CLEMSON
EXTENSION

IC 97 Revised March 2004 COTTON

Cotton Insect Management

Insect pests are a major limiting factor in producing cotton in South Carolina. Hundreds of species of insects may be found in a cotton field, but only about 20 of those species are capable of producing economically important damage. A cotton scout must be able to identify most of the damaging species of insects as well as the common beneficial arthropods. A good scouting program is still the first line of defense against insect pests in cotton.

SCOUTING METHODS

There are many valid techniques that may be used to assess the impact of insects in a field of cotton. The following information is intended to serve as a guide for use in the monitoring and control of insect-pest infestations. Insecticide treatments should only be applied when insect-pest numbers reach levels that correspond to the economic thresholds described here. Avoid treating infestations that are below thresholds, because unnecessary disruptions to populations of beneficial species often result in plants being damaged by other insect pests.

Cotton fields should be checked at least once a week, from seedling emergence through the first week in July. More frequent scouting is recommended from early July through mid August, primarily to detect hatch-out of bollworm larvae. During this time frame, fields should be visited every five days or twice a week. Thereafter, weekly field visits should continue until most plants have reached a stage of maturity, which can be considered relatively safe from insect damage.

Ideally, a scout should examine 100 randomly selected plants for each 20 acres of cotton, since many of the insecticide-treatment recommendations are based upon 100-plant increments (e.g. numbers of bollworms per 100 plants, damaged squares per 100 plants). If fewer plants were examined, bollworm larvae and damage counts should be converted to numbers per 100 plants.

If 100 plants are to be examined in a field, then randomly select single plants at 100 locations in a field, or look at fewer locations and examine multiple plants. For example, a scout may randomly select 10 locations in a field and examine 10 consecutive plants in the same row. To obtain a sample that is truly representative of a field, and one that is unaffected by personal biases, make sure that the 10 locations are randomly selected. Predetermine your scouting pattern and the approximate number of locations that will be selected. One way to randomly select a 10-plant location is to, look away from the crop, take 10 steps diagonally across several rows, and begin by checking the first plant closest to your right foot.

To obtain good representative samples of most insect populations, scouts should walk a substantial portion of a cotton field in a pattern such as a figure "8" or a modified "X" (see Bulletin 126, Cotton Pest Management Scouting Manual). These scouting patterns are designed to enable scouts to detect infestations of insects that exhibit different patterns of behavior in their host-plant selection. For example, insects such as thrips and bollworms may be evenly distributed within a field, while species such as stink bugs and spider mites tend to develop infestations with clumped distributions. Initial infestations of spider mites or stink bugs, will often begin on the edge of a field, as these pests will move into cotton from wild host plants or other crops. Infestations of beet armyworms are often detected on a few plants located on the end-rows of a field. Concentrating scouting efforts on a small portion of a field, such as many farmers tend to do when they practice "roadside scouting," is the worst way to obtain good estimates of the actual numbers of insect pests. Scouts should make it a point to always walk different routes within a field each time they check it. When the same search paths are followed week after week, economically damaging infestations may become established in portions of fields that were previously ignored. The longer infestations of insect pests go undetected the greater the control costs and yield losses will be for the farmer.

INSECT PESTS

The **cotton bollworm** (corn earworm) is the key insect pest of cotton in South Carolina, since it will infest most fields in the state every year. Infestations are most likely to occur in July, after moths that have emerged from cornfields begin to lay eggs on cotton plants. In the Coastal-Plain region, moth flights will usually begin within the period from 7 July to 18 July—with the earliest flights occurring in the Savannah Valley area. Bollworms have generally been less of a threat in the Piedmont region, where infestations generally don't arise before the last week in July. —**Tobacco budworm** infestations have been relatively light during the last several years. Most problems with budworms will occur in the Coastal Plain from moths that lay eggs during the 3rd and 4th week in June. These two heliothine species are often called the bollworm/budworm complex, because they will often be present in the same field, they eat the same plant parts, and they are morphologically quite similar.

Insecticide applications will be triggered when the numbers of eggs and small bollworms reach economic levels (economic thresholds). Scouting for eggs and first-instar larvae is the most critical responsibility of a cotton scout. After bollworm moths have laid their eggs on cotton plants, they will begin hatching in about three days. Eggs are deposited singly, generally on the upper leaf surfaces in the top six inches of the plant terminals. By mid-July or later, moths may deposit a higher percentage of eggs lower on the plants—on leaves, squares, stems, and even blooms or dried blooms (bloom tags). To scout for bollworm/budworm larvae in conventional cotton varieties, randomly select one square, 1/4 inch or larger, from each plant. Alternate selections between lower, middle and upper portions of the plants, selecting squares with no obvious signs of bollworm injury. Disregard those with yellowing or flared bracts. Pull open the bracts of each square and examine the bud for signs of injury. Express the number of squares damaged as a percent of the total number checked. Also examine the terminal of each plant for larvae and/or feeding injury. Procedures for scouting *Bt* cotton are outlined below under INSECT PEST MANAGEMENT IN *BT* COTTON.

Beet armyworm and fall armyworm problems usually do not occur until late July or early August, as neither species is known to overwinter in South Carolina. Moths of both species lay eggs in masses of 80 to 100 on the undersides of leaves. Newly emerged fall armyworms (first instars) tend to feed singly on the younger growth within the middle portion of a plant. Small beet armyworms are gregarious, and will feed in clusters on the undersides of leaves through third instars. When small larvae feed on the inner surfaces of square bracts the etchings will be visible externally. Fall armyworms are often found in blooms, where they feed on floral tissue and pollen. Like bollworms, fall armyworms will eventually damage some larger bolls. Beet armyworms feed on squares and blooms, but they usually do not bore in to bolls. Large beet armyworms are capable of completely defoliating cotton plants.

Thrips feed on leaves and terminals of seedling plants, thereby stunting growth and delaying maturity. Damaged leaves appear crinkled on top and lower surfaces will often have a silvery sheen. Leaf margins become cupped and terminal buds may be destroyed. Post-emergence applications of herbicides may be delayed when plants have been stunted by thrips, allowing weeds to gain the upper hand. Then, when a grower decided to go ahead and apply the herbicide, before the weeds took over the field, the smaller thrips damaged plants would often be over-sprayed and killed. The recent trend toward growing Roundup-Ready cotton varieties has largely negated this affect, since the herbicide can be sprayed directly over the tops of plants (at least through the 4-leaf growth stage). Thus there should be far less damage to the thrips injured plants than would occur with a typical post-directed herbicide.

Aphid infestations usually begin in plant terminals. These soft-bodied insects have piercing, sucking mouthparts, which they use to suck plant juices from leaves and stems. Heavy infestations on the undersides of leaves produce wilting and cause the leaf margins to curl toward the ground. A parasitic wasp and a fungus, *Neozygites fresenii*, often provide adequate aphid control. **Whiteflies** may also damage cotton by sucking plant fluids, but this happens very rarely in South Carolina. These insects are generally controlled by naturally occurring beneficials before their damage can reduce yields. Both aphids and whiteflies excrete a substance with a high sugar content referred to as honeydew. Heavy infestations of aphids can produce large amounts of honeydew, thereby coating lower leaves, and giving them a shiny appearance. After mature bolls have opened, honeydew may produce sticky lint. Honeydew may also serve as a substrate for the growth of a sooty mold, which stains lint and reduces color grade.

Plant bugs (tarnished plant bug and cotton fleahopper) infrequently cause problems in June and July. Tarnished plant bugs may also puncture small bolls, inflicting damage symptoms similar to that caused by stink bugs. Adults of both species of plant bugs move to cotton from wild host plants. Lygus bugs develop in such wild hosts as aster and fleabane, while fleahoppers are fond of tropic croton and primrose. Both adults and nymphs feed on small squares and other tender plant parts.

Stink bugs have piercing, sucking mouthparts, which they use to pierce small bolls and suck sap from the seeds. Seed coats more or less collapse, and the attached lint often acquires a yellowish to brownish colored stain. Small, warty growths on the inside of a boll wall will generally mark the points of penetration. Warts may form within 24 hours after penetration. Water-soaked lesions are signs of more recent penetrations, where warts may not have had time to develop. Warts may never develop when a stink bug penetrates the boll wall, fails to find a seed, and then quickly withdraws its beak. Damaged bolls may open prematurely and become hard-locked. Usually only one or two locks will be damaged, but occasionally, if infestations are heavy, bolls may be completely hard locked.

Boll damage is the main criterion used to evaluate a stinkbug infestation. A scout should randomly select 25 or more quarter-sized bolls, break or cut them open, and check the inner walls of the bolls for the damage symptoms indicated above. Be sure that all the bolls examined are of the same age class, because these will provide the most reliable estimate of the actual damage in a field. When damage symptoms are present, look for adults and large nymphs by shaking plants over a beat cloth or into a plastic pan where they may be examined and identified. It is possible that plant bugs or some other sucking insect may be damaging small bolls, therefore, make sure you have identified the culprit before applying the punishment (in this case an insecticide). By the time a boll is 18-days old it should be relatively safe from attack.

Spider mites are occasionally a problem in cotton. Infestations of mites are often flared by extremely hot and dry weather conditions. Applications of insecticides for other pests may also flare spider mite infestations by reducing the numbers of beneficials that prey upon them. Initial infestations occur from spider mites moving from wild host plants or other crops

into border rows of cotton. Yellow speckling on the upper surfaces of leaves (in proximity to petiole attachment) will be the first indication of a mite infestation. As the mites continue to feed on the undersides of leaves, the upper surfaces will become reddened. Early recognition of these symptoms, and spot treating infested areas, will often prevent spider mites from spreading throughout a field.

ACTION THRESHOLDS

Compare numbers on scouting reports to the action thresholds contained under REMARKS in the recommendations tables in determining need for an insecticide treatment. One must also consider factors such as the stage of plant growth, or whether the cotton is a conventional variety or a *Bt* variety. For some insect pests, such as bollworms, insect numbers or damaged-square counts are provided to enable a grower to determine whether or not an insecticide application is warranted. Action thresholds are not so clear cut for every insect pest, and deciding whether or not to treat may be more difficult. In these situations there is a greater likelihood of treating a field that doesn't really needed to be treated. Threshold numbers are general in nature, and are subject to professional interpretation. County agents and cotton consultants should have the expertise to help determine how these thresholds best apply to field situations on a particular farm.

INSECT PEST MANAGEMENT IN *BT* COTTON

For the last four years, cotton growers in South Carolina have planted cotton varieties, which were protected from budworms and bollworms by a gene derived from the bacterium, *Bacillus thuringiensis* (*Bt*). The *Bt* gene enables cotton plants to produce Cry 1Ac protein. Cells of leaves, stems, squares, blooms and bolls of these genetically engineered cotton plants contain lethal doses of the toxin. When the insects eat the Cry-proteins, their digestive enzymes activate the toxic form of the protein. The Cry-proteins bind to receptors on the lining of the insect gut and cells are ruptured. The poisoned insects stop feeding within a few hours after consuming the Cry-protein, and if the dose is sufficiently high, they will die within 2 or 3 days. Varieties with Bollgard have provided virtually 100% control of budworms, and 75 to 85% control of bollworms. In South Carolina there has been insufficient control of bollworms with *Bt* in some cases, and supplemental applications of insecticides have been needed to prevent economic damage.

The *Bt* endotoxin also provides 70 to 80% control of European corn borer and cabbage looper. Only 25 to 35% control can be expected with beet armyworms, fall armyworms, and soybean loopers. Transgenic varieties that are currently available will have little or no effect on aphids, boll weevils, plant bugs, stink bugs, thrips, and spider mites. Since transgenic cottons are not immune from attack by numerous insect species, good insect scouting practices are just as important as in conventional cotton. **Stink bugs, and possibly plant bugs, may become more of a problem in *Bt* cotton fields** where fewer insecticide applications will be applied to control bollworms. Conversely, the conservation of beneficial insects resulting from reduced spraying may potentially keep other insect-pest species from attaining economic status.

Notice that the action thresholds for bollworm control are different in *Bt* cotton. These thresholds were developed in response to observations that many of the bollworm problems occurred in fields of *Bt* cotton where there had been moderate to high levels of eggs. For this reason the Recommendations Committee adopted thresholds calling for insecticide treatments when egg and small worm numbers are excessive, especially if scouts will be unable to get back within a few days to assess infestations of larvae. An egg threshold of 75 eggs per 100 plants was instituted in the 1997 crop year, along with a threshold of 30 small worms per 100 plants. Square damage has been a poorer indicator of economic damage in *Bt* cotton, as most surviving larvae have been found in association with bloom tagged bolls. Researchers have shown that *Bt* toxin is apparently expressed in lower concentrations in blooms, pollen and dried bloom tags, creating a window of opportunity for small bollworms. If these small larvae can survive and grow for two to three days, they are not likely to be killed by the *Bt* toxin. Scouts should check whole plants for bollworm eggs and larvae and examine the following fruiting forms on each plant: a white bloom, a pink bloom and the two smallest bolls. Remove bloom tags to look for damage on the tips of small bolls where bollworm larvae often gain entry. An insecticide treatment may be needed when 30 or more larvae smaller than 1/4 inch in length are found per 100 plants. The escaped worm threshold is three larvae 1/4 inch or more in length, or 5% damaged bolls.

Bt cotton has many potential benefits in terms of insect control, but there are also some potential problems with stink bugs and other insect pests that are not controlled by the *Bt* toxin. To maximize the benefits of *Bt* cotton and minimize the risks of problems with secondary insect pests: (1) consider planting a non *Bt* cotton variety in fields with a history of problems with stink bugs; (2) plant *Bt* varieties in fields where insecticide treatments are more difficult, or more costly to apply because of power lines, or other factors; (3) scout *Bt* cotton regularly for bollworms and stink bugs; and (4) ensure that scouts are examining quarter-sized bolls for symptoms of injury by stink bugs.

In 2003 about 75% of the cotton acreage was planted to varieties containing the *Bt* toxin (Cry 1Ac protein), trade named Bollgard (Monsanto Company). Several new Bollgard varieties will be available in 2004 and Bollgard II seed will be available in limited quantities. Bollgard II will incorporate two genes for Cry-protein production. Research has shown that in Bollgard II cotton plants, the addition of a gene that produces Cry 2Ab protein greatly increases effectiveness against bollworms, armyworms, and soybean loopers. Clemson University researchers will continue to evaluate insect pest thresholds and control methods with new transgenic varieties, and adjustments will be made to recommendations as deemed appropriate.

RESISTANCE MANAGEMENT IN *BT* COTTON

Adherence to refuge standards will minimize selection pressure for budworm and bollworm to develop resistance to the *Bt* toxin. Monsanto is requiring growers to utilize the following refuge options in 2004, singly or in combination: An Option 1 (5% embedded refuge) will be available. The embedded-conventional cotton must be part of a *Bt* field, or the "field unit." The embedded refuge can not be treated independently with any of the insecticides listed under Option 2, but it may be treated at the same time as "the" Bt cotton. For Option 2 (5% unsprayed refuge), the farmer must plant 5 acres of a conventional cotton variety for every 95 acres of Bollgard cotton. This cotton may not be treated with any of the following insecticides: amitraz, emamectin benzoate, endosulfan, gossyplure, indoxacarb, methomyl, methoxyfenozide, profenofos, sulprofos, pyrethroids, *Helicoverpa zea* nuclear polyhedrosis virus, spinosad, thiodicarb, pepper spray, garlic spray, and/or foliar *Btk*. *Acephate and methyl parathion are now allowed to be used in the 5% refuge options as long as the application rate does not exceed 0.5 lb. active ingredient per acre per application*. Option 3 (20% sprayed) requires that, for every 80 acres of cotton with the Bollgard gene, a grower will plant 20 acres of conventional cotton that may be treated with anything, except *Bt* insecticides. All Bollgard fields must be within 1 mile of the associated refuge field. Distance is measured from field border to field border.

There is also an option to form a community refuge plan requiring an agreement with the company supplying the seed. A group of growers who farm in a contiguous area (a "community") may agree to implement a single plan for the entire area managed by those growers. The community refuge plan must meet the requirements of either the 20% sprayed option or the 5% unsprayed option, or an appropriate combination of the two options. The larger area bounding the entire group of farms would form a geographic "community," and the refuge requirements would apply to the community of growers and the geographic community exactly as they apply to a single grower. The 5% embedded refuge option is not allowed for use by a community group

PYRETHROID RESISTANCE

In 1996 pyrethroid resistant bollworms were found in a couple of fields near Estill in Hampton County. Vial tests conducted with moths trapped in the Savannah Valley in 1997 confirmed the presence of resistance. Also, pyrethroid resistance was confirmed from a field in Orangeburg County and one in Calhoun County in August of 1997. Both of these fields were characterized by the presence of numerous large bollworms following multiple applications of pyrethroids. Pyrethroid resistance was documented in five locations below the lakes in 1998, from bollworms collected in fields where there had been control problems. In 1998 pyrethroid resistant tobacco budworms were reared from fields in Sumter County where there had been control problems in June. In late July, a second collection of hard-to-control worms turned out to be 95% budworms. No cases of resistance were documented from 1999 through 2003. However, the rates of survival shown by bollworm moths in vial tests conducted above the lakes in 2000 were the highest we have recorded, indicating that pyrethroid-resistance genes were still present. Pyrethroid resistance monitoring will continue in 2004.

I wish to express thanks to the Cotton Insecticide Recommendations Committee for reviewing and commenting on this publication. Members are Lonnie Bull, Mike Sullivan, Sam Turnipseed and Tommy Walker.

COTTON INSECT CONTROL RECOMMENDATIONS

PRODUCT NAME	QUALIFIERS	USE RATE	REI	PHI
BEET ARMYWORM AND FALL ARMYWORM				

Remarks: Control of fall armyworms (faw) may be justified when 10 or more worms 3/4 inch in length or smaller are found per 100 plants. For beet armyworms (baw), consider applying an insecticide when there are five or more "hits" per 100 feet of row, with live worms present. A hit is defined as a plant with one or more leaves damaged from the feeding of beet armyworms emerging from one or more egg masses. The first visible sign will be a brown spot about the size of a quarter on the upper surface of a leaf, produced by an aggregate of small worms (hatchlings from a single egg mass) feeding on the underside. As worms increase in size, the upper leaf surface will become net-veined, and the larger worms will eventually feed completely through the leaf. Begin scouting for beet armyworms upon observing the first hit in a field. Randomly select five locations in a field and examine all plants on 100 feet of row at each location—determine the average number of hits per 100 feet of row.

Bt cotton: Cotton with a single Bt-endotoxin (such as Bollgard) will only provide about 25% control of the two armyworm species. The Bt varieties with two endotoxins, Bollgard II for example, may provide 75% control.

Pyrethroids and other ovicides applied for bollworm control will also provide some control of eggs and newly hatched armyworm, however, after the worms have fed on cotton plants these materials will be less effective.

Active Ingredient: diflubenzuron 22%			12 hrs	14 days
R - DIMILIN 2 F (baw only)	Spray	2 to 4 oz/ac		

PRODUCT NAME	QUALIFIERS	USE RATE	REI	PHI

Note: When eggs or small beet armyworms are detected in late July or early August in fields with a history of problems, two or three applications of diflubenzuron may be used to suppress population growth.

Active Ingredient: emamectin benzoate 16%			48 hrs	21 days
R - DENIM 0.16 EC (baw)	Spray	6 to 8 oz/ac		
R - DENIM 0.16 EC (faw)	Spray	8 to 12 oz/ac		
Active Ingredient: indoxacarb 15%			12 hrs	14 days
STEWARD 1.25 SC	Spray	9.2 to 11.3 oz/ac		
Active Ingredient: methoxyfenozide 22.6%			4 hrs	14 days
INTREPID 2 F	Spray	4 to 10 oz/ac		
Active Ingredient: spinosad 44.2%			4 hrs	28 days
TRACER 4 AS	Spray	2.2 to 2.9 oz/ac		
Active Ingredient: thiodicarb 34%			12 hrs	28 days
LARVIN 3.2 AF	Spray	24 to 36 oz/ac		

COTTON BOLLWORM AND TOBACCO BUDWORM

Remarks:
BEFORE FIRST BLOOM, in cotton varieties that do not contain Bt endotoxin(s), treat when 15 small larvae are found per 100 plant terminals, or 20% of squares are damaged. AFTER FIRST BLOOM, in cotton that has not been previously treated, apply an initial insecticide treatment when 20 eggs are found per 100 plants. At least two treatments, with no more than a 5 day interval, should be applied to control bollworms following the initial moth flight in July, thereafter, apply insecticides for 3 small worms or 5% damaged squares. AFTER MID-AUGUST also consider the maturity of the crop in determining the need for a treatment. For example, 3 small worms or 5% damaged squares may still be an applicable threshold in late maturing cotton (early to mid-bloom stage of development), but this infestation level could be tolerated in cotton that is nearing cutout, where most bolls are too mature to be damaged by bollworms.

BEFORE FIRST BLOOM, in Bt-cotton varieties, an insecticide treatment should not be needed. During the month of July and AFTER FIRST BLOOM, in cotton that has not been previously treated (varieties with a single endotoxin), apply an insecticide when 75 eggs, or 30 small worms less than 1/4 inch in length are found per 100 plants. ***Since Bt-cotton with two endotoxins will be more efficacious against bollworms there will be no need to utilize an egg or small worm threshold.*** In all Bt-varieties, apply an insecticide treatment for escaped worms when 3 worms 1/4 inch or more in length are found per 100 plants, or 5% of small bolls are damaged. In fields planted to Bt-varieties, whole plants should be examined for eggs (terminals, middles of plants, blooms, squares, and stems). On each plant a scout should also examine a white bloom, a pink bloom, and the two smallest bolls. If blooms adhere to small bolls (bloom tags), pull them off and look for worms boring in the tips.

Pyrethroids

Active Ingredient: bifenthrin 25.1%			12 hrs	14 days
R - CAPTURE 2 EC	Spray	2.6 to 6.4 oz/ac		
Active Ingredient: cyfluthrin + imidacloprid 17% + 12%			12 hrs	14 days
R - LEVERAGE 2.7 EC	Spray	3 to 3.75 oz/ac		
Active Ingredient: cyfluthrin 25%			12 hrs	up to day of harvest
R - BAYTHROID 2 EC	Spray	1.6 to 2.6 oz/ac		
Active Ingredient: cyhalothrin 22.8%			24 hrs	21 days
R - KARATE Z 2.08 CS	Spray	1.6 to 2.6 oz/ac		
Active Ingredient: cypermethrin 30.6%			12 hrs	14 days
R - AMMO 2.5 EC	Spray	2.6 to 4 oz/ac		

PRODUCT NAME	QUALIFIERS	USE RATE	REI	PHI
Active Ingredient: deltamethrin 16.6%			12 hrs	21 days
R - DECIS 1.5 EC	Spray	1.6 to 2.6 oz/ac		
Active Ingredient: esfenvalerate 8.4%			12 hrs	21 days
R - ASANA XL 0.66 EC	Spray	5.8 to 9.6 oz/ac		
Active Ingredient: tralomethrin 11.4%			24 hrs	28 days
R - SCOUT X-TRA 0.9 EC	Spray	2.6 to 3.4 oz/ac		
Active Ingredient: zetamethrin 18.1%			12 hrs	14 days
R - FURY 1.5 EC	Spray	2.8 to 3.8 oz/ac		
Active Ingredient: zetamethrin 9.6%			12 hrs	14 days
R - MUSTANG MAX 0.8 EC	Spray	2.64 to 3.6 oz/ac		

Remarks: Avoid using pyrethroid insecticides before July 1, unless infestations are extremely high, to reduce selection pressure for resistance in tobacco budworm and bollworm.

Avermectin

Active Ingredient: emamectin benzoate 16%			48 hrs	21 days
R - DENIM 0.16 EC	Spray	8 to 12 oz/ac		

Carbamate

Active Ingredient: thiodicarb 34%			12 hrs	28 days
LARVIN 3.2 AF	Spray	24 to 36 oz/ac		

Oxadiazine

Active Ingredient: indoxacarb 15%			12 hrs	14 days
STEWARD 1.25 SC	Spray	9.2 to 11.3 oz/ac		

Remarks: STEWARD may be used at the rate of 11.3 oz in conventional cotton and 9.2 to 11.3 oz/ac in Bt-cotton.

Naturalyte

Active Ingredient: spinosad 44.2%			4 hrs	28 days
TRACER 4 SC	Spray	2.2 to 2.9 oz/ac		

NOTE: Insecticides listed above may provide effective alternatives to the pyrethroids for early to late season control where there have been control failures, and for use in resistance management. Denim, Steward and Tracer will be more conservative of beneficial insects and spiders.

Larvin, Tracer and the pyrethroids have activity on bollworm/budworm eggs.

LOOPERS

Remarks:
Apply an insecticide treatment when there is 25% or more defoliation, and bolls are still developing. In cotton that is nearing maturity, the bottom defoliation induced by loopers may often be beneficial in allowing increased air movement, thereby mitigating the effects of bacteria and fungi that produce boll rot. There are two species of loopers that defoliate cotton. The cabbage looper is generally controlled by pyrethroids and other insecticides applied for bollworm control. The soybean looper is much more difficult to control and it has become resistant to most insecticide treatments. Cotton varieties with the *Bt* endotoxin may control 75% of cabbage loopers, but probably no more than 25% of soybean loopers.

PRODUCT NAME	QUALIFIERS	USE RATE	REI	PHI
Active Ingredient: emamectin benzoate 16%			48 hrs	21 days
R - DENIM 0.16 EC	Spray	8 to 12 oz/ac		
Active Ingredient: indoxacarb 15%			12 hrs	14 days
STEWARD 1.25 SC	Spray	6.7 to 9.2 oz/ac		
Active Ingredient: methoxyfenozide 22.6%			4 hrs	14 days
INTREPID 2 F	Spray	4 to 10 oz/ac		
Active Ingredient: spinosad 44.2%			4 hrs	28 days
TRACER 4 SC	Spray	2.2 to 2.9 oz/ac		

COTTON APHID

Remarks:
Treat when high numbers of aphids infest 50% or more of plants and the margins of terminal leaves are drooping — aphids will cause more damage when plants are suffering from lack of moisture, and there are few signs of natural control agents. If there is evidence of widespread parasitism (dead aphids, tan colored and swollen in appearance) and/or fungal pathogens (diseased aphid bodies have a grayish-green fuzzy appearance) an insecticide should not be applied.

Avoid treating *Bt* cotton in June or July unless it is absolutely necessary. Subsequent reductions in beneficial populations have resulted in damage from bollworm, beet armyworm or fall armyworm.

CAUTION:
Aphids may be resistant to some insecticides, and controls will be inconsistent.

Active Ingredient: acetamiprid 70%			12 hrs	28 days
ASSAIL 70 WP	Spray	0.6 to 1.1 oz/ac		
Active Ingredient: acetamiprid 70%			12 hrs	28 days
lNTRUDER 70 WP	Spray	0.6 to 1.1 oz/ac		
Active Ingredient: dicrotophos 82%			48 hrs	30 days
R - BIDRIN 8 EC	Spray	4 to 8 oz/ac		
Active Ingredient: dimethoate 44.8%			48 hrs	14 days
DIMETHOATE 4 EC	Spray	4 to 8 oz/ac		
Active Ingredient: imidacloprid 40.7			12 hrs	14 days
TRIMAX 4 F	Spray	1.0 to 1.5 oz/ac		
Active Ingredient: methyl parathion 43.4%			48 hrs	7 days
R - 4 EC	Spray	8 to 16 oz/ac		
Active Ingredient: chlorpyrifos 44.9%			24 hrs	14 days
LORSBAN 4 E	Spray	16 oz/ac		
Active Ingredient: oxydemeton-methyl 25%			48 hrs	14 days
R - METASYSTOX-R 2 EC	Spray	8 to 16 oz/ac		
Active Ingredient: thiamethoxam 25%			12 hrs	21 days
CENTRIC 25 WG	Spray	3 oz/ac		

PRODUCT NAME	QUALIFIERS	USE RATE	REI	PHI
CUTWORMS				

Remarks:
Treat when cutworms threaten to reduce plant populations below an acceptable level. The risk of infestation will be greater under reduced tillage conditions and in heavier soils. In these situations cutworms may become established upon existing vegetation and will move to cotton when it emerges from the soil.
Destroying established vegetation 3 to 4 weeks before planting will often prevent cutworm problems. Some of these insecticides may by used as rescue treatments on cotton seedlings and some are labeled for preemergence use as either broadcast, banded or in-furrow sprays. At-planting treatments may be warranted in situations where cutworms are already established and vegetation cannot be destroyed ahead of time.

Active Ingredient: chlorpyrifos 44.9%			24 hrs	N/A
LORSBAN 4 E	Spray	24 to 32 oz/ac		
Active Ingredient: acephate 97%			24 hrs	21 days
ORTHENE 97 PE	Spray	12 oz/ac		
Active Ingredient: cyfluthrin 25%			12 hrs	up to harvest
R - BAYTHROID 2 EC	Spray	0.8 to 1.6 oz/ac		
Active Ingredient: cyhalothrin 22.8%			24 hrs	21 days
R - KARATE Z 2.08 CS	Spray	0.96 to 1.28 oz/ac		
Active Ingredient: cypermethrin 30.6%			12 hrs	14 days
R - AMMO 2.5 EC	Spray	1.3 to 5 oz/ac		
Active Ingredient: deltamethrin 16.6%			12 hrs	21 days
R - DECIS 1.5 EC	Spray	1.11 to 1.62 oz/ac		
Active Ingredient: esfenvalerate 8.4%			12 hrs	21 days
R - ASANA XL 0.66 EC	Spray	5.8 to 9.6 oz/ac		
Active Ingredient: tralomethrin 11.4%			24 hrs	28 days
R - SCOUT X-TRA 0.9 EC	Spray	2.28 to 2.84 oz/ac		
Active Ingredient: zetamethrin 18.1%			12 hrs	14 days
R - FURY 1.5 EC	Spray	1.4 to 2.0 oz/ac		

PLANT BUGS (COTTON FLEAHOPPER AND TARNISHED PLANT BUG)

Remarks:
Plant-bug injury to squares rarely causes economic problems in South Carolina. An economic problem could develop under the following conditions: an early maturing variety was planted late, an average of one plant bug was found/row ft using a beat cloth, and 25% or more of pinhead squares have been lost. The potential for damage will be greatest during the first 3 weeks of squaring. The pyrethroid insecticides will generally provide control of plant bugs when applied at bollworm control rates. Avoid applying insecticides to *Bt* cotton for plant bug control in June and early July because subsequent reductions in numbers of beneficials often trigger problems with bollworms, beet armyworms or fall armyworms. Plant bugs may also injure small bolls in the same manner as stink bugs. In situations where plant bugs, alone or in combination with stink bugs, are feeding on small bolls, use 15% injury to quarter-sized bolls as the treatment threshold.

Active Ingredient: acephate 97%			24 hrs	21 days
ORTHENE 97 PE	Spray	4 to 8 oz/ac		
Active Ingredient: chlorpyrifos 44.9%			24 hrs	14 days
LORSBAN 4 E	Spray	6 to 16 oz/ac		

PRODUCT NAME	QUALIFIERS	USE RATE	REI	PHI
Active Ingredient: dicrotophos 82%			48 hrs	30 days
R - BIDRIN 8 EC	Spray	4 to 8 oz/ac		
Active Ingredient: dimethoate 44.8%			48 hrs	14 days
DIMETHOATE 4 EC	Spray	8 oz/ac		
Active Ingredient: imidacloprid 40.7%			12 hrs	14 days
TRIMAX 4 F	Spray	1.5 oz/ac		
Active Ingredient: methyl parathion 43.4%			48 hrs	7 days
R - 4 EC	Spray	8 oz/ac		
Active Ingredient: thiamethoxam 25%			12 hrs	21 days
CENTRIC 25 WG	Spray	3 oz/ac		

SPIDER MITES

Remarks:
Mite infestations usually appear in border rows of a field, or sometimes in isolated spots within a field. Treating border rows, or spot treating, when mites first appear may prevent outbreaks.

Active Ingredient: bifenthrin 25.1%			12 hrs	14 days
R - CAPTURE 2 EC	Spray	3.8 to 6.4 oz/ac		
Active Ingredient: chlorpyrifos 44.9%			24 hrs	14 days
LORSBAN 4 E	Spray	16 oz/ac		
Active Ingredient: dicofol 42%			12 hrs	14 days
R - KELTHANE 4 MF	Spray	32 to 48 oz/ac		
Active Ingredient: dimethoate 44.8%			48 hrs	14 days
DIMETHOATE 4 EC	Spray	8 to 16 oz/ac		
Active Ingredient: fenpropathrin 30.9%			24 hrs	21 days
R - DANITOL 2.4 EC	Spray	10.6 to 16 oz		
Active Ingredient: profenofos 73%			48 hrs	14 days
R - CURACRON 8 E	Spray	8 to 16 oz/ac		
Active Ingredient: propargite 73.6%			7 days	50 days
R - COMITE 6.55 EC	Spray	16 to 32 oz/ac		

Remarks: Apply in 25-40 gallons water by ground or 5-15 by air.

STINK BUGS

Remarks:
Treat when 15% of small bolls are injured by stink bugs and adults and/or large nymphs (4th or 5th instars) are present. Begin scouting for stink bugs when small bolls appear. Randomly select 25 or more quarter-sized bolls per field. Break or cut each boll open and examine the carpal walls and seeds for injury symptoms. Stink bugs will produce warty growths or water-soaked puncture marks on the inner walls. There will also be shrunken seeds and lint will become discolored from the actions of microorganisms. Scouts may also rate infestations based upon numbers of stink bugs, by using a beat cloth or a beat pan. When this method is used, an insecticide treatment will be warranted for one or more stink bugs adults or large nymphs/6-row feet. When using a beat cloth,carefully approach and shake the plants on at least 30 feet of row (10, 3-foot samples). A large plastic pan (at least 10"wide x 12" long x 5" deep) may also be used as a sampling device. Just walk along a row of cotton beating the plants into the pan, at the rate of two beats per sample. Take 25 samples in four different locations in a field. In a field that is bordered by corn or thick stands of blackberry, wild cherry, or other host plants, be sure to take some samples in cotton rows bordering the potential trouble spots.

PRODUCT NAME	QUALIFIERS	USE RATE	REI	PHI
When cotton is being treated with pyrethroids for bollworm control, stink bugs may be controlled as well. **Be especially vigilant in fields where no treatments have been applied for budworm/bollworm control.**				
Active Ingredient: dicrotophos 82%			48 hrs	30 days
R - BIDRIN 8 EC	Spray	4 to 8 oz/ac		
Active Ingredient: methyl parathion 43.4%			48 hrs	7 days
R - 4 EC	Spray	16 to 32 oz/ac		
Active Ingredient: acephate 97%			24 hrs	21 days
ORTHENE 97 PE	Spray	12 oz/ac		
Active Ingredient: cyfluthrin 25%			12 hrs	24 days
R - BAYTHROID 2 EC	Spray	1.6 to 2.6 oz/ac		
Active Ingredient: cyhalothrin 22.8%			24 hrs	21 days
R - KARATE Z 2.08 CS	Spray	1.6 to 2.56 oz/ac		
Active Ingredient: deltamethrin 16.6%			12 hrs	21 days
R - DECIS 1.5 EC	Spray	1.62 to 2.56 oz/ac		
Active Ingredient: tralomethrin 11.4%			24 hrs	28 days
R - SCOUT X-TRA 0.9 EC	Spray	2.56 to 3.41 oz/ac		
Active Ingredient: zetamethrin 18.1 oz/ac			12 hrs	14 days
R - FURY 1.5 EC	Spray	2.8 to 3.8 oz/ac		
THRIPS - (ALSO APHIDS AND SPIDER MITES) GRANULAR TREATMENTS				
Active Ingredient: imidachloprid 15%			48 hrs	N/A
R - TEMIK 15 G	In furrow	3.5 to 5 lb.		
Remarks: The high rate of Temik will provide some suppression of nematodes.				
Active Ingredient: disulfoton 15%			48 hrs	N/A
R - DI-SYSTON 15 G	In furrow	4 lb/ac		
Active Ingredient: phorate 20%			48 hrs	N/A
R - THIMET 20 G	In furrow	2.5 lb/ac		
Remarks: Thimet and Di-Syston insecticides act as safeners for Command herbicide when applied at 0.75 lb ai/ac.				
THRIPS - SEED TREATMENTS				
Remarks: When cotton is planted after May 20, seed treatments have proven to be effective in limiting thrips damage to seedling cotton plants. Seed companies provide the following products as optional coatings on cotton seeds.				
Active Ingredient: imidachloprid 600 g/l			N/A	N/A
GAUCHO 600 FS	Seed treatment	6.4 oz/100 lbs seed		
Active Ingredient: thiamethoxam 47.6%			N/A	N/A
CRUISER 5 FS	Seed treatment	30 to 34 mg/seed		

PRODUCT NAME	QUALIFIERS	USE RATE	REI	PHI
THRIPS - FOLIAR SPRAYS				

Remarks:
Foliar treatments will be most effective when applied to cotton seedlings prior to unfolding of the second true leaf — at this growth stage a foliar insecticide treatment may be needed when one or more adult thrips are found per plant. Shake each plant (randomly select 25 or more) into a coffee cup or a similar utensil to facilitate counting. When most plants have severely damaged growing points and immature thrips are present, one or more foliar treatments may be needed to allow the plants to resume normal growth and development. Examine plants 5-7 days after the initial treatment and if immatures are still present on most plants treat again. When the newly unfolded leaves of infested plants are free of damage and plants appear to be growing at a normal rate, further applications of insecticides will have little benefit. Treatments applied beyond the four-leaf stage of growth may actually be counter productive. Subsequent reductions in numbers of beneficials could trigger infestations of budworms or bollworms.

Active Ingredient: acephate 97%			24 hrs	21 days
ORTHENE 97 PE	Spray	2.5 to 3.0 oz/ac		
Active Ingredient: dicrotophos 82%			48 hrs	30 days
R - BIDRIN 8 EC	Spray	1.6 to 3.2 oz/ac		
Active Ingredient: dimethoate 44.8%			48 hrs	N/A
DIMETHOATE 4 EC	Spray	4 to 8 oz/ac		
Active Ingredient: methamidophos 40%			48 hrs	N/A
R - MONITOR 4 EC	Spray	3.2 to 6.4 oz/ac		

Note:Generally a soil insecticide used at planting will protect seedling plants from the severe stunting that is characteristic of thrips injury. Occasionally, however, conditions will be unfavorable for proper uptake of the systemic insecticides (too cool, dry soil, excessive moisture, etc.) and plants may be severely damaged.

WHITEFLIES

Remarks:
Apply three applications at 5-day intervals. Begin treatment in fruiting cotton when 50% of plant terminals have whiteflies present in heavy clusters on the undersides of leaves and immatures are present. Treat mature cotton when clusters of whiteflies are present in terminals and bolls are opening. The following recommendation is for control of banded-wing whiteflies only.

Active Ingredient: acephate 97%			24 hrs	N/A
ORTHENE 97 P	Spray	8 to 16 oz/ac		
Active Ingredient: thiamethoxam 25%			12 hrs	21 days
CENTRIC 25 WG	Spray	3 oz/ac		

TREATMENT TIPS

- Scout your fields regularly to determine insect population levels and to time insecticide applications.
- Where control problems occur, first check your sprayer calibration and insecticide rates to ensure they are correct. *Be especially suspicious of high percentages of bollworms surviving multiple applications of pyrethroids*. Suspected resistance problems should be reported to County Agents immediately.
- Use moderate to high rates of pyrethroid insecticides; avoid low rates.
- Insecticides will be much more effective against bollworms when applied within the first 48 hrs after hatch-out.
- Use higher spray volumes during hot weather and when control of bollworms is difficult.
- Applying insecticides in oil may increase their effectiveness during unusually hot weather or during rainy weather.
- Hollow cone nozzles are superior to flat fan nozzles in getting good coverage of leaves and other plant parts. TX6's or TX8's provide excellent coverage at 7 to 10 gallons per acre and 60 psi.
- **CAUTION:** Pyrethroid labels carry a prohibition against spraying blooming cotton when bees are actively foraging.

Tank Mixing Guide

Insecticide	Pounds technical per gallon	Pounds Active ingredient per acre	Ounces of EC to use per acre	Acres covered per gallon of EC
amitraz OVASYN	1.5	0.125 to 0.25	10.7 to 21.3	12 to 6
bifenthrin CAPTURE	2.0	0.04 to 0.1	2.56 to 3.2	50 to 40
chlorpyrifos LORSBAN	4.0	0.5 to 1.0	16 to 32	8 to 4
cyfluthrin BAYTHROID	2.0	0.025 to 0.05	1.6 to 3.2	80 to 40
cyhalothrin KARATE Z	2.08	0.025 to 0.04	1.6 to 2.56	80 to 50
cypermethrin AMMO	2.5	0.05 to 0.08	2.6 to 4	49.2 to 32
deltamethrin DECIS	1.5	0.019 to 0.03	1.62 to 2.56	79 to 50
dicofol KELTHANE MF	4.0	1.0 to 1.5	32 to 48	4 to 2.7
dicrotophos BIDRIN	8.0	0.1 to 0.5	1.6 to 8	80 to 16
diflubenzuron DIMILIN	2.0	0.03 to 0.06	2 to 4	64 to 32
dimethoate DIMETHOATE	4.0	0.125 to 0.5	4 to 16	32 to 8
emamectin benzoate DENIM	0.16	0.01 to 0.015	8 to 12	16 to 10.7
esfenvalerate ASANA XL	0.66	0.03 to 0.05	5.8 to 9.6	22 to 13.3
fenpropathrin DANITOL	2.4	0.2 to 0.3	10.7 to 16	12 to 8
imidachloprid TRIMAX	4.0	0.03 to 0.047	1 to 1.5	128 to 85.3
indoxacarb STEWARD	1.25	0.09 to 0.11	9.2 to 11.3	13.9 to 11.3
methamidophos MONITOR	4.0	0.1 to 0.2	3.2 to 6.4	40 to 20
methoxyfenozide INTREPID	2.0	0.06 to 0.16	4 to 10	32 to 12.8
methyl parathion	4.0	0.25 to 1.0	8 to 32	16 to 4
oxydemeton-methyl METASYSTOX-R	2.0	0.125 to 0.25	8 to 16	16 to 8
profenofos CURACRON	8.0	0.5 to 1.0	8 to 16	16 to 8
propargite COMITE	6.55	0.82 to 1.64	16 to 32	8 to 4
spinosad TRACER	4.0	0.04 to 0.09	1.4 to 2.9	91.4 to 44.1
thiodicarb LARVIN	3.2	0.125 to 0.9	5 to 36	25.6 to 3.6
tralomethrin SCOUT X-TRA	0.9	0.15 to 0.023	2.13 to 3.33	60.1 to 38.4
zetamethrin MUSTANG MAX	0.8	0.0165 to 0.023	2.64 to 3.6	48.5 to 35.6
zetamethrin FURY	1.5	0.033 to 0.045	2.82 to 3.83	45.4 to 33.4

Prepared by Mitchell E. Roof, Extension Entomologist, and Michael Sullivan, Research Entomologist

Printed on recycled paper with soy ink