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2009 Insect Control Recommendations for Field Crops

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

THE UNIVERSITY of TENNESSEE UT
INSTITUTE of AGRICULTURE

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2009 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, the 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:

- **Fall Stalk Destruction**
  Destruction of cotton stalks as soon as possible following harvest reduces the food supply for boll weevils, thereby reducing the size of the overwintering population.
- **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 budworm populations is well-established in Tennessee. In non-Bt cotton, adequate control of tobacco budworms cannot be expected with pyrethroids. If tobacco budworms are not a small percentage of the population, pyrethroid tank mixtures are not recommended. 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, the 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.

Insect Control Termination

The plant physiological stage of "cutout" can be determined when the uppermost first-position white bloom has only five fruiting branches (nodes) above it (NAWF = 5). Counting from the top, the first branch has an unfolded leaf the size of a quarter.

At "cutout" stage, cotton is not as attractive to late-season insects. Economic thresholds can be adjusted to higher levels in early August than those used during the critical fruiting period (node 6-16) in June and July. Late insecticide applications can often be terminated when considering harvestable bolls that contribute to yield. Fall armyworm and European corn borer are exceptions to this late-season termination and can damage even mature bolls if not controlled. Because leaves continue to contribute photosynthate for bolls to mature, the crop should be protected from excessive defoliation due to pests such as loopers or spider mites.

Nodes above White Flower (NAWF)

An effective decision-making guide for insecticide termination is using heat unit accumulation for a measurement of boll maturity. Current research and demonstrations suggest that accumulating 350 – 450 heat units (DD60s) from the "cutout" date (NAWF = 5) 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. Bolls should be protected during this maturing period, approximately 18-21 days. Related research indicates that this rule also generally applies to the tarnished plant bug and stink bugs.

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 – 2 day-old larvae.
- Two treatments on a 4 – 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

Cotton containing *Bacillus thuringiensis* (Bt) genes will continue to be available for planting 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 damage 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. An insecticide treatment may be justified if an unusually high egg lay occurs in Bt cotton, especially for the original Bollgard technology. Spray coverage and timing are critical for best control.

Resistance Management Plan – Refugia

A refuge of non-Bt cotton is required for Bollgard cotton. A refuge is not required for Bollgard II or WideStrike cotton varieties, but planting a refuge is still a potentially valuable resistance management strategy. Acreage of non-Bt cotton will provide a source of susceptible moths for mating with resistant moths that survive in Bt cotton. Designated refugia acreage should be located adjacent to or in close proximity of Bt-cotton acreage. The refuge should be managed with the intent of producing a viable, vigorous crop.

Refuge guidelines for Bollgard cotton require a producer to select among several options. The following information is intended as a summary of these options. Please refer to the grower licensing agreement and refuge guidelines provided by the company for complete details.

- **Option 1 requires a 20 percent or greater acreage planted to non-Bt cotton.**
  This acreage can be treated with conventional insecticides, except foliar Bt products, to control all caterpillar species as well as other pests. All Bt fields must be within one mile, but preferably one-half mile, of the refuge field.
- **Option 2 is a 5 percent non-Bt refuge that <u>can not</u> be treated for bollworm or tobacco budworm.**
  The refuge must be 150 feet wide, and all Bt fields must be within one half mile of the refuge. This refuge acreage should not be treated with insecticides that control caterpillar pests. Non-caterpillar pests should be treated according to treatment thresholds, but there are restrictions on the kinds and rates of insecticides that can be used (see current licensing agreement).
- **Option 3 is a 5 percent non-Bt, embedded refuge that can be treated for bollworm and tobacco budworm only when Bt fields are also treated.**
  If the embedded refuge is treated for bollworm or tobacco budworm, the associated Bollgard field or field unit must be treated at the same time with the same insecticide. Foliar Bt products cannot be used on the refuge. The refuge must be part of a field or field unit and at least 150 feet wide. A "field unit" is defined as any group of fields that are contained within one square mile.

Bollgard II and WideStrike Cotton

Bollgard II and WideStrike cottons are more effective than the original Bollgard technology, including better activity on bollworm, armyworms and loopers. Research indicates that Bollgard II and WideStrike cotton will require fewer insecticide applications for control of caterpillar pests. New thresholds and scouting procedures are not fully developed for Bollgard II or WideStrike cotton. If bollworm infestations are found, use the existing thresholds for the original Bollgard technology. Do not expect control of cutworm infestations. Bt cotton does not control tarnished plant bugs, stink bugs or other non-caterpillar pests.

Boll Weevil

Tennessee is currently conducting a boll weevil eradication program, and boll weevils should not cause economic damage to any cotton fields. **Evidence of boll weevil infestations should be reported immediately to boll weevil eradication officials.** Although ULV malathion has activity on plant bugs and stink bugs, do not rely on applications by the Boll Weevil Eradication Program to control these pests. The timing or frequency of applications may not be adequate to provide control.

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 fifth true leaf	Thrips	Aphids, Cutworms
Fifth true leaf to first square	---	Aphids, 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 the 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 control cutworms.

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)	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
cypermethrin (Ammo 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
thiodicarb (Larvin 3.2)	0.6	24 oz	5.3
β-cyfluthrin (Baythroid XL 1)	0.0065 – 0.0125	0.8 – 1.6 oz	160 – 80
γ-cyhalothrin (Prolex 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, additional treatment may be needed even when preventative controls have been used. Treat when cotton is up to a stand and thrips average one or more per plant and damage is observed.

Under some conditions, in-furrow treatments may adversely affect stand. A recommended fungicide should be used in fields where in-furrow systemic insecticides are used. Aphids and early spider mites are also suppressed by in-furrow systemic insecticides. Refer to the label for rate changes when using in-furrow materials for hill-dropped cotton.

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 Granules:			
aldicarb (Temik 15G)	0.525 – 0.75	3.5 – 5 lb	---
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
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
Treated Seed:			
acephate 90 (Orthene 90S)	20 – 25 oz Orthene 90S per 100 lb seed, 2.5 – 3.25 oz Orthene 90S/acre for hopper box (to achieve application rate of 3 – 4 oz per acre)		
imidacloprid (Gaucho Grande 5); Aeris contains imidacloprid at recommended rate	0.375 mg active ingredient per seed (about 5.3 oz Gaucho Grande per 250,000 seed, not to exceed 12.8 oz Gaucho Grande per 100 lb seed)		
thiamethoxam (Cruiser 5); Avicta Complete Cotton contains thiamethoxam at recommended rate	0.34 mg active ingredient per seed (about 4.8 oz Cruiser 5FS/250,000 seed)		

* Acephate and methamidophos are preferred if western flower thrips are present in significant numbers.

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. *Consecutive insecticide applications at a 4-5 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 Dry Product
PLANT BUGS – phase I, pre-bloom window*			
acetamiprid (Intruder 70WSP)	0.048	1.1 oz	14.5
flonicamid (Carbine 50WG)	0.081 – 0.089	2.6 – 2.8 oz	6.2 – 5.7
imidacloprid 4.44 (Trimax Pro)	0.047 – 0.062	1.35 – 1.8 oz	95 – 71
imidacloprid 4.0 (Couraze Max)	0.047 – 0.062	1.5 – 2.0 oz	85 – 64
thiamethoxam (Centric 40WG)	0.0375 – 0.05	1.5 – 2.5 oz	10.7 – 8
PLANT BUGS – phase II, blooming window			
acephate 90 (Orthene 90S)	0.30 – 0.45	0.33 – 0.5 lb	3 – 2
acephate 97 (Orthene 97SP)	0.30 – 0.45	0.31 – 0.46 lb	3.2 – 2.2
chlorpyrifos (Lorsban 4, Nufos 4)	0.33 – 0.5	10.7 – 16 oz	12 – 8
dicrotophos (Bidrin 8)	0.31 – 0.5	5 – 8 oz	25.6 – 16
dimethoate 4	0.25	8 oz	16
malathion 5	1.25	32 oz	4
novaluron (Diamond 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. A minimum of two applications is usually required when high populations are present.

*** Some pyrethroid insecticides should provide adequate control of plant bugs in areas where resistance is not established. However, tank mixes with reduced rates of other Phase II recommended insecticides are often suggested.

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)	0.026 – 0.048	0.6 – 1.1 oz	26.7 – 14.5
dicrotophos (Bidrin 8)*	0.25 – 0.5	4 – 8 oz	32 – 16
dimethoate 4*	0.125 – 0.25	4 – 8 oz	32 – 16
flonicamid (Carbine 50 WP)	0.044 – 0.089	1.4 – 2.8 oz	11.4 – 5.7
imidacloprid 4.44 (Trimax Pro)	0.031 – 0.047	0.9 – 1.35 oz	142 – 95
imidacloprid 4.0 (Couraze Max)	0.031 – 0.047	1 – 1.5 oz	128 – 85
thiamethoxam (Centric 40WG)	0.031 – 0.05	1.25 – 2 oz	12.8 – 8

* Because of resistance, these products may only provide suppression.

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).

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 – 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 control failures occur.

Bt Cotton
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 and/or 2 percent boll damage is found. Treatment based on eggs alone is not usually recommended (see Bt Cotton Management). Scout fields once each week pre-bloom and twice per week after blooming has begun (July-August). 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)	0.05 – 0.1	3.2 – 6.4 oz	40 – 20
cypermethrin (Ammo 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 – 0.02	1.6 – 2.6 oz	80 – 49
γ-cyhalothrin (Prolex 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
TOBACCO BUDWORM			
acephate 90 (Orthene 90S)	0.9	1 lb	1
emamectin benzoate (Denim 0.16)	0.01 – 0.015	8 – 12 oz	16 – 10.7
flubendiamide (Belt 4)	0.063 – 0.094	2 – 3 oz	64 – 42.7
indoxacarb (Steward 1.25)	0.11	11.3 oz	11.3
methomyl (Lannate LV 2.4)	0.45	24 oz	5.3
profenofos (Curacron 8)	0.75 – 1	12 – 16 oz	12 – 8
rynaxypyr (Altacor 35 WDG)	0.066 – 0.088	3 – 4 oz	5.3 – 4
spinosad (Tracer 4)	0.045 – 0.089	1.4 – 2.8 oz	90 – 45
thiodicarb (Larvin 3.2)	0.6 – 0.9	24 – 36 oz	5.3 – 3.6
Tank mix products + Pyrethroids (at median rates):**			
acephate 90 (Orthene 90S)	0.45	0.5 lb	1.8
chlorpyrifos (Lorsban 4, Nufos 4)	0.5	16 oz	8
methomyl (Lannate LV 2.4)	0.3	16 oz	8
profenofos (Curacron 8)	0.5	8 oz	16
thiodicarb (Larvin 3.2)	0.3	12 oz	10.7
Other mixtures or Pre-mixed insecticide options:			
acephate 90 (Orthene 90S) + thiodicarb (Larvin 3.2)	0.45 + 0.45	8 + 18 oz	2 + 7.1
profenofos (Curacron 8) + thiodicarb (Larvin 3.2)	0.8 + 0.3	16 + 12 oz	10 + 10.7

* Insecticides listed for tobacco budworm should also control bollworm, but pyrethroids are recommended when the population is exclusively bollworm.

** Do not use if tobacco budworms are a significant part of the infestation or if larval densities are high.

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 12-16 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)*	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 – 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 (Zephyr 0.15, Zoro 1.5)	0.0047 – 0.0094	4 – 8 oz	32 – 16
bifenazate (Acramite 4)	0.375 – 0.75	16 – 24 oz	8 – 5.3
bifenthrin (Brigade 2, Discipline 2)*	0.06 – 0.1	3.8 – 6.4 oz	33 – 20
dicofol 4	1 – 1.5	32 – 48 oz	4 – 2.6
dimethoate 4*	0.25	8 oz	16
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
fenpyroximate (Portal 0.4)	0.05 – 0.075	16 – 24 oz	8 – 5.3
profenofos (Curacron 8)*	0.5 – 1	8 – 16 oz	16 – 8
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.

The original Bollgard cotton does not provide adequate control of fall armyworms. However, Bollgard II and WideStrike cotton provide better control of fall armyworms, and 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 lb	1
emamectin benzoate (Denim 0.16)	0.01 – 0.015	8 – 12 oz	16 – 10.7
flubendiamide (Belt 4)	0.0625	2 oz	64
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)	0.039 – 0.078	6 – 12 oz	21.3 – 10.7
profenofos (Curacron 8)	0.75 – 1	12 – 16 oz	10.6 – 8
rynaxypyr (Altacor 35 WDG)	0.044 – 0.088	2 – 4 oz	8 – 4
spinosad (Tracer 4)	0.067 – 0.089	2.1 – 2.8 oz	60 – 45
thiodicarb (Larvin 3.2)	0.6 – 0.9	24 – 36 oz	5.3 – 3.6

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

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

The original Bollgard cotton does not provide adequate control of beet armyworms. Bollgard II and WideStrike cotton provide better control of beet armyworms, and supplemental applications of insecticide may not be necessary.

Insecticide (Trade Names) for BEET ARMYWORM	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
emamectin benzoate (Denim 0.16)	0.0075 – 0.01	6 – 8 oz	21.3 – 16
flubendiamide (Belt 4)	0.0625	2 oz	64
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
rynaxypyr (Altacor 35 WDG)	0.044 – 0.088	2 – 4 oz	8 – 4
spinosad (Tracer 4)	0.067 – 0.089	2.1 – 2.8 oz	60 – 45

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.

The original Bollgard cotton does not provide adequate control of loopers. Bollgard II and WideStrike cotton should not require treatment for loopers.

Insecticide (Trade Names) for LOOPERS	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
emamectin benzoate (Denim 0.16)	0.01 – 0.015	8 – 12 oz	16 – 10.7
flubendiamide (Belt 4)	0.0625	2 oz	64
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
spinosad (Tracer 4)	0.067 – 0.089	2.1 – 2.8 oz	60 – 45
thiodicarb (Larvin 3.2)	0.6 – 0.9	24 – 36 oz	5.3 – 3.6

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 – 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
thiamethoxam (Centric 40 WG)	0.05 – 0.063	2.0 – 2.5 oz	8 – 6.4

Premixed Insecticide Products

The following products are available as premixes of two 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 at mid-labeled rates.

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)
Bidrin XP (dicrotophos, bifenthrin)*	5.0 – 6.4 oz	25.6 – 20	Plant bugs, stink bugs, bollworm
Brigadier (imidacloprid, bifenthrin)	5.1 – 7.7 oz	25.1 – 16.6	Plant bugs, stink bugs, bollworm
Cobalt (chlorpyrifos, γ-cyhalothrin)	24 – 38 oz	5.3 – 3.3	Plant bugs, stink bugs, bollworm
Endigo ZC (thiamethoxam, λ-cyhalothrin)	4.0 – 5.5 oz	32 – 23.3	Plant bugs, stink bugs, bollworm
Hero (bifenthrin, Z-cypermethrin)	5.2 – 10.3 oz	24.6 – 12.4	Stink bugs, bollworm
Leverage (imidacloprid, cyfluthrin)	3.8 – 5.0 oz	33.7 – 25.6	Plant bugs, stink bugs, bollworm

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

Cotton Insecticide/Miticide Performance Charts

Disclaimer: The following ratings are based on a general consensus from multiple efficacy trials across the Mid-south. 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. Whether single or multiple insecticide applications are made may also influence performance. Ratings are shown for recommended use rates. Efficacy is often influenced by using higher or lower use rates.

Cotton – Insecticide Performance of At-planting Treatments for Pre-Squaring Pests

Insecticide	Mites	Aphids	Thrips
Avicta CP (0.34 mg ai thiamethoxam/seed)	Disruptive	9	8
Cruiser (0.30-0.34 mg ai thiamethoxam/seed)	Disruptive	9	8
Gaucho Grande (0.375 mg ai/seed)	Disruptive	8	8
Orthene 90S, In-Furrow (1 lb/a)	Disruptive	0	8
Orthene 90S, Seed Treatment. (20-25 oz/cwt)	Disruptive	0	7
Temik 15G (3.5 lb/a)	6	8	9

Disruptive, may flare spider mites.

Cotton – Insecticide Performance Ratings for Hemipteran and Homopteran Pests

Insecticide	Tarnished Plant Bug	Stink Bugs		Cotton Aphid
		Green & S. Green	Brown	
Ammo (3 – 5 oz)	5*	7	4	Disruptive
Asana XL (6 - 9 oz)	5*	7	4	Disruptive
Baythroid XL (1.8 – 2.5 oz)	6*	8	6	Disruptive
Bidrin (6 – 8 oz)	9	9	9	6*
Brigade / Capture (4 – 6 oz)	7.5*	9	8	Disruptive
Carbine (2.6 – 2.8 oz)	7	4	3	9
Centric (2 oz)	8	7	4	9
Denim (8 – 12 oz)	3	3	3	0
Diamond (6 – 9 oz)	7 (immatures only)	5 (immatures only)	3 (immatures only)	0
Dimethoate (8 oz)	6	6	6	5*
Intruder (1.1 oz)	6.5	6	3	9.5
Karate (1.8 – 2.2 oz)	7*	9	6	Disruptive
Lorsban (12 – 16 oz)	5	5	4	Disruptive
Malathion ULV (12 – 16 oz)	6	7	5	Disruptive
Methyl parathion 4 (16 oz)	5	9	9	Disruptive
Mustang Max (2.8 – 3.2 oz)	7*	9	7	Disruptive
Orthene (0.5 lb)	8.5	8	8	Disruptive
Prolex (1.3 – 1.8 oz)	7*	9	5	Disruptive
Steward (11.3 oz)	3	3	3	Disruptive
Trimax Pro (1.35 oz)	7	6	3	8
Vydate (10 – 12 oz)	8	7	7	Disruptive

Disruptive, may flare aphids. * Efficacy varies substantially due to resistance.

Cotton – Insecticide and Bt Cotton Performance Ratings for Lepidopteran Insects

Trade Names or Traits	Bollworm*	Tobacco Budworm*	Beet Armyworm	Fall Armyworm	Soybean or Cabbage Looper	Saltmarsh Caterpillar	Black Cutworm
Alticor (3 - 4 oz)	8	9	8?	7?	8?	?	?
Belt (2 -3 oz)	7	8	8?	7?	8?	?	?
Curacron (12 – 16 oz)	6	5	Disruptive	6	3	5	?
Denim (8 – 12 oz)	7	7	8	6	8	8	?
Diamond (6 – 9 oz)	3	3	7	8	7	5	?
Intrepid (4 – 8 oz)	3	3	9	7	8	9	?
Larvin (24 – 36 oz)	7	6	3	6	7	?	8
Orthene (1 lb)	6	5	Disruptive	6	6	?	8
Pyrethroids (mid rates)	8	2	Disruptive	6	3	7	9
Steward (11.3 oz)	7	7	8	6	8	9	?
Tracer (1.75 – 2.25 oz)	7	8	8	6	7	3	8
Bollgard	7	10	4	5	3	4	3
Bollgard 2	9	10	9	8	9	9	4
WideStrike	8	10	8	9	9	?	5?

Disruptive, may flare pest population. ?, Limited data. * Assumes insecticides are applied for small larvae (< 1/4 inch long).

Cotton – Insecticide/Miticide Performance Ratings for Spider Mites

Common Trade Names	Rate	Mites
Acramite	16 oz	7
Brigade / Capture	5 oz	6*
Comite II	20 – 24 oz	6
Curacron	8 – 16 oz	5*
Denim	8 – 12 oz	6
Dicofol 4	1 – 1.5 qts	8.5
Dimethoate 4	8 oz	5*
Lorsban 4	16 oz	3*
Oberon 4	4 – 6 oz	8
Portal	16 – 24 oz	8
Vydate	10 – 12 oz	3*
Zeal	0.75 – 1 oz	8
Zephyr/Zoro	4 – 6 oz	8

* Efficacy may vary widely at different times of season. Complete failure is possible.

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. Some insecticides are effective for looper control, but populations are usually held in check by naturally occurring diseases. Note: Although many pyrethroids are labeled for soybean looper control, resistance has been found in many soybean fields, and these insecticides are not recommended for control of soybean looper.

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 with very 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.

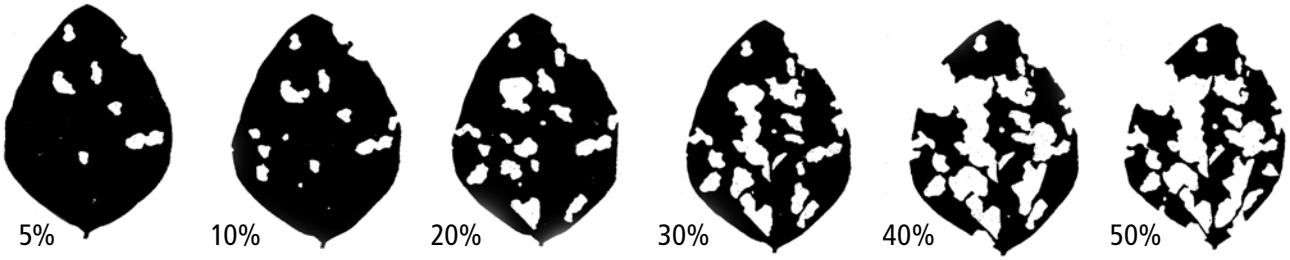
Bean Leaf Beetle: The bean leaf beetle feeds on leaves and sometimes on small pods. The beetles may feed through the pod and eat the beans, leaving damage that resembles bollworm feeding. The adults can cause severe damage on small plants. The larvae feed on roots and nodules and underground portions 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.

Figure 1 – Percent Defoliation



Pod Feeders

Fall Armyworm: The fall armyworm is a multi-colored, 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 and Seedling 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.

Scouting Procedures

A good sampling plan is to check 6 feet of row at five locations or take 25 sweeps at four 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).
- **Foliage Feeders**
  Determine which 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 being "set") look closely for any pod-feeding caterpillars (corn earworms and fall armyworms) and stink bugs that are dislodged onto the shake cloth or into the sweep net. Count these carefully.

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
R5 + (mid to late podfill)	Stink bugs, loopers, green cloverworm	Blister beetles, fall armyworm, loopers, soybean aphid

Insecticide Seed Treatments

Insecticide seed treatments (e.g., Cruiser and Gaucho) 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 1-3 bushels per acre in Tennessee, with the higher responses typically occurring in early-planted soybeans.

<table>
<tr><th colspan="6">Suggested Threshold Levels for Insect Pests of Soybean</th></tr>
<tr><td>Threecornered Alfalfa Hopper</td><td colspan="5">Threecornered alfalfa hopper – 10% of young plants (up to 10-12 inches) are infested with adults and/or nymphs, 1 hopper per sweep for larger plants</td></tr>
<tr><td>Defoliating pests (loopers, cloverworms, blister beetles, etc.)</td><td colspan="5">30% to bloom (R1), 20% from bloom to late pod fill (R1-R7), 30% from late pod fill to maturity (R7 +)</td></tr>
<tr><td>Soybean Aphid</td><td colspan="5">Soybean aphid – Treat when an average of 250 aphids or more are found per plant and soybeans are blooming (R1-R2) or at early pod stage (R3)</td></tr>
<tr><td>Corn Earworm or Fall Armyworm</td><td colspan="5">3 or 4 per foot of row or 9 or more per 25 sweeps</td></tr>
<tr><td rowspan="4">Stink Bugs</td><td></td><td colspan="2">Drop Cloth</td><td colspan="2">Sweep Net*</td></tr>
<tr><td>Time of season</td><td>No./3 ft of row</td><td>No./6 ft of row</td><td>No./25 Sweeps</td><td>No./100 Sweeps</td></tr>
<tr><td>Bloom – Mid-Podfill (R5.5)
Mid-Podfill – Maturity</td><td>1
3</td><td>2
6</td><td>3
9</td><td>12
36</td></tr>
<tr><td colspan="5">* 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.</td></tr>
</table>

Recommended Chemical Controls for Soybean Insects

Insects & Chemicals (Trade Names)	Lbs Active Ingredient Per Acre	Amount Formulation Per Acre	Acres a Gallon Will Cover
CUTWORMS			
bifenthrin (Brigade 2)	0.047 – 0.10	3 – 6.4 oz	42.7 – 20
carbaryl			
(Sevin 80S)	1.0 – 1.5	1.25 – 1.875 lb	---
(Sevin XLR Plus)	1.0 – 1.5	32 – 48 oz	4 – 2.7
chlorpyrifos (Lorsban 4E, Nufos 4E)	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
permethrin (Pounce 3.2E)	0.05 – 0.10	2 – 4 oz	64 – 32
thiodicarb (Larvin 3.2)	0.5 – 0.75	20 – 30 oz	6.4 – 4.3
β-cyfluthrin (Baythroid XL 1)	0.065 – 0.0125	0.8 – 1.6 oz	160 – 80
γ-cyhalothrin (Prolex 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 – 4.0 oz	100 – 32

Insects & Chemicals (Trade Names)	Lbs Active Ingredient Per Acre	Amount Formulation Per Acre	Acres a Gallon Will Cover
THREECORNERED ALFALFA HOPPER			
acephate 90 (Orthene 90S)	0.75 – 0.99	0.83 – 1.10 lb	---
bifenthrin (Brigade 2)	0.063 – 0.10	4 – 6.4 oz	32 – 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 (Prolex 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 – 4.0 oz	45 – 32
BEAN LEAF BEETLE			
acephate 90 (Orthene 90S)	0.75 – 0.99	0.83 – 1.10 lb	---
bifenthrin (Brigade 2)	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
chlorpyriphos (Lorsban 4E, Nufos 4E)	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
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 (Prolex 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 – 4.0 oz	45 – 32
GRASSHOPPERS			
acephate 90 (Orthene 90S)	0.30 – 0.50	0.33 – 0.56 lb	---
bifenthrin (Brigade 2)	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 – 1.875 lb 16 – 48 oz	 --- 8 – 2.7
carbofuran (Furadan 4F)	0.125 – 0.25	4 – 8 oz	32 – 16
chlorpyrifos (Lorsban 4E, Nufos 4E)	0.25 – 0.50	8 – 16 oz	16 – 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 (Prolex 1.25)	0.0125 – 0.015	1.28 – 1.54 oz	100 – 83

Insects & Chemicals (Trade Names)	Lbs Active Ingredient Per Acre	Amount Formulation Per Acre	Acres a Gallon Will Cover
GRASSHOPPERS CONTINUED			
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 – 4.0 oz	40 – 32
MEXICAN BEAN BEETLE			
acephate 90 (Orthene 90S)	0.75 – 0.99	0.83 – 1.10 lb	---
bifenthrin (Brigade 2)	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
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	2.0 – 4.0 oz	64 – 32
β-cyfluthrin (Baythroid XL 1)	0.0125 – 0.022	1.6 – 2.8 oz	80 – 45
γ-cyhalothrin (Prolex 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 – 4.0 oz	45 – 32
BLISTER BEETLE			
bifenthrin (Brigade 2)	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
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 (Prolex 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 – 4.0 oz	45 – 32
JAPANESE BEETLE			
bifenthrin (Brigade 2)	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

Insects & Chemicals (Trade Names)	Lbs Active Ingredient Per Acre	Amount Formulation Per Acre	Acres a Gallon Will Cover
JAPANESE BEETLE CONTINUED			
γ-cyhalothrin (Prolex 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 – 4.0 oz	45 – 32
GREEN CLOVERWORM			
acephate 90 (Orthene 90S)	0.75 – 0.99	0.83 – 1.10 lb	---
Bacillus thuringiensis (e.g., Dipel, Javelin)	See label	See label	See label
bifenthrin (Brigade 2)	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)	0.25 – 0.5	8 – 16 oz	16 – 8
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 – 0.145	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
spinosad (Tracer)	0.031 – 0.062	1 – 2 oz	128 – 64
thiodicarb (Larvin 3.2)	0.25 – 0.4	10 – 16 oz	12.8 – 8
β-cyfluthrin (Baythroid XL 1)	0.025 – 0.044	1.6 – 2.8 oz	80 – 45
γ-cyhalothrin (Prolex 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 – 4.0 oz	45 – 32
SOYBEAN LOOPER			
Bacillus thuringiensis (e.g., Dipel, Javelin)	See label	See label	See label
indoxacarb (Steward 1.25)	0.055 – 0.11	5.6 – 11.3 oz	22.8 – 11.5
methoxyfenozide (Intrepid 2)	0.063 – 0.125	4 – 8 oz	32 – 16
spinosad (Tracer 4)	0.031 – 0.062	1 – 2 oz	128 – 64
thiodicarb (Larvin 3.2)	0.45 – 0.75	18 – 30 oz	7.0 – 4.3
CORN EARWORM			
bifenthrin (Brigade 2)	0.063 – 0.10	4 – 6.4 oz	32 – 20
carbaryl			
(Sevin 80S)	1.0 – 1.5	1.25 – 1.875 lb	---
(Sevin XLR Plus)	1.0 – 1.5	32 – 48 oz	4 – 2.7
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	10.7 – 5.3

Insects & Chemicals (Trade Names)	Lbs Active Ingredient Per Acre	Amount Formulation Per Acre	Acres a Gallon Will Cover
CORN EARWORM CONTINUED			
permethrin (Pounce 3.2E)	0.1 – 0.2	4 – 8 oz	32 – 16
spinosad (Tracer 4)	0.047 – 0.062	1.5 – 2.0 oz	85 – 64
thiodicarb (Larvin 3.2)	0.25 – 0.4	10 – 16 oz	12.8 – 8
β-cyfluthrin (Baythroid XL 1)	0.0125 – 0.022	1.6 – 2.8 oz	80 – 46
γ-cyhalothrin (Prolex 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 – 4.0 oz	45 – 32
FALL ARMYWORM			
acephate 90 (Orthene 90S)	0.75 – 0.99	0.83 – 1.10 lb	---
bifenthrin (Brigade 2)	0.063 – 0.10	4 – 6.4 oz	32 – 20
carbaryl			
(Sevin 80S)	1.0 – 1.5	1.25 – 1.875 lb	---
(Sevin XLR Plus)	1.0 – 1.5	32 – 48 oz	4 – 2.7
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
spinosad (Tracer 4)	0.047 – 0.062	1.5 – 2.0 oz	85 – 64
thiodicarb (Larvin 3.2)	0.25 – 0.4	10 – 16 oz	12.8 – 8
β-cyfluthrin (Baythroid XL 1)	0.0125 – 0.022	1.6 – 2.8 oz	80 – 45
γ-cyhalothrin (Prolex 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
Z-cypermethrin (Mustang Max 0.8E)	0.020 – 0.025	3.2 – 4.0 oz	40 – 32
STINK BUGS			
acephate 90 (Orthene 90S)	0.50 – 0.99	0.56 – 1.10 lb	---
bifenthrin (Brigade 2)	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 (Prolex 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 – 4.0 oz	40 – 32
SPIDER MITES			
bifenthrin (Brigade 2)	0.063 – 0.10	4 – 6.4 oz	32 – 20
chlorpyrifos (Lorsban 4E, Nufos 4E)	0.25 – 0.5	8 – 16 oz	16 – 8
dimethoate 4	0.5	16 oz	8
SOYBEAN APHID			
acephate 90 (Orthene 90S)	0.75 – 0.99	0.83 – 1.10 lb	---

Insects & Chemicals (Trade Names)	Lbs Active Ingredient Per Acre	Amount Formulation Per Acre	Acres a Gallon Will Cover
SOYBEAN APHID CONTINUED			
bifenthrin (Brigade 2)	0.08 – 0.10	5.12 – 6.4 oz	25 – 20
chlorpyrifos (Lorsban 4E)	0.50 – 1.0	16 – 32 oz	16 – 8
γ-cyhalothrin (Prolex 1.25)	0.0175 – 0.025	2.8 – 4.0 oz	45.7 – 32
λ-cyhalothrin (Karate 2.08, Warrior II)	0.025 – 0.030	1.6 – 1.9 oz	133 – 80
Z-cypermethrin (Mustang Max 0.8E)	0.0175 – 0.025	2.8 – 4.0 oz	45 – 32

Premixed Insecticide Product

The following products are available as premixes of two 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)
Cobalt (chlorpyrifos, γ-cyhalothrin)	19 – 38 oz	6.7 – 3.3	Stink bugs, bollworm, green cloverworm, threecornered alfalfa hopper
Endigo ZC (thiamethoxam, λ-cyhalothrin)	3.5 – 4.5 oz	36.6 – 28.4	Stink bugs, bollworm, green cloverworm, threecornered alfalfa hopper
Hero (bifenthrin, Z-cypermethrin)	4 – 10.3 oz	32 – 12.4	Stink bugs, bollworm, green cloverworm, threecornered alfalfa hopper
Leverage (imidacloprid, cyfluthrin)	3.8 oz	33.7	Stink bugs, bollworm, green cloverworm, threecornered alfalfa hopper

Insects rob Tennessee corn producers of about 5 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 systems can add to 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.

Soil Inspection before Planting
Look for white grubs, wireworms and any other insects that may be exposed during land preparation.

At-Planting Insecticides (Including Seed Treatments)
Insecticides can be used at planting to prevent attacks by various insect pests and should be considered when using reduced tillage production systems. Insect pests such as seedcorn maggots, cutworms and white grubs may be more prevalent in fields with crop residue on the surface at planting time. The efficacy of insecticide treatments varies depending upon the rate used and the pest species. At-planting applications and seed treatments can adequately reduce pest infestations. However, some method of incorporation may be necessary with certain liquid or granular insecticides to prevent cutworm and wireworm damage. This insures that the material being used will present a barrier to the insect, protecting the plant.

Consider using at-planting insecticides when:

- The field is no-till or reduced-till.
- You have had previous soil-insect problems.
- You are planting in a field that was previously sod or small grains.
- The soil has high organic matter following extended wet periods.

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 appear as 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 any larvae 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

YieldGard Corn Borer and Herculex I hybrids express a protein that is highly effective in controlling European and southwestern corn borer. These traits are typically recommended on at least part of a grower's acreage and particularly in late-planted fields. YieldGard Rootworm and Herculex RW hybrids express a protein that controls western and northern corn rootworm. These are uncommon pests in Tennessee, and Bt traits for corn rootworm control are seldom recommended. However, continuous corn production increases the likelihood of western corn rootworm infestations. YieldGard VT Triple, YieldGard VT Triple Pro and Herculex XTRA contain Bt traits for control of both corn borers and corn rootworms. Resistance management guidelines for Bt corn require a producer to plant a refuge of non-Bt corn. Please refer to the grower licensing agreement and refuge guidelines provided by the company for complete details.

When to Treat Seedling Plants

Seed or Root-Feeding Insects

Only at-planting insecticide 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 (see above) 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 worms 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 (including seed treatments) may help to suppress pest populations. Rescue treatments of Lorsban 4E or pyrethroid insecticides may provide some control and are recommended when 10 percent of the stand is lost or badly damaged. See Extension publication SP341-Q, *Sugarcane Beetle in Field Corn*, for additional information.
- **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.

When to Treat 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**
  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. Bt hybrids with corn borer protection provide a high level of control for this pest.

- **Southwestern Corn Borer**
  Treat when 20-30 percent or more of plants are found with live larvae. Bt hybrids with corn borer protection provide a high level of control for this pest.
- **Japanese Beetles**
  No formal thresholds have been established. Control may be needed if beetles are clipping silks on *most* ears.
- **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). Do not treat stink bug infestations once silking has begun.

Recommended Chemical Controls for Corn Insects

Insect	Insecticide	Product Rate/Acre (Unless Specified)	Pre-Harvest Interval (Days) And Comments
Seedcorn Maggot	bifenthrin (Brigade 2E, Discipline 2E)	0.15 – 0.3 oz/1000 row ft	At-planting
	chlorpyrifos (Lorsban 15G)*	8 oz/1000 row ft	At-planting
	chlothianidin (Poncho 600)	1.13 – 5.64 oz/80K kernels	Through seed company only
	terbufos (Counter CR)*	6 oz/1000 row ft	At-planting
	thiamethoxam (Cruiser 5)	0.565 – 3.62 oz/80K kernels	Through seed company only
	cyfluthrin, tebupirimphos (Aztec 2.1G)	6.7 oz/1000 row ft	At-planting
	λ-cyhalothrin (Force 3G)	4 – 5 oz/1000 row ft	At-planting
Corn Rootworm	bifenthrin (Brigade 2E, Discipline 2E)	0.3 oz/1000 row ft	At-planting
	chlorpyrifos (Lorsban 15G)*	8 oz/1000 row ft	At-planting
	chlothianidin (Poncho 600)	5.64 oz/80K kernels	Through seed company only
	terbufos (Counter CR)*	6 oz/1000 row ft	At-planting
	thiamethoxam (Cruiser 5)	5.65 oz/80K kernels	Through seed company only
	cyfluthrin, tebupirimphos (Aztec 2.1G)	6.7 oz/1000 row ft	At-planting
	λ-cyhalothrin (Force 3G)	4 – 5 oz/1000 row ft	At-planting
Wireworms	bifenthrin (Brigade 2E, Discipline 2E)	0.15 – 0.3 oz/1000 row ft	At-planting
	chlorpyrifos (Lorsban 15G)*	8 – 12 oz/1000 row ft	In-furrow for best control
	chlothianidin (Poncho 600)	1.13 – 5.64 oz/80K kernels	Through seed company only
	terbufos (Counter CR)*	6 oz/1000 row ft	At-planting
	thiamethoxam (Cruiser 5)	0.565 – 3.62 oz/80K kernels	Through seed company only
	cyfluthrin, tebupirimphos (Aztec 2.1G)	6.7 oz/1000 row ft	At-planting
	λ-cyhalothrin (Force 3G)	4 – 5 oz/1000 row ft	In-furrow for best control
White Grubs	bifenthrin (Brigade 2E, Discipline 2E)	0.15 – 0.3 oz/1000 row ft	At-planting
	chlorpyrifos (Lorsban 15G)*	8 – 12 oz/1000 row ft	In-furrow for best control
	chlothianidin (Poncho 600)	1.13 – 5.64 oz/80K kernels	Through seed company only
	terbufos (Counter CR)*	6 oz/1000 row ft	At-planting
	thiamethoxam (Cruiser 5)	0.565 – 3.62 oz/80K kernels	Through seed company only
	cyfluthrin, tebupirimphos (Aztec 2.1G)	6.7 oz/1000 row ft	Band and incorporate
	λ-cyhalothrin (Force 3G)	4 – 5 oz/1000 row ft	In-furrow for best control

Insect	Insecticide	Product Rate/Acre (Unless Specified)	Pre-Harvest Interval (Days) And Comments
Cutworms	bifenthrin (Brigade 2E, Discipline 2E)	0.15 – 0.3 oz/1000 row ft	At-planting, T-band
	bifenthrin (Brigade 2E, Discipline 2E)	2.1 – 6.4 oz	Foliar application, 30
	carbaryl (Sevin XLR Plus 4)	2 – 6 qt	0
	chlorpyrifos (Lorsban 15G)*	8 – 12 oz/1000 row ft	At-planting (see label)
	chlorpyrifos (Lorsban 4E)*	2 – 4 pt	Foliar application, 35
	chlothianidin (Poncho 600)	5.64 oz/80K kernels	Through seed company only
	esfenvalerate (Asana XL 0.66E)	5.8 – 9.6 oz	21
	methoxyfenozide (Intrepid 2F)	4-8 oz	21
	permethrin (Pounce 3.2E)	4 – 8 oz	30
	β-cyfluthrin (Baythroid XL 1)	0.8 – 1.6 oz	21
	cyfluthrin, tebupirimphos (Aztec 2.1G)	6.7 oz/1000 row ft	At-planting
	γ-cyhalothrin (Prolex 1.25E)	0.77 – 1.28 oz	21
	λ-cyhalothrin (Force 3G)	4 – 5 oz/1000 row ft	At-planting
	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
Armyworm (True)	bifenthrin (Brigade 2E, Discipline 2E)	2.1 – 6.4 oz	30
	carbaryl (Sevin XLR Plus 4)	1 – 2 qt	0
	chlorpyrifos (Lorsban 4E)*	1 – 2 pt	35
	esfenvalerate (Asana XL 0.66E)	5.8 – 9.6 oz	21
	methomyl (Lannate LV 2.4)*	0.75 – 1 pt	3
	methoxyfenozide (Intrepid 2F)	4 – 8 oz	21
	methyl parathion 4 (Methyl 4E)	0.5 pt	12
	permethrin (Pounce 3.2E)	4 – 8 oz	30
	spinosad (Tracer 4SC)	1 – 3 oz	1 grain, 7 forage
	β-cyfluthrin (Baythroid XL 1)	1.6 – 2.8 oz	21
	γ-cyhalothrin (Prolex 1.25E)	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 – 4.0 oz	30 grain, 60 forage

Insect	Insecticide	Product Rate/Acre (Unless Specified)	Pre-Harvest Interval (Days) And Comments
Fall Armyworm	bifenthrin (Brigade 2E, Discipline 2E)	2.1 – 6.4 oz	30
	carbaryl (Sevin XLR Plus 4)	1 – 2 qt	0
	chlorpyrifos (Lorsban 4E)*	1 – 2 pt	35
	methomyl (Lannate LV 2.4)*	0.75 – 1 pt	3
	methoxyfenozide (Intrepid 2F)	4 – 8 oz	21
	methyl parathion 4 (Methyl 4E)	0.5 pt	12
	permethrin (Pounce 3.2E)	4 – 8 oz	30
	spinosad (Tracer 4SC)	1 – 3 oz	1 grain, 7 forage
	β-cyfluthrin (Baythroid XL 1)	2.8 oz	21
	γ-cyhalothrin (Prolex 1.25E)	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 – 4.0 oz	30 grain, 60 forage
Corn Earworm	bifenthrin (Brigade 2E, Discipline 2E)	2.1 – 6.4 oz	30
	carbaryl (Sevin XLR Plus 4)	1 – 2 qt	0
	chlorpyrifos (Lorsban 4E)*	1.5 – 2 pt	35
	esfenvalerate (Asana XL 0.66E)	5.8 – 9.6 oz	21
	flubendiamide (Belt 4)	2 – 3 oz	28
	methomyl (Lannate LV 2.4)*	0.75 – 1 pt	3
	permethrin (Pounce 3.2E)	4 – 8 oz	30
	spinosad (Tracer 4SC)	1 – 3 oz	1 grain, 7 forage
	β-cyfluthrin (Baythroid XL 1)	1.6 – 2.8 oz	21
	γ-cyhalothrin (Prolex 1.25E)	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)	1.76 – 4.0 oz	30 grain, 60 forage
Southwestern and European Corn Borer	bifenthrin (Brigade 2E, Discipline 2E)	2.1 – 6.4 oz	30
	carbaryl (Sevin XLR Plus 4)	1.5 – 2 qt	0
	carbofuran (Furadan 4F)	1.5 – 2 pt	30
	esfenvalerate (Asana XL 0.66E)	7.8 – 9.6 oz	21
	flubendiamide (Belt 4)	2 – 3 oz	28
	methoxyfenozide (Intrepid 2F)	4 – 8 oz	21
	permethrin (Pounce 3.2E)	4 – 8 oz	30
	spinosad (Tracer 4SC)	2 – 3 oz	1 grain, 7 forage
	β-cyfluthrin (Baythroid XL 1)	1.6 – 2.8 oz	21
	γ-cyhalothrin (Prolex 1.25E)	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)	2.72 – 4.0 oz	30 grain, 60 forage

Insect	Insecticide	Product Rate/Acre (Unless Specified)	Pre-Harvest Interval (Days) And Comments
Flea Beetles	bifenthrin (Brigade 2E, Discipline 2E)	2.1 – 6.4 oz	30
	carbaryl (Sevin XLR Plus 4)	1 – 2 qt	0
	chlorpyrifos (Lorsban 4E)*	2 – 3 pt	35
	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 (Prolex 1.25E)	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)	2.72 – 4.0 oz	30 grain, 60 forage
Stink Bugs	bifenthrin (Brigade 2E, Discipline 2E)	2.1 – 6.4 oz	30
	carbaryl (Sevin XLR Plus 4)	1 – 2 qt	0
	methyl parathion 4 (Methyl 4E)	8 – 16 oz	12
	β-cyfluthrin (Baythroid XL 1)	1.6 – 2.8 oz	21
	γ-cyhalothrin (Prolex 1.25E)	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)	2.72 – 4.0 oz	30 grain, 60 forage
Japanese Beetle	bifenthrin (Brigade 2E, Discipline 2E)	2.1 – 6.4 oz	30
	carbaryl (Sevin XLR Plus 4)	1 – 2 qt	0
	β-cyfluthrin (Baythroid XL 1)	1.6 – 2.8 oz	21
	γ-cyhalothrin (Prolex 1.25E)	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)	2.72 – 4.0 oz	30 grain, 60 forage
Grasshoppers	bifenthrin (Brigade 2E, Discipline 2E)	2.1 – 6.4 oz	30
	carbofuran (Furadan 4F)	0.25 – 0.5 pt	30
	chlorpyrifos (Lorsban 4E)*	0.5 – 1 pt	35
	esfenvalerate (Asana XL 0.66E)	5.8 – 9.6 oz	21
	β-cyfluthrin (Baythroid XL 1)	2.1 – 2.8 oz	21
	γ-cyhalothrin (Prolex 1.25E)	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)	2.72 – 4.0 oz	30 grain, 60 forage

* Caution: When using organophosphate insecticides such as Lorsban or Lannate with ALS herbicides such as Accent, Steadfast, Lightning, Option or Resolve, the possibility for plant injury exists. See herbicide label for restrictions.

Premixed Insecticide Products

The following products are available as premixes of two 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)
Cobalt (chlorpyrifos, γ-cyhalothrin)*	3.8 oz/1000 row ft	At-plant T-band, Incorporated; Cutworms, white grubs, seedcorn maggot, wireworms
Cobalt (chlorpyrifos, γ-cyhalothrin)	See label	Foliar applications; Corn earworm, stink bugs, Japanese beetle, corn borers; Pre-harvest interval – 21 days grain, 14 days forage
Hero 1.24 (bifenthrin, Z-cypermethrin)	4.0 – 10.3 oz	Corn borers, stink bugs, corn earworm; Pre-harvest interval – 30 days grain, 60 days forage

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

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.

Insects Sucking Juices from Leaves

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 the midge, fall armyworm, sorghum webworm and corn earworm.

Scouting Procedures for Sorghum Insects and Economic Threshold Levels

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.

Corn Leaf Aphid

The cornicles (tail-pipes at the end of the abdomen), legs and antennae of this species are black. The body is bluish-green 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 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.

Sorghum Midge

This is a small, gnat-like insect, reddish-orange and about 1/10-inch long. Female sorghum midges lay eggs in the 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 a week. Place a clear plastic bag over the head and shake, allowing the bag to remain over the head. Observe any midges that may light on the insides of 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 ½-inch long. They are usually associated with a sticky webbing in the area of their feeding. Check inside grain heads for tiny ½-inch worms and on leaves under grain heads for white fecal droppings from these insects. Close examination is necessary. Treat when an average of 3-4 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 two or more small larvae or one large (> 1/2 inch) larva 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 two or more small larvae or one large (> 1/2 inch) larva 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 are insufficient data showing an economic return of these treatments in Tennessee.

Recommended Chemical Controls for Sorghum Insects

Insect Pest	Insecticide	Rate Product Per Acre	Pre-Harvest Days* (Grain)
Aphids, including greenbugs**	chlorpyrifos (Lorsban 4)	0.5 – 2 pt	30 – 60
	chlorpyrifos, γ-cyhalothrin (Cobalt)	13 oz	30
	dimethoate 4	0.5 – 1 pt	See label
Sorghum Midge	chlorpyrifos (Lorsban 4)	0.5 pt	30
	chlorpyrifos, γ-cyhalothrin (Cobalt)	7 – 13 oz	30
	methomyl (Lannate LV 2.4)	0.75 – 1.5 pt	14
	β-cyfluthrin (Baythroid XL 1)	1.0 – 1.3 oz	14
	γ-cyhalothrin (Prolex 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 – 4.0 oz	14
Corn Earworms & Sorghum Webworm	carbaryl (Sevin 80S)	1.25 – 2.5 lb	21
	carbaryl (Sevin XLR 4)	1 – 2 pt	21
	chlorpyrifos (Lorsban 4)	1 – 2 pt ***	30-60
	chlorpyrifos, γ-cyhalothrin (Cobalt)	19 – 38 oz	See label
	methomyl (Lannate LV 2.4)	1.5 pt	14
	spinosad (Tracer 4)	1.5 – 3.0 oz	7
	β-cyfluthrin (Baythroid XL 1)	1.3 – 2.8 oz	14
	γ-cyhalothrin (Prolex 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 – 4.0 oz	14

Insect Pest	Insecticide	Rate Product Per Acre	Pre-Harvest Days* (Grain)
Fall Armyworm	carbaryl (Sevin 80S)	1.25 – 2.5 lb	21
	carbaryl (Sevin XLR 4)	1 – 2 qt	21
	chlorpyrifos (Lorsban 4)	1 – 2 pt	30-60
	chlorpyrifos, γ-cyhalothrin (Cobalt)	19 – 38 oz	See label
	methomyl (Lannate LV 2.4)	0.75 – 1.5 pt	14
	spinosad (Tracer 4)	1.5 – 3.0 oz	7
	β-cyfluthrin (Baythroid XL 1)	1.3 – 2.8 oz	14
	γ-cyhalothrin (Prolex 1.2)	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 – 4.0 oz	14
Stink Bugs	carbaryl (Sevin 80S)	1.5 – 2.5 lb	21
	carbaryl (Sevin XLR 4)	1.2 – 2 qt	21
	chlorpyrifos, γ-cyhalothrin (Cobalt)	19 – 38 oz	See label
	β-cyfluthrin (Baythroid XL 1)	1.3 – 2.8 oz	14
	γ-cyhalothrin (Prolex 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)	1.7 – 4.0 oz	14

* Waiting period from insecticide application until grain harvest.

** Controls usually unnecessary for corn leaf aphids.

*** Use higher rate for control of corn earworm

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 pair of nearly transparent wings.

Oat-Bird Cherry Aphid
is dark green and is responsible for transmission of the barley yellow dwarf virus. This is usually the most common aphid observed in wheat.

Corn Leaf Aphid
is bluish-green and all of the legs, cornicles and antennae are black.

Greenbug
is pale green, usually with 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.

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.

Other Pests

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 but 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 October 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 - June. The larvae are pale yellow and soft-bodied, but the larvae 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.

Suggested Economic Threshold Levels

Corn Leaf, Oat-Bird Cherry, and Rice Root Aphid
No thresholds have been established in Tennessee. Treatment should be made when heavy populations are causing leaves to dry up and die in several portions of the field. An insecticide seed treatment such as Gaucho or Cruiser can be used to reduce transmission of barley yellow dwarf virus. Data suggest that early-planted wheat is most likely to benefit from use of a seed treatment. Foliar insecticide applications in the fall can also reduce transmission of barley yellow dwarf virus, but they must be applied before aphid populations are already established in the field.

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 should be considered when four or more larvae are present per square foot (16 per 4 square feet). For true armyworm, 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 applied insecticides are difficult to time and only marginally effective. Plant after the fly free date (October 15) and use resistant varieties if they are available. Resistant varieties may help suppress Hessian fly populations, although no varieties provide adequate resistance to Biotype L. Insecticide seed treatments (e.g., Cruiser and Gaucho) will provide some suppression of fall infestations of Hessian fly.

Cereal Leaf Beetle
Check 10 plants per sample site for larvae and adults. Treatment is necessary if one larva and/or adult is present per stem.

Recommended Chemical Controls for Wheat Insects

Insect	Insecticide (Trade Names)	Rate/Acre
Aphids	**Seed Treatments**	
	imidacloprid (Gaucho 600)	0.8 – 2.4 oz per 100 lb seed
	thiamethoxam (Cruiser 5)	0.75 – 1.33 oz per 100 lb seed
	Foliar Treatments	
	dimethoate 4*	8 – 12 oz
	methomyl (Lannate LV 2.4)*	0.75 – 1.5 pt
	methyl parathion 4 (Methyl 4)*	0.5 – 1.5 pt
	β-cyfluthrin (Baythroid XL 1)	1.8 – 2.4 oz
	γ-cyhalothrin (Prolex 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 – 4.0 oz

Armyworms (True & Fall)	carbaryl (Sevin XLR Plus 4)	1 – 1.5 qt
	methyl parathion 4 (Methyl 4)*	1.5 pt
	methomyl (Lannate LV 2.4)*	0.75 – 1.5 pt
	spinosad (Tracer 4)	1.5 – 3 oz
	β-cyfluthrin (Baythroid XL 1)	1.8 – 2.4 oz
	γ-cyhalothrin (Prolex 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 – 4.0 oz
Cereal Leaf Beetle	carbaryl (Sevin XLR Plus 4)	1 qt
	methomyl (Lannate LV, 2.4)*	0.75 – 1.5 pt
	spinosad (Tracer 4)	1 – 3 oz
	β-cyfluthrin (Baythroid XL 1)	1.0 – 1.8 oz
	γ-cyhalothrin (Prolex 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 – 4.0 oz

* Use extra caution when handling these insecticides.

Suggested Economic Threshold Levels

Armyworms
Treatment should be considered when populations exceed 3-4 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.

Recommended Chemical Controls for Pasture Insects

Insect	Insecticide (Trade Names)	Rate per Acre	Restrictions/Comments*
Armyworms or Grasshoppers	carbaryl (Sevin XLR Plus 4)	1 – 1.5 qt	Must remove cattle. Do not apply within 14 days of harvest or grazing. Other Sevin formulations are also available.
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)	2 pt	Must remove cattle. Allow spray to dry before harvest or grazing.
Armyworms	methomyl (Lannate 2.4LV)	0.75 – 1.5 pt	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)	1.5 pt	Must remove cattle. Do not apply within 15 days of harvest or grazing.
Armyworms	spinosad (Tracer 4F)	1 – 2 oz	Do not apply within 3 days of harvest; 0-day restriction for grazing.
Armyworms, Grasshoppers	β-cyfluthrin (Baythroid XL 1)	1.6 – 1.9 oz 1.9 oz	Do not apply within 7 days of harvest; 0-day application restriction for grazing.
Armyworms or 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 or 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, Re-entry Intervals and EPA Registration Numbers

The 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. Re-entry periods vary by product. Scouts should not enter fields until all re-entry intervals have expired. Safety is of utmost importance. Be sure to establish proper communication channels with all parties involved.

Producers are required to keep records, including EPA product registration numbers, of all insecticides applied to fields. Re-entry intervals and product registration numbers for products not listed below are provided on the insecticide labels.

Insecticide*	Re-entry Interval (hours)	EPA Product Registration Number**	Insecticide*	Re-entry Interval (hours)	EPA Product Registration Number**
Acramite	12	400-514	Discipline (P)	12	5481-517
Ammo (P)	12	279-3027-5905	Endigo ZC (P, CN)	24	100-1276
Altacor (D)	4	352-730	Force (P)	0	100-1075
Asana XL (P)	12	352-515	Furadan (C)	48	279-2876
Aztec (P, OP)	48	264-813	Gaucho Grande (CN)	12	264-968
Baythroid XL (P)	12	264-840	Hero (P)	12	279-3315
Belt (D)	12	264-1025	Intrepid (IGR)	4	62719-442
Bidrin (OP)	6 Days	5481-448	Intruder (CN)	12	8033-24-352
Bidrin XP (P, OP)	6 Days	5481-552	Javelin (Bt)	4	70051-66
Brigade (P)	12	279-3313	Karate (P)	24	100-1097
Brigadier (P) (CN)	12	279-3332	Lannate (C)	72	352-384
Capture (P)	12	279-3114	Larvin (C)	48	264-379
Carbine	12	71512-9-279	Leverage (P, CN)	12	264-770
Centric (CN)	12	100-1147	Lorsban (OP)	24	62719-220
Cobalt (P, OP)	24	62719-575	Malathion (OP)	12	See label
Comite II (OS)	7 Days	400-154	Methyl parathion (OP)	96	See label
Counter (OP)	48	5481-545	Monitor (OP)	48	264-729
Couraze Max (CN)	12	264-783-67760	Mustang Max (P)	12	279 - 3249
Cruiser (CN)	12	100-941	Oberon	12	264-850
Curacron (OP)	48	100-669	Orthene (OP)	24	59639-33
Delta Gold 1.5 (P)	12	264-1011-1381	Poncho (CN)	---	264-789
Denim (SA)	48	100 - 903	Pounce (P)	12	279-3051
Diamond (IGR)	12	66222-35-400	Portal (M)	12	71711-19
Dicofol 4 (OC)	12	66222-56	Prolex (P)	24	see label
Dimethoate (OP)	48	See label	Sevin XLR Plus (C)	12	264-333
Dimilin (IGR)	12	400-461	Sevin 80S (C)	12	264-316
Dipel (Bt)	4	73049-17	Steward (OX)	12	352-638
Di-Syston (OP)	48	264-734	Temik (C)	48	264-330

Insecticide*	Reentry Interval (hours)	EPA Product Registration Number**	Insecticide*	Reentry Interval (hours)	EPA Product Registration Number**
Tracer (SPN)	4	62719-267	Warrior (P)	24	100-1112
Trimax Pro (CN)	12	264-855	Zeal	12	59639-123
Vydate CL-V (C)	48	352-532	Zephyr (SA)	12	100-897

* The classes of insecticides listed above are identified by the following abbreviations: Bt, Bacillus thuringiensis (microbial); C, carbamate; CN, chloronicotinyl (= neonicotinoid); (D), Diamides; IGR, insect growth regulator; (M),METI- Acaricides, OX, oxadiazine; OC, organochlorine; OP, organophosphate; OS, organosulfur; P, pyrethroid; SA, synthetic avermectin; SPN, spinosad.

** 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 (Zephyr, Zoro)	Abba, Temprano
acephate (Orthene 90, Orthene 97)	Acephate 90, Acephate 97
bifenthrin (Brigade, Capture, Discipline)	Bifenthrin, Bifenture, Capture LFR, Fanfare, Sniper, Tundra
chlorpyrifos (Lorsban, Nufos)	Chlorpyrifos, Govern, Warhawk, Yuma
λ-cyhalothrin (Karate, Warrior II)	Lambda, Lambda-Cy, LambdaStar, Silencer
cypermethrin (Ammo)	Cypermethrin, Up-Cyde
esfenvalerate (Asana XL)	Adjourn, S-FenvalorStar
imidacloprid (Trimax Pro, Couraze Max)	Alias, Imida, Imidacloprid, Nuprid, Pasada, Provado
methyl parathion (Methyl 4E)	Methyl Parathion 4E, Penncap-M 2E
permethrin (Pounce 3.2E)	Ambush 2E, Permethrin 3.2, Perm-Up
β-cyfluthrin (Baythroid XL)	Tombstone (= cyfluthrin)
γ-cyhalothrin (Prolex)	Proaxis
Z-cypermethrin (Mustang Max)	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.

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. Cell phones 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. Generally, the organophosphate (OP) and carbamate insecticides are the most acutely toxic classes of insecticides. Insecticide labels provide information on minimum re-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 dangerous chemicals. Always seek immediate medical attention if any insecticide is swallowed.

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 exposed to insecticide.

Relative Insecticide Toxicity of Some Commonly Used Insecticides

Insecticide (common name)	Risk level*	Insecticide (common name)	Risk level*
Ammo (cypermethrin)	L-M	Intruder (acetamiprid)	L
Asana XL (esfenvalerate)	L-M	Karate (λ-cyhalothrin)	L-M
Baythroid XL (β-cyfluthrin)	L-M	Lannate (methomyl)	H
Bidrin (dicrotophos)	H	Larvin (thiodicarb)	M
Brigade, Capture (bifenthrin)	L-M	Lorsban (chlorpyrifos)	M
Centric or Cruiser (thiamethoxam)	L	Malathion	L
Comite (propargite)	M	Methyl parathion	H
Counter (terbufos)	H	Monitor (methamidophos)	M
Curacron (profenofos)	H	Mustang Max (Z-cypermethrin)	L-M
Delta Gold (deltamethrin)	L-M	Orthene (acephate)	L-M
Denim (emamectin benzoate)	L	Trimax or Gaucho (imidacloprid)	L
Diamond (novaluron)	L	Sevin (carbaryl)	L
Dicofol	M	Steward (indoxacarb)	L
Dimethoate	M-H	Temik (aldicarb)	H
Furadan (carbofuran)	H	Tracer (spinosad)	L
Intrepid (methoxyfenozide)	L	Vydate (oxamyl)	H

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

Other Safety Considerations

Besides the risk of pesticide poisonings, and more commonly, 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, but 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!

Notes:

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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