. Indoor light traps may help reduce populations inside and are most effective late winter/early spring when the bugs are leaving the structure. Vacuum bugs found inside into knee-hi stocking placed on the end of the vacuum tube prior to attachment placement. After vacuuming, remove knee-hi, tie off, place in a sealed bag and in outside garbage can. If BMSB found on walls in large numbers, they can be removed by removing the top of a capless plastic soda bottle at the widest part of the neck, inverting it and placing back on the bottle to create a funnel trap. When the edge of the modified bottle is moved up the wall toward a BMSB aggregation, the bugs will drop into the trap. Soda bottles can be sealed in a plastic bag and placed in the freezer for a few days. Frozen or drowned bugs can be disposed of outdoors in a garbage can or compost pile. Flushing BMSB down the toilet will waste water and is not recommended.

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
CARPENTER BEES	½ to 4/5 inch long with a blue-black, green or purple metallic sheen. Color and size resembles a bumble bee, but the top of the abdomen is hairless. These bees chew a circular, 3/8-inch entrance hole into wood and nesting gallery 4-6 inches long at a right angle to the entrance hole. Galleries used for several years may extend 10 feet. Carpenter bees overwinter in previously used galleries, so re-inspect and seal galleries in the fall.	Apply dusts into the gallery openings: Tempo 1D DeltaDust Apicide <u>Sprays:</u> Tempo SC Ultra (spray or foam) Tempo Ultra WP (spray or foam) PT Cy-Kick Suspend SC 0.06% Premise .05%-0.1% (spray or foam)	Use a badminton racket to kill flying adults or use a straight wire to break up cells in tunnels. Individual bees can be caught with a net and killed. In the spring, apply foam, spray or puff of insecticidal dust into nest holes in the evening when the carpenter bees are at rest. Allow bees access to the nest for 24 hours. Seal the hole with putty, 3/8 inch diameter dowel or cork to prevent re-infestation. Dusts are the preferred formulation because they coat the porous wood surface of the bee's gallery.
CARPET BEETLES SP 341-I **Black** Carpet Beetle Common; or Furniture; or **Varied** carpet Beetles	Adult 1/8 inch to 1/4 inch in length; black; brown legs. Larva 3/8 inch in length; carrot-shaped; covered with short hair and has long terminal bristles. Adults 1/8 inch long with white and orange; or yellow, white and black; or white, brown and yellow spots; larva with long black to brown hairs.	Thorough HEPA vacuuming of bed, bedding, carpet edges and upholstered furniture removes dander and pet fur that can serve as protein food for carpet beetles. Place wool or silk articles in sealed containers for long-term storage. Treat cracks, crevices and hidden area of walls, closets, stored materials, under carpets, etc. Do not apply insecticide to clothing. **See precautionary statements about pesticides staining carpets.** Tempo Ultra WP Tempo SC Ultra PT Cy-Kick Demand CS Suspend SC DeltaDust Kicker PT Tri-Die Silica & Pyrethrum Dust PT 565 Plus XLO PT Microcare CS Controlled Release Pyrethrum PT Microcare Pressurized Pyrethrum Capsule Suspension	Carpet beetles infest beds, carpeting, clothing, fur, upholstered furniture, books, bird nests, milk powders, articles of animal products, feathers, wool, silk and other materials of animal origin. Locate food source and remove, if possible. Use good housekeeping such as cleaning floor and carpets regularly. Dry clean clothes regularly. Stored materials subject to damage should be thoroughly cleaned and stored in tight container with moth crystals.
CENTIPEDES	Grayish creature with long feelers and many long, slim legs, one pair of legs per body segment. Fast moving. Long antennae.	<u>Indoors:</u> DeltaDust PT Tri-Die Pressurized Silica & Pyrethrin Dust PT Tri-Die Silica & Pyrethrum Dust Talstar P PT Cy-Kick Crack & Crevice Pressurized Residual PT Cy-Kick CS Controlled Release Cyfluthrin Tempo SC Ultra PT Microcare CS Controlled Release Pyrethrum <u>Outside Perimeter</u>: Demon WP WSP DeltaDust Tempo Ultra WP Tempo SC Ultra Cy-Kick Talstar P Talstar granulars DeltaGard G	Feed on insects. Larger species can bite. Usually not numerous. Active at night. Nonchemical control: leave a 12-18 inch bare zone around building foundations. Move wood piles and other clutter away from structure. Spot treat cracks and crevices, door thresholds and moldings where pests may crawl or as directed by label. Residuals may not provide total control. Treatments may need to come into direct contact with pest.

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
CHIGGERS	Very tiny immature mites which get on the person and cause blotches and itching. Don't usually invade homes, but occur in yards and wooded areas.	Use commercial repellents around ankles and waist for personal protection. Apply deet repellent to skin; and Permanone 0.5% spray to shoes, cuffs and socks, heed drying directions before wearing. Apply to infested areas of turf. Tempo SC Ultra Tempo Ultra WP Talstar P	Mow lawn regularly. Remove weeds and brambles from fence rows.
CLOTHES MOTHS SP 341-J	Brownish moths, wingspread 1/2 inch long. Larvae are 1/16-1/3 inch long. Gray silken cases or webbing over surface of fabric.	Vacuum prior to treatment and to remove potential food sources. Apply sprays to cracks and crevices in closets and spot treat other infested areas. Tempo Ultra WP Tempo SC Ultra Cy-Kick DeltaDust Suspend SC Kicker	Adults are not attracted to light and will fly to dark corner when disturbed. Larvae usually found on infested materials, wool, fur, feathers, hair, upholstered furniture, non-synthetic carpets, dust and lint. Do not spray clothes. Dry-clean susceptible items before storage or store with moth crystals in sealed storage container. Heed warning about staining clothing.
CLOVER MITES	Tiny (1/30 inch) mites, brown to olive green with pair of long front legs.	Apply sprays to points of entry such as foundations, windows and doors. Cy-Kick CS PT 221L Talstar P Mavrik Perimeter	Invade homes from the yard in great numbers in fall and spring. Stain walls or fabrics reddish-brown when crushed. Keep grass and shrubs from direct contact with house. Good weed control in turf and a vegetation free border of 12-18 inches around home will help.
COCKROACH German Cockroach Brown Banded or Furniture Cockroach Oriental Cockroach American Cockroach Smokybrown Cockroach	 About 5/8 inch in length, pale brown or tan with 2 parallel dark streaks on pronotum. Usually most abundant in the kitchen and bathrooms. 1/2 to 5/8 inch in length, dark brown with 2 pale bands traversing wings. Widely distributed throughout the house in walls, closets, furnishings, in appliances, but abundant in kitchens. 1 1/4 inches in length, dark reddish-brown to black, wings do not surpass end of abdomen. Usually found in lower floors, outdoors or in crawl space. Frequents water meters, floor drains or moist, dark areas. 1 1/2 inches in length, reddish-brown with pale yellow band around pronotum. May be found throughout house, outdoors, in crawl spaces, sewers, water meters and garbage cans. 1 to 1 1/2 inches, uniform, very dark brown to black; head shield is a solid, dark color. Takes harborage in moist, warm and dark places like tree holes, mulches, soffits in attics with poor ventilation.	Do not spray repellent or fast-acting insecticides near baits. Baits in cracks and crevices: Advion Cockroach Gel Bait Advion Cockroach Bait Arena Advion Evolution Alpine Cockroach Gel Bait Rotation 1 Alpine Cockroach Gel Bait Rotation 2 Maxforce FC Magnum Roach Killer Bait Gel Maxforce FC Select Roach Killer Bait Gel Maxforce Impact Roach Gel Bait Maxforce Roach Killer Small Bait Stations Maxforce Roach Killer Bait Gel Niban G Optigard Cockroach Bait Prescription Treatment Advance Cockroach Gel Bait Reservoir Prescription Treatment Avert Dry Flowable Cockroach Bait Form. 1 Vendetta Vendetta Plus Baits for large roaches: Advion Cockroach Gel Bait Maxforce Granular Bait Maxforce Roach Killer Bait Gel Maxforce FC Magnum Roach Killer Bait Gel MAXFORCE COMPLETE Brand Granular Insect Bait Maxforce Impact Roach Gel Bait Niban G Vendetta	Prevent access to food, water and shelter. Practice good sanitation in food handling, storage and eating areas. Control moisture, prevent leaks or condensation. Seal off harborage sites such as cracks and crevices with caulk, etc. Also use exclusion practices to prevent cockroach movement. Use glue boards or sticky traps placed along edges in dark places to locate and monitor cockroach populations. Baiting is the preferred method for cockroach control. Apply baits to cracks, crevices, pipe openings into walls, joints of furniture and cabinets, pipe conduits, and elsewhere as indicated by glue board catches. Rotate baits regularly. If you choose to spray, use precautions to keep chemicals out of food, spices, and off dishes or eating utensils. Do not apply sprays where electrical shorts may occur; use baits or dusts in these areas. Do not use sprays when baiting because cockroaches may be repelled from the baits. Read label carefully; some products may not be labeled for food handling areas.

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
COCKROACH CONT'D Turkestan Cockroach	1 inch; female dark brown with leathery, short, triangular wings that don't meet in the middle and cream stripe along edge; male orange-brown with edges of wings lighter, wings exceed length of abdomen. Often found in-ground containers, hollow block and other cracks and crevices. Sold as pet food via the internet.	Insect Growth Regulators for small roaches containing hydroprene (Gentrol Aerosol, Gentrol IGR Concentrate, Gentrol Point Source) or pyriproxyfen (Archer, Nylar or others). IGRs are slower acting but longer lasting - sterilizes adults. Lightly dust voids with: PT Tri-Die Drione DeltaDust NiBor-D Cimexa Crack and Crevice Sprays: TempoUltra WP, SC Ultra PT Cy-Kick CS Pressurized Crack & Crevice Residual Suspend Talstar P PT 221L Phantom Outdoor perimeter for large roaches PT Cy-Kick CS Controlled Release Cyfluthrin Suspend Tempo Ultra WP DeltaGard G Niban FG, G MaxForce Complete Granular Insect Bait	Increase ventilation in attic to reduce attraction to smokybrown cockroaches. American cockroaches often enter facilities through drains with a dry p-trap. Keep p-trap filled with water. Items, such as ProSet Trap Guard or Sure Seal Inline Floor Drain, prevent sewer gasses and cockroaches from escaping into living spaces, but still allow water to drain.
CRICKETS	Black, jumping insects with long antennae. Cave or camel crickets are humped and brown.	Baits: MaxForce Complete Granular Insect Bait Niban Granular Bait Sprays and dusts: Tempo Ultra WP Tempo SC Ultra Cy-Kick Demon WP WSP Demand CS Talstar P DeltaDust Suspend SC	Black cricket may damage clothing. Repeat treatment as needed. Spray entry points into structure. Dust crawl space. Camel crickets infest damp basements, under slabs and crawl spaces. Ventilate or dry these areas. Active at night. Apply sprays into cracks and crevices where crickets dwell. Use exclusion practices. Glue boards can be used indoors around entry points and other places in basements, etc.
EARWIGS	Easily identified by pair of "pinchers" at end of abdomen.	Outdoors: Talstar P Demon WP WSP Demand CS PT Cy-Kick CS Controlled Release Cyfluthrin	Earwigs are incidental invaders into houses. They usually dwell in leaf litter, mulch and woodpiles and are common "hitchhikers" on vegetables harvested from the garden. Moving compost piles away from the house will aid pest control. Insecticidal control is usually unnecessary for this insect. If needed, spray possible entry points and mulched area around the house.

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
FLEAS PB 1596	Small, 1/16" long, reddish-brown, wingless insect. Body compressed laterally, legs long and adapted for jumping.	**On pet:** **CATS, KITTENS and PUPPIES ARE MORE SENSITIVE TO INSECTICIDES!!!!!** Consult a veterinarian and always read label prior to treating a pet. **Veterinarian supplied products - usually kill fleas within 12 - 36 h or sooner and provide 90 - 95% control for about 30 days:** see pesticide recommendation at caes.uga.edu/content/dam/caes-website/departments/entomology/documents/ga-pest-management-handbook/2018-pmh/2017-homeowner/2018%20Animals.pdf for a thorough listing of veterinarian supplied on-pet products. **Indoor Premise C & C Treatment Spot treat infested areas and pet resting areas inside with following:** Insect Growth Regulators [and adulticides]: pyriproxyfen **(Archer** and others) pyriproxyfen [and permethrin or pyrethrin] **(PT Ultracide** and other ready-to-use products methoprene (**Precor IGR Concentrate**) methoprene [and pyrethrins etc]. **Precor 2000 Premise Plus Spray, Precor Plus 2625 Premise Spray** and other ready-to-use products Adulticides Suspend SC, Alpine WSG, others **Outdoors (when specified on label):** pyriproxyfen **(Archer** and others); Alpine WSG Demand CS (outdoors only); Suspend Talstar P Talstar PL Granular	**Keep pets and people out of treated area (indoors and outdoors) until spray dries.** Step 1. With veterinarian supplied products that are currently available, control of fleas in small-to moderate-sized infestations is likely to occur by using those pet treatment products alone. May take 2 months to completely break flea life cycle. Sprays of pyrethrum and pyrethroids may not work as well as the newer chemistry used in pet treatments because of insecticide resistance. If pet treatment alone does not provide sufficient control, initiate a complete control program by April. Step 2. Vacuum infested areas twice a week and prior to treatment to remove eggs, larvae, adults and organic matter. Steam cleaning carpet may also reduce populations. Eliminate fleas from pets, bedding and premises before departing on vacation. Step 3. Treat pet resting areas indoors and clean or remove pet bedding on the same day. Insect growth regulators important to break flea life cycle. A combination of an insect growth regulator and an adulticide may be the most efficient formulation to use. Difficult to kill pupae. Step 4. Mow grass, keep weeds down and trim shrubs to expose flea eggs and larvae to lethal desiccation. Irrigating areas surrounding buildings, but not against building, may kill fleas by drowning. If fleas are surviving outdoors, apply insecticide to labeled areas.
FLIES Face flies, cluster flies, and blue bottle flies	Adult flies of these three species hibernate in attics and wall voids. Cluster flies about 1/3" long, dark gray, with checkered black and silver abdomen, with gold hairs on thorax of newly emerged adults. Face fly similar in appearance to the house fly. Adult blue bottle flies have a dull gray thorax and a shiny blue abdomen.	Exclude flies in the fall by sealing entry points, screening behind all vents, sealing holes in walls and attics prior to pest entry in fall. Can apply pyrethroids to potential entry points prior to pest entry. Vacuum or use pyrethrin sprays to kill exposed flies. Use black light trap with sticky surface. Dust voids (boric acid not very effective) where flies may be over-wintering.	Cluster fly larvae are parasites of earth worms. Face fly larvae develop in cow patties. Adults overwinter in attics and wall voids. Blue bottle fly larvae develop in garbage, decaying meat, dead animals, fish and excrement.

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
FLIES CONT'D House flies	About 1/4" in length, dull gray color with 4 longitudinal dark stripes on the thorax.	**Remove larval food sources.** <u>Spray outdoor areas where flies rest such as garbage collection sites:</u> Tempo Ultra WP, Demon WP WSP Demand CS, Suspend SC, CyKick CS, Cynoff <u>Baits (rotate use of diamide, carbamate, and neonicitinoid)</u>**:** For use around commercial facilities. Should not be used inside or around homes, or any other place where children or pets are likely to be present. Zyrox Fly Granular Bait (diamide) Starbar Golden Malrin Fly Bait (carbamate) Starbar Quikstrike Fly Bait (neonicotinoid) Maxforce Granular Fly Bait (neonicotinoid) Maxforce Fly Spot Bait (neonicotinoid) Florida-Fly Baiter with Maxforce Fly Spot Bait (neonicotinoid) <u>EndZone Insecticide Sticker</u> Stickers work best when placed on or near a window or other light source. However, in the absence of light or under low-light conditions, stickers may be placed near a potential fly food source (such as inside a garbage can). If needed, use pyrethrin space spray for temporary relief inside home.	Larvae develop in warm organic matter of animal or vegetable origin. Remove trash at least twice a week to reduce fly populations in homes. Screen windows and doors. Garbage cans should have tight-fitting lids. Use insect light traps indoors. Sanitation is very important.
<u>Bottle Flies</u> Green Bottle Fly Blue Bottle Fly Bronze Bottle Fly Black Bottle Fly	 1/2" in length; green metallic color 1/2" in length; blue metallic color 1/2" in length; bronze metallic color 1/3" in length; shiny grey thorax and dull blue metallic abdomen.	**Remove larval food sources.** Spray outdoor areas where flies rest or try an insecticidal sticker (EndZone) indoors to reduce adult populations.	Bottle flies indoors often indicate a dead mouse or other animal in wall voids, attic, basement, etc. Dispose of dead animal carcasses, animal excrement, and other potential larval food sources such as decaying vegetation and garbage. Garbage cans should have tight-fitting lids.
Small Fruit Fly or Vinegar Fly	1/8" long, red eyes, tan head and thorax, abdomen gray-black. Some species have darker eyes.	**Remove larval food sources.** Check mops and brooms too. Use a wire brush, or foam or other application of microbials or botanical drain cleaners to labeled sites (which may include drains, baseboards, behind bars, drip trays, bundles of sticky syrup lines, grout ruts, under ice machines and other equipment), that should be cleaned, but are often neglected and difficult to clean. May need to be repeated. Traps may reduce adult fly populations. Use pyrethrin aerosols for temporary relief of adults.	Egg to adult in 8-11 days. Larvae in decaying fruit, vegetables and garbage cans, etc. Adults around larvae.

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
FLIES CONT'D Moth Fly Sewer Fly Drain Fly	Small, scaly or hairy, moth-like flies. Wing veins parallel.	**Remove larval food sources.** Remove moist organic materials, clean drains with wire brush or steam clean. Following initial mechanical cleaning in commercial accounts, botanical, microbial and/or enzymatic drain cleaners can be applied to labeled sites, which may include drains, waste water traps, etc., to maintain clean surfaces. A foam formulation may work best on vertical surfaces. Pyrethrins for temporary relief of adults.	Adults rest on walls or foliage. 3-4 weeks from egg to adult. Larvae found in slimy drains, sewer backup or leaks, unsanitary garbage cans, potted plant saucers, baths or feeders for birds, clogged roof gutters or storm drains, drip lines from air conditioners, moist compost, septic tanks and other places that hold very moist organic solids.
Phorid, Humpbacked Fly, or Scuttle Fly	Adult small, 1/16 - 1/8" long; brown, black or yellow; thorax humped when viewed from side. Dark veins along front edge of wing. Adult scuttles or "runs" erratically over surface.	**Remove larval food sources.** Check bottom of trash cans, cracks under appliances/equipment, garbage disposals, rotting vegetables and meats, mop heads, septic systems, and potted plants that have been overwatered, flowers in vases, mausoleums, and soiled bedding of animals. Use insect light traps to catch adults to determine if potential larval source nearby and to temporarily reduce adult populations. If source cannot be found, consider a cracked sewer or waste pipe. If sewer pipe the cause, remove slab, repair pipe and remove contaminated soil. Insecticidal sticker (EndZone) may also help reduce adult fly population.	Development time 11 days (85 F) to 28 days (72 F) for common species. Larvae found in moist decaying organic matter (feces, carrion, fungi and decaying plants). Phorid flies were abundant in 2009 and sometimes the larval source was outside in decaying vegetation near home.
FUNGUS GNATS SP 341-C	Adults 1/8 to 1/4 inch long. Slender larvae have shiny black head and white thread-like body. Adults attracted to light. Collect in windows and soil in potted plants. Run rapidly over surface.	Pyrethrins aerosol, insecticidal sticker (EndZone) or light traps may also help reduce adult fly population caused by moisture and decay from leaks including roofs. See SP 341-C for list of products labeled for adult and larval fungus gnats in interiorscapes. Need a category 3 certification and working under someone licensed in HRI to make interiorscape pesticide applications.	Larvae feed on fungi and plant root hairs. Avoid overwatering plants, letting soil dry between watering to reduce fungal food source. If plants are not the problem, look for water leaks or other moisture problems. Check flat roof and piles of pet bird droppings which can support fungal growth. Remove moisture or dry moist areas. May enter from outdoors. Rake and reduce mulch depth to 2-3 inches.
HEAD LICE SP 341-S	Tiny, flat insects which infest people and can be found on clothing.	Premise sprays are not recommended for head lice control. Several louse shampoos and other hair products are available for homeowner use.	Considered a medical pest with limited ability to live away from a human host. Wash infested clothing and bedding with strong soap and very hot water; tumble dry on high heat. Dry clean woolens. Do not share hair brushes, caps, etc. "Selfies" may also increase the probability of transmission. Use special combs to remove nits (eggs). Nits hatch by 10 days, so another application of head lice shampoo may be needed at this time. Follow label directions.
KUDZU BUG W 358	¼-inch long, almost square-shaped with a brown to olive-green color. The immature stages are similarly shaped but smaller and "hairy." Current distribution at kudzubug.org/distribution-map	If exclusion methods aren't working completely, they may be supplemented with professionally applied outdoor treatments. Insecticides should be applied around windows, doors and other entry points as is done for other occasional invaders. In general,	Exclude the pests before they start aggregating on structures to overwinter. Make spot, crack & crevice and/or void applications where these pests may harbor or hibernate, such as cracks and crevices, in weep holes, wall voids, around window and door frames,

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
KUDZU BUG CONT'D		pyrethroids are faster acting than other chemistries; however, new pesticide labels limit professionally applied pyrethroids to 1-inch bands around windows and doors when the surface is over a hardscape. Alpine WSG Tandem Talstar P Other pyrethroids and combination neonicotinoid & pyrethroids (check label)	attics and behind siding. Apply to exterior wall surfaces around entry points and resting areas where insects congregate. Vacuum bugs found inside into knee-hi stocking placed on the end of the vacuum tube prior to attachment placement. After vacuuming, remove knee-hi, tie off, and dispose in soapy water. Insecticides will have limited persistence outdoors in the sunlight and rain and may not prevent kudzu bugs from entering structures.
LADY BEETLE, MULTICOLOR ASIAN SP 503-C	Multicolored Asian Lady Beetles (MALB) start searching for overwintering sites, your home, on the first or second day when temperatures are greater the 65 F after a dramatic drop in temperature, usually to near freezing. This usually occurs about the third week in October.	Demand CS Suspend SC Talstar P Temprid FX, SC other pyrethroids	1. Pest-Proof: seal entry points before beetles arrive. 2. Treat roof lines or soffits, vertical contrast areas, and entry points (around the following outdoor items: windows, doors, vents, pipe penetrations) with pesticides before the beetles arrive. 3. Remove dead beetles as they pile up because they may cause other MALB to aggregate. 4. If the beetles make their way into the home, vacuum (with HEPA to prevent allergen circulation) or try a light trap.
MICE PB 1624	Adults weigh about ½ ounce. Dusky gray color, slender body, prominent ears, tail about as long as head and body. House mouse: 6-7 inches, feet small, and head small	Place snap traps, multiple catch traps and glue boards along paths traveled by mice. Traps or glue boards should be placed every 8-12 ft. Traps can be baited with: dry rolled oatmeal, bacon squares, small wads of cotton or gumdrops. Baited traps should be set at right angles to rodent runs. Place trap at right angles to rodent pathway with trigger part of trap against the run. EPA has changed allowances regarding use of rodenticide baits in the urban environment.	Mice move in from outdoors in fall as temperatures decline. Exclusion practices needed, mice can fit through an opening ¼ inch in diameter. Sanitation: remove access to food, water and shelter. Rodents use edges of walls, studs and pipes as guidelines. Remember to set traps where children and pets will not be hurt. Mice are curious and will normally approach traps the first night. If you don't catch a mouse in the first few nights, the trap is in the wrong location.
MILLIPEDES W 357	Slender, brownish, multi-legged, hard-shelled, 1-2" long. Two pair of legs per most body segments. Invade home from outdoors. Harmless.	Outdoors: Cy-Kick CS Cynoff WP Demand CS Suspend SC Talstar P Talstar PL (granular) Tempo SC Ultra Tempo Ultra WP	Millipedes are not insects, so insecticides are not always effective. Best control obtained when pest comes in direct contact with the insecticide. Usually occasional invaders and may invade in large numbers. Under these circumstances, nonchemical control may be more effective: remove mulch and other clutter from near the foundation, dethatch lawns and water in the morning. Prune tree limbs to dry their habitat. Use exclusion practices. Treat entry points into structure, shady areas, ivy beds, flower beds and rock walls, leaf-litter or as directed by label. Millipedes will die within 2-3 days after entering a dry structure.

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
MITES, BIRD OR RODENT	Mites occasionally found indoors because of rodent or bird nest in, on, or near structures. Some of these mites may bite people. They are small (about the size of a period), but can usually be seen with the naked eye.	Dust or spray cracks and crevices around infested area. Cimexa D-Fense SC Pyrethroid products containing bifenthrin, cyfluthrin, and deltamethrin may be effective but are not currently labelled for this pest, so would need to apply in cracks and crevices for other pests. If widespread, space sprays of pyrethrins may be necessary.	The first step in controlling bird or rodent mites is to eliminate the host animals and remove their nesting sites. Often, the nests will be found in the attic, around the eaves and rafters or in the gutters or chimney. Gloves should be used when handling dead animals. A respirator should also be worn when removing nest materials to avoid inhaling fungal spores and other potential disease-producing organisms associated with the droppings. See chiggers for repellents.
MOSQUITOES SP 503-B	Delicate insects that bite humans and animals. Larvae and pupae in water. Adults stay in shrubbery, crawl spaces, etc. See the new mosquito control association, Tennessee Mosquito and Vector Control Association, tennmosquito.com for training opportunities.	Treat standing water with: *Bacillus thuringiensis israeliensis* (Bti): Aquabac xt, 200G Teknar CG and G, Vectobac G, GS and 12AS methoprene (IGR) Altosid XR-G, Pellets, Liquid, XR- briquets, briquets Pre-Strike Granules Spinosad Natular G, G30, XRT, T30 For *Culex* mosquitoes in septic conditions, treat standing water with: *Bacillus sphaericus* Vectolex FG, WDG, WSP Outside Area ULV applications by ground equipment for use by trained professional personnel: Anvil 10 + 10 Biomist 3 + 15 ULV Biomist 1.5 + 7.5 Biomist 30 + 30 ULV Kontrol 30 + 30 Mosquitomist One Outside residual barrier (permethrin, malathion, Tempo, Suspend, Talstar and others) can be applied to the underside of vegetation around home and on perimeter of property that is prone to rapid infestation of mosquitoes. This kills adults resting in these sites and some may act as a repellent. *Aedes* species found closer to ground (<10 ft) and *Culex* found higher in the canopy. Spray other shady damp areas where mosquitoes rest. **If needed** indoors, use sprays containing pyrethrins in closets, stairwells, behind and beneath furniture for temporary relief.	To reduce mosquito populations, a complete mosquito control program must be followed. See UT Extension publication PB 1685 The Tennessee Mosquito Control Handbook (Pesticide Applicator Licensing Manual) for more details. Pesticide applicators applying mosquito-control pesticides on public lands and waters need to be certified in category 8 and licensed in PHMC. Eliminate larval sites (standing water) around structure by unclogging gutters, emptying bird baths, children's pools, pet bowls, flower pot saucers, old tires, and other containers around home twice a week. Drain or fill low areas where water collects. Easiest to control mosquitoes in immature stage because confined to water. Treat standing water with labeled insecticide. Repair screens. People should wear repellents when potentially exposed to mosquitoes. The CDC recommends repellents with these active ingredients: N,N-diethyl-m-toluamide (DEET) Picaridin IR3535 Oil of lemon eucalyptus (OLE) or para-methane-diol (PMD) 2-undecanone **Do not use OLE or PMD on children under 3 years of age. Do not use repellents on babies younger than 2 months old.** Mosquito netting can be used over infant carriers, cribs and strollers. Do not apply repellent to skin under clothing. If using sunscreen, apply sunscreen first and insect repellent second. More information on repellents and their safe use can be found at cdc.gov/westnile/prevention/index.html EPA's search tool (epa.gov/insect-repellents/find-repellent-right-you) helps find repellents.

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
MOSQUITOES CONT'D		A more extensive list of mosquito control products for commercial and government agencies can be found at caes.uga.edu/content/dam/caes-website/departments/entomology/documents/ga-pest-management-handbook/2018-pmh/2017-commercial/2018%20Mosquito.pdf These products have not been verified to be registered in Tennessee.	Children and adults can wear clothing with long pants and long sleeves while outdoors. DEET or other repellents such as permethrin can also be applied to clothing (don't use permethrin on skin), as mosquitoes may bite through thin fabric. Reduce the number of areas where adult mosquitoes can find shelter by cutting down weeds adjacent to the foundation and in yards, and mowing the lawn regularly.
PANTRY PESTS Saw-Toothed Grain Beetle Cigarette Beetle Indianmeal Moth Rice Weevil Confused Flour Beetle Red Flour Beetle	 Brownish black, 1/8" long, flattened with 6 saw-tooth like projections on thorax. Feeds in a wide variety of stored products, cereals, nuts, dried fruit, cookies. candy, etc. 1/8" long, oval, reddish brown, head not visible from above, antennae saw-like. General feeder in tobacco, seasonings especially paprika, cereal, dried flowers, and a wide variety of stored foods. 3/8" wing span, inner 2/3 of wing grayish, outer 1/3 of wing mottled copper and black. Feeds in coarse grain products, chocolate, nuts, dried fruit. 1/8" long. Long snout on head, dark brown with 4 bright spots on wing cover. Feeds in grains. 1/8" long, reddish-brown, antennae gradually enlarged to end in a club. Cannot fly. Feeds in flour and cereal products. 1/8" long, reddish-brown, antennae has a distinct 3-segmented club and can fly. Feeds in flour and cereal products.	**Locate food source and discard.** Place grains, flours, nuts and other stored products in insect proof containers when they are brought home from store. Pheromone traps can indicate the presence of pests and may provide control without insecticides when populations are low and pests confined. Vacuum cracks and crevices and wipe down pantry to remove pests and food source. Do this before insecticidal application, also. Do not contaminate food, dishes, shelves or utensils with pesticides. If insecticide application desired, direct spray into cracks and crevices of storage cabinet shelves when shelves are clean and all food and utensils, etc., removed. Treat only cracks and crevices in the pantry. Do not wash off insecticide residue. Cover with paper if desired. pyrethrins Tempo SC Ultra Cy-Kick DeltaDust Suspend SC PT Cy-Kick CS Pressurized Crack & Crevice Residual PT Microcare Pressurized Pyrethrum Capsule Suspension PT Tri-Die Pressurized Silica & Pyrethrin Dust Drione	To prevent infestations: 1) Inspect stored products periodically, 2) Practice good sanitation, 3) Rotate stored product use so older stores are used first and none remain in storage indefinitely, 4) Have adequate ventilation to prevent moisture buildup in storage areas. 5) Insect proofing; use insect-proof package or storage procedures wherever possible. 6) Pheromone traps can indicate the presence of pests and are available for: Indian meal moth, saw-toothed grain beetle, confused and red flour beetle, cigarette beetle, drugstore beetle, clothes moths and others. Nonchemical control: Either destroy the infested products or salvage them by super heating to 140 F for ½ hour, or super cooling in a deep freeze at 0 F for at least 4 days. Store insect-free beans in containers with tight lids.

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
POWDERPOST AND OTHER WOOD-BORING BEETLES PB 1703 **Powderpost Beetles** Lyctid powderpost beetle Anobiid powderpost beetle **Roundheaded borers** Old house borers Others	**Shot-sized holes along with flour-like powder indicate these beetles.** Attacks hardwoods such as oak, ash and hickory found in solid and laminate ring porous hardwood floors and furniture; molding, window and door frames, and wood paneling. Antennae with 2-segmented club. Frass talc-like, smooth, not gritty. Head protrudes forward. Re-infests seasoned wood. Attack hardwoods and softwoods (beams, rafters, joists, studs and other structural framing). Infestations found in moist, poorly ventilated areas such as crawl spaces, basements, etc. Frass gritty. Head hidden by pronotum. Reinfest seasoned wood that may be decades old. **Presence indicated by large hard-shelled beetles with long antennae.** Broadly-oval ¼ inch emergence hole made by old house borer. Larvae in tunnels packed with frass; 3 eye spots to left and right of mandibles. Beetle 3/4 inch long, grey-brown with 2 patches on wing covers; 2 bumps on thorax. Reinfests seasoned softwoods (pine). Neat ½ inch holes may appear in walls where beetles emerge. Don't usually reinfest seasoned softwoods (pine).	Products listed in this column refer to treatment for all reinfesting wood-boring beetles listed. Beetles that have pupated prior to insecticide application may be unaffected and may continue to emerge. Insecticide applications should prevent reinfestation. Products containing disodium octaborate tetrahydrate (DOT) and glycols (**Bora-care, etc.)** may penetrate wood further than other residuals, but penetration is variable and depends on moisture content of the wood and other factors. Other DOT products include **Tim-bor**, **Armor-Guard and others**. DOT treatments must be made to unfinished surfaces as they will not penetrate paint or varnish; sand or power wash logs prior to treatment. Paint, spray, inject or brush on. If infestation spreads into walls or between floors, fumigation may be needed. Fumigation is costly and should only be considered as a last resort. If only small articles infested, such as furniture, antiques, etc., they can be fumigated in a chamber at a lower cost. Only professional pest control operators licensed to fumigate can perform this operation. Rule 0080-09-04-.07 (New 2017) Now allows preventive treatment for reinfesting beetles, but prior to treatment, wood moisture content in the intended treatment area must be tested using a moisture inspection instrument designed to read moisture content in wood; at least five locations should show moisture content of at least 18%. The commercial pest control operator should provide a written report to the property owner listing and diagramming the conditions that warrant a preventative treatment.	Determine extent of infestation. Signs for powder post beetles are: flour-like "frass" dropping from pinhead-sized or slight larger holes, Anobiids' frass are more gritty than Lyctids; adult beetles attracted to light may be found on window sills or foundation vents. Important to determine if infestation active or not. Mark or seal existing holes, vacuum existing sawdust, recheck wood for new holes in spring or early summer. These beetles damage wood slowly. If "frass" is yellow, caked or covered with dust or debris, that damage is old. Old house borers can be detected by hollow sound when wood tapped. **Prevention:** 1) Don't use old lumber from a barn or wood pile unless it has been treated. (2) Don't use improperly dried or stored lumber. (3) Inspect firewood prior to bringing into structure. (4) Paint, varnish or otherwise seal wood to prevent exposed edges. (5) Seal previous emergence holes to prevent egg-laying sites. New houses usually infested by use of infested lumber. Adults may also come from firewood. **Alternative controls** for powder post beetles: small items, such as picture frames, can be heated at 120 to 140 F for six hours to kill existing life stages. Freezing (0 F) infested wood for 72 hours will also kill all life stages. If all evidence indicates the infestation is localized, wood could be replaced. Watch for new holes in adjacent areas. Decrease moisture in wood through ventilation and moisture barriers. Crawlspaces can also be enclosed. Central heat and air may reduce wood moisture so there is insufficient moisture to support large infestations in living areas. Wood kept below 14 percent moisture would be less suitable to Anobiid powderpost beetle reinfestation or development. Professionals should use moisture meters.

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
RATS PB 1624 EPA has changed allowances regarding use of rodenticide baits in the urban environment. Check for latest updates before using baits.	Norway rat: 12-18 inches, tail shorter than head and body, body heavy and thick, ears small Roof rat: 12-17 inches, tail longer than head and body, body light and slender, ears larger Young rat : 6-7 inches, feet large, head large House mouse: 6-7 inches feet small, head small Droppings: Roof rat: pointed, about ½ inch Norway rat: blunt, about 3/4 inch House mouse: pointed, about 1/8 inch	When rats are plentiful or where unsanitary conditions exist with shelter, poisoned baits are the best control method. Often community-wide control needed. Poison baits are available as ready-to-use premixed baits. They come in many forms: paraffinized blocks for outdoor use and high humidity areas; treated meal; seeds; or paraffinized pellets in bulk or in "place packs" for indoor use. Liquid baits are sold as packets of concentrate that are mixed with water. They are administered with a chick waterer and are useful in areas where rodent food is abundant. Poison baits should be placed where they are inaccessible to children and pets. Where rodent runs are exposed and in most outdoor situations, tamper proof bait boxes should be used and anchored. Vitamin K is the antidote for anticoagulants. **Second-Generation Anticoagulant Products for Professional Applicators** must contain at least 16 pounds of bait. Bait stations are required for all outdoor, above-ground placements of second-generation anticoagulants. Bait stations are required indoors if exposure to children, pets, or nontarget animals is possible. Distribution to and sales in “consumer” stores including grocery stores, drug stores, hardware stores, club stores will be prohibited. All outdoor above-ground use must be in a bait station and be applied within 100 feet of buildings.	Exclusion practices needed. Rats can fit through an opening ½ inch in diameter. Locate entrance into structure and exclude. Use materials such as galvanized, stainless or other non-rusting metal such as 24-gauge sheet metal or 19-gauge hardware cloth with 1/4 inch or smaller opening; brick, concrete block, tile or glass; steel wool or copper mesh with expandable foam; and others. Remove debris such as piles of waste lumber or trash, used feed sacks, abandoned large appliances and wood piles from next to structure. Store pet foods and seed in rodent-proof glass or metal containers. Place snap traps, multiple catch traps and glue boards along paths traveled by rats. Of the snap traps, the expanded trigger trap is the most versatile since it can be baited. Place trap 90 degrees to rodent pathway with trigger part of trap against the run. Rodents use edges of walls, studs and pipes as guidelines. Snap traps can be baited with: raisins or grapes for roof rats; sardines packed in oil for Norway rats; bacon squares; or small wads of cotton. All rodenticides should be confined to tamper-resistant bait boxes. Baiting should be reserved for heavy rodent infestations, especially outdoors, due to the potential for rodents to die in accessible locations (no rodenticide drives rats outdoors to die). Many rats are shy of new baits. Consider pre-baiting with nontoxic baits. Leave bait stations in place for at least a week before moving. **Often area-wide effort needed.**
SILVERFISH AND FIREBRATS SP 341-O	Grayish, wingless, rapid-moving insects with 3 long tails. Feed on starchy materials such as bookbinding, wallpaper, cardboard, etc.	Niban Fine Granular Bait Maxforce Complete Granular Insect Bait, Maxforce Fine Granule Insect Bait Tempo Ultra WP Cy-Kick Demand CS PT565 XLO PT Tri-Die Silica & Pyrethrum Dust (+Pressurized) Suspend SC DeltaDust Drione Talstar P	Treat crack and crevice where silverfish and firebrats may dwell. Attics many times source of infestation.
SKUNKS PB 1624	These animals many times live in the ground around or under homes.	Bac-Azap biological odor control or others can be applied to eliminate odors.	Trap and remove skunks from property. Seal the foundation to prevent entry under building.
SNAILS AND SLUGS	Long, grayish, shiny, soft-bodied creatures. Will attack various plants. Leave slime trails on walks and walls.	Snail and slug killer baits containing metaldehyde.	Remove boards and plastic or plant debris and dry damp areas adjacent to foundation.

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SNAKES PB 1624	Snakes of various kinds den around or invade homes and other buildings. Most snake species are harmless and many provide benefits, such as control of rodents. Most venomous snakes in Tennessee can be recognized by their triangular-shaped head and vertical eye pupils.	Place a pile of cool, damp rags in building where snake was last seen. Snake will be attracted and can be removed. Large glue boards can trap snakes. Relocate the snake and use vegetable oil to dissolve the glue and release the snake unharmed.	Mouse-proof building. Mow lawns and field to control grass, weeds and brush. Remove boards, flat rocks, trash piles and other debris.
SOWBUGS OR PILLBUGS	Grayish, hard-shelled, many-legged creatures appear on walks and patios. Roll up in ball when disturbed. Occasional invaders.	Chemical control usually not necessary. If needed, apply to infested areas outdoors around perimeter of structure. This may stop any invasion into the house. Talstar P DeltaDust Suspend SC Tempo SC Ultra Astro	Remove leaf piles, grass clippings, old boards, wood piles and other debris from around foundation. Leave a 12-18-inch plant /mulch-free zone next to foundation base. Use exclusion practices: caulk cracks around foundation and screen vents in foundation. Drain and dry area around house.
SPIDERS or SCORPIONS PB 1193 PB 1191	Many kinds invade homes, basements and roof overhangs from outdoors. Two species most dangerous in Tennessee: **Black Widow**: dark black spider with red hour glass shape on bottom of abdomen. More of an outdoor pest along perimeter of buildings. Use outside perimeter treatment with residuals. **Brown Recluse**, light brown spider, with legs reaching to the size of a quarter or half dollar, dark violin shape on back of front portion of head, 3 pairs of eyes arranged in a semi-circle. Brown recluse pose a serious threat. Remove unnecessary clutter and webs from indoors and outdoors and vacuum especially, under furniture.	Dusts: Cimexa DeltaDust EcoPCO® D•X Dust Insecticide Tempo 1D PT Tri-Die Pressurized Silica & Pyrethrin Dust Drione Sprays: Demand CS Tempo Ultra WP Tempo SC Ultra Cy-Kick Suspend SC TalstarP Space or aerosol: pyrethrins Brown Recluse: Use residual sprays **(Demand, Tempo, Cy-Kick,** or others) around exterior foundation, eaves, closets, storage areas and rugs. Dusts can be applied to wall voids, attics and inaccessible crawl spaces and cracks and crevices. ULV or aerosol treatment with pyrethrins to kill exposed spiders and flush others onto surfaces treated with residuals.	Beneficial organisms because they feed on pest insects. Occasional invaders that can be vacuumed or swept out the door. Remove wood or mulch piles away from house to lower abundance of their insect food source. Apply insecticides to crawl spaces, basements, attic, eaves and outdoor areas of home. Clean up debris where scorpions and spiders hide. Replace outdoor lights with yellow bug lights. Scorpions will fluoresce under a black light, so they and their breeding areas can easily be seen at night. Use glue boards to trap spiders and locate infested areas. Glue boards should be placed against walls and other guidelines where spiders are suspected. Efforts to control brown recluse will cause spiders to become more active. Prevent bites by checking shoes and clothing before wearing, by pulling beds away from walls, and preventing bed skirting and bedspreads from touching the floor. Place glue boards around home or structure to monitor activity and help reduce spider numbers.
SPRINGTAILS	Small, jumping insects with a forked spring mechanism. A dark species, called snow fleas, may be present in the winter.	If pest-proofing unsuccessful, try a perimeter treatment as for other occasional invaders. Cy-Kick CS Suspend SC Talstar P DeltaGard G Mavrik Perimeter	Usually found in moist decaying vegetation and are incidental invaders into houses. Prevent entry into home by pest-proofing. There are a few reports of large populations entering homes. Dry out surrounding landscape, water only in morning, etc.
TERMITES, SUBTERRANEAN PB 1344	Termites invade and eat wood and other cellulose material, causing extensive damage in structural parts of a building. Their presence may not be discovered until they swarm, years after infesting a structure. Workers light-colored, soft-bodied insects 1/8 to 3/16 inch long, soldier with a darkened head capsule.	+ F = may also be foamed **Soil treatment:** Do not apply near (within 100 ft.) any body of water, cistern, or well. **Altriset 0.05%** (DuPont) chlorfenapyr **Phantom 0.125, 0.25%** (BASF) + F fipronil	Termidor allows an **Exterior Perimeter/Localized Interior treatment (EP/LIT) and** Premise allows an **Exterior Perimeter/Interior Spot Treatment**. Ensure localized interior treatment is made.

PESTS	DESCRIPTION	CONTROL MATERIALS AND METHODS	REMARKS
TERMITES, SUBTERRANEAN CONT'D	Swarmers are black, brown or tan with wings. Wings are easily broken off after the mating flight and may be found by windows. Swarmers are easily distinguished from winged ants by termite's straight antennae, broadly attached thorax to waist and four nearly equal wings. Subterranean termites with 2 thickened wing veins traveling the entire length of the fore wing. Inspect for signs of termite infestation such as irregular earthen tubes constructed across walls, floors and foundation. Hammer or probe timbers with a sharp instrument. Damaged wood will be soft, channeled, unsound and may possibly reveal the termite infestation itself. Use a moisture meter. Active termites will increase moisture reading relative to uninfested areas. Termites commonly enter homes around doors, wooden steps and porches and unexcavated portions of structures. The easiest access points are where wood is in direct contact with the soil. Some termiticide labels have listed variable rates depending on soil type. Suggested volumes listed below are usually for the lowest rate. In general, horizontal barriers (under slab) should receive 1 gallon of diluted termiticide per 10 square feet or 1.5 gallons if coarse fill. Vertical barriers (along both sides of foundation wall, around plumbing, piers and conduits) should receive 4 gallons of dilution per 10 linear feet per foot of depth (into a trench 6 inches wide) to the top of the footing, not to exceed 4 ft. Voids in hollow masonry foundation walls should be treated at a rate of 2 gallons per 10 linear feet so the dilution will reach the top of the footing. Occasionally, moisture damaged wood in roofs can support an aerial infestation. No mud tubes will reach to ground. Attic inspection is important, too.	Nonrepellents (Newer a.i.s) Termites do not detect these insecticides and walk over the treated soil. Termiticide may be transferred back to colony. Chlorantraniliprole (no signal word) **Termidor HE 0.125%** (BASF) Applications (2 gal/10 lin.ft., up to 2 ft deep, trench only 2 inch deep X 4 inch wide, 18 inch drill holes) differ from other liquid treatments, see Label for details. **Termidor HP, HPII** High Precision Injection System, see Label for details. **Termidor SC, 0.06%, 0.09%, 0.125%** (BASF) +F **Termidor 80WG, 0.06%, 0.09%, 0.125%** (BASF)+F imidacloprid **Premise 75, 0.05, 0.1%** (Bayer)+F **Premise 2 (small jobs and foaming)** (Bayer) Pyrethroids (Older a.i.) In general, this group tends to be repellent, thus treatments must be applied very carefully to create a continuous barrier. Today's uses restricted mostly to pre-construction treatments. Many generic pyrethroids are now on the market. bifenthrin **TalstarP 0.06, 0.12%** (FMC) + F permethrin **Prelude 0.5, 1, 2%** (Amvac) +F Combination product **Transport** 0.11% bifenthrin and acetamiprid (FMC) A more complete list of termiticides is available at freshfromflorida.com/content/search?SearchText=termiticides but not all FL termiticides listed may be registered in Tennessee. **Baits:** Termites feed on bait and spread bait to colony to eliminate or suppress it. See PB 1344 for advantages and disadvantages of baits. **Sentricon Colony Elimination System** (DowAgrosciences LLC): Bait (**Recruit IV and Recruit IV AG**) contains a chitin synthesis inhibitor, noviflumuron. Bait **Recruit HD** allows once-a-year monitoring. **Hex-Pro Termite Baiting System** (DowAgrosciences LLC): Bait (**Shatter**) contains a chitin synthesis inhibitor, hexaflumuron. **Exterra Termite Interception and Baiting System** (Ensystex, Inc.) The Labyrinth Termite Bait contains a chitin synthesis inhibitor, diflubenzuron. In ground and above-ground stations. **Advance Termite Baiting System** (Whitmire-MicroGen) contains a chitin synthesis inhibitor, diflubenzuron. **TrelonaATBS** (BASF) contains a chitin synthesis inhibitor, novaluron.	Tennessee Department of Agriculture now prefers the use of a disclosure form if less than a complete treatment is applied. Applications following the Exterior Perimeter/Interior treatments of Termidor or Premise are now considered a full treatment. New NPMA 33 Wood-destroying Insect Infestation report required for most real estate transactions. Sample form and directions are found at npmapestworld.org **Follow the product label. Effective control measures for a soil treatment should include:** 1) Inspect basement and underside of house thoroughly to determine the area and extent of infestation. 2) Inspect attic for termite tubes and damage to joists, rafters, flooring and stored materials. 3) Trench the entire foundation inside and out and treat the soil replaced in the trenches with chemicals. 4) Repair all foundation and basement floor and wall breaks with concrete of high cement content. 5) Break all wood-soil contacts, treat such areas with chemicals. 6) Treat infested timbers and replace those which are badly infested. 7) Treat hollow spaces in the foundation — concrete blocks, piers, chimney bases, spaces behind brick veneer. Drill and treat inside of porch foundations, under patios, under concrete slabs and the surface of ground under porches and similar dead places. 8) Provide ventilation and drainage beneath house and porches or enclose crawlspace. 9) Remove all scrap wood from beneath house.

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TERMITES, DRYWOOD agrilife.org/aes/files/2010/06/Drywood-Termites.pdf	Swarmer with 3 thickened wing veins along the first third of the forewing. Soldier head capsule either rectangular with teeth on inner margin of left mandible or plug-shaped. All soldiers with pronotum as wide as, or wider than, head capsule. Workers feed in and across wood grain and leave six-sided fecal pellets piled below gallery openings. **No** mud present in galleries. Do **not** require connection to soil.	**Spot or Localized Treatment** Timbor (dust form) Termidor SC Termidor Foam Termidor Dry Others **Whole Structure or Chamber Fumigation** Sulfuryl Fluoride (requires structural fumigation license) Vikane Zythor Heat	Drywood termites may be controlled with a spot or localized treatment if the colony is small and accessible. If they are widely dispersed in structural lumbers, then a whole-house fumigation may be needed. Small infested items can be fumigated in a chamber. Although drywood termite distribution maps do not include Tennessee, several established populations are known from the Nashville area. Drywood termite infestations are most often introduced in furniture from Gulf Coast states, California or other subtropical areas.
TICKS PB 726	Brown or grey, oval to round, hard-shelled, 6-to-8-legged creatures which invade homes, yards and attach to pets and people. Depending on species, ticks can vector pathogens that cause disease.	Insecticide applications are most effective when directed into areas where ticks and their animal hosts are likely to frequent. Pay particular attention to borders and fences between wooded or brushy areas and the lawn, around ornamental plantings, beside foot paths, house and dog house. Allow surface to dry before people or pets have access. Tempo SC Ultra Tempo Ultra WP Suspend DeltaGard G Talstar P Astro and other synthetic pyrethroids Indoors for brown dog tick: Demand CS Talstar P Cy-Kick other pyrethroids Repellents: Apply deet to skin; and Permanone 0.5% spray to shoes, cuffs and socks. Heed directions about drying before wearing. Dogs: See pesticide recommendations at caes.uga.edu/content/dam/caes-website/departments/entomology/documents/ga-pest-management-handbook/2018-pmh/2017-homeowner/2018%20Animals.pdf for a thorough listing of veterinarian supplied on-pet products	Nonchemical methods for reducing tick problems include mowing the lawn and controlling weeds. This has three advantages — it lowers the moisture in the grass microclimate and allows sunlight to penetrate, which tends to cause ticks to dry out; it discourages rodents (which may serve as hosts) from nesting; and lastly, because there is less plant matter, less pesticide may be needed if a treatment is necessary. Also, removing debris, weeds or clutter from around the house discourages rodents from nesting. Discourage wildlife from entering property. Ticks require a host that can be wildlife. Repair entry points into the house to discourage possible tick hosts from entering. Cracks and crevices, both indoors and out, can be sealed to reduce hiding places for ticks. Inspect and clean pets and their bedding frequently. If bedding is infested, it can be cleaned or destroyed. In the home, ticks stay around baseboards and walls. Use insecticides in cracks and crevice in the home for brown dog tick. Insecticide resistance can be a problem, particularly with the brown dog tick. Steam and vacuuming can suppress populations.
WASPS, HORNETS, YELLOW JACKETS SP 290-A SP 341-M	Many types build paper and mud nests around homes, in ground or in shrubs.	Dusts: Tempo 1D DeltaDust Drione Apicide Sprays: Bee and wasp killer aerosols Tempo Ultra WP Tempo SC Ultra PT Wasp Freeze II Victor Yellow Jacket Trap Traps can used to reduce foraging yellow jacket populations. Place away from areas people congregate.	Wait until dark when wasps return to nest and are slower due to cooler temperatures. Apply insecticides to nest opening and seal nest opening if possible. Remove mud nests in winter to destroy overwintering forms. Paper wasp and other exposed wasp nests can be treated with pressurized sprays of insecticidal soaps, peppermint oil, eugenol and other natural insecticides. These insecticides most commonly work as contact killing agents only, so re-treatment may be needed.

Trade Name	Chemical Name or Use	Website
Advance Termite Bait System	diflubenzuron	BASF http://pestcontrol.basf.us/products/product-index.html
Advion Ant Bait Arena	indoxacarb	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
Advion Ant Gel	indoxacarb	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
Advion Cockroach Bait Arena	indoxacarb	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
Advion Cockroach Gel Bait	indoxacarb	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
Advion Evolution Cockroach Gel Bait	indoxacarb	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
Advion Insect Granule	indoxacarb	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
Alpine Cockroach Gel Bait Rotation 1	dinotefuran	BASF http://pestcontrol.basf.us/products/product-index.html
Alpine Cockroach Gel Bait Rotation 2	dinotefuran	BASF http://pestcontrol.basf.us/products/product-index.html
Alpine WSG	dinotefuran	BASF http://pestcontrol.basf.us/products/product-index.html
Altosid Briquets (B), Liquid Larvicide, Extended Residual Briquets (XR-B), Pellets (P), Extended Residual Granular (XR-G), Pro G	(s) methoprene	Central Life Sciences https://www.centralmosquitocontrol.com/all-products
Altriset Termitcide	chlorantraniliprole	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
Anvil 10 + 10	sumithrin and PBO	Clarke Mosquito Control http://www.clarke.com/
Apicide	carbaryl	Mystic Chemical Company https://www.mysticchemical.com/product-labels/
Aquabac xt, 200	Bacillus thuringiensis subspecies israelensis toxin	Becker Microbial Products http://beckermicrobialproductsinc.com/#!/products
Archer	pyriproxyfen	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
Arilon	indoxacarb	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
Armor-Guard	disodium octaborate tetrahydrate	Perma-Chink Systems https://www.permachink.com/preservatives/armor-guard
Astro	permethrin	FMC http://www.fmcprosolutions.com/
Bac-Azap	enzyme-producing bacteria and others	Nisus http://www.nisuscorp.com/
Bedlam Plus	d-phenothrin. MGK-264, imidacloprid	McLaughlin, Gormley, King Co https://mgk.com/professional-pest-control/
Biomist 3 + 15 ULV, 1.5 + 7.5 ULV, 30 + 30 ULV	permethrin and PBO	Clarke Mosquito Control http://www.clarke.com/
Bora-Care	disodium octaborate tetrahydrate	Nisus http://www.nisuscorp.com/
CimeXa	amorphous silica gel	Rockwell Labs http://www.rockwelllabs.com/

Cirkil	Neem oil	Terramerra, Inc. http://cirkil.com/products, http://cirkil.com/rag
Cynoff EC	cypermethrin	FMC http://www.fmcprosolutions.com
CB-80	pyrethrin, PBO	FMC http://www.fmcprosolutions.com
D-Fense SC	deltamethrin	Control Solutions Inc. http://www.controlsolutionsinc.com/
DeltaDust	deltamethrin	Bayer http://www.backedbybayer.com/pest-management
DeltaGard G	deltamethrin	Bayer http://www.backedbybayer.com/pest-management
Demand CS	lambda cyhalothrin	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
Demon WP WSP	cypermethrin	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
DominAnt 1% Liquid Ant Bait	Sodium Tetraborate Decahydrate (Borax)	Nisus http://www.nisuscorp.com/
Drione	silica gel and pyrethrins	Bayer http://www.backedbybayer.com/pest-management
EcoPCO® D•X Dust Insecticide	2-phenethyl propionate & pyerthrins	Zoecon http://www.zoecon.com/products/botanicals
EcoRaider Bed Bug Killer	natural geraniol, cedar extract, sodium lauryl sulfate and natural derivative surfactant	EcoRaider https://ecoraiderusa.com
EndZone Insecticide Sticker	Acetamiprid	FMC http://pestsolutions.fmc.com/
Exterra Termite Interception & Baiting System, Labyrinth Termite Bait	diflubenzuron	Ensystex http://www.ensystex.com/
Gentrol Aerosol, IGR concentrate	hydroprene	Zoecon http://www.zoecon.com/sds-labels
Gentrol Point Source	hydroprene	Zoecon http://www.zoecon.com/sds-labels
Gourmet Ant Bait Gel	disodium octaborate tetrahydrate	Innovative Pest Control Products http://www.antcafe.com/index.html
Intice Thiquid Ant Bait	1% borax	Rockwell labs http://www.rockwelllabs.com/
Jecta	10% disodium octaborate tetrahydrate	Nisus http://www.nisuscorp.com/
Kicker	pyrethrin and PBO	Bayer http://www.backedbybayer.com/pest-management
Kontrol 30-30	permethrin and PBO	Univar http://masterline.com/product-documents
Mavrik Perimeter	tau-fluvalinate	Zoecon http://www.zoecon.com/sds-labels
Mattress Safe	bed encasement	Mattress Safe http://www.mattresssafe.com/
Maxforce Ant Killer Bait Gel	fipronil	Bayer http://www.backedbybayer.com/pest-management
Maxforce Roach Killer Small Bait Stations	hydramethylnon	Bayer http://www.backedbybayer.com/pest-management
Maxforce Carpenter Ant Bait Gel	0.001% fipronil	Bayer http://www.backedbybayer.com/pest-management
Maxforce Fleet	0.001% fipronil	Bayer http://www.backedbybayer.com/pest-management

Maxforce FC Magnum Roach Killer Bait Gel	0.05% fipronil	Bayer http://www.backedbybayer.com/pest-management
Maxforce FC Roach Bait Stations	fipronil	Bayer http://www.backedbybayer.com/pest-management
Maxforce FC Select Roach Killer Bait Gel	fipronil	Bayer http://www.backedbybayer.com/pest-management
Maxforce Fly Spot Bait	imidacloprid, Z-9-tricosene.	Bayer http://www.backedbybayer.com/pest-management
Maxforce Impact Roach Gel Bait	clothianidin	Bayer http://www.backedbybayer.com/pest-management
Maxforce Roach Killer Bait Gel	hydramethylnon	Bayer http://www.backedbybayer.com/pest-management
Maxforce Quantum Ant Bait	0.03% imidacloprid	Bayer http://www.backedbybayer.com/pest-management
MAXFORCE®COMPLETE Brand Granular insect Bait	1% hydramethylnon	Bayer http://www.backedbybayer.com/pest-management
Maxforce Granular Fly Bait	imidacloprid	Bayer http://www.backedbybayer.com/pest-management
Mosquitomist One	chlorpyrifos	Clarke Mosquito Control https://www.clarke.com/mosquito-products
Natular 2E,G,G30, XRT and T30	spinosad	Clarke http://www.clarke.com/index.php
Niban FG = Niban Fine Granular Bait	orthoboric acid	Nisus http://www.nisuscorp.com/
Niban G = Niban Granular Bait	orthoboric acid	Nisus http://www.nisuscorp.com/
NiBor-D	disodium octaborate tetrahydrate	Nisus http://www.nisuscorp.com/
Nuvan Prostrip	dichlorvos	AMVAC http://www.amvac-chemical.com/Products/tabid/102/Default.aspx
Optigard Ant Gel Bait	thiamethoxam	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
Optigard Cockroach Gel Bait	emamectin benzoate	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
Optigard Flex	thiamethoxam	Syngenta http://www.syngentapmp.com/labels/labelsearch.aspx
Phantom,PT, Phantom®II pressurized insecticide	chlorfenapyr	BASF http://pestcontrol.basf.us/products/product-index.html
Precor Plus 2000 Premise Spray	permethrin, methoprene, phenothrin, etc.	Zoecon http://www.zoecon.com/sds-labels
Precor Plus 2625 Premise Spray	etofenprox,tetramethrin, pyrethrins, PBO and s-methoprene.	Zoecon http://www.zoecon.com/sds-labels
Precor IGR Concentrate	methoprene	Zoecon http://www.zoecon.com/sds-labels
Premise 75, 2	imidacloprid	Bayer http://www.backedbybayer.com/pest-management/
Prelude	permethrin	AMVAC http://www.amvac-chemical.com/ContactUs/ProdDet/tabid/103/Default.aspx?pid=193
Prescription Treatment Advance 375A Select Granular Ant Bait	0.011% abamectin	BASF http://pestcontrol.basf.us/products/product-index.html
Prescription Treatment 388B Advance Ant Bait Gel	5.4% sodium tetraborate decahydrate (borax)	BASF http://pestcontrol.basf.us/products/product-index.html
Prescription Treatment Advance Cockroach Gel Bait Reservoir	0.5% dinotefuran	BASF http://pestcontrol.basf.us/products/product-index.html

Prescription Treatment Alpine Dust	dinotefuran and diatomaceous earth	BASF http://pestcontrol.basf.us/products/product-index.html
Prescription Treatment Avert Dry Flowable Cockroach Bait Form 1	abamectin	BASF http://pestcontrol.basf.us/products/product-index.html
Prescription Treatment Cy-Kick, Cy-Kick CS	cyfluthrin	BASF http://pestcontrol.basf.us/products/product-index.html
Prescription Treatment® Microcare® 3% CS Controlled Release Pyrethrins	pyrethrin, PBO + Other	BASF http://pestcontrol.basf.us/products/product-index.html
Prescription Treatment Tri-Die Dust, PT Tri-Die Pressurized	silica, pyrethrin, PBO	BASF http://pestcontrol.basf.us/products/product-index.html
PT Wasp Freeze II	Prallethrins	BASF http://pestcontrol.basf.us/products/product-index.html
Prescription Treatment Ultracide	nylar (pyriproxyfen), pyrethrins, permethrin, etc.	BASF http://pestcontrol.basf.us/products/product-index.html
Prescription Treatment®221L Residual Insecticide	lambda-cyhalothrin	BASF http://pestcontrol.basf.us/products/product-index.html
Prescription Treatment® 565 Plus XLO Formula 2	pyrethrin, PBO + others	BASF http://pestcontrol.basf.us/products/product-index.html
Protect-A-Bed with BugLock™ 3 sided zipper system and ALLERZIP™seal (bed encasement for bed bugs)	bed encasement	Protect-A-Bed hhttp://www.protectabed.com/ttp://www.protect-a-bed.com/
Recruit IV, Recruit IV AG, Recruit HD	noviflumuron	DowAgroSciences http://www.cdms.net/Label-Database
Sentricon Colony Elimination System	noviflumuron	DowAgroSciences http://www.cdms.net/Label-Database
Shatter	hexaflumuron	DowAgroSciences http://www.cdms.net/Label-Database
Starbar Golden Malrin Fly Bait	methomyl	Wellmark- Zoecon http://www.zoecon.com/sds-labels
Starbar Quikstrike Fly Bait	dinotefuran, z-(9) tricosene	Zoecon Professional Products https://www.zoecon.com/products
Steri-Fab	d-phenothrin isoproponal & others	Noble Pine Products Company http://www.sterifab.com/home.html
Suspend SC	deltamethrin	Bayer http://www.backedbybayer.com/pest-management/
Suspend Polyzone	deltamethrin	Bayer http://www.backedbybayer.com/pest-management/
Talstar P, PL	bifenthrin	FMC http://pestsolutions.fmc.com/
Tandem	thiomethoxam and lambda cyhalothrin	Syngenta http://www.syngentapmp.com/
Teknar CG, G	*Bacillus thuringiensis* subspecies *israelensis* toxin	Valent BioScience http://publichealth.valentbiosciences.com/products
Tempo Ultra WP	β-cyfluthrin	Bayer http://www.backedbybayer.com/pest-management
Tempo SC Ultra	β-cyfluthrin	Bayer http://www.backedbybayer.com/pest-management
Temprid SC, RTS	imidacloprid, β-cyfluthrin	Bayer http://www.backedbybayer.com/pest-management
Termidor Dry, for drywoods or to supplement other subterranean termite treatments	fipronil	BASF http://pestcontrol.basf.us/products/product-index.html

Termidor SC, 80 WG, HE, HP, HPII, Foam	fipronil	BASF http://pestcontrol.basf.us/products/product-index.html
Terro-PCO Liquid Ant Bait	5.4% borax or sodium tetraborate decahydrate	Nisus http://www.nisuscorp.com/
Tim-bor	disodium octaborate tetrahydrate	Nisus http://www.nisuscorp.com/
Transport GHP Insecticide	bifenthrin, acetamiprid	FMC http://pestsolutions.fmc.com/
Transport Termiticide Insecticide	bifenthrin, acetamiprid	FMC http://pestsolutions.fmc.com/
Trelona® ATBS	novaluron	BASF http://pestcontrol.basf.us/products/product-index.html
VectoBac GS, G, 12AS	*Bacillus thuringiensis* subspecies *israelensis* toxin	Valent BioScience http://publichealth.valentbiosciences.com/products
VectoLex FG, WSP, WDG	*Bacillus sphaericus*	Valent BioScience http://publichealth.valentbiosciences.com/products
Vendetta	abamectin B1	MGK http://www.mgk.com/professionalpestcontrol/
Vendetta Plus	abamectin B1, pyriproxyfen	MGK http://www.mgk.com/professionalpestcontrol/
Vikane	sulfuryl fluoride	Douglas Products http://www.cdms.net/Label-Database
Zenprox EC	etofenprox and PBO	Zoecon http://www.zoecon.com/sds-labels
Zenprox Aerosol	etofenprox, tetramethrin, pyrethrins and PBO	Zoecon http://www.zoecon.com/sds-labels
Zyrox Fly Granular Bait	cyantraniliprole	Syngenta http://www.syngentapmp.com/
Zythor	sulfuryl fluoride	Ensystex http://www.ensystex.com/pdf/labels/Zythor%203-9.pdf

PRECAUTIONARY STATEMENT

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store, or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

DISCLAIMER STATEMENT

This publication contains pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. The label takes precedence over the recommendations found in this publication. Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others which may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product. The author(s), The University of Tennessee Institute of Agriculture and the University of Tennessee Extension assume no liability resulting from the use of these recommendations.

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Access PSEP Education Materials by Clicking on the Following Links

SP 363-H: Pesticide Recordkeeping Requirements for Private Applicators
extension.tennessee.edu/publications/Documents/SP363-H.pdf

PB 654: Safe Pesticide Practices
extension.tennessee.edu/publications/Documents/PB654.pdf

SP 363-E: Licensing of Commercial Pest Control Operators
extension.tennessee.edu/publications/Documents/sp363-E.pdf

SP 363-F: Certification of Commercial (Restricted-Use) Pesticide Applicators
extension.tennessee.edu/publications/Documents/SP363-F.pdf

PB 1595: Using Pesticides in Greenhouses
extension.tennessee.edu/publications/Documents/PB1595.pdf

SP 363-D: Tennessee Commercial Applicator Recertification Point System
extension.tennessee.edu/publications/Documents/sp363-D.pdf

SP 363-G: Pesticide Recordkeeping Requirements for Commercial and Licensed Applicators and Dealers
https://extension.tennessee.edu/publications/Documents/SP363-G.pdf

W 448: Preventing Crop Protection Agent Residue Problems in Tobacco
https://extension.tennessee.edu/publications/Documents/W448.pdf

PSEP Information Packet
psep.utk.edu/secondlevel/info/INFO-679/Info-Packet-679.htm

THE 2018 INSECT AND PLANT DISEASE CONTROL MANUAL

Prepared by the
Department of Entomology and Plant Pathology
University of Tennessee Extension
July 2018

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