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2004 Cotton Insect Control Guide

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Integrated Pest Management

Integrated Pest Management (IPM) uses a variety of control tactics rather than relying solely on one method of control such as insecticide use. A successful and economical cotton pest management program requires using a multi-tactical approach to insect pest control. An IPM program integrates control tactics including cultural practices, variety selection, biological control and insecticides to manage/control 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:

Fall Stalk Destruction: Destruction of cotton stalks as soon as possible following harvest reduces the food supply for boll weevils, thereby reducing the size of the overwintering population.

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

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.

Using preventive and cultural control tactics can reduce the need for insecticides by delaying or reducing the severity of insect pest outbreaks. However, proper

scouting procedures and the judicious use of timely insecticide applications will be needed in most years to maximize profits.

Crop Management Considerations

Insecticide Resistance: Management of tobacco budworm in conventional 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.

Management/control decisions for bollworm and tobacco budworm 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 captures, moth flushing counts, identification of "worms" and egg test kits.

Insecticides are recommended on the basis of knowing which species (bollworm vs. budworm) and how many you have in the field.

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. Use of pyrethroids in June will foster resistance in tobacco budworm, bollworm and tarnished plant bug populations. Resistance monitoring clearly shows that resistance levels increase sharply each generation after use of these products is initiated. Avoid using pyrethroid insecticides during Phase I. Population densities of bollworm and tobacco budworm during June are typically low on most of the cotton acreage. Beneficial insects are often abundant in cotton at this time and can contribute to control of bollworm/tobacco budworm. Insecticides should not be applied for control of any insect pests unless scouting techniques suggest economic losses are occurring. Producers should strive for 80 percent square retention during Phase I.

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

Calculating Percent Square Retention:

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

Phase II (July to end of season): Phase II includes the blooming and boll development period, during which the second and subsequent field generations of tobacco budworm/bollworm occur.

It is during this window that cotton is most susceptible to insect injury, and pyrethroid or other appropriate classes of insecticides should be used whenever pest densities exceed economic thresholds. However, **pyrethroid insecticides should not be used for tobacco budworm.** Pyrethroid resistance in budworm populations is well

established in Tennessee. In non-Bt cotton, adequate control of tobacco budworms can not be expected with pyrethroids. If tobacco budworms are not a small percentage of the population, pyrethroid tank mixtures are not recommended. If a failure occurs with a pyrethroid or pyrethroid tank mixture, a second application with full rates of a non-pyrethroid insecticide should be made immediately. It is not realistic to expect follow-up applications made after an insecticide control failure to totally "clean-up" remaining larvae.

When unsatisfactory control with foliar insecticide occurs: All control problems are not related to insecticide resistance, and several factors should be considered in response to these problems. Treatment decisions should consider a variety of factors that influence insecticide efficacy and damage potential: species composition, population density, population age structure, application timing, insecticide dosage, application methods, application carriers, treatment evaluation timing, 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 for early crop maturity is an important component of these guidelines. Cotton producers should plant an early-maturing cotton variety during a 20-day period between April 20 and May 10. At-planting fungicides and insecticides are recommended to promote plant establishment and seedling growth, manage early-season insect pests and accelerate crop maturity.

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

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

Node Above White Flower (NAWF): An effective decision-making guide for insecticide termination is using heat unit accumulation for a measurement of boll maturity. Current research and demonstrations suggest that accumulating 350-450 heat units (DD60s) from the "cutout" date (NAWF = 5) is enough time to mature yield-contributing bolls beyond the point where economic losses from bollworm/budworm are likely to occur. Bolls should be protected during this maturing period, approximately 21 days. Related research indicates that this rule also generally applies to the tarnished plant bug and stink bugs.

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

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 number is the number of heat units (DD60s) accumulated for that day. Add these daily units to obtain the accumulated total.

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

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

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

Bt Cotton Management

Cotton containing *Bacillus thuringiensis* (Bt) genes will continue to be available for planting in Tennessee. The use of Bt cotton is recommended in areas with high occurrence of tobacco budworm and bollworm.

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

During the blooming period, bollworms can damage Bt cotton. Twice a week scouting and closer examination within the plant canopy may be necessary to locate and determine bollworm survival before making a treatment decision. The Bt toxin should be given an opportunity to work; therefore, a treatment based just on eggs present is not usually recommended. An exception to this general recommendation would occur if a high egg count was concentrated on fresh or dried blooms. Insecticide treatments should be applied at hatching stage and prior to larvae penetrating the small boll under the bloom. Spray coverage is critical for satisfactory control.

Resistance Management Plan – Refugia Acreage: Refugia acreage (non-Bt cotton) will provide a source of susceptible moths for mating with resistant moths that survive in Bt cotton. Designated refugia acreage should be located adjacent to or in close proximity of Bt-cotton acreage. The refuge should be managed with the intent of producing a viable, vigorous crop.

Refuge guidelines allow a producer to select among several refuge options. The information below is intended only as a summary of these options. Please refer to the grower licensing agreement and refuge guidelines (Bollgard Refuge Guide) provided by the company for complete details.

Option 1 requires a 20 percent or greater acreage planted to non-Bt cotton. This acreage can be treated with conventional insecticides, except foliar Bt products, to control all caterpillar species as well as other pests. All Bt fields must be within one mile, but preferably one half mile, of the refuge field.

Option 2 is a 5 percent non-Bt refuge that can not be treated for bollworm or tobacco budworm. The refuge must be 150 feet wide, and all Bt fields must be within one half mile of the refuge. This refuge acreage should not be treated with insecticides that control caterpillar pests. Non-caterpillar pests should be treated according to treatment thresholds, but there are restrictions on the kinds and rates of insecticides that can be used (see current licensing agreement).

Option 3 is a 5 percent non-Bt, embedded refuge that can be treated for bollworm and tobacco budworm only when Bt fields are also treated. If the embedded refuge is treated for bollworm or tobacco budworm, the associated Bollgard field or field unit must be treated at the same time with the same insecticide. Foliar Bt products can not be used on the refuge. The refuge must be part of a field or field unit and at least 150 feet wide. A "field unit" is defined as any group of fields that are contained within a one mile square (one mile by one mile) area.

Bollgard II Cotton

Bollgard II is more effective than the original Bollgard technology, including better activity on bollworm, armyworms and loopers. Research indicates that Bollgard II cotton will probably not require insecticide applications to control caterpillar pests except under unusual circumstances. New thresholds and scouting procedures are not fully developed for Bollgard II cotton. If bollworm infestations are found on Bollgard II cotton, use the existing thresholds for the original Bollgard

technology. Do not expect control of cutworm infestations. Bollgard II cotton does not control tarnished plant bugs, stink bugs or other non-caterpillar pests. Refugia requirements are the same as for Bollgard cotton.

Boll Weevil

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

Expected Occurrence of Insect Pests

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	Major Pests	Occasional Pests
Emergence to fifth true leaf	Thrips, Cutworms	Aphids
Fifth true leaf to first square	---	Aphids, Plant Bugs, Spider Mites
First square to first bloom	Plants Bugs, Bollworm,	Aphids, Spider Mites Tobacco Budworm
After first bloom	Bollworm, Tobacco Budworm, Stink Bugs	Aphids, Tarnished Plant Bug, Loopers, Fall and Beet Armyworm, Spider Mites, Clouded Plant Bug, Whiteflies, European Corn Borer

Cutworms

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

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

Bt cotton does not provide control of cutworms.

Insecticide	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
CUTWORMS			
acephate (Orthene 90S)	0.72	0.80 lb	1.25
bifenthrin (Capture 2)	0.04 - 0.10	2.4 - 6.4 oz	53.3 - 20
chlorpyrifos (Lorsban 4)	0.75 - 1.0	24 - 32 oz	5.3 - 4
cyfluthrin (Baythroid 2)	0.0125 - 0.025	0.8 - 1.6 oz	160 - 80
cyhalothrin (Karate 2.08)	0.015 - 0.02	0.96 - 1.28 oz	133 - 100
cypermethrin (Ammo 2.5)	0.025 - 0.1	1.3 - 5.0 oz	100 - 25
deltamethrin (Decis 1.5)	0.013 - 0.019	1.11 - 1.62 oz	115 - 79
esfenvalerate (Asana XL 0.66)	0.03 - 0.05	5.8 - 9.6 oz	22 - 13
thiodicarb (Larvin 3.2)	0.6	24 oz	5.3
zeta-cypermethrin (Mustang Max 0.8)	0.008 - 0.012	1.28 - 1.92 oz	100 - 67

Thrips

Thrips injury causes foliar deformity (leaves crinkle and cup upward), plant stunting and delays in maturity. Preventative in-furrow or seed treatments are recommended. Under adverse growing conditions, additional treatment may be needed even when preventative controls have been used. Treat when cotton is up to a stand and thrips average one or more per plant and damage is observed.

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

Insecticide	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal. or Lb of Dry Product
THRIPS			
In-furrow Systemic Granules:			
aldicarb (Temik 15G)	0.525	3.5 lb	---
disulfoton (Di-Syston 15G)	0.75 - 1.0	5.0 - 6.7 lb	---
In-furrow Systemic Sprays:			
acephate (Orthene 90S)	0.9 - 1.0	1.0 - 1.1 lb	1.0 - 0.9
disulfoton (Di-Syston 8)	0.75 - 1.0	12 - 16 oz	10.7 - 7.8
Foliar Sprays*:			
acephate (Orthene 90S)	0.18	3.2 oz	5
dicrotophos (Bidrin 8)	0.1 - 0.2	1.6 - 3.2 oz	80 - 40
dimethoate 4	0.1 - 0.2	4.0 - 8.0 oz	32 - 16
methamidophos (Monitor 4)	0.1 - 0.2	3.2 - 6.4 oz	40 - 20
Treated Seed:	---		
acephate (Orthene 90S)	2.5 - 3.25 oz Orthene 90S/acre for hopper box (to achieve application rate of 3 - 4 oz per acre)		
imidacloprid (Gaucho 480)	8 oz Gaucho 480/100 lb seed		
thiamethoxam (Cruiser 5)	0.30 - 0.34 mg active ingredient per seed (about 7.5 - 8 oz Cruiser 5FS/100 lb seed, depending on seed size)		

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

Plant Bugs

First two weeks of squaring: Treat when plant bugs number **one** or more per 6 row feet or **eight** per 100 sweeps (standard sweep net) and square loss is occurring.

Third week of squaring until first bloom: Treat when plant bugs number **two** or more per 6 row feet or **15** per 100 sweeps and square damage is occurring.

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

After first bloom: Treat when plant bugs number **four** or more per 6 row feet or **30** per 100 sweeps. Treatment should also be considered if 15 or more plant bugs are observed per 100 plants during visual examination. Two consecutive insecticide applications may be required to control established populations of nymphs and adults.

The tarnished plant bug is the predominant species. Clouded plant bugs and cotton fleahoppers are observed some

Insecticide*	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
PLANT BUGS			
acephate (Orthene 90S)	0.23 - 0.45	0.25 - 0.5 lb	4 - 2
chlorpyrifos (Lorsban 4)	0.19 - 0.25	6 - 8 oz	21- 16
dicrotophos (Bidrin 8)	0.25 - 0.5	4 - 8 oz	32 - 16
imidacloprid (Trimax 4)	0.047	1.5 oz	85
malathion 5	1.25	32 oz	4
methyl parathion 4	0.25 - 0.50	8 - 16 oz	16 - 8
oxamyl (Vydate C-LV 3.77)	0.25 - 0.31	8 - 10.6 oz	16 - 12
thiamethoxam (Centric 40WG)	0.050	2 oz	8

* Do not use low rates when infestations are well above threshold. Phase II — most pyrethroid insecticides will provide some control of plant bugs when used for other pests.

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

Visual sampling should include examining terminals for adults and nymphs, and checking inside squares, blooms and small bolls for nymphs. Boll injury appears as small, dark sunken spots on the outside. Seed and lint damage is usually localized to the lock where feeding occurred. Distinguishing plant bug damage from stink bug based on external symptoms is difficult. “Dirty blooms” (anthers dark and brown) are a sign of plant bug feeding.

Aphids

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

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

Insecticide	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
APHIDS			
acetamiprid (Intruder 70WP)*	0.026 - 0.048	0.6 - 1.1 oz	26.7 - 14.5
dicrotophos (Bidrin 8)	0.25 - 0.50	4 - 8 oz	32 - 16
dimethoate 4	0.125 - 0.25	4 - 8 oz	32 - 16
imidacloprid (Trimax 4)*	0.031 - 0.047	1.0 - 1.5 oz	128 - 85
thiamethoxam (Centric 40WG)*	0.031 - 0.050	1.25 - 2 oz	12.8 - 8

* Apply low rates in a band application early in season or as tank mix partner.

Bollworm/Tobacco Budworm

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 5 percent or more of the squares are damaged and larvae are present)

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

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

Insecticide	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
BOLLWORM*			
bifenthrin (Capture 2)	0.05 - 0.10	3.2 - 6.4 oz	40 - 20
cyfluthrin (Baythroid 2)	0.025 - 0.05	1.6 - 3.2 oz	80 - 40
cyhalothrin (Karate 2.08)	0.025 - 0.04	1.6 - 2.56 oz	83 - 52
cypermethrin (Ammo 2.5)	0.04 - 0.1	2 - 5 oz	64 - 26
deltamethrin (Decis 1.5)	0.02 - 0.03	1.7 - 2.56 oz	75 - 50
esfenvalerate (Asana XL 0.66)	0.03 - 0.05	5.8 - 9.6 oz	22 - 13
zeta-cypermethrin (Mustang Max 0.8)	0.0165 - 0.0225	2.64 - 3.6 oz	48.5 - 35.6
TOBACCO BUDWORM			
acephate (Orthene 90S)	0.9	1 lb	1
emamectin benzoate (Denim 0.16)	0.01 - 0.015	8 - 12 oz	16 - 10.7
indoxacarb (Steward 1.25)	0.11	11.3 oz	11.3
methomyl (Lannate LV 2.4)	0.45	24 oz	5.3
profenofos (Curacron 8)	0.75 - 1	12 - 16 oz	12 - 8
spinosad (Tracer 4)	0.045 - 0.089	1.4 - 2.8 oz	90 - 45
thiodicarb (Larvin 3.2)	0.6 - 0.9	24 - 36 oz	5.3 - 3.6
Tank mix products + Pyrethroids (at median rates):**			
acephate (Orthene 90S)	0.45	0.5 lb	1.8
chlorpyrifos (Lorsban 4)	0.50	16 oz	8
methomyl (Lannate LV 2.4)	0.30	16 oz	8
profenofos (Curacron 8)	0.50	8 oz	16
thiodicarb (Larvin 3.2)	0.30	12 oz	10.7
Other mixtures of non-pyrethroid chemistry:			
profenofos (Curacron 8) + thiodicarb (Larvin 3.2)	0.80 + 0.30	16 + 12 oz	10 + 10.7
acephate (Orthene 90) + thiodicarb (Larvin 3.2)	0.45 + 0.45	8 + 18 oz	2 + 7.1

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

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

BT COTTON: Prior to bloom, treat when eight or more surviving larvae (> 1/4 inch or longer) are present per 100 plants, or when populations threaten to reduce square retention below 80 percent. **After first bloom**, treat when four or more surviving larvae (> 1/4 inch or longer) per 100 plants are present and/or 2 percent boll damage is found. Treatment based on eggs alone is not usually recommended (see Bt Cotton Management). Scout fields once each week pre-bloom and twice per week after blooming has begun (July-August). Whole plant examination may be necessary to find eggs and/or surviving larvae within the plant canopy, especially around blooms. Check bolls and bloom tags from two nodes directly below the current first position white bloom. Bt-toxin expression may be reduced during late season when plants have a full boll load.

Stink Bugs

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

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

Insecticide*	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
STINK BUGS			
acephate (Orthene 90S)	0.72	0.8 lb	1.25
bifenthrin (Capture 2)	0.05 - 0.10	3.2 - 6.4 oz	60 - 30
dicrotophos (Bidrin 8)	0.33 - 0.5	5.3 - 8 oz	24 - 16
methyl parathion 4	0.5	16 oz	8
oxamyl (Vydate C-LV 3.77)	0.32 - 0.5	11.0 17.0 oz	11.6 - 7.5

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

Spider Mites

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

Insecticide	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
SPIDER MITES			
bifenthrin (Capture 2)	0.06 - 0.10	3.8 - 6.4 oz	33 - 20
dicofol (Kelthane 4)	1 - 1.5	32 - 48 oz	4 - 2.6
emamectin benzoate (Denim 0.16)*	0.01 - 0.015	8 - 12 oz	16 - 10.7
profenofos (Curacron 8)	0.5 - 1	8 - 16 oz	16 - 8
propargite (Comite 6.55)	0.8 - 1.6	16 - 32 oz	8 - 4

*Denim provides suppression of spider mite populations.

Fall Armyworm

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

The original Bollgard cotton does not control fall armyworms. However, Bollgard II cotton provides much better control of fall armyworms, and insecticide treatments should not be made unless surviving larvae (> 1/4 inch in length) are found at the threshold numbers indicated above.

Insecticide*	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
FALL ARMYWORM			
emamectin benzoate (Denim 0.16)	0.01 - 0.015	8 - 12 oz	16 - 10.7
indoxacarb (Steward 1.25)	0.09 - 0.11	9.2 - 11.3 oz	13.9 - 11.3
methomyl (Lannate 2.4)	0.45	24 oz	5.3
methoxyfenozide (Intrepid 2)	0.06 - 0.16	4 - 10 oz	32 - 12.8
profenofos (Curacron 8)	0.75 - 1	12 - 16 oz	10.6 - 8
spinosad (Tracer 4)	0.067 - 0.089	2.1 - 2.8 oz	60 - 45
thiodicarb (Larvin 3.2)	0.6 - 0.9	24 - 36 oz	5.3 - 3.6

*Most pyrethroid insecticides provide some suppression of fall armyworm populations.

Beet Armyworm

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

Prior to August 15: Treat for beet armyworm when 5-6 "hits" (active clusters of small larvae) are found per 300 row feet. **After August 15:** Treat when 10 or more "hits" are found per 300 row feet.

The original Bollgard cotton does not control beet armyworms. It is unlikely that Bollgard II cotton will need additional treatment for this pest.

Insecticide	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
BEET ARMYWORM			
emamectin benzoate (Denim 0.16)	0.0075 - 0.01	6 - 8 oz	21.3 - 16
indoxacarb (Steward 1.25)	0.09 - 0.11	9.2 - 11.3 oz	13.9 - 11.3
methoxyfenozide (Intrepid 2)	0.06 - 0.16	4 - 10 oz	32 - 12.8
spinosad (Tracer 4)	0.067 - 0.089	2.1 - 2.8 oz	60 - 45

Loopers

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

The original Bollgard cotton <u>may</u> provide some suppression of loopers. Bollgard II cotton should not require treatment for loopers.

Insecticide	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
LOOPERS			
emamectin benzoate (Denim 0.16)	0.01 - 0.015	8 - 12 oz	16 - 10.7
indoxacarb (Steward 1.25)	0.09 - 0.11	9.2 - 11.3 oz	13.9 - 11.3
methoxyfenozide (Intrepid 2)	0.06 - 0.16	4 - 10 oz	32 - 12.8
spinosad (Tracer 4)	0.067 - 0.089	2.1 - 2.8 oz	60 - 45
thiodicarb (Larvin 3.2)	0.6 - 0.9	24 - 36 oz	5.3 - 3.6

Whitefly

Treat when 50 percent of the terminals are infested with adults, particularly if honeydew is accumulating on leaves. These small moth-like insects feed on the underside of leaves and readily fly when disturbed. More than one application on a 4-5 day schedule may be required if eggs continue to hatch.

Insecticide	Lb Active Ingredient per Acre	Amount Formulation per Acre	Acres Treated per Gal or Lb of Dry Product
WHITEFLY			
acephate (Orthene 90S)	0.45 - 0.9	0.5 - 1 lb	2 - 1
methamidophos (Monitor 4)	0.25 - 0.5	8 - 16 oz	16 - 8
thiamethoxam (Centric 40 WG)	0.05	2 oz	8

Reentry Intervals and EPA Product Registration Numbers for Cotton Insecticides

The reentry interval is the time period required by federal law between application of pesticides to crops and the entrance of workers into those crops without protective clothing. Reentry intervals serve to protect workers from possible pesticide poisonings. Growers, scouts and other farm laborers must effectively communicate when and where pesticides have been applied. Reentry periods vary by product. Scouts should not enter fields until all reentry intervals have expired. Safety is of utmost importance. Be sure to establish proper communication channels with all parties involved.

Producers are required to keep records, including EPA product registration numbers, of all insecticides applied to fields. Reentry intervals and product registration numbers for products not listed below can be found on the insecticide label.

Insecticide*	Reentry Interval (hours)	EPA Product Registration Number**	Insecticide*	Reentry Interval (hours)	EPA Product Registration Number**
Ammo (P)	12	279-3037	Karate (P)	24	10182-414
Asana (P)	12	352-515	Kelthane (OC)	12	707-229
Baythroid (P)	12	3125-351	Lannate (C)	72	352-384
Bidrin (OP)	48	5481-488	Larvin (C)	12	264-379
Capture (P)	12	279-3069	Lorsban (OP)	24	62719-220
Centric (CN)	12	100-1147	malathion (OP)	12	See label
Comite (OS)	48	400-104	methyl parathion (OP)	96	See label
Cruiser (CN)	12	100-941	Monitor (OP)	48	3125-280
Curacron (OP)	48	100-669	Mustang Max (P)	12	279 - 3249
Decis (P)	12	34147-12-264	Orthene (OP)	24	59639-33
Denim (SA)	48	100 - 903	Trimax (CN)	12	3125-585
Di-Syston (OP)	48	3125-307	Steward (I)	12	352-598
dimethoate (OP)	48	See label	Temik (C)	48	264-330
Gaucho 480 (CN)	12	7501-155	Tracer (SPN)	4	62719-267
Intrepid (IGR)	4	62719-442	Vydate (C)	48	352-532
Intruder (CN)	12	8033-24-352			

* Classes of insecticides listed above are identified by the following abbreviations: OC, organochlorine; C, carbamate; OP, organophosphate; CN, chloronicotinyl (= neonicotinoid); I, indoxacarb; IGR, insect growth regulator; OS, organosulfur; P, pyrethroid; SA, synthetic avermectin; SPN, spinosad.

** Registration numbers change with company brands, although the product name or active ingredient may be the same. Check the label to be sure.

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