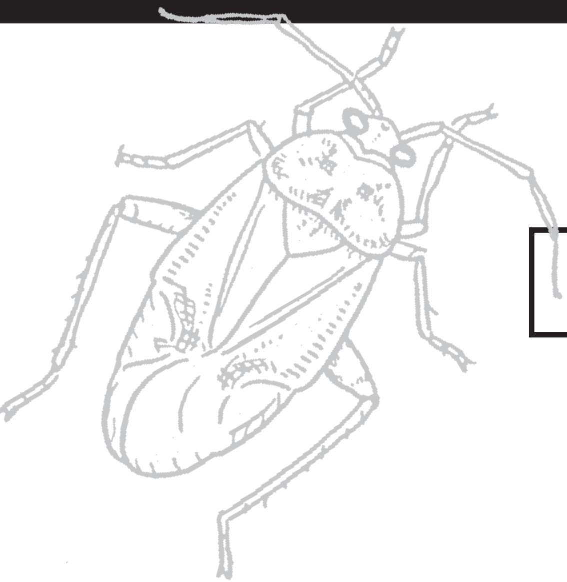
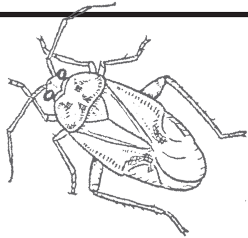
2007

COTTON INSECT Control Guide





Mississippi State University Extension Service

General Comments and Guidelines

Objective

To produce an early high-yielding crop:
Follow recommended practices for soil preparation, variety, planting dates, use of fungicides and herbicides, and protection from insect and mite damage.

To minimize the impact of pests and pest control costs:

a. Scout fields regularly, and make careful **counts** of insect pest populations.

b. Use all available, practical noninsecticidal IPM tools.

c. Apply insecticides promptly when needed.

d. Use the most cost-efficient insecticide recommended for the target pest, and target applications against the most susceptible stage of development.

e. Follow recommended guidelines for practicing insecticide-resistance management.

Before deciding to treat and before choosing the insecticide, consider such factors as the potential to intensify secondary pest problems and insecticide resistance.

Warning

Information in this guide is provided for educational and planning purposes only. When using agricultural chemicals, you, the user, are responsible for ensuring that the intended use complies with current regulations and conforms to the product label. Before applying any insecticide, be sure to obtain current information about usage, and read and heed the product label.

Precautions

Before using a pesticide, read the label carefully. Follow the directions, and heed all precautions on the pesticide container label. Observe all regulations on worker protection and pesticide record keeping. Store pesticides in plainly labeled containers, safely away from livestock, pets, and children. Store pesticides in an area where they will not contaminate food or feed.

Resistance

Research indicates pesticide resistance in most cotton pests. Some pesticides control in one area and not in another. Excessive use of pesticides will intensify the problem.

Integrated Pest Management

Successful, economical control of cotton insect pests requires using a variety of control methods rather than relying exclusively on a single method of control such as scheduled insecticide use. Integrated pest management, or IPM, is the term used to refer to this multitactical approach to insect control. Current cotton insect control recommendations are based on the IPM concept.

Insecticides are a key component in cotton IPM, but sustained economical insect control relying solely on insecticides is not possible in Mississippi.

The objective of cotton IPM is to use all available, practical nonchemical methods of suppressing insect populations; to monitor pest populations closely; and when scouting indicates that pest populations have exceeded economic thresholds, to integrate insecticides into the system in a manner that optimizes crop production and minimizes ecosystem disruption.

Because of the number of insect pests attacking cotton and the relatively high unit value of the crop, cotton IPM is quite complex. Management tactics applied against one pest may be favorable or unfavorable to the development of other pests in the system. Also, treatments applied during one part of the season may affect future pest populations or ability to control those pests at later points during the season, or even in subsequent years. Thus, an overall cotton IPM program must consider these types of long-term effects, because they greatly influence the ability of Mississippi growers to maintain economical cotton production.

There are many components of IPM that must be used to effectively manage cotton insect pests. These include using resistant varieties, managing for early crop maturity, various cultural practices, insecticide resistance management, using economic thresholds, thorough scouting, and timely application of insecticides when needed.

Scouting

Proper scouting is the backbone of an effective cotton insect management program. The goal of any scouting program should be to minimize insecticide use and insect control costs by avoiding unnecessary treatments and by proper timing of required treatments. Effective scouting requires spending adequate time in the field and taking enough samples to make an accurate decision on whether or not treatment is required. Frequency of scouting is critical. During most of the growing season, scout fields thoroughly every 3 to 4 days, and allow enough time in the scouting schedule to allow "spot checks" on a more frequent basis when necessary.

Thresholds

Making insect management decisions based on established treatment thresholds rather than applying treatments based on schedules or presence or absence of pests is a proven method of reducing insect management costs. Effective use of thresholds requires frequent, intensive scouting to obtain accurate estimates of populations of various pest species that may be present in a field.

The term "treatment threshold" represents the pest population level at which treatment must be applied to avoid economic loss that would be greater than the cost of the treatment. Thresholds can vary, depending on species of pest present, stage of crop development, yield potential of the crop, cost of the treatment, price of cotton, populations of other pests present, number of beneficial insects, potential for flaring secondary pests, ability to control secondary pests, and a variety of other factors. While the thresholds recommended in this guide vary according to pest species and stage of crop development, fixed thresholds cannot fully consider the many other factors that can influence a treatment decision. Although the thresholds recommended in this guide are generally somewhat conservative (quick to treat), factors such as multiple pest species or unusually low fruit retention could indicate a need to reduce thresholds. Likewise, factors such as high beneficial insect populations, risk of flaring difficult to control secondary pests, high treatment costs, low price potential, etc., could indicate a need to use higher thresholds.

Variety Selection

Available varieties vary in their relative susceptibilities to certain insect pests. Consider insect resistance/tolerance when selecting seed varieties. General effects of some key traits on certain insect species are as follows:

Early Maturity — Early maturing, short-season varieties are more likely to escape attack/damage from late-season infestations of budworm/bollworm, beet armyworm, fall armyworm, etc.

Smooth Leaf — Aphid and whitefly populations tend to be reduced on smooth leaf varieties. Egg deposition by budworm/bollworm is also generally less compared to hairy varieties. However, the smooth leaf trait may be somewhat more favorable to plant bugs.

Okra Leaf – Varieties with okra leaf trait allow improved canopy penetration of foliar insecticide treatments. This trait also has been associated with resistance to whiteflies.

Nectariless — Plant bug populations tend to be lower on nectariless varieties. Also, the nectariless trait tends to reduce egg production capacity of most moth species due to reduced nectar availability. On the negative side, populations of beneficial insects that aid in suppressing bollworm/budworm are also generally lower in nectariless cotton.

High Glanding — Varieties with the high glanding trait have additional gossypol glands, resulting in increased resistance to attack by budworm/bollworm.

Bt-transgenic Varieties — Transgenic varieties containing the Bollgard Bt gene provide high levels of resistance to tobacco budworm, good resistance to bollworm, and suppression of some other caterpillar pests.

Cultural Practices

Cultural practices can affect populations of specific insect pests. Effects of some common cultural practices include:

Fall Stalk Destruction — Destruction of stalks as soon as possible after harvest aids greatly in reducing populations of overwintered boll weevils.

Fall Tillage — Budworm/bollworm overwinter as pupae 1 - 3 inches deep in the soil. Fall tillage destroys some pupae and disrupts exit tunnels, thus reducing numbers that emerge from overwintering.

Spring Tillage — Destruction of weeds and/or cover crops, either by tillage or herbicide 3 or more weeks before planting, minimizes risk of cutworm problems. Tillage in early spring, before April 15, will also destroy many overwintering tobacco budworm and bollworm pupae.

No-till Planting — No-till planting has both negative and positive effects on cotton insect populations. Fields planted no-till are at greater risk for cutworm infestations and are also much more likely to have stand-threatening infestations of occasional early-season seedling pests, such as grasshoppers, false chinch bugs, and a variety of other pests. Fields planted no-till should be scouted very frequently during the first 3 to 4 weeks following emergence. One of the most significant features of no-till production is the establishment of high populations of fire ants. Fire ants will tend and protect certain sucking pests, such as aphids and three-cornered alfalfa hoppers, causing their numbers to be higher in no-till cotton. However, fire ants are also very aggressive predators of the eggs, larvae, and pupae of caterpillar pests. The impact of fire ants on caterpillar populations in no-till cotton can be very significant, and it is not unusual for fire ants, in combination with other beneficial insects, to provide effective season-long suppression of caterpillar pests in both Bt and not-Bt fields that are planted no-till. High numbers of snails and negro bugs often occur in no-till fields, but neither of these species has been observed to cause damage to cotton, even when populations are extremely high.

Plant Stand Density — Excessive plant stand density can result in delayed fruit initiation and delayed maturity, increasing exposure to late-season insects.

Early Maturity — Early maturing crops are more likely to escape attack/damage from late-season infestations of tobacco budworm, bollworm, armyworms, loopers, and other pests. Cultural practices such as excessive nitrogen use, late irrigation, or excessive stand density can result in delayed maturity and increased exposure to late-season insects.

Insecticide Treatment Termination — Terminating insecticide treatments for tobacco budworm, bollworm, and other pests as soon as crop maturity monitoring indicates the crop is reasonably safe from further damage will reduce insecticide use and control costs and reduce selection for resistance in future generations of pests.

Border Vegetation Management — Plant bugs can build up on flowering plants growing around field borders and move into cotton fields when these more favored hosts are destroyed or begin to dry up. Timely mowing of such source areas can aid in reducing available hosts for plant bugs. **Initiate mowing before cotton is established**. Mowing after these weed hosts begin forming flower buds will only force plant bugs into adjacent cotton. Likewise, wild geranium is an important spring host of tobacco budworm, and controlling it by mowing or by displacing it with a nonhost plant may aid in reducing tobacco budworm populations. **Caution: do not spray field borders with insecticides.** Such use is not labeled and will intensify selection for resistance.

Biological Control

Mississippi cotton producers are fortunate to have a wide array of naturally occurring biological control agents that play an important role in managing pest populations. **Collectively, these biological control agents are the primary method of controlling cotton insect pests in Mississippi.** Often the full economic value of these biological agents is not recognized or appreciated. Severe outbreaks resulting in high levels of crop loss or unusually high control costs seldom occur unless natural control has been disrupted. Profitable cotton production would not be possible in Mississippi without the aid of these biological control agents that include predators such as big-eyed bugs, lady beetles, spiders, and minute pirate bugs; parasites such as *Cardiochiles*, a wasp that parasitizes tobacco budworms; and diseases such as the *Neozygites* fungal disease that is effective in controlling aphid outbreaks.

To gain the maximum economic benefit from the control provided by these natural control agents, growers need to know which species are beneficial, how to identify these species, which pests they attack, what factors enhance their usefulness, when they are most useful, and when they may not provide effective control.

Predators and Parasites

Predators and parasites can often prevent a pest population from reaching treatable levels, and the control they provide is often cheaper, better, and longer lasting than that provided by insecticides. Scouts and producers should be aware of population levels of naturally occurring predators and parasites and should recognize that treatment thresholds can often be increased when predator and population levels are high. Certain cultural practices may favor populations of specific predators (for example, fire ants and reduced tillage). When insecticide treatment is necessary, it is often possible to select treatments that have minimal impact on populations of certain beneficial insects, while still providing control of the target pest.

Pathogens or Diseases

Most species of insect pests are susceptible to one or more known diseases. In some cases, the impact of the disease is relatively subtle, acting as a drag on population development. In other cases, the disease is quite dramatic, providing rapid, nearly complete control of a pest population that has neared or exceeded damaging levels. Growers should be especially aware of these latter types of diseases, because an outbreak of this type can eliminate the need for any insecticide treatment. Two examples of diseases of this type are the *Neozygites* fungal disease that attacks cotton aphid populations and a similar fungal disease that attacks loopers.

Eradication

When feasible, eradication of a pest can be a highly effective IPM tool. While eradication is seldom feasible for native pests, it is sometimes possible to eradicate non-native pests, such as the boll weevil. Since it invaded the state in the early 1900's, the boll weevil has been considered to be a "key pest" of cotton. This is because the early season insecticide treatments that had to be applied to control boll weevil also destroyed beneficial insects and resulted in flaring of "secondary pests," such as tobacco budworms and cotton aphids. Eradication of the boll weevil not only eliminates the yield losses and control costs that are directly caused by boll weevil, but also eliminates yield losses and control costs due to secondary pest problems that are induced by boll weevil control efforts.

Currently, all cotton in Mississippi is involved in some phase of a boll weevil eradication program, but low numbers of boll weevils remain in most areas of the state. Producers and consultants can help facilitate the success of boll weevil eradication efforts in a variety of ways:
• Avoid planting cotton in small, tree-bound fields that are difficult to treat. • Make boll weevil eradication personnel aware of all cotton fields. • Provide boll weevil eradication personnel access to all cotton fields. • Assure that pheromone traps are kept standing and operational. • **Promptly alert eradication personnel of any field detections of live boll weevils or weevil-punctured squares.** • Destroy stalks as soon as possible following harvest.

Additional Information

In addition to the *Cotton Insect Control Guide*, several other Extension publications on cotton insect biology and management can be obtained by contacting your county Extension agent.

Publication 1614—*Pest, Thresholds, and the Cotton Plant*
Publication 1640—*Cotton Insect ID Guide*
Publication 2294—*The Boll Weevil in Mississippi: Gone but not Forgotten*
Publication 2108—*Insect Scouting and Management in Bt-Transgenic Cotton*
Publication 2302—*Biology and Control of Thrips on Seedling Cotton*
Cotton Insect Situation Newsletters (call 662-325-2085 for information)

MSU Cotton Entomology web site:
MSUcares.com/insects/cotton

NOTE: The scientific name of the cotton bollworm, formerly *Heliothis zea*, has been changed to *Helicoverpa zea*. However, in this guide the use of *Heliothis* or *Heliothis* spp. continues to refer to both **cotton bollworm** and **tobacco budworm**.

Insecticide Resistance and Resistance Management

"Insecticide Resistance" can be defined as "increased tolerance to a particular insecticide by a pest population to the point the insecticide no longer controls effectively." This definition applies to insecticides delivered through transgenic crops as well as to foliar applied insecticides.

Resistance develops as a result of repeated or continuous exposure of a pest population to a particular insecticide or class of insecticides. Following an insecticide application, the death rate for susceptible insects is considerably higher than the death rate of resistant insects. Thus the numbers of resistant insects increase, and the frequency of resistance genes is increased in the next generation. If the same insecticide or class of insecticide is used against the next generation of pests, the level of resistance increases even more. At first the number of resistant individuals within a population may be extremely low, one individual in every 10,000 or more, and loss in efficiency is very small. However, with repeated use of the same insecticide or class of insecticides, the percent of the population composed of resistant insects becomes great enough that efficacy declines and field failures begin to occur.

High Cost of Resistance: Resistance is costly to cotton producers because it results in the need to increase insecticide rates, shorten treatment intervals, use expensive mixtures of insecticides, or use more costly alternative insecticides to maintain effective control. Reduced control means increased yield losses, which further reduce profits. In the absence of effective treatment alternatives, outbreaks of resistant pests can result in disastrous levels of crop destruction.

Resistance Management: "Insecticide resistance management" can be defined as "a plan of insecticide use that limits exposure of a pest population to a particular class of insecticide chemistry in order to prolong the useful life of that insecticide or class of insecticides." It is important to note that the goal of resistance management is not necessarily to prevent resistance from ever occurring, but to slow the development of resistance.

To be most effective, resistance management must be started before resistance is evident (while the frequency of resistance genes is very low) rather than waiting until resistance is evident in the field (frequency of resistance is high). Because most cotton insects can readily move from farm to farm, resistance management efforts are most effective when all producers in a large geographic area practice them.

With foliar insecticides, selection for resistance may occur whenever an insecticide is used, simply because the pests that survive exposure to the treatment are more likely to be resistant. Thus, the proportion of the pest population that carries genes for resistance to a particular insecticide is higher after that insecticide has been applied. With foliar insecticides, resistance can be delayed by not exposing successive generations of pests to insecticides from the same class. Rotating different classes of insecticides against different generations of pests is an effective resistance management tool because insects resistant to one class of chemistry are often susceptible to insecticides from a different class. This provides immediate benefits in terms of improved control as well as long-term benefits in terms of reduced selection for resistance.

The risk of resistance developing to transgenic control methods is especially high because the toxicant is present throughout the life of the plant and any target pests that attack the crop are subjected to selection for resistance. With transgenic crops resistance can be delayed by limiting the planting of crops that express a particular insecticide and by planting significant acreage of non-transgenic crops close to the transgenic crops. The objective is to let nonresistant insects from the nontransgenic crops interbreed with any resistant insects that survive in the transgenic crop.

In past years cotton growers have had difficulty effectively managing resistance because of the limited availability of effective alternative control tools. Mississippi growers are currently very fortunate to have a wide array of tools available to control many of the most damaging pests. These include Boll Weevil Eradication, transgenic Bt cotton, and an impressive array of highly effective foliar-applied insecticides. By effectively using all of these tools and avoiding overuse of any single method of control, Mississippi cotton producers have a greater opportunity than ever before to effectively practice resistance management.

Resistance Management Plan, Caterpillar Pests: Growers can optimize their ability to manage resistance to both Bt cotton and foliar applied insecticides by observing the following precautions:

1) Continue to support boll weevil eradication/eradication maintenance and take advantage of the benefits it offers in managing caterpillar pests.

These benefits include increased ability to rely on beneficial insects to suppress populations of caterpillar pests and an overall reduction in the number of foliar insecticide treatments required to control caterpillar pests.
2) Plant the crop in a timely manner (April 15 to May 15 is optimum planting window), and manage crop to promote early maturity.
3) Plant both Bt and non-Bt varieties. (See additional resistance management guidelines for Bt cotton.)
4) Avoid planting large blocks of either Bt or non-Bt varieties. Plant fields in a manner that results in a patchwork of Bt and non-Bt fields so no Bt field is more than ½ mile from a non-Bt field.
5) Plant fields that historically experience heaviest tobacco budworm infestations to Bt varieties.
6) Scout Bt fields for caterpillar pests and treat promptly with supplemental foliar insecticides if damaging levels of caterpillar pests are detected.
7) When non-Bt fields require treatment for caterpillar pests, rotate use of different classes of foliar insecticides against different generations of pests. Do not use the same insecticide or class of insecticides on successive generations of pests.
8) Stop insecticide applications as soon as the majority of the harvestable crop reaches maturity.

Resistance Management Guidelines, Bt Cotton: Because Bt cotton provides season-long activity against tobacco budworm and bollworm, there is a high potential for one or both of these pests to develop resistance unless an effective resistance management plan is implemented. Resistance management in Bt cotton uses the refuge approach to maintain a pool of susceptible moths to mate with resistant moths that may survive on the Bt cotton. Success of this approach depends strongly on how close non-Bt refuges are planted to Bt cotton and on how well cotton producers manage refuge acres and comply with refuge requirements.

In 2005, one of three refuge options is required for growers who plant Bt cotton. **Of these three options, the 20% non-Bt refuge option is recommended.** However, growers who choose the 20% option should recognize this is the minimum recommended refuge size. Growers are encouraged to plant higher percentages of non-Bt cotton to make the best use of available varieties and insect management tools and to slow development of resistance.

Caution: Before choosing and planting a refuge option, refer to the grower licensing agreement and refuge guidelines (Bollgard Refuge Guide) provided by the company for full details and requirements of each option. Following is a general overview of each refuge option.

OPTION 1:
20 Percent, Sprayed Refuge Option (treated for budworm/bollworm)
At least 20 percent of total acreage must be planted to non-Bt varieties.

- All Bt fields must be within 1 mile (preferably ½ mile) of a non-Bt field.
- This refuge may be treated to control tobacco budworm, bollworm, and other cotton pests.
- Foliar Bt products should not be used on designated refuge areas.

OPTION 2:
5 Percent, Unsprayed Refuge Option (untreated for budworm/bollworm)
5 percent of total acreage must be planted to non-Bt varieties.

- All Bt fields must be within ½ mile of a non-Bt refuge planting.
- Non-Bt refuge plantings must average at least 150 feet wide.
- This 5 percent refuge should not be treated for control of caterpillar pests.
- Non-caterpillar pests such as thrips and plant bugs should be controlled on the refuge crop.
- The refuge crop should be planted and managed similarly to the Bt cotton, with a goal of producing a refuge crop with high vigor, fruit production, and yield potential.

OPTION 3:
5 Percent, Embedded Refuge Option (treated for budworm/bollworm only when Bt fields are treated)
5 percent of total acreage must be planted to non-Bt varieties.

- For large fields, each field must contain a refuge planting (embedded refuge).
- Small fields may be grouped into "field units" consisting of an area of 1 mile square or less, and each field unit must contain a non-Bt refuge.
- Non-Bt refuge plantings must average at least 150 feet wide.
- Non-Bt refuge may be treated for caterpillar pests only when surrounding Bt cotton is treated.
- Non-Bt refuge may not be treated for caterpillar pests independently of surrounding Bt cotton.

Note: The recommendations on resistance management in Bt cotton are intended as general recommendations only. They are not intended to represent or replace the full details or requirements of any use agreement into which producers may enter with suppliers of transgenic seed or technology. Producers should know all details of such agreements.

Resistance Management Plan, Tarnished Plant Bugs and Cotton Aphids:
1) When choosing insecticides for use at planting or as foliar sprays for early season thrips control, avoid using products that will be used later to control cotton aphids.
2) When choosing insecticides for use against aphids or plant bugs, avoid making repeated applications of the same insecticide or insecticides from the same class against following generations of pests.

Responding to Control Failures

Key considerations and responses following suspected insecticide failures

1. Don't panic! Do not automatically assume that the presence of live insects following an insecticide application is the result of an insecticide failure.
2. Examine the possible reasons that unsatisfactory control may have occurred. Control decisions should consider a wide range of variables that influ ence insecticide efficacy and damage potential: species complex, population density and age structure, application timing, insecticide dosage rate, application methods and carriers, treatment evaluation timing, need for multiple applications, environmental conditions, and **levels of insecticide resistance.**
3. **Under continuous pressure, multiple insecticide applications are required to reduce crop damage. Against high sustained infestations, multiple close interval (3 - 5 days) applications of recommended economical treatments are often more effective than applications of expensive mixtures at high rates applied at longer intervals.**
4. Selected combinations of insecticides are recommended to manage tobacco budworm at discrete time periods throughout the growing season. Do not use excessive rates of one or more insecticides in these mixtures. Control will not always improve above the recommended rate ranges.
5. If a field failure is suspected to be due to insecticide resistance, do not reapply the same insecticide at any rate. Alternate to another class of insecticides or use mixtures of insecticides from different classes.
6. Do not apply insecticides to control tobacco budworm beyond the time the major portion of the crop is resistant to insect damage. Protecting fruit that will not be harvested is not cost-effective and further selects for insecticide resistance.

Cotton Insect Control Recommendations — 2006

Important: The following cotton insect control recommendations include treatment thresholds, insecticides, and suggested rates for specific pests. The **recommendations are divided into three distinct sections based on stage of plant development** (Emergence to First Square, First Square to First Bloom, and After First Bloom). Because important pests, thresholds, and control recommendations vary greatly, depending on stage of plant development, **be sure you are referring to the proper section when using this guide.**

Caution: Recommendations of specific insecticides are based on information on the manufacturer's label and performance in a limited number of efficacy trials. Because levels of insecticide resistance, environmental conditions, and methods of application by growers may vary widely, insecticide performance will not always conform to the safety and pest control standards indicated by experimental data.

Insecticides are listed alphabetically, not in order of their effectiveness. Effectiveness of a particular insecticide can vary greatly from field to field, depending on previous insecticide use, pest species, levels of resistance, and many other factors. Within a group of insecticides recommended for control of a specific pest, there often will be considerable variability in cost, effectiveness against the primary target pest, and secondary pests controlled. Growers must consider each of these factors as well as the need to rotate among different insecticide classes (for resistance management purposes) when selecting insecticides.

Classes of insecticides: Effective resistance management requires rotation among the various classes of available insecticide chemistry. Often when one insecticide in a class fails because of insecticide resistance, other insecticides in the same class will also be ineffective, and selection of an insecticide from a different class will improve the chances of obtaining control. **Growers need to be very aware of the type of insecticide chemistry being used.** Classes of insecticides recommended in this guide are identified by the following abbreviations:

Carbamate — (C)	Pyrethroid — (P)	Oxadiazine — (OX)	Biologicals — (B)	Spinosyns (SPN)
Organochlorine — (OC)	Organophosphate — (OP)	Insect Growth Regulators — (IGR)	Chloro-nicotinyl — (CN)	Avermectins (AV)
Pyridine Carboxamide – (PC)	Tetronic Acid – (TA)			

Insect Pests — Early Season (Emergence to First Square) *To reduce the probability of resistance, minimize applications of all classes of insecticides.*		Foliar Treatments lb ai/a
Thrips	The order of preference for treatments 1. In-furrow Systemics 2. Seed Treatments 3. Foliar Treatments Cotton plants are most susceptible to injury from thrips from emergence to the 3rd or 4th leaf stage. Treatment for thrips is seldom necessary on plants that are beyond this stage. **Make foliar treatments if thrips numbers reach or exceed one per plant on seedling cotton.** **In-Furrow Systemics*** acephate (Orthene) (OP) 1.11 lb 90 S/acre sprayed in drill aldicarb (Temik) (C) 3.50 - 5 lb 15 G/acre (hill dropped 2 - 4 lb/acre) When disulfoton (Di-Syston) or phorate (Thimet) are used as "safeners" for certain herbicides, they will suppress thrips. Use of in-furrow insecticides can result in increased susceptibility to seedling diseases. Therefore, use of a recommended fungicide is recommended when using in-furrow insecticide treatments. These recommendations on use of in-furrow systemic materials are directed specifically toward insect control. Some in-furrow insecticides, such as aldicarb, also provide nematode control, but most in-furrow insecticides do not control nematodes. **See specific publications on nematode control for information on controlling these noninsect pests.** Where Nemacur 15G is used for nematode control, it will suppress thrips. **Be sure to follow water well buffer zone precautions on labels.*	0.2 lb acephate (Orthene) (OP) 0.2 lb dicrotophos (Bidrin) (OP) 0.2 lb dimethoate (OP) 0.2 lb methamidophos (Monitor) (OP)

continued

	Insect Pests — Early Season (Emergence to First Square) (continued) ***To reduce the probability of resistance, minimize applications of all classes of insecticides.***	**Foliar Treatments lb ai/a**
Thrips (continued)	**Caution:** Several of the systemic thrips insecticides interact with some of the herbicides used on cotton and influence the cotton plants' susceptibility to herbicide injury. For example, the organophosphate insecticides, disulfoton (Di-Syston) or phorate (Thimet), are used to "safen" cotton to injury from the herbicide clomazone (Command); however, herbicides containing diuron or fluometuron should not be used on cotton treated with either disulfoton (Di-Syston) or phorate (Thimet) because of the potential for a phytotoxic interaction. **Seed Treatments** acephate (Orthene 90S) (OP) — 20 - 32 oz 90S/100 lb seed (depends on seeding rate) hopper box — 2.5 - 3.25 oz 90S/acre imidacloprid (Gaucho Grande) (CN) — .375 mg per seed thiamethoxam (Cruiser 5FS) (CN) — 0.30 - 0.34 mg **per seed**	Pyrethroid insecticides are not recommended for control of thrips because their use at this time in the season will intensify insecticide resistance problems in tarnished plant bugs.
Cutworms	**Treat if cutworm infestations threaten to reduce stand below 35,000 plants/acre (3 plants/row foot) in a field or part of a field.** Area considered is smallest area a producer will treat. Repeat treatment if needed. In no-till or limited-till situations, cutworms may become established on existing vegetation and move to emerging cotton seedlings once this vegetation is killed. Risk of cutworm attack can be greatly reduced by destroying all existing vegetation 3 to 4 weeks before planting. Treatment at planting may be warranted in situations where cutworms are already established and vegetation cannot be destroyed 3 to 4 weeks before planting. Pyrethroid insecticides are highly effective against cutworms and can be used in ground treatments applied at planting with limited risk of contributing to increased resistance in tobacco budworm.	0.8 lb acephate (Orthene) (OP) 0.04 - 0.1 lb bifenthrin (Brigade) (P) 0.0065 - 0.0125 beta-cyfluthrin (Baythroid XL) (P) .02 - 0.03 lb cyhalothrin (Karate) (P) 0.025 lb cypermethrin (Ammo) (P) 0.013 - 0.019 lb deltamethrin (Decis) (P) 0.03 lb esfenvalerate (Asana XL) (P) 0.008 - 0.012 lb zetamethrin (Mustang Max) (P) 0.0075 - 0.01 lb gamma - cyhalothrin (Prolex) (P)

	In-furrow, at planting treatments of Orthene or Payload (acephate) will aid in suppressing cutworms. **Bt Cotton:** Bt cotton will not control cutworms.	
Plant Bugs and Fleahoppers	Treat if you find one plant-bug-flagged plant and one or more plant bugs per 10 row feet.	See Foliar Treatment, page 16, under Plant Bugs and Fleahoppers.
Aphids	Several species other than cotton aphid can occur on presquaring cotton. These species may be easier to control than cotton aphid; however, need for treatment before squaring is unlikely. Naturally occurring factors often provide control of aphid populations. Some soil systemics aid in suppression of aphids on seedling cotton. Treatment should be considered when heavy populations threaten to stunt plants on a significant portion of the field.	See Foliar Treatment, page 22, for Aphids' recommended materials.

Insect Pests — First Square to First Bloom		Foliar Treatments lb ai/a
	Intensity Scouting — Treat only when pests are at or above threshold levels.	
Overwintered Boll Weevils	All cotton in Mississippi is involved in a boll weevil eradication program. Growers are urged to take the following steps to support the eradication effort: • Make all fields easily accesible to trapping and insecticide treatment efforts. • Promptly report fields in which traps are not present or are not being run properly. • **Contact Boll Weevil Eradication personnel immediately to report any fields where you find live boll weevils or squares with boll weevil oviposition punctures!**	Do not apply the herbicide pyrithiobac (Staple) within 24 hours before or after a malathion spray. Do not tank mix pyrithiobac (Staple) and malathion.

	Insect Pests — First Square to First Bloom (continued)	Foliar Treatments lb ai/a
Plant Bugs and Fleahoppers	**Thresholds:** **First 2 weeks of squaring** Drop Cloth: 1 Bug/6 row ft Visual: 5 Bugs/100 terminals Sweep Net: 8 Bugs/100 sweeps **Third week of squaring to first bloom** Drop Cloth: 2 Bugs/6 row ft Visual: 10 Bugs/100 terminals Sweep Net: 15 Bugs/100 sweeps The sweep net is a very effective tool for monitoring adult plant bug populations, but the ground cloth is more effective for monitoring nymphs. Thorough scouting requires the use of both the sweep net and ground cloth. Visual scouting is a less reliable method of sampling for plant bugs. Prior to first bloom, sample fields twice weekly for plant bugs. Treat if populations exceed levels given for the specified growth stage. Mapping plants to determine percent square retention is a critical part of monitoring prior to first bloom. Plants that are fruiting normally should retain at least 80 percent of the first and second position fruiting sites on the upper five branches. However, there are many factors other than plant bugs that can cause poor square retention. If low square retention or a sudden decline in square retention is noted, intensify sampling for plant bugs to determine if they are the cause. When square retention is lower than 80 percent prior to first bloom, plant bug thresholds should be lowered accordingly. **Note:** Research has shown that there is no benefit from maintaining excessively high square retention rates. (Plots with square retention rates in the range of 70 to 85 percent at first	0.3 - 0.5 lb acephate (Orthene) (OP) 0.25 - 0.50 lb dicrotophos (Bidrin) (OP) 0.031 - 0.062 lb imidacloprid (Trimax Pro) (CN) 0.92 - 1.22 lb malathion ULV (Fyfanon) (OP) 0.33 - 0.5 lb methamidophos (Monitor) (OP) 0.33 lb oxamyl (Vydate) (C) 0.05 lb thiamethoxam (Centric) (CN) 0.04 - 0.06 lb Novaluron* (Diamond) (IGR) 0.053 - 0.089 lb flonicamid (Carbine) (PC) *Novaluron (Diamond) has activity only on immature plant bugs and should be tank mixed with a labeled adulticide.

	bloom often produce slightly higher yields than plots with higher retention rates.) Attempting to maintain excessively high early season square retention rates through the use of additional insecticide treatments will result in increased costs and increased risks of secondary pest outbreaks. **Bt Cotton:** Prior to bloom, plant bugs in Bt cotton should be scouted and managed similarly to conventional cotton. Avoid automatic/prophylactic-type treatments.	
Aphids	Before treating aphids at this time, consider ability to obtain control and potential impact on other pest populations, such as the tobacco budworm and beet armyworm. Consider treatment when spots of high aphid populations are causing heavy localized honeydew accumulation, aphid numbers are increasing over the remainder of the field, and no signs of diseased aphids are present. See additional notes on aphid control on page 22.	**See treatments listed on page 22.**
Bollworms and Budworms	Before bloom, treat when population reaches or exceeds **8 larvae/100 plants**. Before bloom, avoid using pyrethroid insecticides or the organophosphate profenofos (Curacron). **Foliar Bt products for control of tobacco budworm in non-Bt cotton:** Under good conditions, Bts are expected to provide around 20 to 50 percent control of small tobacco budworms. Because Bts do not destroy predators and parasites of tobacco budworm, this level of control may be adequate against low (slightly over threshold) to moderate populations of tobacco budworm during early season. **Bts are much less effective against bollworm** and should not be used against populations consisting primarily of bollworms.	**Transgenic Control:** (Bt cotton) Bollgard, Bollgard II, WideStrike **Larvicides:** 0.09 - 0.11 lb indoxacarb (Steward) (OX) 0.45 lb methomyl (Lannate)** (C) 0.6 lb thiodicarb (Larvin) (C) 0.045 - 0.089 lb spinosad (Tracer) (SPN) foliar Bt products (B) - See product labels for rates 0.01 - 0.015 lb emamectin benzoate (Denim) (AV) ** See Lannate footnote page 21.

continued

Insect Pests — First Square to First Bloom (continued)		Foliar Treatments lb ai/a
Bollworms and Budworms (continued)	The Bt products listed are recommended for use against low (slightly over threshold) to moderate populations of small 1- to 3-day-old tobacco budworm larvae. Tank mixing with ovicides is recommended when significant numbers of eggs are present. **Bt Cotton:** Bt-transgenic cotton primarily targets control of tobacco budworm and bollworm and should initially provide good to excellent control of these pests. However, high populations, especially high populations of bollworms, may require treatment in some situations. **Treatment of Bt cotton may be warranted if damaged fruit counts exceed 5 percent or the number of larvae reaching approximately ⅛ inch in length exceeds 8 larvae/100 plants.** **Dual Toxin Bt Cotton:** Varieties of Bt cotton that express two Bt toxins are more effective against bollworms than are single toxin Bt cottons but may still require supplemental treatments under conditions involving unusually high insect populations and/or compromised toxin expression.	**Ovicides:** 0.25 lb methomyl (Lannate)** (C) 0.25 lb thiodicarb (Larvin) (C) **Caution:** Do not apply foliar Bts to areas designated as resistance management refuges for Bt cotton. **See page 17**
Spider Mites	If spider mites are present at economic levels, use dicofol (Kelthane) or propargite (Comite II).	(See Foliar Treatments, page 23, under Spider Mites.)

Insect Pests – After First Bloom		Foliar Treatments lb ai/a
Plant Bugs and Fleahoppers	**Thresholds** Drop Cloth: 3 bugs/6 row ft on white drop cloth and 3 bugs/5 row ft on black drop cloth Visual: 9 bugs/100 plants (Examine terminal area for adults, and search inside the bracts of large squares and small bolls and inside blooms for nymphs and adults.) Sweep Net: 12 bugs/100 sweeps **Drop cloths black in color are recommended.**	0.3 - 1.0 lb acephate (Orthene) (OP) 0.25 - 0.50 lb dicrotophos (Bidrin) (OP) 0.047 - 0.062 lb imidacloprid (Trimax Pro) (CN) 0.92 - 1.22 lb malathion ULV (Fyfanon) (OP) 0.33 - 0.5 lb methamidophos (Monitor) (OP) 0.33 lb oxamyl (Vydate) (C) 0.25 - 0.5 lb profenofos (Curacron) (OP) 0.05 lb thiamethoxam (Centric) (CN)

	After plants begin to bloom, effective use of the sweep net and ground cloth becomes more difficult and more emphasis is placed on visual scouting. Scout by examining randomly selected plant terminals for presence of adults or nymphs and by checking inside squares, blooms, and small bolls for presence of nymphs. “Dirty blooms,” blooms in which many of the anthers are dried and brown colored, are a sign of established infestations of plant bug nymphs feeding on larger squares. No threshold exists for percent dirty blooms, but observation of “dirty blooms” indicates a need to intensify visual scouting for plant bugs. Some pyrethroids have activity against plant bugs and, when applied against budworm/bollworm as the primary target, will provide control of low to moderate levels of plant bugs that may be present. Because resistance to both pyrethroids and organophosphates has been documented in populations of plant bugs at some locations, do not assume that treatments targeting budworm/bollworm will always provide effective control of plant bugs. Because of insecticide resistance and/or difficulty obtaining adequate coverage in larger cotton, a single application of insecticide may not provide effective control of heavy established populations of plant bugs. Multiple applications applied at 4- to 5-day intervals may be required in such cases. Plant bug populations are often highest along field borders. This is especially true for field borders next to maturing fields of corn, sorghum, or early maturing soybeans. In such situations it is often helpful to scout and manage such field borders separately from the remainder of the crop. Such areas may require spot treatments that are not needed on the remainder of the field. **Bt Cotton:** Postbloom infestations of plant bugs may be higher or more common in Bt cotton due to the reduction in mid- to late-season foliar sprays targeting budworm/bollworm.	0.04 - 0.06 lb novaluron* (Diamond) (IGR) 0.053 - 0.089 lb flonicamid (Carbine) (PC) 0.05 lb acetamiprid (Intruder) (CN) * Novaluron (Diamond) has activity only on imature plant bugs and should be tank mixed with a labeled adulticide. ** Use higher rates of products under heavy infestations.
Boll Weevils	**Contact Boll Weevil Eradication personnel immediately to report any fields where you find live boll weevils or squares with boll weevil oviposition punctures!**	

	Insect Pests – After First Bloom (continued)	**Foliar Treatments lb ai/a**
Bollworms and Budworms	**From first bloom to cutout**. Treat when counts reach or exceed **4 larvae/100 plants**. Apply treatments before larvae are ½ inch long. **After cutout to termination of insect control.** (See page 28 for notes on monitoring crop maturity to determine when to terminate insect control.) Treat when counts reach or exceed **8 larvae/100 plants.** **Bollworms or Tobacco Budworms?:** Infestations of bollworm and tobacco budworm may occur concurrently at any time in the growing season, but these two insects are difficult to distinguish from one another as small larvae. Infestations of small larvae may be primarily bollworm, primarily tobacco budworm, or some combination of each. Knowing which is the primary species present can greatly influence choice and costs of treatments. Information obtained from moth flushing counts, commercially available egg/larval identification assays, and/or pheromone trap counts may aid in estimating the species composition of an infestation and in making treatment choices. **Caution: Pyrethroid insecticides (P) are not recommended for use against infestations that are primarily composed of tobacco budworms,** because of high levels of pyrethroid resistance. Tobacco budworms also exhibit high levels of resistance to some other classes of insecticides. However, pyrethroids (P) continue to be cost effective options for control of infestations that are composed primarily of bollworms. Pyrethroids have potentially high negative effects on aquatic animals. Therefore, strict adherence to label precautions should be observed near aquatic habitats. **If insecticide resistance is thought to be the cause of a treatment failure, switch to another chemistry immediately. Do not re-treat with a second application of the same class of material.**	**Transgenic Control:** Bollgard, Bollgard II, Widestrike (Bt cotton) **Ovicides:** 0.25 lb methomyl (Lannate)* (C) 0.25 lb profenofos (Curacron)** (OP) 0.25 lb thiodicarb (Larvin) (C) **Foliar Larvacide Treatments:** 0.06 - 0.10 lb bifenthrin (Brigade) (P) 0.0125 - 0.0205 lb beta-cyfluthrin (Baythroid XL) (P) 0.025 - 0.04 lb cyhalothrin (Karate) (P) 0.04 - 0.10 lb cypermethrin (Ammo) (P) 0.03 - 0.05 lb esfenvalerate (Asana XL) (P) 0.09 - 0.11 lb indoxacarb (Steward) (OX) 0.45 lb methomyl (Lannate)* (C) 0.75 - 1.00 lb profenofos (Curacron)** (OP) 0.067 - 0.089 lb spinosad (Tracer) (SPN) 0.60 - 0.90 lb thiodicarb (Larvin) (C) 0.0165 - 0.0225 lb zetamethrin (Mustang Max) (P) 0.01 - 0.015 lb emamectin benzoate (Denim) (AV) 0.0125 - 0.02 lb gamma – cyhalothrin (Prolex) (P)

Other pests controlled:

acephate — Thrips, plant bugs, fleahoppers, cabbage loopers, whiteflies
pyrethroids — Plant bugs, fleahoppers, thrips, cutworms
**profenofos — Spider mites, fall armyworms
bifenthrin — In addition to pests controlled by other pyrethroids, bifenthrin gives control of spider mites.
thiodicarb — Armyworms, loopers
Indoxacarb — Tarnished plant bugs, loopers, armyworms
spinosad — Armyworms, loopers

***Lannate footnote:** A minimum of 10 days should elapse between 0.45 lb methomyl (Lannate) applications. The lower rate of methomyl (0.25-0.33 lb) may be applied as needed. If reddening of leaves is excessive, discontinue use of the combination or alternate with other insecticides.

**Profenofos (Curacron) is an organophosphate insecticide that has high risk of fish kill when it contaminates aquatic habitats by drift or runoff. Carefully follow label restrictions and avoid applications that have a risk of getting the product into bodies of water.

Bt Cotton: Bollworms are less susceptible to Bt cotton than are tobacco budworms. Intensify scouting of Bt cotton when high numbers of bollworm moths are present. Scout for larvae in blooms and bolls as well as in terminal area. **Bt cotton may require treatment if the number of plants infested with larvae surviving to ⅛ inch in length or greater exceeds 4 larvae/100 plants** (or 8 larvae/100 plants after “cutout”). Regardless of size of larvae, treatment may be warranted if damaged-boll counts exceed 2 percent and significant numbers of larvae are present and continuing to cause damage.

Mixtures (pyrethroids at recommended rates plus one of the following):

0.50 lb acephate (Orthene) (OP)
0.30 lb methomyl (Lannate)* (C)
0.50 lb profenofos (Curacron)** (OP)
0.30 lb thiodicarb (Larvin) (C)
0.045 - 0.067 lb spinosad (Tracer) (SPN)

Caution: Do not apply foliar Bts to areas designated as refuge area for Bt cotton.

Other mixtures:

0.67 + 0.32 lb profenofos + thiodicarb (Curacron + Larvin) (OP, C)

	Insect Pests – After First Bloom (continued)	**Foliar Treatments lb ai/a**
Bollworms and Budworms (continued)	**Caution:** Transgenic Bt cotton is available in several varieties. Efficacy of Bt cotton may vary, depending on seed source and variety. **Dual Toxin Bt Cotton:** Varieties of Bt cotton that express two Bt toxins are more effective against bollworms than are single toxin Bt cottons but may still require supplemental treatments under conditions involving unusually high insect populations and/or compromised toxin expression.	
Aphids	It appears that, in some areas, aphids may be resistant to all available insecticides; thus, under severe population pressure, probably no insecticide will give satisfactory control. The impact of aphids on yield varies greatly, depending on a variety of factors, including: number of aphids, duration of infestation, and presence of other stress factors such as drought. In some cases, relatively high populations caused no yield loss. In other cases, research has shown that untreated infestations that peaked as low as 35 aphids per leaf caused yield losses of approximately 45 pounds of lint. Higher yield losses have been recorded from heavier, more prolonged infestations. Important factors to consider before treatment include: 1) possibility of a fungal epizootic that will likely occur under high aphid infestation; historically this occurs during early to mid-July; 2) possibility of control failure with recommended insecticides (control must exceed 80 percent in order to give benefit); 3) predator and parasite populations that may suppress aphids; 4) presence of additional plant stress factors, such as drought or low plant vigor; 5) need to apply insecticide for control of other pests.	0.30 - 0.50 lb dicrotophos (Bidrin) (OP) 0.047 - 0.062** lb imidacloprid (Trimax Pro) (CN) 0.05 lb thiamethoxam (Centric) (CN) 0.031 - 0.05 lb acetamiprid (Intruder) (CN) 0.044 - 0.089 lb flonacamid (Carbine) (PC) ** Two applications of Trimax Pro applied at a 7- to 10-day interval may be needed to achieve control of heavy aphid infestations. Provado may not provide adequate control if cotton is under stress from heat, drought, diseases, extreme pest pressure, or when cotton "hardens off" as it begins to mature. Check with your county Extension agent regarding status of additional aphid insecticides that may be available under new registration or Section 18 Emergency Exemption.

	Treatment may be beneficial in avoiding yield reduction when the following conditions exist simultaneously: 1) isolated spots occur through the field where heavy aphid infestations cause honeydew-coated plants; 2) aphid numbers are increasing on remaining plants throughout the field; and 3) no indication of aphid fungal disease is present. When treating aphids, strive to obtain good coverage, particularly to undersides of leaves. Control effectiveness of various recommended chemicals varies by location; therefore, it is advisable to seek current information about what is working locally (talk to county Extension agents, Extension specialists, consultants, neighbors, etc.). When selecting aphicides, consider which classes of materials were used on the field earlier during the season (including in-furrow treatments). An aphicide from the least commonly used class may provide best control. Control may be improved by applying a second application 4 to 7 days after the initial treatment. Rotating classes of insecticide chemistry used may enhance control.	
Spider Mites	Treat when populations start to expand. **Treatment is essential when 50 percent or more of plants are infested and populations are increasing.** Except for "Comite II," two applications at 5-day intervals are required. When applied at recommended rates to control caterpillar pests, Denim will suppress spider mites. *Lower product rates should be used only in early season.	0.06 - 0.10 lb bifenthrin (Brigade) (P) 1.00 - 1.50 lb dicofol (Kelthane) (OC) 0.2 - 0.3 lb fenpropathrin (Danitol) (P) 0.94 - 1.68 lb propargite (Comite II) 0.03 - 0.045 lb etoxazole (Zeal) (IGR) 0.1 - 0.25 lb spiromesifen (Oberon) (TA) 0.005 - 0.01875 lb abamectin (Zephyr) (AV)

	Insect Pests – After First Bloom (continued)	Foliar Treatments lb ai/a
Loopers	Treat only when populations threaten premature defoliation. Two species of loopers (cabbage looper and soybean looper) occur in cotton. These insects differ in their susceptibility to insecticides and diseases. **Bt Cotton:** Bt cotton may suppress loopers. However, some varieties of Bt cotton are more susceptible to loopers and may be damaged by high populations. **Dual Toxin Bt Cotton:** Varieties of Bt cotton that express two Bt toxins are considerably more effective against loopers than are single toxin Bt cottons but may still require supplemental treatments under conditions involving unusually high insect populations and/or compromised toxin expression.	0.09 - 0.11 lb indoxacarb (Steward) (OX) 0.06 - 0.1 lb methoxyfenozide (Intrepid) (IGR) 0.067 - 0.089 lb spinosad (Tracer) (SPN) 0.60 - 0.90 lb thiodicarb (Larvin) (C) 0.01 - 0.015 lb emamectin benzoate (Denim) (AV)
Beet Armyworms	Production of an early crop and preservation of beneficial insects are the most important factors in reducing risks of beet armyworm (BAW) outbreaks. Certain organophosphate and pyrethroid insecticides are particularly damaging to the beneficial insects that help control BAW. Prior to bloom, use short residual organophosphates and other nonpyrethroid materials only when necessary to control other pests. Reserve use of pyrethroids until midseason in order to aid in minimizing reliance on organophosphates at this time. Established populations of BAW can be difficult and expensive to control. Treatment thresholds vary greatly, depending on time of year and stage of crop when BAW outbreaks occur, plant parts being attacked, and presence or absence of other predisposing factors. During early to mid-season, if beneficial insect numbers are low and risk factors favorable to development of BAW outbreaks are present, **initiate treatment at 2 to 5 "hits" (egg masses and/or clusters of small larvae) per 100 feet of row.**	0.09 - 0.11 lb indoxacarb (Steward) (OX) 0.06 - 0.1 lb methoxyfenozide (Intrepid) (IGR) 0.067 - 0.089 lb spinosad (Tracer) (SPN) 0.8 lb thiodicarb (Larvin) (C) 0.125 - 0.25 lb tebufenozide (Confirm) (IGR) 0.0075 - 0.01 lb emamectin benzoate (Denim) (AV) The growth regulator diflubenzuron (Dimilin) may also be useful in suppressing developing beet armyworm populations (use rate is 0.0625 - 0.125 lb ai/acre).

	The damage potential of late-season, foliage-feeding populations is much less than that of mid-season, fruit-feeding populations. Cotton nearing maturity can tolerate relatively higher populations without sustaining yield loss. When treating BAW, multiple, close interval applications (3-5 days) may be needed against high populations. Apply treatments against hatching to 1/4 inch long larvae and strive to maximize coverage to undersides of leaves. Increasing spray volume and pressure may improve control when treating by ground. **Bt Cotton:** Bt cotton may provide some limited suppression of beet armyworms, but high populations of BAW will require treatment to prevent damage. **Dual Toxin Bt Cotton:** Varieties of Bt cotton that express two Bt toxins are considerably more effective against beet armyworms than are single toxin Bt cottons but may still require supplemental treatments under conditions involving unusually high insect populations and/or compromised toxin expression.	
Fall Armyworms	**Treat when 4 or more worms per 100 blooms and/or bolls are found.** Time applications against young larvae and strive to maximize coverage deep within the plant canopy by increasing spray volume and pressure. Some pyrethroids may aid in suppression of fall armyworm when applied against newly hatched larvae. The growth regulator diflubenzuron (Dimilin) may also be useful in suppressing developing fall armyworm populations (use rate is 0.0625-0.125 lb ai/a).	0.04 - 0.08 lb novaluron (Diamond) (IGR) 1.00 lb acephate (Orthene) (OP) 0.09 - 0.11 lb indoxacarb (Steward) (OX) 0.45 lb methomyl (Lannate)** (C) 0.1 - 0.16 lb methoxyfenozide (Intrepid) (IGR) 1.00 lb profenofos (Curacron) (OP) 0.067 - 0.089 lb spinosad (Tracer) 0.60 - 0.90 lb thiodicarb (Larvin) (C) 0.01 - 0.015 lb emamectin benzoate

Insect Pests – After First Bloom (continued)		Foliar Treatments lb ai/a
	Bt Cotton: Fall armyworms may be more common in Bt cotton due to the decrease in mid- to late-season sprays against budworm/bollworm. However, Bt cotton does have activity against fall armyworms, and infestations that are initially heavy often dwindle without causing significant boll damage. Intensify scouting for fall armyworms in Bt cotton, particularly in July and August. Some varieties of Bt cotton are more effective against fall armyworms than others. Treatment of Bt cotton is recommended when the number of larvae more than ¼ inch long is greater than 4 per 100 bolls and/or blooms. **Dual Toxin Bt Cotton:** Varieties of Bt cotton that express two Bt toxins are considerably more effective against fall armyworms than are single toxin Bt cottons but may still require supplemental treatments under conditions involving unusually high insect populations and/or compromised toxin expression. ****Lannate footnote:** A minimum of 10 days should elapse between 0.45 lb methomyl (Lannate) applications. The lower rate of methomyl (0.25-0.33 lb) may be applied as needed. If reddening of leaves is excessive, discontinue use of the combination or alternate with other insecticides.	
Bandedwinged Whiteflies	Large populations can reduce yield and affect quality. **Apply control when 50 percent or more of the terminals are infested with adults.** Thorough coverage of foliage is necessary for adequate control. Whiteflies can be difficult to control and can rebound quickly following treatment. Two to three applications at approximately 5-day intervals are usually necessary to control heavy infestations.	0.50 - 1.00 lb acephate (Orthene) (OP) 0.25 - 0.50 lb methamidophos (Monitor) (OP) 0.05 lb thiamethoxam (Centric) (CN) 0.05 lb acetamiprid (Intruder) (CN)

Silverleaf Whiteflies	Infestations of this insect are uncommon but are most likely to occur on cotton grown close to nursery crops or greenhouses. Heavy, prolonged infestations can cause substantial yield loss. This insect is difficult and costly to control. When using non-IGR type treatments you must make repeated applications at 5-day intervals.	0.054 - 0.067 lb pyriproxyfen (Knack) (IGR) **Mixture:** 0.15 - 0.3 lb fenpropathrin (Danitol) (P) + 0.5 - 0.9 lb acephate (Orthene) (OP)
Western Flower Thrips	Economic impact is currently unknown. If treatment is made, target immatures on bottom of leaves. Effective control of western flower thrips may be difficult to obtain with currently labeled materials.	
Stink Bugs and Clouded Plant Bugs	These pests usually appear in late season but sometimes occur earlier. These insects feed on squares, blooms, and bolls, but most damage is concentrated on young bolls. Infestations of these pests are more likely to occur in areas where boll weevil is no longer present. High numbers of stink bugs can develop in crops, such as corn, sorghum, or early maturing soybeans and then migrate into nearby cotton during late season. Intensify scouting for stink bugs when nearby alternative hosts begin to mature. Scout for stink bugs by randomly pulling and cracking soft, quarter-sized bolls and checking for internal signs of stink bug feeding injury (stained lint, pierced areas or warts on internal boll wall, or damaged seed). **Caution:** Spined soldier bugs are beneficial stink bugs that sometimes occur in high numbers in fields infested with caterpillar pests. These beneficial insects are often mistaken for brown stink bugs. Be sure of species identification before treating. **Bt Cotton:** Stink bugs and clouded plant bugs are more likely to occur in Bt cotton because of the reduction in mid- to late-season treatments targeting budworm/bollworm. Intensify scouting for these pests in Bt cotton.	**Stink bugs:** 0.75 - 1.0 lb acephate (Orthene) (OP) 0.0125 - 0.0205 lb beta-cyfluthrin (Baythroid XL) (P) 0.025 - 0.03 lb cyhalothrin (Karate) (P) 0.4 - 0.5 lb dicrotophos (Bidrin) (OP) 0.5 lb methyl parathion (OP) 0.0165 - 0.0225 lb zetamethrin (Mustang Max) (P) 0.06 - 0.1 lb bifenthrin (Brigade) (P) 0.0125 - 0.02 lb gamma – cyhalothrin (Prolex) (P) Pyrethroid insecticides are less effective against brown stink bug species.

continued

Insect Pests – After First Bloom (continued)		Foliar Treatments lb ai/a
Stink Bugs and Clouded Plant Bugs (continued)	**Thresholds:** *Visual:* Average of 5 or more adults and/or nymphs (one-fourth inch or greater) per 100 plants. *Ground Cloth:* Average of 1 bug per 6 feet of row (one-fourth inch or greater). *Damaged Bolls*: Treat when 15 to 20 percent or more of the soft, quarter-sized bolls show internal signs of stink bug feeding (damaged seed, stained lint, pierced areas or warts on internal boll wall) and stink bugs are present. **Caution:** Stink bugs are difficult to detect. Supplement by scouting for damaged bolls.	**Clouded plant bugs:** There are no insecticides specifically labeled for control of clouded plant bugs. Insecticides recommended for control of tarnished plant bug (see page 16) will likely be effective against clouded plant bugs.
Terminating Control of Bollworm/ Tobacco Budworm and Tarnished Plant Bug	**Insect Control Termination:** In a normal healthy crop, "cutout" is defined as the point when Node Above White Flower averages 5 (NAWF = 5), i.e., when terminal growth slows to the point that the first position white flower is at the 5th node below the first "unfurled" leaf (a leaf about the size of a quarter) in the terminal. Sample at least 10 plants per site from 4 representative sites per field to determine average NAWF. Begin monitoring NAWF at weekly intervals shortly after first bloom. Shift to twice weekly monitoring as NAWF counts begin to decline toward 5. Begin monitoring daily heat unit (DD60s) accumulation on the day the crop reaches NAWF = 5. Recent research has shown that growth and development in a normal, healthy crop are such that the last population of bolls that will effectively contribute to yield will be represented by those white blooms that are present at "cutout" (when the crop reaches NAWF = 5). Research has also shown that when these bolls accumulate 350 to 400 heat units (HU), or DD60s, they have a low probability of sustaining economic damage from tarnished plant bugs (nymphs or adults) **or from budworm/bollworm larvae that emerge after this point**. Therefore, control of tarnished plant bugs and **budworm/bollworm** can generally be terminated at **NAWF = 5 + 350-400 HU (DD60s)**. Note, however, that threshold populations of larvae hatching before this point in the development of the	

crop should be controlled. Also note that this guideline for terminating insecticide treatments applies primarily to bollworm and tobacco budworm and tarnished plant bugs.

Although bolls are also relatively safe from boll weevils at this point, boll weevil control should not be terminated at this time because doing so may allow high populations of weevils to build and overwinter (see recommendations for Diapause Control). Also because leaves continue to contribute photosynthate for bolls to mature, the crop should be protected from excessive defoliation due to pests such as loopers, beyond this point of NAWF = 5 + 350 - 400 HUs.

Note: This technique for deciding when to terminate cotton insect control has not been tested under all weather and crop conditions, especially where early stress or insect damage results in poor square set or any other condition that causes late maturity. Growers and consultants must monitor crop maturity and insect populations carefully **on a field by field** basis and use all available information on crop development and status in making personal judgments on when to terminate insecticide treatments. Consult with your Extension entomologist or county Extension agent for additional information on how to use this technique.

	Insect Pests – Late Season (August-October)	Foliar Treatments lb ai/a
Diapausing Boll Weevils	**Contact Boll Weevil Eradication personnel immediately to report any fields where you find live boll weevils or squares with boll weevil oviposition punctures!**	

Estimating plants/acre, squares/acre, bolls/acre, etc.
An acre of land is 43,560 square feet. If the crop is planted on 40-inch row centers, there are about 13,070 linear row feet on an acre. If crop is planted on 38-inch row centers, there are about 13,760 linear row feet on an acre. The following technique for estimating plants/acre, etc., involves making total counts of plants, etc., on about 1/1,000 of an acre. Choose four 40-inch lengths of row (one at four different locations in the field); count all plants, etc., on these 40-inch units; take the sum of the individual counts and multiply by 1,000. This gives an estimate of the number of plants, squares, etc., per acre.

Insect pests to expect at different stages of plant development
Based on historical data, the following pests could be expected at different stages of plant development. This is a generalized statement, therefore, conditions may be different on specific farms or in specific seasons.

Stages of Plant Development	Major Pests	Occasional Pests
Emergence to fourth true leaf	Thrips	Aphids, cutworms, armyworms, saltmarsh caterpillars, grasshoppers
Fourth true leaf to first square	None	Plant bugs, spider mites, aphids, armyworms, saltmarsh caterpillars, grasshoppers
First square to first bloom	Bollworms, plant bugs, tobacco budworms	Spider mites, aphids, fleahoppers, armyworms
After first bloom	Bollworms, tobacco budworms	Aphids, whiteflies, plant bugs, beet armyworms, loopers, spider mites, fall armyworms, stink bugs

Cotton Spray Drift Precautions

- Keep all aerial and ground application equipment maintained and calibrated using appropriate carriers.
- Do not make aerial or ground applications during temperature inversions.
- Make aerial or ground applications when wind velocity (approximately 3-10 mph) favors on-target product deposition. Do not apply when wind velocity exceeds 15 mph.
- For aerial applications, mount the spray boom on the aircraft to reduce drift caused by wing tip or rotor vortices. Boom length must not exceed 75 percent of wing span or rotor diameter.
- When using pyrethroid insecticides, do not apply by ground within 25 feet or by air within 150 feet of lakes, reservoirs, rivers, permanent streams, marshes, natural ponds, estuaries, commercial fish ponds, or other bodies of water. Increase the buffer zone to 450 feet when ultralow volume (ULV) applications are made. Be sure to observe all other label restrictions regarding drift precautions for pyrethroids and all other insecticides.

Dilution table of more common formulations and rates

Pesticide	Lb/gal or percent active	Rate desired lb ai/a	No. acres 1 gal EC or 1 lb SP/WP will cover
abamectin	0.15	0.005	30
(Zephyr) (AV)		0.007	21.4
		0.01875	8
acephate	90% SP	0.200	4.50
(Orthene) (OP)		0.500	1.80
		1.000	0.90
	97%	0.500	1.94
		1.000	0.97
acetamiprid	70%	0.031	22.60
(Intruder) (CN)		0.05	14.00
bifenthrin	2.00	0.060	33.33
(Brigade) (P)		0.100	20.00
beta-cyfluthrin	1.00	0.0125	80.00
(Baythroid XL) (P)		0.0205	48.00
cyhalothrin	2.08	0.025	83.20
(Karate-Z) (P)		0.033	63.00
		0.040	52.00
cypermethrin	2.50	0.040	62.50
(Ammo) (P)		0.100	25.00
deltamethrin		0.020	75.00
dicofol	4.00	0.500	8.00
(Kelthane) (OC)		1.500	2.66
dicrotophos	8.00	0.200	40.00
(Bidrin) (OP)		0.250	32.00
		0.500	16.00
diflubenzuron	2F	0.0312	64.00
(Dimilin) (IGR)		0.0625	32.00
dimethoate	4.00	0.100	40.00
(OP)		0.200	20.00
		0.250	16.00
emamectin benzoate	0.16	0.0075	21.3
(Denim) (AV)		0.01	16
		0.015	10.67
encapsulated	2.00	0.125	16.00
methyl parathion		0.250	8.00
(Penncap-M) (OP)		0.500	4.00
esfenvalerate	0.66	0.030	22.00
(Asana XL) (P)		0.050	13.20
etoxazole	72%	0.03	24
(Zeal) (IGR)		0.045	16
fenpropathrin	2.4	0.15	16
(Danitol) (P)		0.3	8
imidacloprid	4.44	0.031	143.00
(Trimax Pro) (CN)		0.047	94.50
		0.062	71
indoxacarb	1.25	0.09	13.9
(Steward) (OX)		0.11	11.4
malathion	5.00	0.940	5.33
(OP)		1.250	4.00
malathion ULV	9.79	0.92	10.60
(Fyfanon ULV) (OP)		1.22	8.00
methamidophos	4.00	0.200	20.00
(Monitor) (OP)		0.250	16.00
		0.500	8.00
		0.750	5.30
		1.000	4.00

continued

Pesticide	Lb/gal or percent active	Rate desired lb ai/a	No. acres 1 gal EC or 1 lb SP/WP will cover
methomyl (Lannate) (C)	2.40 (LV)	0.250	9.60
		0.330	7.30
		0.450	5.30
methoxyfenozide (Intrepid) (IGR)	2.0	0.06	33
		0.1	20
		0.16	12.5
methyl parathion (OP)	4.00	0.250	16.00
		0.500	8.00
		1.000	4.00
oxamyl (Vydate) (C-LV) (C)	3.77	0.250	15.08
		0.330	11.42
propargite (Comite II)	6.0	0.94	6.4
		1.638	3.55
profenofos (Curacron) (OP)	8.00	0.750	10.70
		1.000	8.00
	6.00	0.750	8.00
		1.000	6.00
pyriproxyfen (Knack) (IGR)	0.86	0.054	16
		0.067	12.8
spinosad (Tracer) (SPN)	4.00	0.045	90.00
		0.067	60.00
		0.089	45.00
spiromesifen (Oberon) (TA)	4.0	0.1875	21.3
		0.5	8
tebufenozide (Confirm) (IGR)	2.00	0.125	16.00
		0.250	8.00
thiamethoxam (Centric) (CN)	40%	0.05	8.0
thiodicarb (Larvin) (C)	3.20	0.250	12.80
		0.450	7.10
		0.600	5.33
		0.800	4.00
zetamethrin (Mustang Max) (P)	0.80	0.0165	48.5
		0.0225	35.5
gamma-cyhalothrin (Prolex) (P)	1.25	0.01	150
		0.0125	100
		0.015	833
		0.02	62.5
Novaluron (Diamond) (IGR)	0.83	0.04	21
		0.06	14

Cotton Insecticide Recommendations Summary Chart

This chart shows specific insecticides recommended for each pest. See recommendations for specific rates and additional details regarding use. Recommended treatments may vary in efficacy.

Class[1]	Insecticide	Thrips	Cutworms	Plant Bugs	Flea Hoppers	Clouded Plant Bugs	Stink Bugs	Aphids	Bollworms	Budworms	Fall Armyworm	Beet Armyworm	Loopers	Spider Mites	Bandedwinged Whitefly	Silverleaf Whitefly
OP	acephate (Orthene)	R	R	R	R	R	R				R				R	R
	dicrotophos (Bidrin)	R		R	R	R	R	R								
	dimethoate	R														
	methyl parathion						R									
	malathion			R	R	R										
	methamidophos (Monitor)	R		R	R	R									R	
	profenofos (Curacron)			R	R	R			R	R	R			R		
	propargite (Comite)													R		
C	oxymyl (Vydate)			R	R	R										
	methomyl (Lannate)								R	R	R					
	thiodicarb (Larvin)								R	R	R	R	R			
CN	acetamiprid (Intruder)							R							R	
	imidacloprid (Trimax)			R	R	R		R								
	thiamethoxam (Centric)			R	R			R							R	
IGR	diflubenzuron (Dimilin)											R				
	tebufenozide (Confirm)											R				

Class[1]	Insecticide	Thrips	Cutworms	Plant Bugs	Flea Hoppers	Clouded Plant Bugs	Stink Bugs	Aphids	Bollworms	Budworms	Fall Armyworm	Beet Armyworm	Loopers	Spider Mites	Bandedwinged Whitefly	Silverleaf Whitefly
IGR *continued*	methoxyfenozide (Intrepid)										R	R	R			
	novaluron (Diamond)			R*												
	pyriproxyfen (Knack)															R
SPN	spinosad (Tracer)								R	R	R	R	R			
AV	emamectin benzoate (Denim)								R	R	R	R	R			
OX	indoxacarb (Steward)								R	R	R	R	R			
OC	dicofol (Kelthane)													R		
P	bifenthrin (Capture)						R		R					R		
	cyfluthrin (Baythroid)		R				R		R							
	cyhalothrin (Karate-z)		R				R		R							
	cypermethrin (Ammo)		R						R							
	deltamethrin (Decis)		R				R		R							
	esfenvalerate (Asana XL)		R						R							
	fenpropathrin (Danitol)													R		R
	gamma-cyhalothrin (Prolex)		R				R		R							
	zetamethrin (Mustang Max)		R				R		R							

[1]OP=organophosphate; C=carbamate; CN=chloro-nicotinyl; IGR=insect growth regulator; AV=Avermectin; SPN=spinosyn; OX=oxadiazine; OC=organochlorine; P=pyrethroid.

*Nymphs only

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