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2027 Insect Control Recommendations for Field Crops

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

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UTEXTENSION
INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

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Integrated Pest Management

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

Scouting/Monitoring

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

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

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

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

Pre-plant Vegetation Management: Destruction of weeds and/or cover crops by tillage or herbicide three or more weeks prior to planting will reduce the risk of cutworm infestations and some other pests.

Field Border Maintenance: Plant bugs often build up on flowering plants surrounding cotton fields and move into fields when these preferred hosts dry up or are destroyed. Timely mowing of such vegetation can aid in reducing available hosts for plant bugs.

Managing for Earliness: Early crop maturity decreases the period of crop susceptibility to yield loss by insects, reduces insect control costs and lowers selection pressure for resistance development to insecticides.

Crop Management Considerations

Insecticide Resistance

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

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

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

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

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

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

Phase I (Planting through June)

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

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

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

Calculating Percent Square Retention

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

Phase II (July to end of season)

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

When Unsatisfactory Control with Foliar Insecticide Occurs

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

Managing for Earliness

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

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

Nodes Above White Flower (NAWF) and Terminating Insect Control

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

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

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

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

- Promote earliness (plant between April 20 and May 10 with an early maturing variety, use an at-planting fungicide and insecticide, avoid excessive fertilization, control all insect pests when populations exceed thresholds, consider multiple pests and maintain 80 percent or higher square retention prior to bloom).
- Do not apply automatic applications of insecticides.
- Scout fields twice each week if possible.
- Time insecticide applications against eggs and 1- to 2-day-old larvae.
- Two treatments on a 4- to 5-day interval may be needed.
- Multiple applications, at median rates, are often more effective than a single application at a high rate.
- Consider pheromone-trapping data and moth-flushing counts to determine species composition (tobacco budworm vs. bollworm) before choosing an insecticide.
- Pyrethroids are generally not recommended for control of mixed budworm/bollworm populations.
- Only use pyrethroids, or pyrethroids tank mixed with carbamates or organophosphates, if tobacco budworms are a small part of the population (less than 25 percent) **and** overall larval **and** egg numbers are less than 8-10 per 100 plants.
- Use insecticides from different classes of chemistry if a pyrethroid failure occurs.
- Improve insecticide coverage by use of nozzles producing relatively small droplets while maintaining adequate spray volume.
- Monitor crop maturity and terminate insecticide applications when yield-contributing bolls are no longer susceptible to insect damage.

Bt Cotton Management

Bt cotton varieties, which produce toxins from the bacterium *Bacillus thuringiensis*, are widely used in Tennessee. The use of Bt cotton is recommended in areas with high occurrence of tobacco budworm and bollworm. Bt cotton must be monitored on a regular basis for pests, including bollworm. Tobacco budworm should not cause economic damage to Bt cotton at any time during the season, and damaging infestations of bollworm are uncommon prior to

bloom. Prior to bloom, concentrate efforts in Bt cotton on monitoring square retention and scouting for pests such as plant bugs. However, fields should be checked for the presence of surviving larvae if a bollworm egg lay occurs. Larvae must feed on plant tissue to ingest a toxic dose of Bt toxin. This feeding is generally superficial and will not cause economic damage. A larva that is 1/4 inch or greater in length is considered to have survived or "escaped" the toxin.

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

Bt Cotton and Bt Resistance Management

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

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

Relative Efficacy of Selected, Commercially Available Bt Cotton Products

Brands	Traits	Tobacco Budworm	Bollworm	Fall Armyworm	Beet Armyworm	Pink Bollworm
WideStrike 3	**Cry1F, Cry1A, Vip3A**	Excellent	Very Good	Excellent	Excellent	Excellent
Bollgard 3/TwinLink Plus	**Cry1A, Cry2A, Vip3A**	Excellent	Very Good	Excellent	Excellent	Excellent

Excellent (spraying not needed), Very Good (spraying is only rarely needed), Fair to Good (spraying is commonly needed at least during some times of the season or when pest pressure is high)

Boll Weevil

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

Expected Occurrence of Insect Pests in Cotton

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

Stage of Plant Development	Common Pests	Occasional Pests
Emergence to first square	Thrips	Aphids, cutworms, plant bugs, spider mites
First square to first bloom	Plant bugs	Aphids, spider mites, bollworm, tobacco budworm
After first bloom	Bollworm, tobacco budworm, plant bugs, stink bugs	Aphids, loopers, fall and beet armyworm, spider mites, whiteflies

Cutworms

Several species of cutworm larvae (caterpillars) may reduce stands by cutting the stems of seedling plants below the cotyledons. Larvae are active at night and hide in the soil during the day. Cutworm damage occurs most frequently following legume cover crops or in reduced tillage systems. They often become established on existing vegetation and feed on emerging cotton once this vegetation has been killed. Destroying all green vegetation at least 21 days prior to planting reduces the likelihood of cutworm attack.

Sampling: Scout for cutworms by counting the number of cut and undamaged plants in 50 feet of row at multiple locations in a field. A pocket knife or garden trowel can be used to dig up larvae from the soil around damaged or adjacent plants to confirm their presence.

Treatment Thresholds: Treat when cutworms threaten to reduce stands to less than three plants per row foot. Alternatively, consider treating if five percent or more of plants have been freshly cut. Infestations may be spotty within a field and only require treatment where damage and live cutworms are found.

- **Bt cotton may not provide adequate control of cutworms, although it provides some protection against small larvae or low infestation levels. Newer Bt technologies that express the VIP trait, such as Bollgard 3 and WideStrike 3 varieties appear to provide better control.**
- **A near-planting foliar insecticide application may be justified if non-crop vegetation was not burned down at least 21 days prior to planting. This application can be applied in a band over the row.**

Insecticide (Trade Names) for CUTWORMS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
acephate 90	0.72	0.8 lbs.	6
bifenthrin (Brigade 2, Discipline 2, Fanfare 2)	0.05 - 0.1	3.2 - 6.4 oz	6
cypermethrin 2.5	0.025 - 0.1	1.3 - 5 oz	8
deltamethrin (Delta Gold 1.5)	0.013 - 0.019	1.11 - 1.62 oz	8
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	8
β-cyfluthrin (Baythroid XL 1)	0.0065 - 0.0125	0.8 - 1.6 oz	8
γ-cyhalothrin (Declare 1.25)	0.0075 - 0.01	0.77 - 1.02 oz	8
λ-cyhalothrin (Warrior II 2.08)	0.015 - 0.02	0.96 - 1.28 oz	8
Z-cypermethrin (Mustang Maxx 0.8)	0.008 - 0.012	1.28 - 1.92 oz	8

Thrips

Despite their small size, thrips are a consistent pest of seedling cotton. Tobacco thrips are the most common species observed in Tennessee, but several other species may also occur. Winged adults migrate into fields when seedlings emerge. Adult and immature stages feed by puncturing leaf cells and emptying their contents. Injury causes foliar deformity (leaves crinkle and cup upward), stunting, delays in maturity and may cause stand loss. Preventative in-furrow insecticides or seed treatments are recommended. A foliar treatment may also be needed in some cases. Tobacco thrips have recently developed resistance to some neonicotinoid insecticides such as thiamethoxam (i.e., Cruiser).

Sampling: The presence of deformed, crinkled leaves and a silvery color is often a sign of thrips infestations. Scouts should visually assess the level of injury on emerging leaves. Numbers of thrips can be sampled by vigorously shaking/thumping seedling plants over a white-surfaced container (e.g., cigar box or Cool Whip container). A 5-10 X hand lens is suggested to help distinguish adult and immature stages.

Treatment Thresholds: In-furrow insecticides or seed treatments are recommended. Foliar treatment is recommended, on non-ThryvOn varieties, prior to the third leaf stage when an average of one or more thrips are found per plant, especially when immature thrips are present and there are obvious signs of injury on newly emerged leaves. **ThryvOn varieties should not require a thrips overspray even in the presence of adult or immature thrips or damage not exceeding 3.0 on a 0.0 to 5.0 scale.**

Insecticide (Trade Names) for THRIPS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating Thrips/WFT**
In-furrow Systemic Sprays or Granular:			
acephate 90***	0.9 - 1	1 - 1.1 lbs.	5 / 5
aldicarb (AgLogic 15G)	0.525 - 0.75	3.5 - 5	9 / 7
imidacloprid (Admire Pro 4.6)	0.27 - 0.33	7.4 - 9.2 oz	7 / 2
imidacloprid (Velum Total 2.17)	0.24 - 0.31	14 - 18 oz	7 / 2
Foliar Sprays: *			
acephate 90***	0.25 - 0.5	4.4 - 8.9 oz	6 / 5
acephate 97 (Orthene 97)***	0.25 - 0.5	4.1 - 8.2 oz	6 / 5
dicrotophos (Bidrin 8)***	0.188 - 0.2	3.0 - 3.2 oz	6 / 5
dimethoate 4***	0.188 - 0.25	6 - 8 oz	5 / 2
spinetoram (Radiant SC 1)**	0.012 - 0.023	1.5 - 3 oz	8 / 7
spinetoram, methoxyfenozide (Intrepid Edge)**	See Label	3 oz	8 / 7
isocycloseram (Vertento SC 3.33)	0.02 – 0.05	1.1 – 2.0 oz	8/8
Treated Seed			
imidacloprid (Gaucho 600, Aeris, Acceleron Standard, Acceleron Elite, Avicta Elite Cotton Plus)	0.34 - 0.375 mg active ingredient per seed		6 / 2
Orthene 97 SP or Acephate 80S * ***	Acephate can be applied to a seed at 6.4 oz/100 lbs. seed (Orthene 97 ST) or 8 oz/100 lbs. seed (Acephate 80 S)		5 / 3

*Not recommended as a standalone treatment for thrips control.

**Radiant SC is suggested if western flower thrips (WFT) are present in significant numbers. The use of an adjuvant is recommended when using Radiant SC or Intrepid Edge for control of thrips, although several herbicides that are commonly co-applied with thrips application can act as an adjuvant.

***Tobacco thrips resistance to organophosphate insecticides is increasing, use with caution.

Plant Bugs

The tarnished plant bug is among the most important pests of cotton. Clouded plant bugs and cotton fleahoppers are two other plant bug species sometimes observed in Tennessee. Both adults and immature stages (nymphs) feed on squares, flowers and bolls. Small squares and small bolls that have been fed upon will often shed from the plant. This fruit loss can directly reduce yields or delay crop maturity. Bolls that do not shed may have reduced size and quality. Bolls more than 14 days old are not preferred feeding sites and are relatively immune to injury. However, clouded plant bugs will injure larger bolls. Tarnished plant bugs have developed resistance to some insecticides (e.g., pyrethroids).

Sampling: Small squares and small bolls that have been fed upon will usually shed from the plant. Larger squares may not shed, but evidence of plant bug feeding is evident by yellow staining (“dirty squares”) and anther damage that is observed when a square opens into a flower (“dirty blooms”). Feeding may cause cat-facing (dark spotting) on the surface of the boll, similar to stink bug injury.

Square retention: A management goal is to maintain 80 percent or higher square retention up to early bloom. Low or dropping square retention can be a warning sign of plant bug problems. Square retention should be monitored prior to flowering and during early bloom. In the top five nodes of plants, count the number of shed, first-position squares until at least 25 fruiting sites have been examined and repeat this in at least four locations in a field. Record percent square loss.

Sweep net: A sweep net is an effective tool for monitoring adult plant bugs and detecting movement into the field. It is recommended prior to flowering and during early bloom. Take a minimum of 25 sweeps with a standard 15-inch diameter sweep net at four locations in a field. Record the number of adult and immature plant bugs.

Drop cloth: Also called a beat sheet or ground cloth, this is the preferred method of sampling plant bugs during bloom because it is more effective at detecting nymphs. The cloth is typically 2.5-3 feet in length, and black is a preferred color. At 4-6 locations in a field, shake plants from two rows over the drop cloth and record the number of adult and immature plant bugs. Record numbers of plant bugs per drop cloth (or per feet of row sampled). Also count stink bugs that may be observed.

Treatment Thresholds

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).

After first bloom: Treat when plant bugs number **three** or more per drop cloth (0.6 per row foot) or 15 or more per 100 sweeps. Count clouded plant bugs as equivalent to 1.5 tarnished plant bugs when determining if populations are above treatment level. Treatment should also be considered if 15 or more plant bugs are observed per 100 plants during visual examination, or 10 percent or more of squares show external evidence of plant bug feeding (i.e., dirty squares).

- **Plant early maturing varieties.**
- **Attempt to plant cotton in a block of fields. This improves the efficiency of management and often reduces infestation levels.**
- **Under heavy pressure, a second application made at a 4-5 day interval may be necessary for best control.**
- **Insecticide applications can be terminated when cotton has accumulated 250-300 DD60s past NAWF5 (NAWF5 = average of five nodes above a first position white flower).**
- **After bloom, the tarnished plant bug nymph threshold doubles from 3 to 6 per drop in ThryvOn varieties. The adult threshold remains the same throughout the growing season.**

Insecticide (Trade Names)	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
PLANT BUGS - PHASE I, PRE-BLOOM WINDOW*			
acetamiprid (Intruder Max 70WP, Strafer Max 70WP)	0.074 - 0.101	1.7 - 2.3 oz	6
flonicamid (Carbine 50WG)	0.081 - 0.089	2.6 - 2.8 oz	5
imidacloprid 2.0	0.047 - 0.062	3 - 4 oz	7
imidacloprid 4.0 (Couraze Max)	0.047 - 0.062	1.5 - 2 oz	7
imidacloprid 4.6 (Admire Pro)	0.047 - 0.062	1.3 - 1.7 oz	7
sulfoxaflor (Transform 50WG)	0.047 - 0.071	1.5 - 2.25 oz	8
thiamethoxam (Centric 40WG)	0.0375 - 0.05	1.5 - 2.5 oz	7 - 8
isocycloseram (Vertento SC 3.33)	0.041 – 0.052	1.6 – 2.0 oz	9
PLANT BUGS - PHASE II, BLOOMING WINDOW			
acephate 90	0.45 - 0.675	0.5 - 0.75 lbs.	9
acephate 97 (Orthene 97SP)	0.49 - 0.73	0.5 - 0.75 lbs.	9
dicrotophos (Bidrin 8)	0.31 - 0.5	5 - 8 oz	8
dimethoate 4	0.25 - 0.5	8 - 16 oz	6
malathion 5	1.25	32 oz	6
novaluron (Diamond 0.83)**	0.058 - 0.078	9 - 12 oz	8
oxamyl (Vydate C-LV 3.77)	0.29 - 0.35	10 - 12 oz	6
pyrethroids***	See labels (use highest recommended rates)		2 - 4
sulfoxaflor (Transform 50WG)	0.047 - 0.071	1.5 - 2.25 oz	9
isocycloseram (Vertento SC 3.33)	0.041 – 0.052	1.6 – 2.0 oz	9

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

Aphids

Aphids occur in most cotton fields every year but only occasionally cause economic damage. Economic damage is most likely when environmental conditions such as dry weather are already stressing cotton growth. Aphids are usually found on the undersides of leaves or feeding in the terminals. They feed by sucking sap from phloem tissue. Heavily infested leaves will often curl downward along their edges. The accumulation of honeydew causing sticky and shiny leaf surfaces often indicates the presence of aphids (or whiteflies). Severe infestations can stunt plants and reduce yields, particularly if populations persist for a long period of time. Honeydew secretions on open bolls may result in lint staining or “sticky cotton.” This is rarely a concern in Tennessee because late-season aphid infestations are generally uncommon and cleansing rains often occur prior to harvest.

Sampling: The presence of honeydew or leaves that curl downward along the edge is a sign of aphid infestations. Check for aphids on the undersides of leaves. Estimate the average number of aphids found per leaf on leaves located 3-5 nodes below the top node.

Treatment Thresholds: Treat when aphids are numerous, honeydew is present, and plants are showing signs of stress. Treatment with insecticides is sometimes recommended when populations exceed an average of 50 aphids per leaf and honeydew is accumulating, especially under conditions of drought stress. Parasites and predators usually keep aphid populations below treatment levels. Consider the possibility of a fungal epizootic (*Neozygites*

fresnii) before treating. This may be recognized by a sudden crashing of populations in the same or nearby fields where insecticides were not applied.

- **In the Mid-South, cotton aphids have developed resistance to several classes of insecticides including pyrethroids, neonicotinoids and several organophosphates (OP's). Spray for aphids and other pests only as needed to help reduce selection for insecticide resistance.**
- **When possible and especially prior to bloom, avoid using insecticides that disrupt populations of natural enemies such as pyrethroid insecticides and acephate.**

Insecticide (Trade Names) for APHIDS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
acetamiprid (Intruder Max 70WSP, Strafer Max70WP)*	0.026 - 0.048	0.6 - 1.1 oz	8
dicrotophos (Bidrin 8)*	0.25 - 0.5	4 - 8 oz	6
dimethoate 4*	0.125 - 0.5	4 - 16 oz	5
flonicamid (Carbine 50 WP)	0.044 - 0.089	1.4 - 2.8 oz	8
imidacloprid 2.0*	0.031 - 0.047	2 - 3 oz	4
imidacloprid 4.0 (Couraze Max)*	0.031 - 0.047	1 - 1.5 oz	4
imidacloprid 4.6 (Admire Pro)*	0.047 - 0.062	0.9 - 1.3 oz	4
thiamethoxam (Centric 40WG)*	0.031 - 0.05	1.25 - 2 oz	4
sulfoxaflor (Transform 50WG)	0.023 - 0.031	0.75 - 1 oz	9

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

Bollworm/Tobacco Budworm

Both bollworm and tobacco budworm cause similar injury to cotton by feeding on squares, flowers and bolls. In the field, it is difficult or impossible to distinguish between the caterpillars (larvae) of these two species. Damaged fruiting structures typically shed or large bolls may rot. The bollworm continues to be a serious threat in Tennessee despite the use of Bt cotton on most acres. Tobacco budworm typically causes little damage because of the wide adoption of Bt cotton, to which it is highly susceptible. However, infestation of tobacco budworm on non-Bt cotton can cause substantial yield loss, and they are highly resistant to insecticides from several classes of chemistry (e.g., pyrethroids).

Sampling: Larvae feed on squares, flowers and bolls. Holes and frass on these structures are a sign of infestation. Treatment is based on the average number (and size) or larvae found or the percentage of damaged fruiting structures. Examine a group of five plants at a minimum of 10 locations in a field. Look for larvae and signs of injury in the top five nodes and also examine at least one white or pink bloom and one additional boll in the mid canopy on each plant. Record the average number and size of larvae found per plant. A supplemental or alternative method is to examine 25 squares and 25 bolls in at least four locations in a field and record the number of squares and bolls with injury.

Treatment Thresholds

Non-Bt Cotton: 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 when 6 percent or more of squares and bolls are damaged and larvae are still present).

Bt Cotton: Economic infestations are unlikely prior to bloom, but treat when eight or more surviving larvae (greater than one-fourth 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 are found per 100 plants (or when six percent or more of squares and bolls are damaged and larvae are still present).

In both Bt and non-Bt cotton, insecticide applications for bollworm and tobacco budworm are not recommended once it accumulates 350-400 DD60's past cutout (i.e., NAWF5 + 350-400 DD60's).

- **Plant early maturing varieties and avoid unnecessary insecticide applications that may disrupt populations of natural enemies.**
- **Bt cotton varieties provide excellent control of tobacco budworm.**
- **Bt cotton varieties provide good but variable levels of control of bollworm. Insecticide applications may be needed in some cases, particularly in flowering cotton.**
- **Insecticide applications can be terminated when cotton has accumulated 350-400 DD60s past NAWF5 (NAWF5 = average of five nodes above a first position white flower).**

Insecticide (Trade Names)	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
BOLLWORM*			
bifenthrin (Brigade 2, Discipline 2, Fanfare 2)	0.078 - 0.1	5 - 6.4 oz	7
cypermethrin 2.5	0.078 - 0.1	4 - 5 oz	7
deltamethrin (Delta Gold 1.5)	0.023 - 0.03	2 - 2.56 oz	7
esfenvalerate (Asana XL 0.66E)	0.036 - 0.05	7 - 9.6 oz	7
β-cyfluthrin (Baythroid XL 1)	0.0156 - 0.02	2 - 2.6 oz	7
γ-cyhalothrin (Declare 1.25)	0.0146 - 0.02	1.5 - 2.05 oz	7
λ-cyhalothrin (Warrior II 2.08)	0.03 - 0.04	1.92 - 2.56 oz	7
Z-cypermethrin (Mustang Maxx 0.8)	0.0188 - 0.0225	3 - 3.6 oz	7
BOLLWORM AND TOBACCO BUDWORM			
acephate 90	0.9	1 lbs.	5
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.047 – 0.089	1.2 – 2.28 oz	9
chlorantraniliprole, bifenthrin (Elevest)	See label	5.6 – 9.6 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	7 - 12.5 oz	9
emamectin benzoate (Denim 0.16)	0.01 - 0.015	8 - 12 oz	7
indoxacarb (Steward 1.25)	0.11	11.3 oz	8
methomyl (Lannate LV 2.4)	0.45	24 oz	4
spinetoram, methoxyfenozide (Intrepid Edge)	See label	6 - 8 oz	8
spinetoram (Radiant SC 1)	0.033 - 0.0625	4.25 - 8 oz	8
spinosad (Blackhawk 36% WDG)	0.056 - 0.072	2.0 - 3.2 oz	8

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

Stink Bugs

Stink bugs are a common pest of cotton in Tennessee. The green stink bug is the most common species observed, but the brown stink bug, brown marmorated stink bug and others may also be found. Stink bugs are primarily seed feeders and migrate into cotton from wild hosts or other crops when bolls begin to develop. Infestation may occur first on field edges. Both adult and immature stink bugs will feed on bolls, and injury may reduce lint production in one or more locks, reduce fiber quality and damaged bolls may rot because of secondary infection by plant pathogens.

Sampling: Scouting specifically for stink bugs is suggested once bolls are present. Stink bugs prefer bolls between 7-21 days in age. External signs of feeding injury include the appearance of circular black lesions on the surface of bolls (i.e., "catfacing"). These sunken lesions are typically about 1/16th of an inch in diameter. The lint of bolls may be stained, seed may be destroyed and feeding warts may be observed on the internal surface of the boll wall. Stink bugs can be scouted for visually, but most thresholds are based on drop cloth samples or the occurrence of internal symptoms of feeding damage to bolls.

Drop cloth: Also called a beat sheet or ground cloth, is a preferred method of sampling stink bugs. The cloth is typically 2.5-3 feet in length. In at least 4-6 locations in a field, shake plants from two rows over the drop cloth and record the number of adults and nymphs. Record the number of stink bugs per drop cloth or per feet of row sampled.

Boll damage: Examine 25 thumb sized bolls in four locations in each field, and record the number of bolls with internal signs of stink bug feeding (stained lint).

Treatment Thresholds: Treat when infestations exceed an average of one or more stink bugs per drop cloth (5-6 row feet). Treatment is also recommended if 20 percent or more of 12- to 16-day-old (thumb-sized) bolls have internal feeding warts and/or stained lint. Because stink bug infestations may co-occur with plant bug infestations, a rule of thumb is to count stink bugs as equivalent to three tarnished plant bugs when determining if treatment thresholds have been exceeded for a complex of stink bugs and plant bugs.

- **Plant early maturing varieties.**
- **Infestations are more likely in fields that have not recently been treated with insecticides.**
- **Insecticide applications can be terminated when cotton has accumulated 400-450 DD60s past NAWF5 (NAWF5 = average of five nodes above a first position white flower). However, fields free of stink bugs at 350 DD60s past NAWF5 are unlikely to develop economically damaging infestations after this point.**
- **Predatory stink bugs such as the spined soldier bug are sometimes confused for pest species.**

Insecticide (Trade Names) for STINK BUGS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating Green / Brown
acephate 90	0.49 - 0.72	0.54 - 0.8 lbs.	9 / 9
acephate 97 (Orthene 97SP)	0.49 - 0.73	0.5 - 0.75 lbs.	9 / 9
bifenthrin (Brigade 2, Discipline 2, Fanfare 2)*	0.05 - 0.1	3.2 - 6.4 oz	9 / 8
dicrotophos (Bidrin 8)	0.33 - 0.5	5.3 - 8 oz	9 / 9
oxamyl (Vydate C-LV 3.77)	0.32 - 0.5	10.9 - 17 oz	8 / 7
isocycloseram (Vertento SC 3.33)	0.041 – 0.052	1.6 – 2.0 oz	9

***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

Two spotted spider mites are occasional pests in Tennessee cotton. Infestations are often most severe during hot and dry weather, in part because a fungus (*Neozygites floridana*) that attacks this species is not effective in these conditions. Immature and adult spider mites injure cotton by feeding on the contents of individual cells. They may feed on all plant structures but are most commonly observed on the undersides of leaves. Mites reduce the plant's ability to produce photosynthate, and under severe infestations, cause premature defoliation and stunting. Spider mites disperse by crawling or by wind. Eggs are usually deposited on the undersides of leaves. Infestations often occur on field edges or in isolated spots and then spread across the field. Spider mites can complete a generation in as little as 4-5 days, so infestations may grow quickly under the right conditions.

Sampling: The top surface of infested leaves may have white or yellow stippling/speckling. Older damage often appears as a reddening of leaves. Injury is often concentrated on the leaf near the petiole, around leaf veins and at leaf folds. Sample by observing the percentage of plants with symptoms of injury, and confirming the presence of spider mites. Look for mites on the undersides of leaves, and a 5-10 X hand lens is suggested to see mites and their eggs.

Treatment Thresholds: Treat when 30-50 percent of plants are affected and mites are still present. More than one application on a 4- to 5-day interval may be required depending upon the miticide selected and intensity of infestation.

- **Avoid unnecessary insecticide applications. Spider mite infestations are flared by the repeated use of some broad-spectrum insecticides such as pyrethroids and acephate.**
- **Spider mite infestations often start and end suddenly. Population crashes following a rain are sometimes observed, and irrigation or frequent rainfall generally reduces the impact of spider mites on yield.**
- **Equipment, sweep nets or people can spread spider mites.**

Insecticide (Trade Names) for SPIDER MITES	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
abamectin (Abba 0.15, Agri-Mek 0.15, Zoro 0.15)	0.0047 - 0.019	4 - 16 oz	8
(Agri-Mek SC 0.7)	0.0055 - 0.019	1 - 3.5 oz	8
bifenazate (Acramite 4)	0.375 - 0.75	16 - 24 oz	8
emamectin benzoate (Denim 0.16)*	0.01 - 0.015	8 - 12 oz	6
etoxazole (Zeal SC 2.88, Stifle SC 2.88)	0.300 - 0.045	1.33 - 2 oz	9
fenpyroximate (Portal 0.4)	0.05 - 0.075	16 - 24 oz	8
propargite (Comite II 6)	0.94 - 1.69	20 - 36 oz	6
spiromesifen (Oberon 4)	0.094 - 0.25	3 - 8 oz	8
isocycloseram (Vertento SC 3.33)	0.028 – 0.052	1.1 – 2.0 oz	9

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

Fall Armyworm

Fall armyworm is an occasional pest of cotton grown in Tennessee. The caterpillars (larvae) feed on fruiting structures and especially on flowers or bolls. The injury they cause is similar to that of bollworm. Larger larvae can often be distinguished from bollworm or tobacco budworm by having a dark-colored head with a light-colored inverted Y. Infestations almost always occur after flowering has begun and are more likely to cause yield loss in late

maturing fields. Bt cotton varieties have reduced the importance of this pest, but insecticide applications may still be justified.

Sampling: Small larvae are often found in white blooms, pink blooms or behind the bracts of medium-sized bolls. Large larvae are often seen in blooms or found inside bolls. Scout by examining 25 flowers (white or pink) and 25 mid-sized bolls at a minimum of four locations in a field. Alternatively, the number of fall armyworm larvae can be counted while inspecting plants for bollworm or tobacco budworm.

Treatment Thresholds: Treat when an average of four or more larvae are found in 100 blooms and/or bolls, or treat when 10 or more larvae are found per 100 plants. Timing applications to control small larvae is more effective than trying to control larger larvae.

- **Plant early maturing varieties.**
- **Bt cotton varieties provide good but variable levels of control. Insecticide applications may be needed in some cases, particularly in flowering cotton.**
- **Insecticide applications can be terminated when cotton has accumulated 400-450 DD60s past NAWF5 (NAWF5 = average of five nodes above a first position white flower).**

Insecticide (Trade Names)* for FALL ARMYWORM	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
acephate 90	0.9	1.0 lbs.	5
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.067 - 0.089	1.71 - 2.28 oz	9
chlorantraniliprole, bifenthrin (Elevest)	See label	5.6 – 9.6 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	8 - 12.5 oz	9
emamectin benzoate (Denim 0.16)	0.01 - 0.015	8 - 12 oz	8
indoxacarb (Steward 1.25)	0.09 - 0.11	9.2 - 11.3 oz	8
methomyl (Lannate LV 2.4)	0.45	24 oz	7
methoxyfenozide (Intrepid 2)	0.06 - 0.16	4 - 10 oz	8
novaluron (Diamond 0.83)	0.039 - 0.078	6 -12 oz	8
spinetoram (Radiant SC 1)	0.033 - 0.0625	4.25 - 8 oz	7
spinetoram, methoxyfenozide (Intrepid Edge)	See label	6 - 8 oz	9
spinosad (Blackhawk 36% WDG)	0.056 - 0.072	2.4 - 3.2 oz	7

*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

The caterpillar (larval) stage of beet armyworm feeds on leaves and reproductive parts of the plant. The use of Bt cotton varieties has greatly reduced the risk of infestations, and economically damaging infestations in cotton are rare. Also, newer insecticide chemistries have made infestations easier to control.

Sampling: Egg masses and freshly hatched larvae are typically found on the undersides of the leaves in the mid and lower canopy. Small larvae feed in a group and leave a windowpane-like feeding sign on the leaves. The larvae can be recognized by a characteristic small black dot directly above the second true leg. Scout by counting the numbers of “hits” (active clusters of small larvae) observed while walking down a row. Infestations are often worse where wide- or skip-row spacing is used, and they are sometimes associated with the presence of alternate hosts like Palmer amaranth or other pigweed species.

Treatment Thresholds

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

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

- **Production of an early crop and preservation of beneficial insects will reduce the risk of a beet armyworm outbreak.**
- **Bt cottons generally provide good control of beet armyworms. Supplemental insecticide applications are unlikely unless infestation levels are unusually high.**

Insecticide (Trade Names) for BEET ARMYWORM	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.067 - 0.089	1.71 - 2.28 oz	9
chlorantraniliprole, bifenthrin (Elevest)	See label	5.6 - 9.6 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	8 - 12.5 oz	9
emamectin benzoate (Denim 0.16)	0.0075 - 0.01	6 - 8 oz	9
indoxacarb (Steward 1.25)	0.09 - 0.11	9.2 - 11.3 oz	9
methoxyfenozide (Intrepid 2)	0.06 - 0.16	4 - 10 oz	9
spinetoram (Radiant SC 1)	0.033 - 0.0625	4.25 - 8 oz	9
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 8 oz	9
spinosad (Blackhawk 36% WDG)	0.056 - 0.072	2.4 - 3.2 oz	9

Loopers

Loopers have become an uncommon pest of cotton due to the use of Bt cotton varieties. Both the cabbage looper and soybean looper may occur. Both are light green and have two pairs of prolegs, which distinguishes them from other caterpillars found in cotton. Looper infestations almost always occur after plants have begun to flower. The caterpillars (larvae) feed on leaves, causing irregularly shaped holes. Looper populations are often held below damaging levels by natural biological control agents.

Sampling: Scout by estimating the percent of defoliation observed throughout the field. Use a sweep net or drop cloth to confirm the presence of loopers.

Treatment Thresholds: Treat when loopers cause 25 percent or more defoliation.

- **Plant early maturing varieties and avoid unnecessary insecticide applications that may disrupt populations of natural enemies.**
- **Bt cotton varieties typically provide good control, and supplemental insecticide applications are rarely needed.**
- **Insecticide applications can be terminated when cotton has accumulated 600-700 DD60s past NAWF5 (NAWF5 = average of five nodes above a first position white flower).**

Insecticide (Trade Names) for LOOPERS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating Soybean / Cabbage
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.067 - 0.097	1.71 - 2.5 oz	8 / 9
chlorantraniliprole, bifenthrin (Elevest)	See label	5.6 - 9.6 oz	8 / 9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	10 - 12.5 oz	8 / 9
emamectin benzoate (Denim 0.16)	0.01 - 0.015	8 - 12 oz	9 / 9
indoxacarb (Steward 1.25)	0.09 - 0.11	9.2 - 11.3 oz	9 / 9
methoxyfenozide (Intrepid 2)	0.06 - 0.16	4 - 10 oz	9 / 9

spinetoram (Radiant SC 1)	0.033 - 0.0625	4.25 - 8 oz	8 / 9
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 8 oz	9 / 9
spinosad (Blackhawk 36% WDG)	0.056 - 0.072	2.4 - 3.2 oz	9 / 9

Bandedwinged Whitefly

Bandedwinged whitefly is a relatively uncommon pest of cotton. Infestations may occur at any time but are most commonly observed late in the season. Adults are small, white, moth-like insects feeding on the undersides of leaves and readily fly when disturbed. Immatures are immobile and also found on the undersides of leaves. Both adults and immatures feed on sap (phloem) similar to aphids, and like aphids, the presence of honeydew and sticky leaves is a sign of infestations. Yield loss may occur when infestations are high and especially when plants are already under drought stress. Sooty mold may develop on leaves and lint.

Sampling: The presence of honeydew or sooty mold is a sign of infestation. Look on the undersides of leaves for the presence of adults or immatures. Adults will often fly when disturbed.

Treatment Thresholds: Treat when whiteflies are present on most plants and particularly if honeydew is accumulating on leaves. A second application made at a 4- to 5-day interval may be required in some cases, depending upon the insecticide used and the intensity of infestation.

- **Infestations are often associated with repeated insecticide applications for other pests that have disrupted populations of natural enemies. Avoid unnecessary insecticide applications.**

Insecticide (Trade Names) for WHITEFLY	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
acephate 90	0.45 - 0.9	0.5 - 1 lbs.	7
spiromesifen (Oberon 4)	0.125 - 0.25	4 - 8 oz	8
thiamethoxam (Centric 40 WG)	0.05	2 - 2.5 oz	7

Premixed Insecticide Products

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

treatment level. Use of these products is suggested primarily after first bloom. These products may be appropriate for pest complexes but are not generally listed under the recommendations for individual pests.

Trade Name (Insecticides)	**Amount Product per Acre**	**Primary Target Pests (see label for other pests that may be controlled)**
Athena (bifenthrin, abamectin)	10 - 17 oz	Spider mites
Besiege (chlorantraniliprole, λ-cyhalothrin)	7 - 12.5 oz	Most caterpillar pests, stink bugs
Bidrin XP II (dicrotophos, bifenthrin)*	8 - 12.8 oz	Plant bugs, stink bugs, bollworm
Brigadier (imidacloprid, bifenthrin)	5.1 - 7.7 oz	Plant bugs, stink bugs, bollworm
Double Take (diflubenzuron, λ-cyhalothrin)	4 oz	Stink bugs, bollworm
Elevest (chlorantraniliprole, bifenthrin)	5.6 - 9.6 oz	Most caterpillar pests, stink bugs
Endigo ZC (thiamethoxam, λ-cyhalothrin)	4 - 5.5 oz	Plant bugs, stink bugs, bollworm
Fyfanon Plus ULV (malathion, γ-cyhalothrin)	10 - 16 oz	Plant bugs, stink bugs, bollworm
Hero (bifenthrin, Z-cypermethrin)	5.2 - 10.3 oz	Stink bugs, bollworm
Intrepid Edge (methoxyfenozide, spinetoram)	4 - 8 oz	Most caterpillar pests
Leverage 360 (imidacloprid, β-cyfluthrin)	2.8 - 3.2 oz	Plant bugs, stink bugs, bollworm
Triple Crown (Z-cypermethrin, bifenthrin, imidacloprid)	4.5 - 6.4 oz	Plant bugs, stink bugs, bollworm

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

Introduction

Many different insects can be found on soybeans in Tennessee. Many times, insecticides are not needed for control, but in some cases, damaging populations cause serious impact on yield if left untreated. The most economical and effective pest management program begins with scouting, proper insect identification and a determination of possible economic damage. Some of these pests feed on leaves and stems and others are primarily pod feeders. Soybean fields should be scouted weekly, paying special attention during the first two weeks after emergence and during the time of full bloom (R2) to full seed (R6).

Scouting Procedures

General Scouting Procedures: A good sampling plan is to 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.

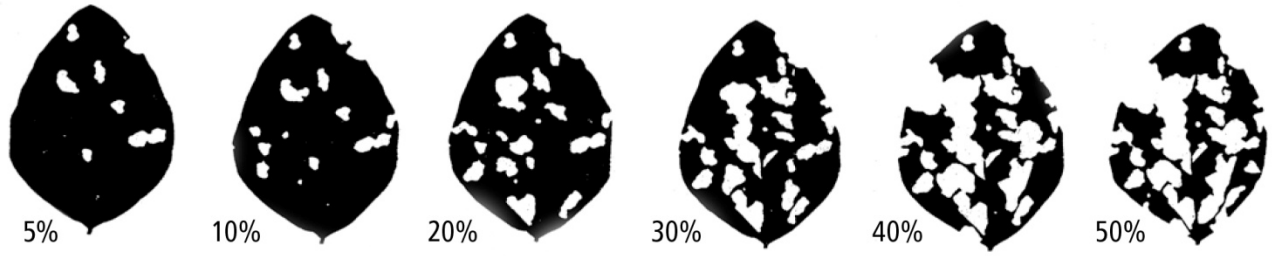
Seedling/Stem Feeding: Check seedlings very closely until the plants are about 12 inches tall. The stems become woody and severe damage from seedling pests becomes less likely at this time. Look for insects that may be on the plant (threecornered alfalfa hopper) or in the soil around the base of the 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 what insects are eating the foliage and estimate percent defoliation. Use a sweep net or a drop cloth (shake sheet) to sample for insect pests. At each sample point, estimate percent foliage loss so that an average can be calculated for the field.

Pod-Feeders: After full bloom, when pods are forming, look closely for any pod-feeding caterpillars (corn earworms and fall armyworms) and stink bugs which are caught in a sweep net.

Representation of Percent Defoliation: Inexperienced scouts often overestimate percent defoliation. Use the image below to help calibrate your estimates, but ratings should be for the entire canopy, not just upper canopy leaves.

Figure 1 – Percent Defoliation



Expected Occurrence of Insect Pests in Soybean

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

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

Insecticide Seed Treatments

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

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

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

Premixed Insecticide Products

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

Trade Name (Insecticides)	Amount Product per Acre	Primary Target Pests (see label for other pests that may be controlled)
Argyle (acetamiprid, bifenthrin)	5 – 9 oz	Bean leaf beetle, aphids, armyworms, kudzu bugs
Besiege (chlorantraniliprole, λ-cyhalothrin)	5 - 10 oz	Caterpillars, stink bugs, threecornered alfalfa hopper, kudzu bug
Brigadier (imidacloprid, bifenthrin)	4 - 6.1 oz	Corn earworm, green cloverworm, stink bugs, kudzu bug
Double Take (diflubenzuron, λ-cyhalothrin)	2 - 4 oz	Green cloverworm, stink bugs, threecornered alfalfa hoppers, kudzu bug, grasshoppers
Elevest (chlorantraniliprole, bifenthrin)	4.8 – 9.6 oz	Caterpillars, stink bugs, threecornered alfalfa hopper, kudzu bug
Endigo ZC (thiamethoxam, λ-cyhalothrin)	3.5 - 4.5 oz	Stink bugs, corn earworm, green cloverworm, threecornered alfalfa hopper, kudzu bug
Hero (bifenthrin, Z-cypermethrin)	4 - 10.3 oz	Stink bugs, corn earworm, green cloverworm, threecornered alfalfa hopper, kudzu bug
Intrepid Edge (methoxyfenozide, spinetoram)	4 - 6.4 oz	Most caterpillar pests
Leverage 360 (imidacloprid, β-cyfluthrin)	2.8 oz	Stink bugs, corn earworm, green cloverworm, threecornered alfalfa hopper

Fall Armyworm, Beet Armyworm and Yellowstriped Armyworm

Spodoptera spp. including the fall, beet and yellowstriped armyworm are often found in soybean, although they only occasionally cause economic damage. All three species feed on foliage. The fall and beet armyworm, in particular, may also feed on pods. Armyworms lay their eggs in a mass that is covered with tan (fall and yellowstriped) or white (beet) scales from the moth's body. The caterpillars (larvae) vary in color but generally lack obvious setae (hairs) on the body. All species are approximately 1.5 inches long when fully grown and have four pairs of prolegs.

Fall armyworm is a multicolored, striped caterpillar. They often have a prominent, light-colored inverted "Y" on a dark-colored head, but the head of this species is often lighter in color when it occurs on soybean, in pastures or on weedy grasses. Armyworms may feed on leaves, stems and pods. Economically damaging infestations are most common in late maturing fields. Serious damage is sometimes seen when larvae occur on weedy grasses within the field and move onto soybean when the grasses are consumed or removed with an herbicide application. Infestations may also be worse along field edges where grasses are present.

Beet armyworm larvae are generally green in color, and the small larvae feed in clusters of 10-30 individuals, often skeletonizing the undersides of leaves. Larger larvae are less aggregated and may feed on leaves, flowers and pods. They have a small black dot on either side of the body above the second pair of true legs. Beet armyworm larvae are often found on plants near Palmer pigweeds, a preferred host of this species. Thus, infestations may be worse in fields where this weed is common. Beet armyworm infestations can be worsened by the previous use of insecticides that disrupt populations of beneficial insects. Infestations also tend to be worse in fields with wider rows or skimpy stands, and particularly during hot and dry summers.

Yellowstriped armyworm is rarely a pest, and when treatment is needed, it is almost always on seedling plants where larvae may cause excessive defoliation. Larvae are typically dark in color with a prominent yellow stripe running the length of its body on either side. They usually have an obvious dark spot on either side of the body on the body segment behind the last pair of true legs. The thorax, where the true legs are located, of smaller larvae tends to be slightly wider than the rest of the body (giving it a barrel-chested appearance). Larvae sometimes feed on flowers or small pods. However, treatment is rarely if ever needed once blooming has begun.

Sampling: In an average sized field, take 25 sweeps with a sweep net and count the number and kinds of larvae that are found at four locations. Increase the number of sampling sites in large fields (greater than 50 acres). Also, visually estimate percent defoliation at each sampling point and evaluate if and how much pod feeding is occurring. It is important to document what other pests are present and may also be contributing to defoliation or pod feeding.

Treatment Thresholds: Treatment should be made if defoliation levels exceed 30 percent prior to bloom (R1), 20 percent from bloom to full seed (R1-R6), and 30 percent after R6 to R6 plus 7-10 days. For fall armyworm, and once pods are present, treat when an average of nine or more larvae is found per 25 sweeps (or if one or more larvae are found per foot of row).

- **Scout closely for fall armyworm on grassy weeds when making herbicide applications, particularly on late-planted fields where a lot of grasses are present.**
- **Infestations originating from grasses may be easier to control with insecticides such as pyrethroids.**
- **Use of disruptive insecticides such as pyrethroids may worsen infestations of beet armyworm.**

Insecticide (Trade Names) for FALL ARMYWORM	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
acephate 90	0.75 - 0.99	0.83 - 1.10 lbs.	6
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	8
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.047 - 0.067	1.2 - 1.71 oz	9
chlorantraniliprole, bifenthrin (Elevest)	See label	5.6 - 9.6 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	8 - 10 oz	9
indoxacarb (Steward 1.25)	0.055 - 0.11	5.6 - 11.3 oz	8
methomyl (Lannate LV 2.4)	0.23 - 0.45	12 - 24 oz	7
methoxyfenozide (Intrepid 2)	0.063 - 0.125	4 - 8 oz	8
novaluron (Diamond 0.83 E)	0.039 - 0.052	6 - 9 oz	8
spinetoram (Radiant SC 1)	0.031	4 oz	8
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 6.4 oz	9
spinosad (Blackhawk 36% WDG)	0.038 - 0.05	1.7 - 2.2 oz	7
β-cyfluthrin (Baythroid XL 1)*	0.0125 - 0.022	1.6 - 2.8 oz	7
γ-cyhalothrin (Declare 1.25)	0.065 - 0.075	1.28 - 1.54 oz	7
λ-cyhalothrin (Warrior II)	0.025 - 0.03	1.6 - 1.92 oz	7
Z-cypermethrin (Mustang Maxx 0.8E)	0.020- 0.025	3.2 - 4 oz	7

*First and second instars (small larvae) only

Insecticide (Trade Names) for BEET ARMYWORM	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.047 - 0.067	1.2 - 1.71 oz	9
chlorantraniliprole, bifenthrin (Elevest)	See label	5.6 - 9.6 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	10 oz	9
indoxacarb (Steward 1.25)	0.055 - 0.11	5.6 - 11.3 oz	8
methoxyfenozide (Intrepid 2)	0.063 - 0.125	4 - 8 oz	8
spinetoram (Radiant SC 1)	0.031	4 oz	8
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 6.4 oz	9
spinosad (Blackhawk 36% WDG)	0.038 - 0.05	1.7 - 2.2 oz	7

Insecticide (Trade Names) for YELLOWSTRIPED ARMYWORM	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	8
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	8 - 10 oz	9
indoxacarb (Steward 1.25)	0.055 - 0.11	5.6 - 11.3 oz	8
methoxyfenozide (Intrepid 2)	0.063 - 0.125	4 - 8 oz	8
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 6.4 oz	9
spinosad (Blackhawk 36% WDG)	0.038 - 0.05	1.7 - 2.2 oz	7
β-cyfluthrin (Baythroid XL 1)	0.0125 - 0.022	1.6 - 2.8 oz	7
γ-cyhalothrin (Declare 1.25)	0.0125 - 0.015	1.28 - 1.54 oz	7
λ-cyhalothrin (Warrior II)	0.025 - 0.03	1.6 - 1.92 oz	7
Z-cypermethrin (Mustang Maxx 0.8E)	0.020 - 0.025	3.2 - 4 oz	7

Bean Leaf Beetle

The bean leaf beetle is almost always present in soybean fields and sometimes causes economic injury. Adults are about 1/4 inch (six mm) in length and sometimes have pairs of black spots on their wings. The color of adult beetles varies, but they are usually reddish, yellowish or tannish. A key identifying characteristic of bean leaf beetles is a rear-facing black triangle on the top of the wings just behind the thorax. Eggs are laid on the soil surface and larvae are found in the soil, where they cause little injury and are rarely seen.

Adult bean leaf beetles damage soybean plants by chewing holes in leaves and may occasionally feed on pods. Holes in leaves are roughly spherical in shape. In very rare cases, heavy feeding by first generation beetles on seedling plants can lead to stand loss. However, most economic damage is caused by defoliation of larger soybeans from later generations. Bean leaf beetle is also a vector of bean pod mottle virus. Soybean plants infected with bean pod mottle virus can show a variety of symptoms from chlorotic leaf mottling, puckering and necrosis. This virus may also cause harvest problems as it may cause "green stem syndrome," a disorder where the soybean stem stays green even after the plant has matured, making harvest more difficult. Although there is potential for economic loss from bean pod mottle virus, it is rarely a major concern in Tennessee.

Sampling: In an average sized field, take 25 sweeps with a sweep net and count the number of beetles that are found at four locations. Increase the number of sampling sites in large fields (greater than 50 acres). Also, visually estimate percent defoliation at each sampling point. It is important to document what other pests are present and may also be contributing to defoliation.

Treatment Thresholds: Treat at 30 percent defoliation until bloom (R1), 20 percent from bloom to full seed (R1-R6), and 30 percent after R6 to R6 plus 7-10 days. Alternatively, insecticide treatment can be made when infestations average two bean leaf beetles per sweep (50/25 sweeps), but this is generally not suggested unless defoliation is already near the threshold level.

Insecticide seed treatments such as Cruiser, Gaucho and NipsIt Inside provide protection to small seedlings and can help prevent the spread of bean pod mottle virus.

- **Early-season infestations are often concentrated in the first emerging soybean fields in the area. These infestations will often subside once plants in other fields begin to emerge.**
- **Late-season infestations are often worst in the latest maturing fields. Adults are very mobile, and re-infestations can occur quickly, reducing the efficacy of control**.

Insecticide (Trade Names) for BEAN LEAF BEETLE	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
acephate 90	0.75 - 0.99	0.83 - 1.10 lbs.	6
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)*	0.063 - 0.10	4 - 6.4 oz	7
esfenvalerate (Asana XL 0.66E)*	0.03 - 0.05	5.8 - 9.6 oz	5
methomyl (Lannate LV 2.4)	0.23 - 0.45	12 - 24 oz	5
permethrin (Pounce 3.2E)*	0.05 - 0.1	2 - 4 oz	6
β-cyfluthrin (Baythroid XL 1)*	0.0125 - 0.022	1.6 - 2.8 oz	5
γ-cyhalothrin (Declare 1.25)*	0.0075 - 0.0125	0.77 - 1.28 oz	6
λ-cyhalothrin (Warrior II)*	0.015 - 0.025	0.96 - 1.6 oz	7
Z-cypermethrin (Mustang Maxx 0.8E)*	0.0175 - 0.025	2.8 - 4 oz	7
isocycloseram (Vertento SC 3.33)	0.028 – 0.052	1.1 – 2.0 oz	9

*Control with pyrethroid insecticides may vary because of resistance in some populations of bean leaf beetles. This appears more common in the western region of the state, and particularly in the area near the Mississippi River Delta. Tank mixing acephate (0.5 lbs. active ingredient) with a pyrethroid insecticide will improve control.

Blister Beetle, Japanese Beetle and Mexican Bean Beetle

Bister beetles, Japanese beetles and Mexican bean beetles are part of a defoliating beetle complex found in soybean that may also include bean leaf beetle, grape colaspis and spotted cucumber beetle. Individually, these pests will seldom do enough leaf feeding to cause economic damage, but together or in combination with other defoliators, treatment is occasionally needed.

Blister beetles get their name from the defensive secretion, cantharidin, they secrete from the joints of their legs when disturbed, which can cause burning and blistering of the skin. Adults are soft-bodied beetles. Their appearance varies based on species, but adults are roughly two cm (3/4 inch) in length. The striped blister beetle has alternating dark brown and yellow stripes along the length of the body. The margined blister beetle is black with a gray border along the margins of its wing covers. The prothorax of blister beetles, the area between the head and the wings, is narrower than the head and the wings. Larvae are grub-like and found in the soil. Adults of both species, and especially the striped blister beetle, feed in clusters and skeletonize soybean leaves, making large and irregular holes between the leaf veins. Some soybean varieties are more preferred by blister beetles than others. Feeding is typically localized to a few small areas of the field, and often times, blister beetles will leave a soybean field as quickly as they arrived.

Japanese beetles can be a pest of gardens, trees, ornamental plants and agricultural fields. Adults have a bright metallic green head and thorax with copper colored elytra (hardened wings) and a row of five spots of white hairs on each side of the abdomen below the wings. They are oval shaped and vary in length from 8-11 mm (3/8-1/2 inch) and a width of 5-7 mm (1/4 inch). Larvae or “white grubs” are found in the soil and do not cause economic damage in soybean. Japanese beetles have one generation per year in Tennessee. Adults typically emerge from late May through July and often feed in small clusters. Japanese beetles primarily feed on the upper foliage of soybean, consuming leaf tissue between veins and leaving a lace-like skeleton.

Mexican bean beetles belong to the same family of insects as the lady beetles. Adults are copper colored with 16 black spots on its back. Larvae are yellow to brown with many spines on the back and sides. Adults and full-grown larvae are about six mm long (1/4 inch), and both damage soybean by feeding on the undersides of leaves, resulting in a lacy skeletonized appearance. Mexican bean beetles rarely occur at economically damaging levels, and this primarily occurs in the central and eastern parts of Tennessee.

Sampling: Sweep-net sampling and visual scouting can be used to determine which insects are causing defoliation in soybean fields. This may include beetles, caterpillars, grasshoppers and other insects. Visually estimate percent defoliation at each sampling point.

Treatment Thresholds: Treat at 30 percent defoliation until bloom (R1), 20 percent from bloom to full seed (R1-R6), and 30 percent after R6 to R6 plus 7-10 days.

- **Although pyrethroid insecticides such as those listed below are generally used, other pyrethroids or other classes of insecticides may be labeled for at least one of these species.**
- **For more information see http://utcrops.com/soybean/soybean_insects/SoybeanBeetles.htm.**

Insecticide (Trade Names) for BLISTER BEETLE, JAPANESE BEETLE, AND MEXICAN BEAN BEETLE	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	9
β-cyfluthrin (Baythroid XL 1)	0.0125 - 0.022	1.6 - 2.8 oz	8 - 9
γ-cyhalothrin (Declare 1.25)	0.0125 - 0 .015	1.28 - 1.54 oz	8 - 9
λ-cyhalothrin (Warrior II)	0.025 - 0.03	1.6 - 1.9 oz	8 - 9
Z-cypermethrin (Mustang Maxx 0.8E)	0.0175 - 0.025	2.8 - 4 oz	8 - 9

Corn Earworm

Caterpillars (larvae) of the corn earworm, also called the bollworm or podworm, may cause occasional but serious damage to soybean by feeding on flowers and pods. Some leaf feeding may also be observed but is rarely a concern. Large caterpillars may be green, brown or yellow, with light and dark stripes running the length of the body, and they also have sparse setae (hairs) on their bodies. Larvae reach a length of 1.5 inches and have four pairs of prolegs and a pale brown or orange head.

Sampling: Focus sampling for corn earworm beginning at flowering (R1), and pay special attention to late maturing fields. Moth catches in pheromone traps can indicate times when scouting for corn earworm should be intensified. Take 25 sweeps with a sweep net and count the number of larvae that are found at four locations. Increase the number of sampling sites in large fields (greater than 50 acres). Also document what other pests are present and may be contributing to pod feeding, such as fall armyworm.

Treatment Thresholds: Treatment for corn earworm is most likely when plants are blooming and through the early pod development period (R5). Treatment is generally not recommended prior to flowering. The suggested treatment threshold, based on sweep-net sampling, is shown in the table below. To determine the treatment level, estimate the potential value of the crop and the cost of the insecticide application. For example, if the crop value is $8/bushel and the cost of control is $14/acre, including application costs, the sweep-net threshold would be an average of 8.6 larvae per 25 sweeps. Alternatively, treatment should be considered if an average of one or more larvae is found per foot of row.

- **Infestations are far more likely in late maturing soybean. Planting early and planting early-maturing varieties can help avoid infestations that typically occur beginning in August.**
- **Moths prefer to lay eggs in open canopies, so infestations are often worse in fields with a wide row spacing or when plant populations are low.**
- **Avoid unnecessary applications of insecticides that may disrupt populations of beneficial insects.**

Crop Value ($/bu)	Number of Corn Earworm Larvae/25 Sweeps						
	Control Costs ($/acre) Including Application						
	8	10	12	14	16	18	20
6	6.5	8.2	9.8	11.4	13.1	14.7	16.3
7	5.6	7	8.4	9.8	11.2	12.6	14
8	5	6.1	7.4	8.6	9.8	11	12.3
9	5	5.4	6.5	7.6	8.7	9.8	10.9
10	5	5	5.9	6.9	7.8	8.8	9.8
12	5	5	5	5.7	6.5	7.4	8.2
13	5	5	5	5.3	6	6.8	7.5
15	5	5	5	5	5.2	5.9	6.5

Insecticide (Trade Names) for CORN EARWORM	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)*	0.063 - 0.10	4 - 6.4 oz	6
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.047 - 0.067	1.2 - 1.71 oz	9
chlorantraniliprole, bifenthrin (Elevest)	See label	4.8 - 9.6 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	6 - 8 oz	9
esfenvalerate (Asana XL 0.66E)*	0.03 - 0.05	5.8 - 9.6 oz	6
indoxacarb (Steward 1.25)	0.055 - 0.11	5.6 - 11.3 oz	8
methomyl (Lannate LV 2.4)	0.23 - 0.45	12 - 24 oz	7
NPV virus (Heligen)**	----	1.0 - 1.6 oz	6
permethrin (Pounce 3.2E)*	0.1 - 0.2	4 - 8 oz	5
spinetoram (Radiant SC 1)	0.031	4 oz	8
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 6.4 oz	8
spinosad (Blackhawk 36% WDG)	0.038 - 0.05	1.7 - 2.2 oz	8
β-cyfluthrin (Baythroid XL 1)*	0.0125 - 0.022	1.6 - 2.8 oz	6
γ-cyhalothrin (Declare 1.25)*	0.0098 - 0.0125	1 - 1.28 oz	6
λ-cyhalothrin (Warrior II)*	0.015 - 0.025	0.96 - 1.6 oz	6
Z-cypermethrin (Mustang Maxx 0.8E)*	0.0175 - 0.025	2.8 - 4 oz	6

*Corn earworm has developed some level of resistance to pyrethroid insecticides. Thus, they may not provide adequate control. Use another insecticide or tank mix acephate (at least 0.5 lbs. active ingredient) with a pyrethroid insecticide if infestations are well above the threshold level.

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

Dectes Stem Borer

The Dectes stem borer is a long-horned beetle. It is native to the United States east of the Rocky Mountains. Larva tunnel within in the stem of soybean and wild host plants. The adult beetle is gray and approximately 3/8 inch in length. Eggs are yellowish, shiny, elongated and darken to an amber color prior to hatching. The legless larva is creamy white or yellowish with brown mouthparts. It is less than 1/16-inch long when it hatches from the egg but reaches a length of one-half to five-eighths inch when full grown. The pupa is yellowish-white, turning to dark brown before the adult emerges. Besides soybean, giant ragweed, sunflower and cocklebur are known hosts. The Dectes stem borer has only one generation annually. Mature larvae overwinter within the stem at the base of infested plants, near or just below the soil level. Pupation occurs in the spring, lasting 10-15 days in Tennessee, with emergence of adults beginning in late June and continuing to August. An adult female can live 4-8 weeks and lay as

many as 50 eggs. The female beetle chews a small hole in the leaf petiole, or less commonly in stems, where she lays a single egg. Females prefer to lay eggs in relatively bigger plants, often during bloom (R1 - R3 growth stages). In no-till production areas, it is not uncommon for some soybean fields to have 80 percent or more infested plants.

As it grows, a larva moves from an infested leaf petiole into the main stem where it tunnels within the pith of the main stem until the plant matures. More than one larva may infest a soybean plant, but only one individual survives to maturity. In preparation for overwintering, older larvae girdle the stem from the inside at 2-5 inches above the soil. Tunneling in leaf petioles or in the main stem has little direct effect on yield. However, the girdling behavior can result in lodging, which can cause yield loss, primarily by reducing harvest efficiency. The timing and amount of girdling is unpredictable and often doesn't result in significant lodging, even in heavily infested fields.

Sampling: Dectes beetles are commonly seen when sampling soybean fields and are often caught in sweep nets. The egg stage is small and inserted into leaf petioles, and therefore rarely seen. Likewise, larvae or pupae will not be seen unless leaf petioles or plant stems are 'split'. Wilted or dead leaves, resulting from larval tunneling in petioles, is a sign of infestation. Girdled plants may be evident near or after harvest, and a larva can often be found inside the stem of a girdled plant during the late fall, winter and spring months.

Treatment Thresholds: Treatment with insecticides for Dectes stem borer is not cost effective or recommended. The egg, larval and pupal stages are inside the plant and protected from insecticide applications. It is not practical to control adults because they emerge over a long period of time, live several weeks and lay many eggs.

- **Harvest heavily infested fields as quickly as possible to minimize potential losses caused by lodging.**
- **Even light tillage practices can reduce overwintering survival, but because adults are strong fliers and have other weedy hosts, this has little value unless done over a large area.**

Grasshoppers

Grasshoppers are a generalist group of plant feeders. Short-horned grasshoppers (family Acrididae) are most commonly observed in soybean. They have short, thread-like antennae with enlarged hind legs which aid in jumping. Grasshoppers have chewing mouthparts, and the adults have two pairs of wings that are folded over their ‘backs’ when not flying. Adults of some species can exceed two inches in length. The color patterns of grasshoppers vary considerably because there are multiple species observed in soybean, colors change as they molt from one life stage to another, and because their colors may change to match their environment.

Grasshoppers are an occasional pest of soybean. However, some fields in Tennessee require an insecticide application in most years. Grasshoppers feed primarily on foliage and are part of the defoliating pest complex in soybean, but feeding on flowers, pods and other plant parts is sometimes observed. Leaf feeding is characterized by irregular holes that extend in from the leaf margins or between the leaf veins. Plants are most susceptible to damage when they are small, from the time of emergence to V2. Thus, most serious infestations are seen on seedling soybean plants. Both immatures (nymphs) and adults may feed on the main stems of seedlings and reduce plant stands to the point where replanting is needed. However, serious damage is usually caused by large numbers of nymphs. Grasshopper infestations are often worse following a dry year.

Sampling: Grasshoppers tend to concentrate on field edges first before dispersing further into the field and are easily observed or caught with a sweep net. However, insecticide treatment is generally based on average defoliation levels and the potential to cause stand loss.

Treatment Thresholds: Treatment is suggested when an unacceptable level of stand loss is occurring or defoliation exceeds 30 percent. Treatment specifically for grasshoppers is rarely needed once blooming has begun, but as part of a defoliator complex, treatment is recommended between first bloom (R1) and full seed (R6) when 20 percent or more defoliation is observed.

- **Grasshoppers are primarily a problem in reduced-tilled fields because tillage can destroy egg masses.**
- **A beneficial cultural practice is to mow ditch banks and field edges before crop emergence to minimize the optimal habitat for grasshoppers before they relocate into cropping fields.**

Insecticide (Trade Names) for GRASSHOPPERS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
acephate 90	0.30 - 0.50	0.33 - 0.56 lbs.	8
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	7
diflubenzuron (Dimilin 2L), for immatures only	0.031	2 oz	8
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	7
novaluron (Diamond 0.83E)	0.039 - 0.052	6 - 9 oz	8
β-cyfluthrin (Baythroid XL 1)	0.0155 - 0.022	2.1 - 2.8 oz	7
γ-cyhalothrin (Declare 1.25)	0.0125 - 0.015	1.28 - 1.54 oz	7
λ-cyhalothrin (Warrior II)	0.025 - 0.030	1.6 - 1.9 oz	7
Z-cypermethrin (Mustang Maxx 0.8E)	0.020 - 0.025	3.2 - 4 oz	7

Green Cloverworm

Green cloverworms are commonly found in soybean. The caterpillar (larva) is green, slender and reaches a length of about one inch. It has three pairs of abdominal prolegs. This distinguishes it from other caterpillars found in soybean. It feeds only on leaves, and the feeding damage is similar to that of loopers. Smaller green cloverworm larvae crawl in a looping, inch-worm fashion similar to loopers. However, green cloverworm larvae often wriggle spastically when disturbed or prodded, helping to distinguish them from loopers. They may be found at any time during the season, but they are damaging only at high populations or in combination with other defoliators.

Sampling: In an average sized field, take 25 sweeps with a sweep net and count the number of larvae that are found at four locations. Increase the number of sampling sites in large fields (greater than 50 acres). Also, visually estimate percent defoliation at each sampling point. It is important to document what other pests are present and may also be contributing to defoliation.

Treatment Thresholds: Treat at 30 percent defoliation until bloom (R1), 20 percent from bloom to full seed (R1-R6), and 30 percent after R6 to R6 plus 7-10 days. Alternatively, treatment can be made based on a threshold of 38 green cloverworms per 25 sweeps.

- **Do not confuse green cloverworm (three pairs of prolegs) with loopers (two pairs), which are more difficult to control with insecticides.**

Insecticide (Trade Names) for GREEN CLOVERWORM	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
acephate 90	0.75 - 0.99	0.83 - 1.10 lbs.	8
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	9
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.047 - 0.067	1.2 - 1.71 oz	9
chlorantraniliprole, bifenthrin (Elevest)	See label	4.8 - 9.6 oz	9

chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	6 - 8 oz	9
diflubenzuron (Dimilin 2)	0.031 – 0.063	2 - 4 oz	9
esfenvalerate (Asana XL 0.66E)	0.015 - 0.03	2.9 - 5.8 oz	9
indoxacarb (Steward 1.25)	0.055 - 0.11	5.6 - 11.2 oz	9
methomyl (Lannate LV 2.4)	0.23 - 0.45	12 - 24 oz	9
methoxyfenozide (Intrepid 2)	0.063 - 0.125	4 - 8 oz	9
novaluron (Diamond 0.83E)	0.039 - 0.052	6 - 9 oz	8
permethrin (Pounce 3.2E)	0.05 - 0.1	2 - 4 oz	8
spinetoram (Radiant SC 1)	0.016 - 0.031	2 - 4 oz	9
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 6.4 oz	9
spinosad (Blackhawk 36% WDG)	0.034 - 0.05	1.1 - 2.2 oz	9
β-cyfluthrin (Baythroid XL 1)	0.025 - 0.044	1.6 - 2.8 oz	9
γ-cyhalothrin (Declare 1.25)	0.0075 - 0.0125	0.77 - 1.28 oz	9
λ-cyhalothrin (Warrior II)	0.015 - 0.025	0.96 - 1.6 oz	9
Z-cypermethrin (Mustang Maxx 0.8E)	0.0175 - 0.025	2.8 - 4 oz	9

Kudzu Bug

Infestations of kudzu bug on kudzu or soybean have been reported from most soybean producing areas of Tennessee, and this invasive insect has spread rapidly through the state. Adult kudzu bugs are about the same size as adult lady beetles. They are approximately 1/4-inch long, almost square in shape with a brown to olive-green hue. The immature stages are more rounded, smaller and "hairy." Eggs of kudzu bugs are light-colored, barrel-shaped and placed on leaves or other plant parts in two rows. Kudzu bugs are generally found on the stems where they feed on plant juices (phloem). They do not feed on seeds. It takes many kudzu bugs to cause economic damage to soybean, but infestation levels may reach hundreds of bugs per plant.

Sampling: In an average sized field, take 25 sweeps with a sweep net and count the number of immature kudzu bugs that are found at four locations. Increase the number of sampling sites in large fields (greater than 50 acres). Kudzu bug infestations often begin once plants start blooming. Infestations in soybean, at least initially, are often concentrated on field edges. Randomly select sampling locations and make treatment based on field average counts.

Treatment Thresholds: Treat between emergence and R1 when five or more kudzu bugs are found per plant. From R1 to R7, treat when an average of one or more immature kudzu bugs are present per sweep (25 per 25 sweeps).

- **Treatment based only on the presence of adults is generally discouraged because re-infestations may occur quickly, and it takes sustained infestations to cause yield loss.**
- **One well-timed insecticide application will generally provide satisfactory control.**

A white-colored fungus, *Beauveria bassiana*, often attacks kudzu bugs and suppresses or almost completely controls infestations.

Insecticide (Trade Names) for KUDZU BUG	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
acephate 90	0.75 - 0.99	0.83 - 1.10 lbs.	7
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.078 - 0.10	5 - 6.4 oz	9+
γ-cyhalothrin (Declare 1.25)	0.0125 - 0.015	1.28 - 1.54 oz	8
λ-cyhalothrin (Warrior II)	0.031	1.92 oz	9
Z-cypermethrin (Mustang Maxx 0.8E)	0.025	4 oz	9

Saltmarsh Caterpillar

Saltmarsh caterpillars and other woolly worms are commonly found in soybean. Larvae feed only on leaves and occasionally cause enough defoliation to justify treatment. The feeding damage is similar to that of other defoliating caterpillars. Eggs are laid in a mass, usually on leaves, and the small, light-colored and somewhat hairy larvae may be found clustered together after hatching. Larger larvae of the saltmarsh caterpillars are hairy and vary considerably in color, although they tend to be white, yellowish or cream colored when an outbreak occurs. The larvae have four pairs of prolegs and grow to a length exceeding two inches.

Sampling: Saltmarsh caterpillars may be found at any time during the season, but they are most commonly observed after flowering has begun. In an average sized field, take 25 sweeps with a sweep net and count the number of larvae that are found at four locations. Increase the number of sampling sites in large fields (greater than 50 acres). Also, visually estimate percent defoliation at each sampling point. It is important to document what other pests are present and may also be contributing to defoliation.

Treatment Thresholds: Treat at 30 percent defoliation until bloom (R1), 20 percent from bloom to full seed (R1-R6), and 30 percent after R6 to R6 plus 7-10 days.

- **A naturally occurring fungus that attacks saltmarsh caterpillars will sometimes quickly reduce infestation levels.**

Insecticide (Trade Names) for SALTMARSH CATERPILLAR	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	6
chlorantraniliprole, bifenthrin (Elevest)	See label	4.8 - 9.6 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	6 - 8 oz	9
esfenvalerate (Asana XL 0.66E)	0.015 - 0.03	2.9 - 5.8 oz	6
methoxyfenozide (Intrepid 2)	0.063 - 0.125	4 - 8 oz	8
novaluron (Diamond 0.83E)	0.039 - 0.052	6 - 9 oz	8
permethrin (Arctic 3.2, Pounce 3.2)	0.05 - 0.1	2 - 4 oz	6
spinetoram (Radiant SC 1)	0.016 - 0.031	2 - 4 oz	9
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 6.4 oz	9
spinosad (Blackhawk 36% WDG)	0.039 - 0.05	1.7 - 2.2 oz	9
β-cyfluthrin (Baythroid XL 1)	0.013 - 0.022	1.6 - 2.8 oz	6
γ-cyhalothrin (Declare 1.25)	0.0075 - 0.0125	0.77 - 1.28 oz	6
λ-cyhalothrin (Warrior II)	0.015 - 0.025	0.96 - 1.6 oz	6
Z-cypermethrin (Mustang Maxx 0.8E)	0.0175 - 0.025	2.8 - 4 oz	6

Soybean Aphid

Economically damaging infestations of soybean aphid are rare and more likely in the eastern one-half of the state. Soybean aphids are pale yellow, small and soft-bodied insects typically found on the undersides of leaves or on stems where they feed on sap (phloem) with piercing-sucking mouthparts. Most aphids will lack wings. They are the only aphid found in soybean that will occur in large numbers. Feeding by immatures and adults may result in the accumulation of honeydew on the plant. Previous infestations in Tennessee have mostly occurred later in the season when temperatures have been relatively mild. Soybean mosaic virus and other viral diseases are sometimes transmitted by aphids during feeding.

Sampling: For soybean aphids, begin scouting in early July. Look for aphids on the undersides of upper and middle canopy leaves. Estimate aphid density per plant at 5-10 locations throughout the field.

Treatment Thresholds: Treat when an average of 250 aphids or more is found per plant from early bloom (R1) until early pod fill (R5). Treatment after R5 is less likely to increase yield. Treatment should also be considered if honeydew is accumulating in the field at any time before R5.

Insecticide (Trade Names) for SOYBEAN APHID	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
acephate 90	0.75 - 0.99	0.83 - 1.10 lbs.	8
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	9
γ-cyhalothrin (Declare 1.25)	0.010 - 0.0125	1.0 - 1.28 oz	9
λ-cyhalothrin (Warrior II)	0.025 - 0.030	1.6 - 1.9 oz	9
Z-cypermethrin (Mustang Maxx 0.8E)	0.0175 - 0.025	2.8 - 4 oz	9

Soybean Looper

Loopers are a common defoliating caterpillar found in soybeans. They do not feed on pods. Both soybean looper and cabbage looper may be present. However, in Tennessee, economically damaging infestations are uncommon until mid-August and September, and these infestations are often composed mostly of the soybean looper. Larvae of both species are light green and have two pairs of prolegs (excluding the pair on the last abdominal segment). The caterpillars move with an inch-worm or looping fashion when crawling. The body is thickest at the rear and tapers to the head, reaching a length of about 1.3 inches. Populations are often held in check by beneficial insects and diseases.

Sampling: In an average sized field, take 25 sweeps with a sweep net and count the number and kinds of larvae that are found at four locations. Increase the number of sampling sites in large fields (greater than 50 acres). Also, visually estimate percent defoliation at each sampling point. It is important to document what other pests are present and may also be contributing to defoliation.

Treatment Thresholds: Treat at 30 percent defoliation until bloom (R1), 20 percent from bloom to full seed (R1-R6), and 30 percent after R6 to R6 plus 7-10 days. Alternatively, an insecticide application can be made when infestations average 19 loopers per 25 sweeps, but it is generally suggested not to count larvae less than one-half inch long because small larvae do not cause much defoliation and natural mortality is often high.

- **Late maturing varieties are much more likely to be infested with soybean loopers.**
- **Soybean looper is more difficult to control with insecticides than the cabbage looper. Although many pyrethroid insecticides are labeled for soybean looper control, they are not recommended because resistance is well documented. Indeed, use of pyrethroid insecticides can worsen infestations of soybean looper.**
- **Soybean loopers often, but not always, have black true legs (those behind the head) and/or black spots on the bodies.**
- **Treatable infestations of loopers prior to August, although uncommon, are likely to be cabbage looper and can often be controlled with pyrethroid or other insecticides. It is generally best to assume late season infestations are composed mostly of soybean looper and to use recommended insecticides accordingly.**
- **Do not confuse loopers (two pairs of prolegs) with green cloverworm (three pairs), which are easier to control with insecticides.**

Insecticide (Trade Names) for LOOPERS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating Soybean / Cabbage
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.047 - 0.067	1.2 - 1.71 oz	8 / 9
chlorantraniliprole, bifenthrin (Elevest)	See label	5.6 - 9.6 oz	8 / 9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	10 oz	8 / 9
indoxacarb (Steward 1.25)	0.055 - 0.11	5.6 - 11.3 oz	8 / 9
methoxyfenozide (Intrepid 2)	0.063 - 0.125	4 - 8 oz	8 / 9
spinetoram (Radiant SC 1)	0.016 - 0.031	2 - 4 oz	8 / 9
spinetoram, methoxyfenozide (Intrepid Edge)	See label	4 - 6.4 oz	9 / 9
spinosad (Blackhawk 36% WDG)	0.034 - 0.05	1.1 - 2.2 oz	8 / 9

Other Defoliating Caterpillars

There are several other caterpillars found in soybean that may cause some level of defoliation, although it is very rare for these species to cause economic damage in Tennessee. However, a brief description is included below because these insects may be encountered.

Velvetbean Caterpillar: This insect is common in the coastal regionals of the South. In Tennessee, it is sometimes found late in the growing season on late maturing soybean, especially after one or more particularly mild winters. The larvae grow larger than most other caterpillars found in soybean and can cause substantial defoliation when present in large numbers. Color varies considerably, but when found in Tennessee, the larvae are typically green in color. Small larvae loop in an inch-worm fashion similar to green cloverworm or loopers, but velvetbean caterpillars have four pairs of prolegs. Similar to the green cloverworm, the larvae wiggle rapidly when prodded. This behavior helps to distinguish them from corn earworm with which they are sometimes confused.

Silver-Spotted Skipper: Scouts will sometimes encounter this unusual looking caterpillar in soybean. The caterpillars are easily recognized by a dark, often maroon-colored head with yellow-orange eyespots, and by having a narrow "neck" and relatively fleshy, thick green body. Larvae feed on leaves which may be loosely woven together with silk.

Painted Lady: The larvae of this butterfly will feed on soybean leaves, sometimes occurring in groups. Similar to silver-spotted skippers, the caterpillars will web leaflets together while feeding. Their color varies, and they are sometimes confused with the saltmarsh caterpillar because the larvae are hairy, although typically with shorter, stouter and less dense 'hairs' (giving them a more spiny appearance).

Sampling: These species will be caught in sweep net or drop cloth samples, but they are typically not counted because they occur at low numbers. Any defoliation caused by these species would be accounted for while estimating defoliation caused by other pests.

Treatment Thresholds: Treatment for defoliating pests should be made if defoliation levels exceed 30 percent prior to bloom (R1), 20 percent from bloom to full seed (R1-R6), and 30 percent after R6 to R6 plus 7-10 days.

Insecticide applications are seldom needed for these pests in Tennessee. However, insecticides used to control other caterpillar pests generally provide effective control.

Spider Mites

Spider mites are an occasional pest of soybean. They are not insects, being more closely related to spiders. The twospotted spider mite is the most common mite found infesting soybean. At full size, spider mites are only 0.3-0.4 mm long and difficult to see with the naked eye. They are pale-yellow to orange in color, and under magnification, a dark spot can be seen on either side of the body. Sometimes, a dark red body color is observed (previously called the carmine mite). The adult and nymphal stages have eight legs, but the larval stage that emerges from the egg has six legs. Both immature and adult spider mites cause injury to soybean by sucking juices from plants. As their name suggests, a fine silken webbing is produced by the mites and may be observed on infested leaves. They may feed on all plant structures but are most commonly observed on the undersides of leaves. Infestations are often most severe during hot and dry weather. Mites reduce the plant's ability to produce photosynthate, and under severe infestations, cause premature defoliation.

Sampling: Sampling for mites is based on visual observations of injury symptoms, such as leaf speckling and premature yellowing of leaves, or by seeing mites on the undersides of leaves.

Treatment Thresholds: Thresholds for spider mites are not well established in soybean. Consider treatment when spider mites are present on the majority of plants and premature defoliation is occurring.

- **Avoid unnecessary insecticide applications that may disrupt populations of beneficial insects and may cause outbreaks of spider mites.**
- **Well-watered or irrigated soybean are less likely to be heavily infested or benefit from treatment**.

Insecticide (Trade Names) for SPIDER MITES	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
abamectin (Agri-Mek SC 0.7)	0.01 - 0.019	1.75 - 3.5 oz	8
dimethoate 4*	0.5	16 oz	4
etoxazole (Zeal SC 2.88, Stifle SC 2.88)	0.045 - 0.135	2 - 6 oz	8
isocycloseram (Vertento SC 3.33)	0.028 – 0.052	1.1 – 2.0 oz	9

*These products may only provide suppression of spider mites.

Stink Bugs

Stink bugs are common pests in Tennessee. There are several species of stink bugs that may occur in soybean, and both the adults and nymphs cause injury by feeding on developing seed with their piercing-sucking mouthparts. Adults are shield-shaped, either mostly green or brown in color, and 0.5-0.67 inches long. Immatures vary considerably in size and color, both within and among species. Stink bugs may introduce diseases into developing seeds, reduce seed size and germination and lower milling quality. Damaged seed may appear wrinkled and smaller than normal.

The green stink bug is the most common species that feeds on soybean in Tennessee. The brown stink bug and brown marmorated stink bug are also common components of the stink bug complex. Other plant feeding species that may be present include the red-shouldered stink bug and the dusky brown stink bug. The southern green stink bug is less common but may be observed after warm winters, particularly in the southernmost counties. The redbanded stink bug is an invasive species that may also be observed in some areas of the state. Like the southern green stink bug, redbanded stink bugs are more likely to occur after a very mild winter. Finally, predatory (beneficial) stink bugs such as the spined soldier bug may also be found in soybean and are sometimes mistaken for brown or dusky brown stink bugs.

Sampling: Because stink bugs are seed feeders, sampling should be concentrated when plants are filling seed (R3-R6). In an average sized field, take 25 sweeps with a sweep net and count the number of adult and immature stink bugs that are found at four locations. Increase the number of sampling sites in large fields (greater than 50 acres). Stink bug eggs are characteristically laid in a mass of 20-100 barrel-shaped eggs. Easily observing stink bug adults, immatures and egg masses while walking through fields is a sign that thorough scouting is needed.

It can be important to correctly identify the kinds of stink bugs being found. Some species are more difficult to control with insecticides. Do not count predatory stink bugs, and they may be common in fields infested with caterpillars. The spined soldier bug and other predatory stink bugs have a beak approximately twice as wide as the antennae (a sword); whereas, plant-feeding stink bugs have a beak about the same width as the antennae (a needle).

Treatment Thresholds: From beginning bloom (R1) to full seed (R6), treat when an average of nine or more stink bugs is found per 25 sweeps (or one stink bug is found per foot of row). For 7-10 days beginning at R6, treat when an average of 18 or more stink bugs is found per 25 sweeps.

- For redbanded stink bug, use a reduced treatment threshold of four stink bugs per 25 sweeps.

Insecticide (Trade Names) for STINK BUGS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating Green / Brown*
acephate 90	0.50 - 0.99	0.56 - 1.10 lbs.	8 / 9
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	9 / 8
β-cyfluthrin (Baythroid XL 1)	0.025 - 0.044	1.6 - 2.8 oz	8 / 5
γ-cyhalothrin (Declare 1.25)	0.0125 - 0.015	1.28 - 1.54 oz	7 / 5
λ-cyhalothrin (Warrior II)	0.025 - 0.030	1.6 - 1.9 oz	8 / 5
Z-cypermethrin (Mustang Maxx 0.8E)	0.020 - 0.025	3.2 - 4 oz	8 / 5
isocycloseram (Vertento SC 3.33)	0.041 – 0.052	1.6 – 2.0 oz	9 / 8

*Use acephate or relatively high rates of bifenthrin if brown stink bugs compose a significant percentage of the stink bug population. For redbanded stink bugs, use the maximum labeled rate of acephate, bifenthrin, or a tank mix of these two insecticides.

Threecornered Alfalfa Hopper

The adult threecornered alfalfa hopper is a green, wedge-shaped insect about one-fourth inch long. They are an occasional pest of soybean. The adults are very mobile and hop when disturbed. Adults and nymphs feed by inserting their piercing-sucking mouthparts and girdling the circumference of stems or leaf petioles. A callus (girdle) is created at the site of feeding. Plants may snap over while walking through the field or during a storm if threecornered alfalfa hoppers, typically the adults, have girdled the main stem of plants less than 10-12 inches tall. Lodging is often observed long after the girdle was made and when plants are no longer susceptible to damage. Leaves may be seen turning brown where petioles have been girdled. Feeding by threecornered alfalfa hopper does

not cause yield loss unless lodging occurs, and especially when this lodging occurs during the mid or late reproductive stages (R4 and beyond).

Sampling: Sampling for threecornered alfalfa hoppers in seedling soybeans is difficult. Fields should be scouted for this pest from emergence until plants are 10-12 inches tall. A sweep net can be used to detect the presence of adults. Adults may also be observed hopping as you walk through the field. A sweep net handle can be used to bend seedling plants over. Girdled plants often snap when this is done. Make sure sample points are scattered over the entire field as infestations are often highest along field margins.

Treatment Thresholds: There is no established sweep net threshold for threecornered alfalfa hopper, but treatment may be needed if you catch more than 10 hoppers per 25 sweeps **and** when plants are less than 10 inches tall, and especially in fields where plant stands are below optimal levels. Also consider treatment if 10 percent or more of seedling plants are infested with nymphs or adults or when 50 percent or more of plants are girdled. Treatment is not generally recommended for plants greater than 12 inches tall. Fields may be re-infested quickly after an insecticide application is made, but multiple applications for this pest are rarely justified.

Insecticide seed treatments such as Cruiser, Gaucho and NipsIt Inside provide some protection during the seedling stage, but injury may still be observed, particularly in small fields or on the edges of larger fields.

- **Threecornered alfalfa hoppers are more problematic in reduced tillage systems. The highest populations are typically observed in late-planted fields such as double-cropped soybeans.**
- **Lodging of plants tends to be worse in fields with low plant populations, and thus, achieving adequate plant stands can reduce the risk of economic injury.**
- **Maintaining a clean field border may help reduce population numbers.**

Insecticide (Trade Names) for THREECORNERED ALFALFA HOPPER	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
acephate 90	0.75 - 0.99	0.83 - 1.10 lbs.	8
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.05 - 0.10	3.2 - 6.4 oz	9
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	8
β-cyfluthrin (Baythroid XL 1)	0.025 - 0.044	1.6 - 2.8 oz	8
γ-cyhalothrin (Declare 1.25)	0.0075 - 0.0125	0.77 - 1.28 oz	8
λ-cyhalothrin (Warrior II)	0.015 - 0.025	0.96 - 1.6 oz	8
Z-cypermethrin (Mustang Maxx 0.8E)	0.0175 - 0.025	2.8 - 4 oz	8

Thrips

Several kinds of thrips may be observed feeding on soybean. Common examples include tobacco thrips and soybean thrips. Thrips are small, slender insects. Adults are about 1.5-2.0 mm long and can usually be distinguished from the immatures by the presence of two pairs of wings that are held folded behind the back. Each wing is characterized by a fringe of hairs on the posterior margin, but this is not visible except under magnification. Some adults may be wingless. Depending upon the species, adult color varies from yellowish to black. Eggs are very small and are inserted into the host plant. Immature thrips found in soybean are pale yellow to straw colored. Both immature and adult stages have modified, piercing-sucking mouthparts and feed on plant juices from the wounds made by their "beak."

Thrips are very common insects found in soybean but rarely justify an insecticide treatment because soybean plants are tolerant to injury. Economic damage to soybean is only likely during the seedling stage when environmental conditions result in poor seedling growth and low vigor. Feeding often causes yellow or white speckling on leaves, particularly around leaf veins, and a general stunting of plants. Leaves may be somewhat crinkled or cupped when thrips populations are high, and in rare cases, plants may be killed.

Sampling: Vigorously thumping seedling plants over a white surface or into a white container is sometimes done as a means of counting thrips. Visual observations of plant injury, such as leaf speckling, is also a sign of thrips infestation.

Treatment Thresholds: Treatment for thrips is not recommended except in rare cases when serious injury such as plant death or extreme stunting is observed. Treatment should not be made once plants have two or more trifoliate leaves.

Insecticide seed treatments such as Cruiser, Gaucho and NipsIt Inside provide some protection during the seedling stage, but poor control may be observed because of insecticide resistance in populations of tobacco thrips.

Acephate products, such as Orthene, at a rate of 0.2-0.33 lbs. active ingredient per acre can be used to control infestations of thrips. Pyrethroid insecticides are not recommended.

2027 Corn Insect Control Recommendations

Introduction

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

Prevention

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

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

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

Seed and At-Planting Insecticide Treatments: Almost all seed corn comes treated with insecticide. These insecticides will control or suppress a number of seed and seedling insect pests. Insecticide seed treatments, specifically clothianidin (e.g., Poncho) and thiamethoxam (e.g., Cruiser), have largely replaced the use of in-furrow insecticides which were applied at planting. However, at-planting insecticides or higher labeled rates of insecticide seed treatments can be used for supplemental control of seed and seedling pests (see Below Ground Pests).

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

Resistance management guidelines for Bt corn require a producer to plant a refuge of non-Bt corn. Some newer trait packages require a smaller refuge of non-Bt corn. Please refer to the grower licensing agreement and refuge guidelines provided by the company for complete details.

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

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

[1]50 percent and 20 percent non-Bt corn refuge requirement in cotton and corn areas, respectively.

[2]20 percent non-Bt corn refuge is required in cotton and corn areas.

[3]20 percent and 5 percent refuge requirement in cotton and corn areas, respectively.

[4]5 percent refuge in bag system in non-cotton areas; a separate 20 percent non-Bt refuge is required in cotton growing areas.

[5]10 percent refuge in bag system in non-cotton areas; a separate 20 percent non-Bt refuge is required in cotton growing areas.

***Designated "Cotton Areas" in Tennessee:** The counties of Carroll, Chester, Crockett, Dyer, Fayette, Franklin, Gibson, Hardeman, Hardin, Haywood, Lake, Lauderdale, Lincoln, Madison, Obion, Rutherford, Shelby and Tipton. Refer to the licensing agreement for specific details on refuge requirements for selected Bt corn hybrids.

Scouting Corn

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

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

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

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

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

Below Ground (Soil) Insect Pests

Most insect pests that attack corn at or below the soil surface are most damaging to seedling corn. Planting corn early can reduce the chances of insect infestations and injury. Controlling soil insects that threaten corn stands and seedling health is important for corn production. Factors such as reduced tillage, no-till corn and fields with a history of soil insects justify the use of insecticides or insecticide seed treatments at planting. These products are used as prevention, because when there is high potential for infestation rescue treatments offer less control.

Adult **Southern Corn Rootworms** are also called the twelve-spotted cucumber beetle and have a wide host range. Females lay eggs at the base of corn plants or alternate weed hosts and, after hatching, larvae feed on roots, leading to wilting or lodging (known as “goose necking”) or plant death. The larvae have three pairs of legs just behind the head. Larvae are up to one-half inch long with brownish patches on the head and tail end.

- **Western or Northern Corn Rootworms** are rare pests in Tennessee. However, serious damage is sometimes seen if corn is continuously grown for many consecutive years, as sometimes done in dairy operations. Insecticide seed treatments are much less effective on these species compared with the southern corn rootworm. Because of the biology of these rootworm species, rotating to an alternate crop every 3-4 years is suggested to prevent infestations. Some Bt corn technologies provide excellent control of western or northern corn rootworm, but do not affect southern corn rootworm (see table below).

The **Seedcorn Maggot** is the larval stage of a fly that feeds on decaying organic matter in the soil. Larvae are less than one-quarter inch, pale white, and lack legs or an obvious head. Seedcorn maggots feed on germinating corn seed planted in cool, wet weather or when corn is planted into fields with freshly decaying vegetation.

Wireworms are the larval stage of click beetles. Larvae are usually brown, elongated and slender and may take between two and five years to mature, depending on the species. Control is often difficult in fields that were fallow or pasture before corn. Wireworms feed on the seed and roots and bore into the underground part of the corn seedling, which can lead to wilting, deadheart or plant death.

White Grubs are the larvae of scarab beetles (e.g., May and June beetles), and some species feed on the roots of seedling corn plants. Grubs are C-shaped and white to cream in color.

- The **Sugarcane Beetle** is a scarab beetle that may cause significant economic damage in corn less than two feet tall. Although the larva is a white grub, it is the adults that cause damage by feeding on the stem and roots just below the soil surface. The adult beetle is about one-half inch long, black, with strong legs and coarse spines adapted for digging. The back of the beetle has numerous "pits." Adults can infest fields after planting. Infestation can be especially severe in fields where Bermudagrass is common.

Cutworms are the larvae of several species of moths which spend much of their time below ground, typically venturing out at night to feed above ground on the stems and leaves of plants. Additional information about the management of cutworms is below.

Sampling: There are no standardized sampling methods for most below-ground pests of seedling corn. Because foliar-applied insecticides are generally ineffective, sampling is often done to evaluate the health of seedling plants, determine the cause of weak or dying plants, and to determine if re-planting is needed. The symptoms of below-ground insect feeding are often similar, regardless of which insect caused the injury. Plants may be stunted, leaning or lodged, leaves may have white or yellow streaking, and if severe, affected plants may wilt and die.

To check for the presence of wireworms, bait stations of untreated seed (e.g., one cup mixture of corn and wheat) can be buried a few inches deep prior to planting. Several bait stations should be used in a field and checked after 7-10 days. An average of one or more wireworms per station suggests in-furrow insecticides or an insecticide seed treatment should be used.

- **No-till or reduced-tillage farming generally increases the likelihood of soil insect pests.**
- **Consider using the higher-labeled rates of an insecticide seed treatment or an in-furrow applied insecticide (see tables below) when you have a known soil insect problem, planting in a field that was fallow, pasture or sod the previous season, or a cover crop was used and not terminated at least 3-4 weeks before planting.**
- **Economic damage from southern corn rootworm, seedcorn maggot, and white grubs is uncommon because most seed corn companies apply an insecticide seed treatment.**
- **Higher insecticide seed treatment rates or the use of in-furrow insecticides may be needed if wireworms, western corn rootworms, or sugarcane beetles are present in significant numbers.**

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

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

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

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

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

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

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

See the insecticide label for specific use instructions.

*Caution: When using organophosphate insecticides such as Aztec or Counter with herbicides such as Accent, Callisto, Capreno, Halex GT, Steadfast, Option or Resolve, the possibility for plant injury exists. See herbicide label for restrictions.

**Many other pyrethroid insecticides are labeled for at-planting control of cutworms and some other pests. These include Asana XL, Baythroid XL, Declare, Mustang Maxx and Pounce. Please see their labels for specific use instructions.

Cutworms

Several species of **cutworms** damage field corn in Tennessee, with the black cutworm being most common. Cutworm damage is most frequently found during cool, wet seasons when corn is following legume cover crops or in reduced tillage systems. Moths lay eggs on winter weeds in early spring and cutworms move to emerging corn once this vegetation has been killed. Cutworms are less likely to cause economic damage after corn reaches two feet in height.

Sampling: Check twice weekly for cutworms 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. Plants less than 12 inches tall are most susceptible to injury.

Treatment Thresholds: Treat when larvae are present and five percent or more of plants are damaged or when two larvae per 100 plants are present.

- **Burndown with herbicides well in advance of planting (3-4 weeks) can reduce the risks of infestation.**
- **Certain Bt corn technologies provide some protection against cutworms.**

Insecticide (Trade Names) for CUTWORMS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.033 - 0.10	2.1 - 6.4 oz	8
carbaryl (Sevin XLR Plus 4)	2	64 oz	5
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	8
permethrin (Pounce 3.2E)	0.1 - 0.2	4 - 8 oz	8
β-cyfluthrin (Baythroid XL 1)	0.006 - 0.0125	0.8 - 1.6 oz	8
γ-cyhalothrin (Declare 1.25)	0.008 - 0.0125	0.77 - 1.28 oz	8
λ-cyhalothrin (Warrior II)	0.016 - 0.026	0.96 - 1.6 oz	8
Z-cypermethrin (Mustang Maxx 0.8E)	0.008 - 0.0175	1.28 - 2.8 oz	8

Flea Beetles

Several species of **flea beetles** may occasionally cause economic damage, with the corn flea beetle being the most common. Adults are small (one-sixteenth inch), shiny black beetles known for their ability to jump long distances when disturbed. Corn flea beetles injure corn by removing leaf tissue and transmitting the bacterium *Erwinia stewartii*, which causes Stewart's wilt. Beetles feed on the upper and lower sides of corn leaves causing scarring that may appear whitish or silvery.

Sampling: Begin scouting corn for scarring from flea beetles when seedlings emerge. Flea beetles will often first appear around field edges as they move from grassy areas and other overwintering sites.

Treatment Thresholds: Treat seedling plants with five or fewer leaves when 75 percent of the plants show obvious scarring by beetles on stems and leaves. Insecticide seed treatments and some other at-planting insecticides typically provide adequate protection from flea beetles.

Insecticide (Trade Names) for FLEA BEETLES	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.047 - 0.1	3 - 6.4 oz	6
carbaryl (Sevin XLR Plus 4)	1 - 2	32 - 64 oz	8
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	6
permethrin (Pounce 3.2E)	0.1 - 0.2	4 - 8 oz	5
β-cyfluthrin (Baythroid XL 1)	0.006 - 0.0125	0.8 - 1.6 oz	6
γ-cyhalothrin (Declare 1.25)	0.01 - 0.015	1.02 - 1.54 oz	6
λ-cyhalothrin (Warrior II)	0.02 - 0.03	1.28 - 1.92 oz	6
Z-cypermethrin (Mustang Maxx 0.8E)	0.017 - 0.025	2.75 - 4 oz	6

Armyworms

Armyworms may feed on seedling corn, in whorls and on kernels within the ear. Feeding from smaller armyworm larvae can result in "window-paning" of the upper side of leaves, while large larvae can chew holes in leaves. Both fall and true armyworm have four pairs of abdominal prolegs.

In corn, **fall armyworms** are typically brown colored and striped caterpillars with a characteristic inverted "Y" on a dark head capsule. They commonly infest the whorls of late-planted non-Bt corn, and later in the season, will feed within the ears, similar to corn earworm.

Mature **true armyworm** 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. They are sometimes seen feeding on corn during the seedling stage. Infestations are often associated with grassy field edges or where cover crops contained wheat, oat, barley or cereal rye. They seldom cause economic loss.

Sampling: During the whorl stage, scout fields for the presence of feeding (defoliation). Examine whorls with signs of leaf feeding. Other caterpillars may also be found in the whorls (e.g., European and southwestern corn borer). Fall armyworm egg masses are usually laid on the undersides of leaves. Moths lay their eggs in clusters of 50 to several hundred on corn leaves and other vegetation.

Treatment Thresholds:

Seedling plants. Treat when 50 percent of the plants have one or more larvae per plant.

Whorl stage or larger plants. Controls should be initiated when 75 percent of whorls have larvae present. Control of larvae in ears is not economically practical in field corn.

- **Production of an early crop and preservation of beneficial insects will reduce the risk of armyworm outbreaks.**
- **Several of the new Bt corn technologies are effective at controlling fall armyworms in the whorls and ears.**

Insecticide (Trade Names) for FALL ARMYWORM	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.10	4 - 6.4 oz	6
carbaryl (Sevin XLR Plus 4)	1 - 2	32 - 64 oz	4
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.047 - 0.067	1.2 - 1.71 oz	9
chlorantraniliprole, bifenthrin (Elevest)	See label	5.6 - 9.6 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	see label	6 - 10 oz	9
methomyl (Lannate LV 2.4)	0.225 - 0.3	12 - 16 oz	7
methoxyfenozide (Intrepid 2F)	0.6 - 0.125	4 - 8 oz	7
permethrin (Pounce 3.2E)	0.1 - 0.2	4 - 8 oz	5
spinetoram (Radiant SC 1)	0.02 - 0.05	3 - 6 oz	8
spinosad (Blackhawk 36% WDG)	0.04 - 0.07	1.7 - 3.3 oz	7
β-cyfluthrin (Baythroid XL 1)	0.02	2.8 oz	6
γ-cyhalothrin (Declare 1.25)	0.01 - 0.015	1.02 - 1.54 oz	6
λ-cyhalothrin (Warrior II)	0.02 - 0.03	1.28 - 1.92 oz	6
Z-cypermethrin (Mustang Maxx 0.8E)	0.02 - 0.025	3.2 - 4 oz	6

Corn Earworm

Corn earworms, or bollworms, feed directly on developing kernels. Large caterpillars may be green, brown or yellow with a pale brown or orange head. Corn earworms have light and dark stripes running the length of their body and four pairs of abdominal prolegs.

Sampling: During whorl stages, corn fields should be checked at least weekly until the crop is mature to determine the presence of insect pests or their damage. Sample 10 plants in 10 locations on a weekly basis for signs of tattered and torn whorls. Fewer plants can be sampled depending on pest density. To check for live corn earworm larvae, cut open at least two (or more) plants in each sample and record the number of larvae.

Pheromone (sex-attractant) traps are also used to monitor various insect flights, and can 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.

Treatment Thresholds: *Whorl stage plants:* Controls should be initiated when 75 percent of whorls have larvae present. Control of larvae in ears is not economically practical in field corn.

- **Planting in the recommended planting window is suggested to avoid late-season infestations of caterpillar pests.**
- **Certain Bt corn technologies are effective at controlling corn earworms in whorls or in corn ears.**

Insecticide (Trade Names) for CORN EARWORM	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.1	4 - 6.4 oz	6
carbaryl (Sevin XLR Plus 4)	1 - 2	32 - 64 oz	4
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.047 - 0.067	1.2 - 1.71 oz	9
chlorantraniliprole, bifenthrin (Elevest)	See label	5.6 - 9.6 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	6 - 10 oz	9
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	6
methomyl (Lannate LV 2.4)	0.225 - 0.3	12 - 16 oz	7
permethrin (Pounce 3.2E)	0.1 - 0.2	4 - 8 oz	5
spinetoram (Radiant SC 1)	0.023 - 0.05	3 - 6 oz	7
spinosad (Blackhawk 36% WDG)	0.05 - 0.07	2.2 - 3.3 oz	7
β-cyfluthrin (Baythroid XL 1)	0.0125 - 0.02	1.6 - 2.8 oz	6
γ-cyhalothrin (Declare 1.25)	0.008 - 0.0125	0.77 - 1.28 oz	6
λ-cyhalothrin (Warrior II)	0.016 - 0.026	0.96 - 1.6 oz	6
Z-cypermethrin (Mustang Maxx 0.8E)	0.0125 - 0.025	2 - 4 oz	6

Grasshoppers

Grasshoppers are an occasional pest of corn in Tennessee. Nymphs and adults can feed on corn at any stage, but are not typically observed until the silking stage and later. Infestations often begin and are usually worse along field margins. Grasshoppers may injure corn by feeding on the leaves, silks and ear tips.

Sampling: During the whorl stage and later, 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.

Treatment Thresholds: Treatment is rarely needed, and thresholds have not been established in Tennessee.

Insecticide (Trade Names) for GRASSHOPPERS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.047 - 0.1	3 - 6.4 oz	8
esfenvalerate (Asana XL 0.66E)	0.03 - 0.05	5.8 - 9.6 oz	7
β-cyfluthrin (Baythroid XL 1)	0.016 - 0.022	2.1 - 2.8 oz	8
γ-cyhalothrin (Declare 1.25)	0.01 - 0.015	1.02 - 1.54 oz	8
λ-cyhalothrin (Warrior II)	0.02 - 0.03	1.28 - 1.92 oz	8
Z-cypermethrin (Mustang Maxx 0.8E)	0.017 - 0.025	2.75 - 4 oz	8

Japanese Beetles

The **Japanese beetle** is a scarab beetle commonly found in Tennessee. This beetle can be a pest of gardens, trees, shrubs, turf grass and agricultural fields. Adults have a bright metallic green head and thorax with copper-colored elytra (hardened wings) and a row of five spots of white hairs on each side of the abdomen below the wings. Japanese beetles injure corn by feeding on the fresh silks of developing ears. This feeding/clipping may interfere with kernel pollination if it occurs during the first week of silking. Drought conditions may exacerbate this issue.

Sampling: Corn fields should be checked the first week of silking to determine the presence of Japanese beetles and other pests of corn. Walk in a U-shaped pattern over the field looking for beetles feeding on silks. Sample 10 plants in 10 locations throughout the field.

Treatment Thresholds: Treat when three or more beetles are found per ear during the first week of silking. Infestations are usually worse along field margins.

Insecticide (Trade Names) for JAPANESE BEETLE	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.047 - 0.1	3 - 6.4 oz	8
carbaryl (Sevin XLR Plus 4)	1 - 2	32 - 64 oz	6
β-cyfluthrin (Baythroid XL 1)	0.0125 - 0.022	1.6 - 2.8 oz	8
γ-cyhalothrin (Declare 1.25)	0.01 - 0.015	1.02 - 1.54 oz	8
λ-cyhalothrin (Warrior II)	0.02 - 0.03	1.28 - 1.92 oz	8
Z-cypermethrin (Mustang Maxx 0.8E)	0.017 - 0.025	2.75 - 4 oz	8

Stink Bugs

Several species of **stink bugs** can occasionally be pests of corn in Tennessee. Stink bugs can damage the growing point of small plants resulting in irregular growth or even death. Feeding on small developing ears (one-half to three-fourths inches long) prior to silking may also result in malformed or aborted ears.

Sampling: In seedling corn, check twice weekly for stink bugs and other seedling corn pests. Walk in a zigzag pattern through the field, checking at least six places in a field. Count the number of stink bugs and damaged plants in ten feet of row. Check at least 100 plants.

Just prior to tassel emergence, corn fields should be checked for the presence of stink bugs. Walk in a U-shaped pattern over the field. Visually examine 10 plants in 10 locations of a field. Infestations are likely to be worse on field margins.

Treatment Thresholds:

Seedling plants. Treat corn less than 24 inches tall if 10 percent or more of plants are infested with stink bugs.

Late Whorl stage. Treat corn if 10 percent or more of plants are infested with stink bugs at or shortly before ear shoots appear (about V15). Treating for stink bugs is generally not recommended once silking has begun.

- **In Tennessee, stink bug injury to seedling plants is often more common in the earliest planted corn.**
- **Some at-planting insecticides and seed treatments may suppress stink bug feeding on seedling corn but may not provide adequate protection.**
- **Pyrethroid insecticides are generally less effective on brown stink bugs.**

Insecticide (Trade Names) for STINK BUGS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating Green / Brown
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.047 - 0.1	3 - 6.4 oz	9 / 8
carbaryl (Sevin XLR Plus 4)	1 - 2	32 - 64 oz	4 / 4
β-cyfluthrin (Baythroid XL 1)	0.0125 - 0.022	1.6 - 2.8 oz	8 / 4
γ-cyhalothrin (Declare 1.25)	0.01 - 0.015	1.02 - 1.54 oz	8 / 4
λ-cyhalothrin (Warrior II)	0.02 - 0.03	1.28 - 1.92 oz	8 / 4
Z-cypermethrin (Mustang Maxx 0.8E)	0.017 - 0.025	2.75 - 4 oz	8 / 4

Corn Borers

The **southwestern corn borer** (SWCB) is a well-known caterpillar pest of corn. Larvae are creamy white with large brown or black dots on each body segment and a dark head. Older larvae tunnel into the stalk, in ear shanks, or feed on ears until they pupate (usually inside the stalk). Tunneling interferes with nutrient and water flow within the plant and to the ears. Tunneled shanks may break, causing ears to fall on the ground. Overwintering larvae usually girdle the stalk from the inside. Girdling often results in lodging below the ear, particularly in high winds or when infested corn is not harvested in a timely manner. Lodging can dramatically reduce yield and slow harvesting operations.

The **European corn borer** (ECB) is found throughout Tennessee and may be the most common corn borer species found in the Middle and Eastern parts of the state, although it is only an occasional pest of corn. ECB larvae are gray or tan with rows of light brown spots. The injury caused by ECB is similar to southwestern corn borer. During the whorl stage, feeding from ECB include elongated window-pane lesions on emerging leaves. In tasseling corn, small larvae are found behind leaf collar and sheath areas or in silks. Older larvae tunnel into the stalk, ear shanks or ears until they pupate inside stalks or ears. Tunneling interferes with nutrient and water flow in the plant. Tunneled shanks may break, causing ears to fall on the ground. Injury to ears may affect kernel quality and introduce or spread disease organisms. Unlike SWCB, late-season tunneling tends to be concentrated in the stem near or above the ear, and ECB larvae do not girdle the stem prior to overwintering. One sign of ECB infestation is when stalks break above the ear compared to SWCB which often cause lodging below the ear.

Sampling: Scouting is not needed where Bt corn hybrids are used for corn borer control. For non-Bt corn, look on the undersides of leaves for corn borer egg masses. SWCB and ECB lay eggs in an overlapping pattern that look like small fish scales. SWCB egg masses are usually smaller (2-8 eggs) than those of ECB (10 or more eggs).

When corn is tasseling or silking, 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, on the undersides of the leaves. Small larvae may be

found between ear husks or behind leaf collars. It is important to correctly identify larvae which are found because corn borers, corn earworm and fall armyworm may all be present. Treatment for insect pests during this stage will be more difficult. Insecticidal control for corn borers in tasseling corn is generally not as efficient as corn in the whorl stage. Small larvae are more easily controlled than larger larvae.

Pheromone (sex-attractant) traps are also used to monitor various insect flights, and can complement an effective scouting program. Traps can be used in each county or on individual farms to provide producers with an advance warning of insect infestations. When several traps are run on a farm, the numbers of southwestern corn borer moths caught can be used to trigger a foliar insecticide application.

Treatment Thresholds:

Southwestern corn borer. Prior to tasseling, treat for SWCB when five percent (or more) of plants are found with egg masses or live larvae or 7-10 days after pheromone traps catch an average of 50-plus moths over a seven-day period. Beginning at tasseling (VT) and through the milk stage (R3), treat for SWCB when 10 percent (or more) of plants are found with egg masses or live larvae or 7-10 days after pheromone traps catch an average of 100+ moths on a seven-day catch. Treatment is generally not recommended once corn reaches the dough stage (R4).

European corn borer. For non-Bt corn, treat for ECB 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.

- **Planting field corn early, during the recommended planting window, will reduce the chances of crop damage from several insect species.**
- **Bt technologies with corn borer protection provide a high level of control for SWCB and ECB.**

Insecticide (Trade Names) for SOUTHWESTERN AND EUROPEAN CORN BORER	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
bifenthrin (Brigade 2E, Discipline 2E, Fanfare 2E)	0.063 - 0.1	4 - 6.4 oz	7
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.047 - 0.067	1.2 - 1.71 oz	9
chlorantraniliprole, bifenthrin (Elevest)	See label	5.6 - 9.6 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	6 - 10 oz	9
esfenvalerate (Asana XL 0.66E)	0.04 - 0.05	7.8 - 9.6 oz	6
methoxyfenozide (Intrepid 2F)	0.0625 - 0.125	4 - 8 oz	8
permethrin (Pounce 3.2E)	0.1 - 0.2	4 - 8 oz	5
spinetoram (Radiant SC 1)	0.023 - 0.047	3 - 6 oz	8
spinosad (Blackhawk 36% WDG)	0.05 - 0.07	2.2 - 3.3 oz	6
β-cyfluthrin (Baythroid XL 1)	0.0125 - 0.02	1.6 - 2.8 oz	6
γ-cyhalothrin (Declare 1.25)	0.01 - 0.015	1.02 - 1.54 oz	6
λ-cyhalothrin (Warrior II)	0.02 - 0.03	1.28 - 1.92 oz	6
Z-cypermethrin (Mustang Maxx 0.8E)	0.017 - 0.025	2.75 - 4 oz	6

Premixed Insecticide Products

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

Trade Name (Insecticides)	Amount Product per Acre	Comments and Primary Target Pests (see label for other pests that may be controlled)
Besiege (chlorantraniliprole, λ-cyhalothrin)	6 - 10 oz	Corn borers, corn earworm, stink bugs; Pre-harvest interval - 21 days
Elevest (chlorantraniliprole, bifenthrin)	4.8 - 9.6	Corn borers, corn earworm, stink bugs; Pre-harvest interval - 30 days
Hero 1.24 (bifenthrin, Z-cypermethrin)	4 - 10.3 oz	Corn borers, corn earworm, stink bugs; Pre-harvest interval - 30 days grain, 60 days forage

2027 Sorghum Insect Control Recommendations

Introduction

Grain sorghum is a minor rotational crop in Tennessee. Sorghum is more drought-tolerant than either corn or soybean, 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 pests may reduce yield, and sorghum should be routinely scouted for insects and other problems. By planting grain sorghum in the recommended planting window, some insect problems can be reduced or avoided. Infestations of the sorghum midge, corn earworm, fall armyworm and sorghum webworm will typically cause more damage to late-planted sorghum. Fortunately, there are many insecticides that will control economically damaging populations of sorghum insect pests.

Sap-feeding Insects
Different types of aphids may be found on grain sorghum early in the season. These insects are found on top and underneath the leaves and whorls of sorghum plants, where they cause damage by sucking juices from the plant. The most common aphids found in grain sorghum are the sugarcane aphid, corn leaf aphid and greenbug. The greenbug can be a serious pest of seedling plants, and the sugarcane aphid is a serious pest later in the season (see below).

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

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

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

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

Aphids

Several species of aphids may be found on grain sorghum. These insects damage by sucking juices from the plant, and some inject a toxin that can kill plant tissue while feeding. The most common aphids found in grain sorghum are the corn leaf aphid and sugarcane aphid.

The corn leaf aphid has black cornicles, legs and antennae. The body is bluish-green in color and about one-sixteenth inch long. Corn leaf aphids are usually found feeding in the whorl of the sorghum plant. Check primarily in the whorls of sorghum plants for this insect. The corn leaf aphid does not inject a toxic saliva into the leaves, but it can transmit Maize Dwarf Mosaic Virus if Johnsongrass is present in the field.

The greenbug aphid is a small, light green aphid with a dark green stripe down the back. It is approximately one-sixteenth inch long. Early-planted sorghum is more susceptible to attack from greenbug. The greenbug has a toxic substance in its saliva that causes red spots on leaves where it has fed. It can also transmit viral diseases like Maize Dwarf Mosaic Virus.

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

The sugarcane aphid is an invasive pest first found in Tennessee in 2014. Of the aphids that infest sorghum, they are most likely to cause serious economic damage. They are small and white to yellow in color. Infestations are often initially concentrated on field edges. Populations can build rapidly and may kill entire plants in some circumstances. The accumulation of honeydew on heads may also cause problems during harvest.

Sampling: Sample for aphids by visually examining plants. Aphids are most commonly found on the undersides of leaves, but corn leaf aphids often specifically congregate in the whorls. Aphids excrete honeydew as they feed, and sticky and shiny leaves often indicate high populations of corn leaf aphids or sugarcane aphids.

Because sugarcane aphids do not survive the winter in Tennessee, populations migrate in from more southern regions each year. Thus, serious infestations typically do not occur until July or later. Sugarcane aphid infestations are almost always worse and first detected on field edges, thus, edge sampling can be used to detect the presence or absence of this pest. Once detected, randomly sample several areas of the field every 4-5 days.

Treatment Thresholds:

Corn leaf aphid. Sorghum plants can tolerate large numbers of corn leaf aphids, and treatment is usually unnecessary.

Greenbug and yellow sugarcane aphids. Treatment for greenbug and yellow sugarcane aphids is most likely during the seedling stage. Treat when one or two aphids are on the majority of plants during the seedling stage (less than 3-4 true leaves) and leaves are showing injury. For larger plants, treat when 1-2 leaves are dying on most plants.

Sugarcane aphid. Current recommendations are to treat when aphids are present on 30 percent or more of plants and occasional leaves have 100 or more aphids present. Treatment should also be considered if honeydew is present in multiple spots throughout the field and aphid populations are increasing. Unlike the other aphid species, treatment may be needed until near crop maturity because serious infestations can cause an accumulation of honeydew and sooty mold that interferes with harvest.

- **Insecticide seed treatments such as Cruiser, Gaucho and Poncho can suppress early-season aphid infestations for 30 days or longer.**
- **Early planting substantially reduces the risk of sugarcane aphid infestations.**

- **Varieties with tolerance to sugarcane aphid infestations are available and should be used providing they have adequate yield potential.**

Insecticide (Trade Name) for APHIDS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
Aphids Except Sugarcane Aphid			
dimethoate 4	0.25 - 0.5	8 - 16 oz	8
Sugarcane and Other Aphids			
flupyradifurone (Sivanto Prime 1.67)	0.15 - 0.09	4 - 7 oz	9
sulfoxaflor (Transform 50WG)	0.023 - 0.047	0.75 - 1.5 oz	9

Corn Earworm

Corn earworm larvae are a common pest of grain sorghum. The larva has alternating light and dark stripes and tiny spines down the length of the body. The color of larvae varies considerably, but the head capsule is a creamy yellow. Full grown larvae are about 1 1/2 inches long. Corn earworms will feed in the whorls of young plants, like fall armyworm. However, feeding on the kernels of grain heads is more likely to cause economic damage.

Sampling: Check in the whorls of young plants and the grain heads of older plants. Examine a minimum of 50 plants throughout the field. Sets of 10 heads can be briskly shaken into a bucket or sweep net. Carefully look through the debris for larvae of all sizes. Fall armyworm or sorghum webworm will also be found feeding in heads. Frass (worm poop) often accumulates in the collars of upper leaves if large larvae are present.

Treatment Thresholds: Treatment is recommended when an average of one or more larvae is found per plant.

- **Planting early, before mid-May, may help avoid some damage from corn earworm and fall armyworm.**

Insecticide (Trade Names) for CORN EARWORM	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
carbaryl (Sevin 80S)	1 - 2	1.25 - 2.5 lbs.	5
carbaryl (Sevin XLR 4)	0.5 - 1	16 - 32 oz	5
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.047 - 0.067	1.2 - 1.71 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	6 - 10 oz	9
methomyl (Lannate LV 2.4)	0.45	24 oz	7
NPV virus (Heligen)*	See label	1 - 1.4 oz	6
spinosad (Blackhawk 36% WDG)	0.038 - 0.074	1.7 - 3.3 oz	6
esfenvalerate (Asana XL 0.66)**	0.015 - 0.03	2.9 - 5.8 oz	6
β-cyfluthrin (Baythroid XL 1)**	0.01 - 0.02	1.3 - 2.8 oz	6
γ-cyhalothrin (Declare 1.25)**	0.01 - 0.015	1.02 - 1.54 oz	6
λ-cyhalothrin (Warrior II 2.08)**	0.02 - 0.03	1.23 - 1.85 oz	6
Z-cypermethrin (Mustang Maxx 0.8)**	0.01 - 0.025	1.76 - 4 oz	6

*NPV virus (Heligen) will only control corn earworm. Applications should be made when larvae are small. Do not apply if most larvae are large or if infestations are well above treatment threshold.
**Pyrethroid insecticides may not provide adequate control of corn earworm or fall armyworm and are not recommended if infestations are well above treatment threshold.

Fall Armyworm

Fall armyworm larvae are commonly found feeding in the whorls of sorghum and also feed on the grain of older plants. Larvae generally have a dark head capsule and a prominent, light-colored inverted Y on the front of the head. The body color is greenish to brownish with dark stripes along its length. It has relatively few tiny spines (setae) on the body, contrasting it with the corn earworm.

Sampling: Check in the whorls of young plants and the grain heads of older plants. Examine a minimum of 50 plants throughout the field. Sets of 10 heads can be briskly shaken into a bucket or sweep net. Carefully look through the debris for larvae of all sizes. Corn earworm or sorghum webworm will also be found feeding in heads. Frass (worm poop) often accumulates in the collars of upper leaves if large larvae are present.

Treatment Thresholds: Treatment is recommended when an average of one or more larvae is found per plant, either in the whorl or head stage.

- **Planting early, before mid-May, will generally help avoid some damage from fall armyworm and corn earworm.**

Insecticide (Trade Names) for FALL ARMYWORM	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
carbaryl (Sevin 80S)	1 - 2	1.25 - 2.5 lbs.	7
carbaryl (Sevin XLR 4)	1 - 2	32 - 64 oz	7
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.047 - 0.067	1.2 - 1.71 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	6 - 10 oz	9
methomyl (Lannate LV 2.4)	0.225 - 0.45	12 - 24 oz	8
methoxyfenozide (Intrepid 2F)	1 - 1.25	8 - 10 oz	8
spinosad (Blackhawk 36% WDG)	0.038 - 0.074	1.7 - 3.3 oz	8
β-cyfluthrin (Baythroid XL 1)*	0.01 - 0.02	1.3 - 2.8 oz	5
γ-cyhalothrin (Declare 1.25)*	0.01 - 0.015	1.02 - 1.54 oz	5
λ-cyhalothrin (Warrior II 2.08)*	0.02 - 0.03	1.23 - 1.85 oz	5
Z-cypermethrin (Mustang Maxx 0.8)*	0.01 - 0.025	1.76 - 4 oz	5

*Pyrethroid insecticides may not provide adequate control of corn earworm or fall armyworm and are not recommended if infestations are well above the treatment threshold.

Sorghum Midge

Serious infestations of sorghum midge are relatively uncommon in Tennessee, but they can be very damaging. Sorghum midge is a small, gnat-like insect that is reddish-orange and about one-tenth inch long. Female sorghum midges lay eggs only during the bloom stage. Eggs are laid in the spikelets between the glumes of a floret. The larvae feed on the developing seeds, causing them to dry up and die.

Sampling: Once grain heads are present, check for sorghum midge throughout bloom every 4-5 days. You can visually look for the reddish-orange flies, but a preferred method is to place a clear plastic bag over the head and shake, looking for midges that land on the plastic. Examine a minimum of 50 heads in randomly selected areas of the field.

Treatment Thresholds: During flowering, once 20-30 percent of heads are blooming, treat when an average of one midge is found per head. More than one treatment may be needed in some cases.

- **Insecticide applications are made to control adults and prevent egg laying because larvae are hidden from insecticides.**
- **Planting early, before mid-May, may help avoid some damage from sorghum midge.**
- **Sorghum midge are often worse in sorghum next to earlier maturating fields that serve as a source of infestations.**
- **Johnsongrass is an alternative host that may serve as a nursery for sorghum midge. Maintaining good weed control in and around a field can reduce infestations.**

Insecticide (Trade Names) for SORGHUM MIDGE	**Lbs. Active Ingredient per Acre**	**Amount Formulation per Acre**	**Performance Rating**
methomyl (Lannate LV 2.4)	0.225 - 0.45	12 - 24 oz	6
esfenvalerate (Asana XL 0.66)	0.015 - 0.03	2.9 - 5.8 oz	8
spinosad (Blackhawk 36% WDG), suppression	0.034 - 0.074	1.5 - 3.3 oz	8
β-cyfluthrin (Baythroid XL 1)	0.008 - 0.01	1 - 1.3 oz	8
γ-cyhalothrin (Declare 1.25)	0.0075 - 0.01	0.77 - 1.02 oz	8
λ-cyhalothrin (Warrior II 2.08)	0.015 - 0.02	0.92 - 1.23 oz	8
Z-cypermethrin (Mustang Maxx 0.8)	0.008 - 0.025	1.28 - 4 oz	8

Sorghum Webworm

The sorghum webworm is a hairy caterpillar with four reddish-brown stripes down its back. Full-grown larvae are only about one-half inch long. They are commonly seen feeding on grain in developing heads. They are usually associated with a sticky webbing in the area of their feeding.

Sampling: Check grain heads for larvae. Examine a minimum of 50 plants throughout the field. Sets of 10 heads can be briskly shaken into a bucket or sweep net. Carefully look through the debris for larvae. Corn earworm or fall armyworm will also be found feeding in heads.

Treatment Thresholds: During heading, treat when an average of 3-4 or more larvae is found per grain head.

- **Planting early, before mid-May, may help avoid some damage from sorghum webworm.**
- **Resistance to pyrethroid insecticides in well documented and has been observed in Tennessee. Use of alternative chemistries is generally suggested.**

Insecticide (Trade Names) for SORGHUM WEBWORM	**Lbs. Active Ingredient per Acre**	**Amount Formulation per Acre**	**Performance Rating**
carbaryl (Sevin 80S)	1 - 2	1.25 - 2.5 lbs.	7
carbaryl (Sevin XLR 4)	0.5 - 1	16 - 32 oz	7
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.047 - 0.067	1.2 - 1.71 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	6 - 10 oz	9
methomyl (Lannate LV 2.4)	0.45	24 oz	7
spinosad (Blackhawk 36% WDG)	0.038 - 0.074	1.7 - 3.3 oz	9

Stink Bugs

Several species of stink bugs including the rice stink bug and brown stink bug will attack sorghum during grain fill. Although treatment is only occasionally needed, feeding can affect grain quality and yield. Sorghum is most susceptible when the grain is in the milk and soft dough stage.

Sampling: Visually examine at least 50 heads throughout the field for adult and immature stink bugs, or sets of 10 heads can be briskly shaken into a bucket or sweep net to check for insects.

Treatment Thresholds: Treat when an average of five or more stink bugs per head is found from flowering to soft dough. When sorghum reaches hard dough stage, treat when an average of 16 or more stink bugs is found per head.

Insecticide (Trade Names) for STINK BUGS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
carbaryl (Sevin 80S)	1.2 - 2	1.5 - 2.5 lbs.	5
carbaryl (Sevin XLR 4)	1 - 2	38 - 64 oz	5
β-cyfluthrin (Baythroid XL 1)	0.01 - 0.02	1.3 - 2.8 oz	8
γ-cyhalothrin (Declare 1.25)	0.01 - 0.015	1.02 - 1.54 oz	8
λ-cyhalothrin (Warrior II 2.08)	0.02 - 0.03	1.23 - 1.85 oz	8
Z-cypermethrin (Mustang Maxx 0.8)	0.01 - 0.025	1.76 - 4 oz	8

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2027 Wheat Insect Control Recommendations

Introduction

Many farmers in Tennessee use wheat as a double-crop with soybean. 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 information 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 aphid species feed on the leaves and grain heads of wheat. Adult aphids are only about one-eighth inch long, and may or may not have two pairs of nearly transparent wings. These pests are significant in that they are capable of transmitting diseases, such as barley yellow dwarf (BYD) virus, in addition to the damage inflicted by their feeding habits.

The bird cherry-oat aphid is dark green and the primary species that transmits BYD. It is usually the most common species observed in wheat.

The English grain aphid is pale green with black antennae and cornicles ('tailpipes'), which are longer than the antennae and also longer than the cornicles of other aphid species normally observed in wheat.

The greenbug is pale green with a dark green stripe down the back of the wingless form. The tips of the legs and cornicles are black, and the antennae are mostly black.

The corn leaf aphid is bluish-green with black legs, cornicles and antennae.

The rice root aphid occurs on the roots of wheat and is also known to transmit BYD.

Sampling: A good sampling plan is to scout one row foot of wheat at 10 locations throughout the field. Aphids are typically found on the stems and underside of leaf blades. Examine each plant within the row foot for number of aphids and determine the aphid species present. Samples should be taken during the fall (e.g., approximately 30 days after planting) or late winter (prior to March).

Treatment Thresholds: *Bird cherry-oat, English grain, corn leaf and rice root aphids*. With the exception of greenbug (below), treatment for high numbers of aphids is generally not recommended unless they are causing leaves to dry up and die in several portions of the field. However, more aggressive management is needed to prevent BYD. Insecticide seed treatments such as Gaucho, Cruiser and NipsIt Inside can be used to reduce transmission of BYD. Data suggests that early-planted wheat is most likely to benefit from the use of a seed treatment. If a seed treatment is not used, a foliar insecticide application during the fall or late winter (prior to March) can also reduce transmission of BYD. These applications should be made when aphids are present but before populations exceed 6-8 aphids per row foot, otherwise transmission of BYD may have already occurred.

Greenbug. This aphid injects a toxin while feeding. Treatment should me made when aphids are killing three or more leaves per plant. For wheat less than six 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.

- **Early-planted wheat is more likely to be infested by aphids during the fall and often results in higher infection with BYD. Thus, planting is not recommended until October 15 or later, which also helps avoid infestations from Hessian fly.**

Insecticide (Trade Names) for APHIDS	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
Seed Treatments			
clothianidin (NipsIt Inside 5)	----	0.75 - 1.79 oz per 100 lbs. seed	8
imidacloprid (Gaucho 600)	----	0.8 - 2.4 oz per 100 lbs. seed	8
thiamethoxam (Cruiser 5)	----	0.75 - 1.33 oz per 100 lbs. seed	8
Foliar Treatments			
dimethoate 4	0.25 - 0.375	8 - 12 oz	7
methomyl (Lannate LV 2.4)	0.225 - 0.45	12 - 24 oz	7
β-cyfluthrin (Baythroid XL 1)	0.014 - 0.019	1.8 - 2.4 oz	8
γ-cyhalothrin (Declare 1.25)	0.015	1.54 oz	8
λ-cyhalothrin (Warrior II 2.08)	0.02 - 0.03	1.28 - 1.92 oz	8
Z-cypermethrin (Mustang Maxx 0.8)	0.02 - 0.025	3.2 - 4 oz	8

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 migrate to other areas of other fields, eating foliage as they go.

True armyworm larvae are smooth, almost without any hairs, and 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. Damaging infestations of true armyworm normally occur in the spring. Besides feeding on foliage, larvae will sometimes cut the heads of maturing wheat plants.

Fall armyworms are normally a pest of early-planted seedling wheat during the fall. These insects can completely defoliate a wheat field when populations are very large. Fall armyworm larvae differ from true armyworms by having a prominent inverted Y on the front of the head and no dark bands on the outer portion of the prolegs.

Sampling: Scout one square foot of wheat in 10 locations throughout the field during the fall and spring. Armyworms fall to the ground when disturbed, and larvae may also be hidden under debris on the soil surface during hot times of the day.

Treatment Thresholds:

True Armyworm. For infestations that occur during the spring, use a threshold of 6-8 larvae per square foot if wheat is still in the milk stage. Once past the milk stage, wheat can tolerate higher populations and treatment is not usually recommended unless larvae are cutting wheat heads.

Fall Armyworm. Treatment for fall armyworm during the fall should be considered when four or more larvae are present per square foot.

- **Avoid planting before the Hessian fly free date (October 15) as infestations of fall armyworm almost always occur in early-planted wheat, especially for wheat planted in September.**

Insecticide (Trade Names) for ARMYWORMS (True and Fall)	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.047 - 0.067	1.2 - 1.71 oz	9
chlorantraniliprole, λ-cyhalothrin (Besiege)	See label	6 - 10 oz	9
methomyl (Lannate LV 2.4)	0.225 - 0.45	12 - 24 oz	7
spinetoram (Radiant SC 1)	0.023 - 0.047	3 - 6 oz	9
spinosad (Blackhawk 36% WDG)	0.038 - 0.074	1.7 - 3.3 oz	8
β-cyfluthrin (Baythroid XL 1)	0.014 - 0.019	1.8 - 2.4 oz	8
γ-cyhalothrin (Declare 1.25)	0.01 - 0.015	1.02 - 1.54 oz	8
λ-cyhalothrin (Warrior II 2.08)	0.02 - 0.03	1.28 - 1.92 oz	8
Z-cypermethrin (Mustang Maxx 0.8)	0.02 - 0.025	3.2 - 4 oz	8

Cereal Leaf Beetle

The cereal leaf beetle is a pest of wheat, oats, barley and other cereal crops. They have one generation per year. Adults, eggs and larvae may be found in wheat during April to June. Adults are shiny, black beetles with red legs and thorax and are approximately three-sixteenths inch long. The larvae are pale yellow and soft-bodied, but they are normally covered with their fecal material giving them a dark gooey, shiny appearance. Adults and larvae skeletonize the leaf tissue between the veins, but the larvae cause most of the injury.

Sampling: Visually examine 10 tillers (stems) at 10 randomly selected locations in a field. Count the total number of eggs and larvae found on 100 tillers.

Treatment Thresholds: Treatment is necessary if 25 or more eggs and/or larvae are present per 100 tillers until wheat reaches the dough stage.

- **Follow good agronomic practices for wheat production, including adequate plant populations and fertility.**

Insecticide (Trade Names) for CEREAL LEAF BEETLE	Lbs. Active Ingredient per Acre	Amount Formulation per Acre	Performance Rating
methomyl (Lannate LV, 2.4)	0.225 - 0.45	12 - 24 oz	8
spinosad (Blackhawk 36% WDG)	0.025 - 0.074	1.1 - 3.3 oz	7
β-cyfluthrin (Baythroid XL 1)	0.008 - 0.014	1 - 1.8 oz	7
γ-cyhalothrin (Declare 1.25)	0.01 - 0.015	1.02 - 1.54 oz	7
λ-cyhalothrin (Warrior II 2.08)	0.02 - 0.03	1.28 - 1.92 oz	7
Z-cypermethrin (Mustang Maxx 0.8)	0.01 - 0.025	1.76 - 4 oz	7

Hessian Fly

The Hessian fly has 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 as they mature. Larvae are legless, resemble small grains of rice and are approximately one-fourth inch long when fully grown. The pupae, or flax seed stage, are brown in color 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).

Sampling: Sampling for Hessian fly is generally not considered useful due to the inherent difficulty in making effective insecticide applications.

Treatment Thresholds: Foliar insecticide applications for this pest are difficult to time, and thus are only marginally effective and rarely recommended.

- **Plant after the fly free date (October 15) and use resistant varieties if they are available.**
- **Insecticide seed treatments will provide some protection against fall infestations of Hessian fly, especially when used at the highest labeled rates.**

Stink Bugs

Stink bugs, primarily the rice stink bug and brown stink bug, are frequently observed on wheat that is heading where they feed on developing seed. Rice stink bug is generally most common, but this may vary from field to field.

Sampling: Stink bugs can be sampled visually by examining the heads of plants. However, a sweep net can be used to confirm the presence or absence of stinks bugs. Samples should be distributed throughout the field.

Treatment Thresholds: Treatment thresholds are not well defined, but large numbers of stink bugs are needed to justify treatment. Published thresholds vary from one stink bug per 5-10 heads to one stink bug per head.

- **Economically damaging infestations in Tennessee are rare, and thus, insecticide treatments are seldom needed.**
- **If treatment is needed, pyrethroid insecticides that are labeled for wheat would generally be recommended. The highest labeled rates are suggested if brown stink bugs are numerous.**

When to Treat

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

Grasshoppers: Treatment thresholds have not been established.

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

Suggestions for Chemical Control of Pasture Insects

Insects	Insecticide (Trade Names)	Rate per Acre	Restrictions/Comments*
Armyworms or Grasshoppers	carbaryl (Sevin XLR Plus 4)	32 - 48 oz	Must remove cattle. Do not apply within 14 days of harvest or grazing. Other Sevin formulations are also available.
Armyworms	chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	0.9 - 1.1 oz	0 day application restriction for forage or hay.
Armyworms, Bermudagrass Stem Maggot, Grasshoppers	chlorantraniliprole, λ-cyhalothrin (Besiege, premix)	6 - 10 oz	Do not apply within seven days of harvest; 0 day application restriction for grazing.
Grasshoppers	diflubenzuron (Dimilin 2L)	2 oz	Allow one day after treatment before cutting for hay. Apply when grasshoppers are small.
Armyworms or Grasshoppers	malathion (malathion 57E)	32 oz	Must remove cattle. Allow spray to dry before harvest or grazing.
Armyworms	methomyl (Lannate 2.4LV)	12 - 24 oz	Bermudagrass only. Must remove cattle. Do not apply within three days of harvest or seven days of grazing.
Armyworms	methoxyfenozide (Intrepid 2F)	4 - 8 oz	Do not apply within seven days of harvest; 0 day application restriction for grazing.
Armyworms	spinosad (Blackhawk 36% WDG)	1.1 - 2.2 oz	Do not apply within three days of harvest; 0 day restriction for grazing.

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

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

Insecticide Classes, Modes of Action and EPA Registration Numbers

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

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

Insecticide (IRAC Class)*	EPA Product Registration Number**
Elevest	279-9652
Fanfare (3A)	66222-99
Fyfanon Plus ULV (1B,3A)	67760-108
Gaucho (4A)	264-968
Hero (3A)	279-3315
Intrepid (18)	62719-442
Intrepid Edge (5, 18)	62719-666
Intruder (4A)	8033-24-10163
Lannate (1A)	352-384
Leverage 360 (3A,4A)	264-1104
Malathion (1B)	See label
Mustang Maxx (3A)	279 - 3249
Oberon (23)	264-850
Orthene 90S (1B)	59639-33
Poncho (4A)	264-789
Pounce 25WP (3A)	279-3051
Portal (21A)	71711-19
Radiant (5)	62719-545
Sevin XLR Plus (1A)	264-333
Sevin 80S (1A)	264-316
Sivanto Prime (4D)	264-1141
Steward (22A)	352-638
Transform WG (4C)	62719-625
Vantacor	279-9656
Vydate CL-V (1A)	352-532
Warrior II (3A)	100-1295
Zeal (10B)	59639-123

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

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

Active Ingredients (Common Brand Names)	Additional Brands with Same or Similar Active Ingredient*
abamectin (Abba, Agri-Mek, Agri-Mek SC, Zoro)	Abamex, Epi-Mek, Reaper
acephate (Orthene 90, Orthene 97)	Acephate 90, Acephate 97, Bracket, Livid 90WDG, Livid 97 Prill
bifenthrin (Brigade, Discipline, Fanfare)	Bifenthrin, Bifenture, Capture LFR, Reveal, Sniper, Tundra
bifenthrin + imidacloprid (Brigadier)	Avenger Bold, Skyraider, Swagger, Tempestri
chlorantraniliprole (Vantacor 5 SC, Coragen eVo)	Shenzi 400
cypermethrin	Cypermethrin, Holster, Up-Cyde
dicrotophos (Bidrin 8E)	Dicromax 8
diflubenzuron (Dimilin 2L)	Cavalier 2L
esfenvalerate (Asana XL)	S-FenvalorStar, Zyrate
imidacloprid (Admire Pro, Couraze Max)	Advise Four, Alias, Imida, Imidacloprid, Nuprid, Pasada, Provoke, Wrangler
methoxyfenozide (Intrepid 2F)	Troubadour 2F
oxamyl (Vydate C-LV)	ReTurn XL
permethrin (Pounce 3.2E)	Ambush 2E, Arctic, PermaStar AG, Permethrin 3.2, Perm-Up
spinosad (Blackhawk 36% WDG)	Success 2F
β-cyfluthrin (Baythroid XL)	Tombstone (= cyfluthrin)
γ-cyhalothrin (Declare)	Proaxis
λ-cyhalothrin (Warrior II)	Grizzly, Grizzly Too, Grizzly Z, Kendo, Lambda, Lambda-Cy, LambdaStar, Ravage, Silencer

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

Protection of Honeybees and Other Pollinators

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

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

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

Relative Toxicity of Commonly Used Insecticides to Adult Honeybees*

Trade Name	Common Name	Hazards to Adults (residual toxicity)
Acramite	bifenazate	moderate
Admire Pro	imidacloprid	high (3.5 days)
Agri-Mek, Abba	abamectin	moderate (less than 1 day)
Asana	esfenvalerate	high (less than 1 day)
Baythroid XL, Tombstone	β–cyfluthrin, cyfluthrin	high (greater than 1 day)
Besiege	chlorantraniliprole + λ-cyhalothrin	high
Blackhawk, Success	spinosad	moderate (less than 2 hours)
Brigade, Sniper, Fanfare	bifenthrin	high (1 day)
Carbine	flonicamid	low
Centric	thiamethoxam	moderate to high
Comite	propargite	none
Cruiser	thiamethoxam (seed treatment)	none to very low
Cypermethrin	cypermethrin	high (less than 1 day)
Diamond	novaluron	high
Dimethoate	dimethoate	high (3.5 days)
Dimilin	diflubenzuron	none

Trade Name	Common Name	Hazards to Adults (residual toxicity)
Elevest	chlorantraniliprole + bifenthrin	high
Endigo	thiamethoxam + λ-cyhalothrin	high
Gaucho	imidacloprid (seed treatment)	none to very low
Intrepid	methoxyfenozide	none
Intruder, Strafer	acetamiprid	none
Leverage 360	imidacloprid + cyfluthrin	high (3.5 days)
Malathion	malathion	high (2 days)
Mustang Maxx	zeta-cypermethrin	high (less than 1 day)
Oberon	spiromesifen	unknown
Orthene, Acephate	acephate (foliar)	high (2.5 days)
Portal	fenpyroximate	unknown
Radiant	spinetoram	moderate (greater than 2 hours)
Steward	indoxacarb	high
Vantacor, Coragen eVo	chlorantraniliprole	moderate
Vydate C-LV	oxamyl	high (4 days)
Warrior	λ-cyhalothrin	high
Zeal, Stifle	etoxazole	low

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

Restricted Entry Intervals

The restricted entry interval (or re-entry interval) is the time period required by law between application of pesticides 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 without the required personal protective equipment (PPE) until re-entry intervals have expired.

REI in Hours for Commonly Used Insecticides	Cotton	Soybeans	Corn	Sorghum	Wheat
Ambush, Arctic, Permethrin, PermaStar, Perm-Up, Pounce	-	12	12	-	-
Admire Pro, Advise Four, Alias, Imida, Nuprid, Pasada, Provoke, Wrangler	12	-	-	-	-
Agri-Mek, Abba, Abamex, Couraze, Epi-Mek, Reaper, Zoro	12	12	-	-	-
Asana XL, S-FenvalorStar, Zyrate	12	12	12	12	-
Baythroid XL, Tombstone	12	12	12	12	12
Belay	-	12	-	-	-
Besiege	24	24	24	24	24
Bidrin	72	-	-	-	-
Bidrin XP II	144	-	-	-	-
Blackhawk 36% WDG, Success 2F	4	4	4	4	4
Brigade, Bifenture, Capture LFR, Discipline, Reveal, Sniper, Tundra	12	12	12	-	-
Brigadier, Avenger Bold, Skyraider, Swagger, Tempestri	12	-	-	-	-
Centric	12	-	-	-	-
Cypermethrin, Holster, Up-Cyde	12	-	-	-	-
Declare, Proaxis	24	24	24	24	24
Denim	12	-	-	-	-
Diamond	12	12	-	12	-
Dimethoate	48	48	-	48	48
Dimilin, Cavalier	12	12	-	-	12
Elevest	12	12	12	-	-
Endigo	24	24	-	-	-
Hero	-	12	12	-	-
Intrepid, Troubadour	4	4	4	4	-
Intrepid Edge	4	4	-	-	-
Intruder, Strafer	12	-	-	-	-
Lannate	48	48	48	48	48
Leverage 360	12	12	-	-	-
Malathion	48	-	12	-	12
Mustang Maxx	12	12	12	12	12
Oberon	12	-	-	-	-
Orthene, Acephate, Bracket, Livid	24	24	-	-	-
Portal	12	-	-	-	-
Radiant	4	4	-	-	-
Sivanto Prime	-	-	-	4	-
Transform	24	-	-	24	-
Vantacor, Coragen eVo	4	4	4	4	4
Vydate C-LV	48	-	-	-	-
Warrior, Grizzly, Kendo, Lambda, Lambda-Cy, LambdaStar, Ravage, Silencer	24	24	24	24	24
Zeal, Stifle	12	12	-	-	-

Insecticide Safety Considerations

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

Know Your Insecticides

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

Relative Insecticide Toxicity of Some Representative Insecticides

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

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

Insecticide Poisoning

Symptoms may include eye tearing, blurred vision, salivation, unusual sweating, coughing, vomiting and frequent bowel movements and urination. Breathing may become difficult, and muscles may twitch and become weak. It is rare, but death can occur. Symptoms last hours to days after exposure to carbamate insecticides but can last for

weeks after exposure to organophosphate insecticides. Pyrethroid insecticides can cause sneezing, eye tearing, coughing, and occasional difficulty breathing. Serious symptoms rarely develop.

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

Other Safety Considerations

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

Safety Tips:

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



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