



IPM-0415

Cotton

Insect, Disease, Nematode, and Weed Control
Recommendations for 2017



INSECT CONTROL

Maximum profits in cotton production depend on an effective and economical insect management program. To plan such a program, you must know what insects are present and the amount of damage they are doing. The “tools of technology” available in managing cotton insects are cultural practices, the selective use of insecticides, insect scouting, transgenic varieties, and beneficial arthropods. The effectiveness of these tools can be maximized when they are used by all growers over a large area. Insect management does not mean reduction of the insect population to zero but merely to below the level of economic damage.

Cultural Practices

Certain production practices can have a significant effect on insect management and thus should be evaluated by considering the overall effect of the practice. For example, cotton grown under various conservation tillage methods may increase the likelihood of cutworm problems but may reduce thrips infestations. Any practice that delays fruiting or extends the fruiting period will increase the potential for damage by a variety of insects. High plant populations, excessive nitrogen rates, late planting, and excessive or careless herbicide use can all delay or extend the fruiting period. Generally, cultural practices that promote the health, vigor, and normal maturation of the cotton crop will benefit insect management.

Beneficial Arthropods

Parasites and predators are the first line of defense against bollworms, beet armyworms, and tobacco budworms. Predators such as nabids, big-eyed bugs, spiders, insidious flower bugs, green lacewings, and lady beetles are important regulators of caterpillars, particularly in early and mid season. Parasitic flies and wasps are less noticeable than are the predators, but their importance should not be underestimated. Cotton insecticides vary widely as to their toxicity toward beneficial arthropods and those characteristics should always be considered when choosing a product.

Selective Use of Insecticides

Selection of insecticides should be based on several factors; effectiveness in controlling target insects should not be the only consideration. Insects' potential to develop resistance, effects on beneficial arthropods and on other nontarget organisms, ease of application, human safety hazards, availability, and economic considerations are also important.

Apply insecticides only when the economic threshold level of the pest is reached. This can be determined only by thorough and regular scouting of the fields to obtain population densities of both destructive and beneficial insects. The use of scouting

and thresholds often reduces insecticide and application costs, lowers the amount of unnecessary insecticides in the environment, and helps maximize profits.

Insecticide Application

Proper timing and coverage of insecticide applications are extremely important. Only field scouting will enable you to time applications for best effectiveness. Good coverage using ground equipment usually involves applying 5 to 8 gallons of water per acre at 60 to 70 pounds per square inch. Keep nozzles clean and functioning correctly. Maintain appropriate boom height.

Fixed-wing aircraft used to apply insecticides should be equipped with standard nozzles or rotary atomizing devices that will deliver the majority of the insecticides in droplets within the range of 100 to 300 microns. Fly 5 to 10 feet above the crop for the most effective insecticide placement and least drift. Mix emulsifiable concentrates with water immediately before application and apply from 1 to 5 gallons of the insecticide-water mixture per acre. For mid- to late-season insect control, particularly “worms,” apply 3 to 5 gallons of total mixture per acre. Fly proper swath widths to obtain complete coverage of the field. Correct swath widths depend on the type aircraft used, weather, number and kind of insects present, and other factors.

Insect Pests of Cotton

Boll Weevils. The boll weevil has now been eradicated from the state. Therefore, neither economic weevil numbers nor damage should exist in any fields this year. However, reinfestations may occur from non-eradicated areas of the country. If weevil infestations are observed, they should be reported immediately to the local Boll Weevil Eradication Program.

Bollworms. Both the cotton bollworm and tobacco budworm can be devastating pests of cotton. Widespread problems with insecticide resistance, especially with pyrethroids, have occurred in the state. Planting transgenic cotton or using alternative insecticides will be necessary to control high levels of budworms in most areas. Cotton bollworms are capable of damaging both transgenic and conventional cotton varieties. Caterpillars reaching 0.25 inch or longer often survive on transgenic cotton. Escaped bollworms are usually found in the blooming zone of the plant in Bollgard II cotton. Some caterpillars may also be found in the upper part of plants containing Widestrike technology.

During periods of moth activity, monitor fields twice weekly. In previously untreated fields, apply a recommended larvicide when you find ten small larvae per 100 plants. In previously

treated fields, apply a recommended larvicide when you find five small larvae per 100 plants.

Spider Mites. In some areas of Alabama, spider mites cause severe damage. Normally, they cause more trouble during hot, dry weather. Spider mites feed on plant juices and cause leaves to become discolored. A heavy infestation can cause complete defoliation of cotton.

Planting behind a winter cereal cover crop, as opposed to fallow ground, reduces the risk of early mite infestations. Conservation tillage acreage containing winter weeds should be burned down well in advance of planting.

If damaging populations develop, make foliar applications of a recommended miticide. Two-spotted spider mites are notorious for developing resistance, and lasting control with any product is seldom achieved before mid-July. Excellent coverage is critical to mite control.

Fall Armyworms. Fall armyworms may cause economic damage to cotton in Alabama. Fall armyworms feed on and inside squares, blooms, and bolls in a manner similar to bollworms. The eggs are laid in masses of 150 or more on the undersides of leaves that are on the lower parts of the plants. The larvae are light green or cream colored at hatching but turn darker shades of brown, black, or green as they mature. Small larvae may have a characteristic black dot above and behind the third pair of true legs. Fall armyworm larvae usually have a light colored inverted Y-shape on their heads. The fall armyworm that attacks pastures, lawns, etc. is a different strain and does not damage cotton.

Beet Armyworms. The beet armyworm is a sporadic pest of cotton. The eggs are deposited in a fuzzy mass, usually on the bottom of leaves, and are similar to the egg masses of the fall armyworm. The newly hatched larvae feed en masse, skeletonizing leaves near the old egg mass. As they mature, they disperse, eating the fruit and foliage as they do. The beet armyworm will damage blooms, squares, and small bolls and even bore into the stalk. Beet armyworm infestations often begin along field edges or in skippy stands.

The larvae vary from pale to dark olive green, have dark stripes down their backs and pale stripes down each side, and reach a maximum length of 1 inch. A characteristic black spot is located above the second pair of thoracic (true) legs. The spot is often obscured by a dark lateral line. Take care not to confuse the beet armyworm with other armyworms that often possess an evident spot on the side of the first abdominal segment.

Cabbage and Soybean Loopers. Loopers are small, greenish, looping worms with white stripes down their backs. These worms feed on leaves, causing a ragged appearance. Loopers that occur in late season in high numbers are most likely the soybean looper. Begin control when worms are small if the top bolls expected for harvest are not mature. Late-season looper infestations are seldom widespread but may defoliate all cotton in a community when they occur.

Cutworms. There are several species of cutworms that attack seedling cotton. Use control measures where cotton stands are threatened. Cotton planted into weedy fields, cotton produced under various conservation tillage systems, and cotton produced on cool soils are more susceptible to cutworm infestation.

Cotton Aphids. Aphids may be numerous in cotton fields at any time during the growing season. They are usually found on the underside of leaves, on stems, and on terminals. Curling and yellowing of leaves indicate infestation. At-planting insecticides may aid in controlling aphids early in the season. Apply additional control measures when honeydew production is heavy. Aphid populations normally crash in July due to a naturally occurring fungus.

Grasshoppers. Grasshoppers have emerged as a pest of seedling cotton in recent years, primarily in conservation tillage systems. They chew the main stem of young plants, causing a reduction in stands. Cotton is most susceptible to grasshopper injury from the time it begins to emerge in the “crook stage” until the plants have about six true leaves. Both the immature and the adult stages may cause injury. Controls are warranted when stands are threatened.

Thrips. Thrips feed on the young leaves and buds and stunt the growth of seedling cotton. A common sign of a heavy thrips infestation is distorted leaves that have turned brownish around the edges and cup upward. Control of thrips increases yields and generally results in earlier maturity.

Plant Bugs and Fleahoppers. Plant bugs and fleahoppers migrate to cotton from weeds and various legumes. In prebloom cotton, both adults and nymphs feed on tiny squares, causing them to turn black. These insects are usually found in terminals and move quickly about the plant or fly when disturbed. Make one or more applications during the first 2 weeks of squaring when drop cloth samples yield 1 plant bug per 6 row feet or sweep net samples detect 8 bugs per 100 sweeps. During the third week of squaring through bloom, treat when drop cloth samples collect 3 bugs per 6 row feet or sweep net samples detect 15 bugs per 100 sweeps. Do not allow square retention to drop below 80 percent due to plant bug feeding. Check plants by shaking terminals over a sweep net or drop cloth prior to first bloom. Sampling techniques are not adequate when the majority of the plant bug population is in the adult stage.

Plant bugs can also be a problem in blooming cotton (July-August). At this point of the season, a large portion of the plant bug population is nymphs, and large squares and young bolls are damaged in addition to the small squares. Plant bug damage to young bolls results in “hard-locking” of one or more locks per boll. Damage to large squares is revealed as “dirty blooms,” which show necrotic flower parts and warty petals caused when the bugs feed on large squares.

Controlling plant bugs in blooming cotton generally is warranted when 15 to 20 percent of bolls the diameter of a quarter reveal internal plant bug damage.

Whiteflies. Whiteflies damage cotton by sucking sap from plants and by secreting honeydew on which sooty mold grows and stains the lint. Heavy whitefly feeding reduces plant vigor, causes premature defoliation, and reduces yield. All whitefly stages are found on the undersurface of cotton leaves. The tiny, white, gnat-like adults lay small eggs that hatch into immature whiteflies, which soon resemble scale insects.

Historically, the banded-wing whitefly is the species that has been present in Alabama. A new species, the silverleaf whitefly, has now been identified in Baldwin, Mobile, and Houston

counties. It is much more difficult to control with insecticides. The adult banded-winged whitefly has faint but visible grayish zigzag bands on the wings; the silverleaf whitefly is solid white.

Stink Bugs (Various species). Three main species occur on cotton—the green stink bug, the southern green stink bug, and the brown stink bug. A new invasive species, the brown marmorated stink bug, has been found in 22 north Alabama counties and the population is slowly increasing. Stink bugs are shield-shaped, about one-half inch long, and have sucking mouthparts.

The southern green stink bug adults are green, and the nymphal stage has white spots on the back or abdomen. The green stink bug is also green, but the nymphal stage has a striped abdomen. The brown stink bug closely resembles another predaceous stink bug, the spined soldier bug, but can be distinguished from it by the very sharply pointed “shoulders” on the spined soldier bug. Markings unique to the brown marmorated stink bug include light bands on the antennae and alternating dark bands on the thin outer edge of the abdomen. Stink bug eggs are barrel-shaped and metallic-colored and are deposited in a regular cluster on foliage. The leaf footed bug may be a part of the boll feeding bug complex, especially in the southern part of Alabama.

Stink bugs overwinter as adults in a variety of habitats, such as leaf litter, tree holes, and fields. Their primary host crops in Alabama are corn, wheat, soybeans, and peanuts. Cotton grown near corn or peanuts may be at a greater risk for stink bug infestations and damage. The egg stage lasts about four days, the nymphs develop over 33 days, and the adults live up to 58 days.

Stink bugs damage cotton by feeding on developing seeds within the bolls. Damaged bolls may or may not have a small black spot on the outside. To be certain whether bolls are damaged or not requires an internal examination. Seeds usually turn brown from their feeding and a warty growth is often

present where the carpel wall was penetrated.

Stink bug damage is generally warranted when 15 to 20 percent of the quarter-sized bolls reveal damage.

Precautions and General Restrictions.

Read the label before using any insecticide to prevent misuse. When applying insecticides, change clothes at least once a day. If spray concentrates come in contact with your skin or clothing, remove the clothing immediately and wash your skin with soap and water. For field re-entry intervals, refer to the insecticide label or consult your county agent.

Restricted Use Pesticides. Your county Extension office has the necessary forms and information concerning all Restricted Use pesticides. Permits to use Restricted Use insecticides will be issued only by the State Department of Agriculture and Industries, Montgomery, Alabama.

Premixes/Combination Packages

Multiple insecticide active ingredients are being combined into single products, presumably to increase the number of pest species controlled or to address resistance issues. (See Table 2.) Premixes may be useful to insect management programs, but also may encourage the unnecessary use of some ingredients or encourage their use at less than optimum rates. Unnecessary applications or applications of reduced rates may lead to the development of insecticide resistance and flare untargeted pest species. Be sure the use of all active ingredients is warranted and that proper rates are being delivered.

Effectiveness of Insecticides and Transgenic Cotton on Target Pests

The insecticide ratings found in Tables 4 and 5 are based on research across the Cotton Belt and in field experiences by entomologists. Ratings should be considered only general guidelines for comparison purposes. Insecticide ratings assume standard rates, good timing, thorough coverage, no wash off, etc.

Table 1. Cotton Insect Control

Insecticide and Formulation	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest	Comments
BEET ARMYWORMS				
chlorantraniliprole CORAGEN 1.67 SC	5–7 oz.	0.065–0.09	21	
PREVATHON 0.43 SC	14–27 oz.	0.047–0.09	21	
emamectin benzoate DENIM 0.16EC	6–8 oz.	0.0075–0.01	21	
indoxacarb STEWARD 1.25EC	9.2–11.3 oz.	0.09–0.11	14	
methoxyfenozide INTREPID 2F	4–10 oz.	0.06–0.16	14	
spinosad BLACKHAWK	2.4–3.2 oz.	0.054–0.072	28	
methoxyfenozide + spinetoram INTREPID EDGE	4–8 oz.	0.09–0.187	28	

Table 1. Cotton Insect Control (cont.)				
Insecticide and Formulation	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest	Comments
BOLLWORMS/TOBACCO BUDWORMS				
Seed				
Bt transgenic cotton BOLLGARD II TWINLINK WIDESTRIKE WIDESTRIKE 3				See Table 4 for activity against all caterpillar pests.
Bollworms: Larvicides				
alpha-cypermethrin FASTAC EC	2.6–3.6 oz.	0.017–0.023	14	In previously untreated fields where beneficials are present, apply when ten small larvae (0.25 inch) per 100 plants are found. In previously treated fields where beneficials are low or absent, apply when five small larvae per 100 plants are found. Isolated problems with pyrethroid resistance have been reported throughout the eastern United States.
beta-cyfluthrin BAYTHROID XL 1EC Other brand names (See label.)	1.6–2.6 oz.	0.0125– 0.0205	0	
bifenthrin BRIGADE 2EC Other brand names (See label.)	4–6.4 oz.	0.06–0.1	14	
chlorantraniliprole CORAGEN 1.67SC PREVATHON 0.43SC	5–7 oz. 14–27 oz.	0.065–0.09 0.047–0.09	21 21	
cypermethrin AMMO 2.5EC Other brand names (See label.)	2–5 oz.	0.04–0.1	14	
esfenvalerate ASANA XL 0.66EC	5.8–9.6 oz.	0.03–0.05	21	
gamma-cyhalothrin PROLEX 1.25EC Other brand names (See label.)	1.3–2.0 oz.	0.0125–0.02	21	
indoxacarb STEWARD 1.25EC	11.3 oz.	0.11	14	
lambda-cyhalothrin KARATE Z 2.08CS Other brand names (See label.)	1.6–2.56 oz.	0.025–0.04	21	
methomyl LANNATE 2.4 LV	1.5–2 pt.	0.45	15	
spinosad BLACKHAWK	2.4–3.2 oz.	0.054–0.072	28	
zeta-cypermethrin MUSTANG MAX 0.8EC	2.64–3.6 oz.	0.017–0.022	14	

Table 1. Cotton Insect Control (cont.)				
Insecticide and Formulation	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest	Comments
BOLLWORMS/TOBACCO BUDWORMS (cont.)				
Tobacco Budworms: Larvicides				
chlorantraniliprole CORAGEN 1.67SC	5–7 oz.	0.065–0.09	21	<i>In previously untreated fields where beneficials are present</i> , apply when ten small larvae (0.25 inch) per 100 plants are found. <i>In previously treated fields where beneficials are absent</i> , apply when five small larvae per 100 plants are found. Tobacco budworms have proven to be more difficult to control with most insecticides (see Table 4). Minimum rates of the recommended insecticides may not be effective against larger larvae or under high pressure. Rates should be adjusted according to the size of the larvae and the level of infestation. Methomyl may be used as an ovicide to control the egg stage at rates of 0.125 to 0.25 pound active ingredient per acre.
PREVATHON 0.43SC	14–27 oz.	0.047–0.09	21	
indoxacarb STEWARD 1.25EC	11.3 oz.	0.11	14	
methomyl LANNATE 2.4 LV	1.5 pt.	0.45	15	
spinosad BLACKHAWK	1.6–3.2 oz.	0.036–0.072	28	
COTTON APHIDS				
acetamiprid INTRUDER 70WP	0.6–1.1 oz.	0.025–0.05	28	Apply when leaves appear sticky. Make one application; repeat when necessary. At-planting treatments may also give effective early-season control (see Seedling Thrips). Aphids are resistant to many insecticides. Control may vary with location and time of season. Additional applications of the same chemicals are usually ineffective. Check registration status of Transform WG prior to use.
flonicamid CARBINE 50 WG	1.4–2.8 oz.	0.044–0.088	30	
imidacloprid ADMIRE PRO 4.6	0.9–1.7 oz.	0.032–0.061	14	
sulfoxaflor TRANSFORM WG (see comments)	0.75 oz.	0.023	14	
thiamethoxam CENTRIC 40WG	2 oz.	0.05	21	
CUTWORMS				
acephate ORTHENE 97	0.75 lb.	0.72	21	Apply when worms appear and stands are threatened; cover plants and surfaces of ground along rows with insecticide. Preplant or at-plant applications have been successful for high-risk fields.
ORTHENE 90	0.80 lb.	0.72	21	
alpha-cypermethrin FASTAC EC	1.3–1.9 oz.	0.008–0.012	14	
beta-cyfluthrin BAYTHROID XL 1EC	0.8–1.6 oz.	0.0065–0.125	0	
Other brand names (See label.)				
chlorpyrifos LORSBAN 4E	1 qt.	1	14	
Other brand names (See label.)				
cypermethrin AMMO 2.5EC	1.3–5 oz.	0.025–0.1	14	
Other brand names (See label.)				
esfenvalerate ASANA SL 0.66EC	5.8 oz.	0.03	21	
gamma-cyhalothrin PROLEX 1.25EC	0.77–1.0 oz.	0.0075–0.01	21	
lambda cyhalothrin KARATE Z 2.08CS	0.96–1.28 oz.	0.015–0.02	21	
Other brand names (See label.)				
zeta-cypermethrin MUSTANG MAX 0.8EC	1.3–2 oz.	0.008–0.012	14	

Table 1. Cotton Insect Control (cont.)				
Insecticide and Formulation	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest	Comments
FALL ARMYWORMS				
chlorantraniliprole CORAGEN 1.67SC	5–7 oz.	0.065–0.09	21	Apply when ten or more larvae per 100 plants are found.
PREVATHON 0.43SC	14–27 oz.	0.047–0.09	21	
indoxacarb STEWARD 1.25EC	9.2–11.3 oz.	0.09–0.11	14	
novaluron DIAMOND 0.83EC	6–12 oz.	0.39–0.77	30	
spinosad BLACKHAWK	2.4–3.2 oz.	0.054–0.072	28	
GRASSHOPPERS				
chlorpyrifos LORSBAN 4E Other brand names (See label.)	0.5–1.5 pt.	0.25–0.75	14	Lower rates may be used to control immature grasshoppers early in the spring (March, April). However, the highest suggested rates will be needed on the adult stage in May and June. Reinfestations may occur from field borders if the first application is made prior to planting. Under these conditions, a second application may be necessary if cotton is still younger than the sixth true leaf stage. Dimilin is an insect growth regulator and is only effective on nymphs.
dicrotophos BIDRIN 8EC	4–8 oz.	0.25–0.5	10	
diflubenzuron DIMILIN 2L	2 oz.	0.03	—	
pyrethroids	See label..	See Table 3.		
PLANT BUGS, FLEAHOPPERS				
acephate ORTHENE 90SP	0.37–0.55 lb.	0.33–0.5	21	Do not allow pinhead square retention to drop below 80 percent due to plant bug feeding. During the first 2 weeks of squaring, treat when drop cloth samples yield 1 plant bug per 6 row feet or sweep net sampling detects 8 bugs per 100 sweeps. During the third week of squaring through bloom, treat when drop cloth samples detect 3 bugs per 6 row feet or sweep net samples collect 15 bugs per 100 sweeps. No threshold exists for percent dirty blooms, but if you find 10 to 15 percent dirty blooms, intensify scouting plant for bugs. During peak bloom and beyond, applications should be made when 15 percent of the bolls have damage and plant bugs are present. Diamond is an insect growth regulator and is only active on the immature stage of plant bugs. Use of Bidrin between pinhead square and first bloom is prohibited.
ORTHENE 97 Other brand names (See label.)	0.35–0.55 lb.	0.33–0.53	21	
acetamiprid INTRUDER 70WP	1.1 oz.	0.05	28	
chlorpyrifos LORSBAN 4E Other brand names (See label.)	16 oz.	0.5	14	
clothianidin BELAY	3–6 fl.oz.	0.05–0.1	21	
dicrotophos BIDRIN 8EC	3.2–5.3 oz.	0.2–0.33	10	
flonicamid CARBINE	2.8 oz.	0.088	30	
imidacloprid ADMIRE PRO 4.6 Other brand names (See label.)	1.37–1.7 oz.	0.049–0.061	14	
methomyl LANNATE 2.4 LV	13 oz.	0.25	15	
novaluron DIAMOND 0.83EC	6–9 oz.	0.39–0.58	30	
oxamyl VYDATE C-LV 3.77	11.2–17 oz.	0.33–0.5	14	

Table 1. Cotton Insect Control (cont.)				
Insecticide and Formulation	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest	Comments
PLANT BUGS, FLEAHOPPERS (cont.)				
pyrethroids sulfoxaflor TRANSFORM WG (see comments)	See label. (See comments.) 1.5 oz.	See Table 3. 0.047	14	Research has shown that pyrethroids have not provided adequate control of plant bugs in most of north Alabama. Check registration status of Transform WG prior to use.
thiamethoxam CENTRIC 40WG	2 oz.	0.05	21	
SEEDLING THRIPS				
Foliar Treatment				
acephate ORTHENE 90SP ORTHENE 97 Other brand names (See label.)	3.2 oz. 3 oz.	0.18 0.18	21 21	Make one or more applications to seedling cotton (one- to four-leaf stage) when damage is evident and early crop maturity is important. If western flower thrips are present, higher rates will be necessary for control. See recommendations listed under western flower thrips. Radiant provides suppression; it must be used with an adjuvant.
dicrotophos BIDRIN 8EC	1.6–3.2 oz.	0.2	10	
dimethoate 4E Other brand names (See label.)	6.4 oz.	0.2	14	
spinetoram RADIANT SC	1.5–3 oz.	0.012–0.023	28	
thiamethoxam CENTRIC 40WG	2 oz.	0.05	21	
In-Furrow Liquid Treatment				
acephate ORTHENE 90SP ORTHENE 97 Other brand names (See label.)	1 lb. 1 lb.	0.9 0.97	21 21	Both Orthene and Admire Pro in-furrow sprays may be applied with a liquid fungicide at planting directed on or below the seed. Admire Pro rate depends on row spacing.
imidacloprid ADMIRE PRO 4.6	7.4–9.2 oz.	0.266–0.33	21	
Seed Treatment				
imidacloprid GAUCHO 600 AERIS	See label.			
thiamethoxam CRUISER AVICTA	See label.			
SOYBEAN LOOPERS				
chlorantraniliprole CORAGEN 1.67SC PREVATHON 0.43SC	5–7.5 oz. 20–29 oz.	0.065–0.098 0.067–0.097	21 21	Treat when four to five loopers per row foot are present and the top bolls expected for harvest are not mature. Populations of soybean loopers are resistant to pyrethroid insecticides.
emamectin benzoate DENIM 0.16EC	8–12 oz.	0.01–0.015	21	
indoxacarb STEWARD 1.25EC	6.7–9.2 oz.	0.065–0.09	14	
methoxyfenozide INTREPID 2F	4–10 oz.	0.06–0.16	14	
spinosad BLACKHAWK	2.4–3.2 oz.	0.054–0.072	28	
methoxyfenozide + spinetoram INTREPID EDGE	4–8 oz.	0.09–0.187	28	

Table 1. Cotton Insect Control (cont.)				
Insecticide and Formulation	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest	Comments
SPIDER MITES				
abamectin AGRI-MEK 0.15EC Other brand names (See label.)	8–16 oz.	0.009–0.018	20	Foliar Treatment: Control of spider mites on rapidly growing cotton is difficult. Treat fields when mites are widely distributed and mottling of leaves is common. Hot, dry weather favors spider mite population increase. Bifenthrin is recommended for use only in late season. When using bifenthrin, you will often need to repeat applications on a 5- to 7-day interval.
bifenthrin BRIGADE 2 EC (See comments.)	6.4 oz.	0.1	14	
etoxazole ZEAL	0.66–1 oz.	0.03–0.45	28	
fenpyroximate PORTAL 0.4	12–16 oz. (early season) 24–32 oz. (mid-season)	0.0375–0.05	14	
spiromesifen OBERON 2SC	8–16 oz.	0.125–0.25	30	
BROWN STINK BUGS, LEAF FOOTED BUGS				
acephate ORTHENE 90S ORTHENE 97	0.8 lb. 0.75 lb.	0.72 0.72	21 21	The boll injury threshold should be adjusted up or down based on the number of susceptible bolls present. Use a 10 to 15 percent boll injury threshold during weeks 3 to 5 of bloom (numerous susceptible bolls present), 20 percent injury during weeks 2 and 6, and 30+ percent during weeks 7+ of bloom (fewer susceptible bolls present).
dicrotophos BIDRIN 8EC	6–8 oz.	0.375–0.5	10	
BROWN MARMORATED, GREEN AND SOUTHERN GREEN STINK BUGS				
Organophosphates				
acephate ORTHENE 90S ORTHENE 97	0.8 lb. 0.75 lb.	0.72 0.72	21 21	Use same thresholds as for brown stink bugs. Brown marmorated stink bugs can damage larger bolls than other stink bugs.
dicrotophos BIDRIN 8EC	4–8 oz.	0.25–0.5	10	
Pyrethroids				
beta-cyfluthrin BAYTHROID XL1 Other brand names (See label.)	2.13–2.6 oz.	0.0166– 0.0205	0	
bifenthrin BRIGADE 2EC Other brand names (See label.)	4–6.4 oz.	0.06–0.1	14	
cypermethrin AMMO 2.5EC Other brand names (See label.)	3.1–5 oz.	0.06–0.1	14	
esfenvalerate ASANA SL 0.66EC	7.5–9.6 oz.	0.04–0.05	21	
gamma-cyhalothrin PROLEX 1.25EC	1.3–2 oz.	0.0125–0.02	21	
lambda-cyhalothrin KARATE Z 2.08CS Other brand names (See label.)	1.8–2.56 oz.	0.03–0.04	21	
zeta-cypermethrin MUSTANG MAX 0.8EC	2.6–3.6 oz.	0.0165–0.022	14	

Table 1. Cotton Insect Control (cont.)				
Insecticide and Formulation	Amount of Formulation per Acre	Lb. Active Ingredient per Acre	Minimum Days from Last Application to Harvest	Comments
WESTERN FLOWER THRIPS				
acephate ORTHENE 90SP ORTHENE 97 Other brand names (See label.)	0.6–0.83 lb. 0.52–0.77 lb.	0.5–0.75 0.5–0.75	21 21	Economic thresholds are not well defined. To suppress, make two applications at 5- to 7-day intervals.
spinetoram RADIANT	3 oz.	0.023	28	Use of an adjuvant with Radiant is recommended.
WHITEFLIES (BANDEDWING)				
acephate ORTHENE 90SP ORTHENE 97 Other brand names (See label.)	0.6–1 lb. 0.52–1 lb.	0.5–1 0.5–1	21 21	For actively growing cotton, apply when 50 percent of plant terminals have adults clustering on them. It may be necessary to apply more than once to control infestation. For mature or stressed cotton or cotton not growing, apply when honeydew or sooty mold appears on leaves, usually in late season. Make two or three applications 5 days apart.
acetamiprid INTRUDER 70WP	1.7–2.3 oz.	0.075–0.1	28	
imidacloprid ADMIRE PRO 4.6	0.9–1.7 oz.	0.032–0.061	14	
thiamethoxam CENTRIC 40WG	2 oz.	0.05	21	
WHITEFLIES (SILVERLEAF)				
acetamiprid INTRUDER 70WP	1.7–2.3 oz.	0.075–0.1	28	The insect growth regulator Knack is the most consistent treatment for management of silverleaf whiteflies. Knack has a long residual (several weeks) and is generally slow acting. When females feed on foliage treated with Knack, eggs will be sterile. Knack will control the immature stage as they pupate into adults; therefore, established nymphs will continue feeding for several days. Threshold: When five immature whiteflies are found in an area the size of a nickle on the underside of the leaf surface.
buprofezin COURIER 40SC	9–12.5 oz.	0.25–0.35	14	
dinotefuran VENOM 70WDG	1–3 oz.	0.045–0.134		
pyriproxifen KNACK 0.86EC	8–10 oz.	0.054–0.067	28	

Table 2. Premix/Combination Packages

Premix/combination insecticide packages are available and include the following: (See page 3 for more detailed information about premix/combination insecticide packages.)	
avermectin B1 + bifenthrin (ATHENA)	flubendiamide + buprofexin (TOURISMO)
bifenthrin + zeta-cymethrin (HERO)	imidacloprid + bifenthrin (BRIGADIER)
chlorantraniliprole + lambda-cyhalothrin (BESIEGE)	imidacloprid + cyfluthrin (LEVERAGE 2.7)
chlorpyrifos + gamma-cyhalothrin (COBALT)	imidacloprid + beta-cyfluthrin (LEVERAGE 360)
chlorpyrifos + lambda-cyhalothrin (COBALT ADVANCED)	methoxyfenozide + spinetoram (Intrepid Edge)
dicrotophos + bifenthrin (BIDRIN XP II)	spinosad + gamma-cyhalothrin (CONSERO)
diflubenzuron + lambda-cyhalothrin (DoubleTake)	thiamethoxam + lambda-cyhalothrin (ENDIGO)

Table 3. Pyrethroid Rates for Cotton in Pounds Active per Acre, Acres per Gallon, and Ounces per Acre

Materials and Formulation	Pounds Active per Acre, (Acres per Gallon), [Ounces per Acre]		
	Low	Medium	High
Ambush 2	0.1 (20) [6.4]	0.15 (13) [9.6]	0.2 (10) [12.8]
Ammo 2.5	0.04 (63) [2] – 0.05 (50) [2.6]	0.06 (42) [3.1]	0.08 (31) [4]
Asana 0.66	0.02 (33) [3.9] – 0.03 (22) [5.8]	0.04 (17) [7.5]	0.05 (13) [9.7]
Baythroid XL	0.0125 (80) [1.6] – 0.014 (71) [1.8]	0.0166 (60) [2.13]	0.0205 (49) [2.6]
Brigade 2	0.04 (50) [2.6] – 0.05 (40) [3.2]	0.06 (33) [3.9]	0.08 (25) [5.1]
Decis 1.5	0.019 (79) [1.6]	0.025 (60) [2.1]	0.03 (50) [2.6]
Karate 2.08	0.015 (140) [1]	0.03 (69) [1.8]	0.04 (52) [2.6]
Mustang Max 0.8	0.008 (100) [1.3]	0.0165 (50) [2.6]	0.022 (36) [3.6]
Pounce 3.2	0.1 (32) [4]	0.15 (21) [6]	0.2 (16) [8]
Prolex 1.25	0.0075 (167)[0.77]	0.0125 (100) [1.3]	0.02 (62) [2.0]

Table 4. Transgenic Technology Ratings*

TRANSGENIC TECHNOLOGY	INSECTS							
	Beet Armyworm	Cotton Bollworm	Cutworm	European Corn Borer	Fall Armyworm	Loopers	Southern Armyworm	Tobacco Budworm
Bollgard**	3	2	5	1	4	5	5	1
Bollgard II	1	1	4	1	2	1–2	1	1
TwinLink	1	1	?	1	1	1	1	1
WideStrike	1	2	4	1	1–2	1	1	1
WideStrike3	1	1	?	1	1	1	1	1

* Ratings range from 1-5. 1 = Very Effective; 5 = Not Effective.

** Bollgard technology is no longer registered; it is listed as a reference only.

Some variation in the expression of Bt proteins can be caused by environmental conditions, time of season, and cultivar.

Table 5. Insecticide Effectiveness Ratings*

INSECTICIDES	INSECTS						
	Aphids	Beet Armyworms	Beneficial Insects**	Boll Weevils	Bollworms	Budworms	Fall Armyworms
Altacor	5	1	4	5	1	1	2
Ammo	4	5	1	1-2	1	3	3
Asana XL	4	5	1	2	1	3	3
Baythroid XL	4	5	1	1-2	1	3	3
Belay	—	5	—	—	5	5	5
Belt	5	1	4	5	2	1	2
Bidrin	3	5	1	3	5	5	5
Blackhawk	5	1	5	5	1-2	1	1-2
Brigade	3	5	1	1	1	3	2
Carbine	1-2	5	3	5	5	5	5
Centric	1-2	5	2	5	5	5	5
Decis	4	5	1	2	1	3	2
Denim	5	1	4	5	3	3	2
Diamond	5	2-3	3	4	4	4	2
Dimilin	5	3	5	4	5	5	3
Intrepid	5	1	5	5	3	3	2
Intruder	1	5	3	5	5	5	5
Karate	4	5	1	1-2	1	3	2
Knack	2	5	3	5	5	5	5
Lannate	4	3-4	3	5	2	2	2
Larvin	5	2	3	5	2	2	2
Lorsban	4	2	2-3	3	3	4	2
Malathion	5	5	1	1	5	5	5
Monitor	5	5	1	5	5	5	5
Mustang Max	4	5	1	1-2	1	3	2
Orthene	5	4-5	1	5	3	3-4	4
Penncap M	4	5	3	1	3	5	4
Prevathon	5	1	5	5	1	1	1
Prolex	4	5	1	1-2	1	3	2
Radiant	5	5	5	5	—	—	—
Steward	5	1	4	5	2	1	2
Tracer	5	1	4	5	2	1	2
Transform	1	5	5	5	5	5	5
Trimax Pro	1-2	5	3	5	5	5	5
Venom	—	5	—	5	5	5	5
Vydate	5	5	2	3	5	5	5

continued

*Ratings range from 1 - 5: 1 = Very Effective; 5 = Not Effective.

**A rating of 1 on beneficial insects means the chemical is very hard on beneficials; a rating of 5 indicates selectivity toward beneficials.

Table 5. Insecticide Effectiveness Ratings* (cont.)

INSECTICIDES	INSECTS						
	Plant Bugs**	Seedling Thrips	Soybean Loopers	Spider Mites	Stink Bugs (Brown)	Stink Bugs (Green)	Whiteflies
Altacor	5	5	2	5	5	5	5
Ammo	2-5	3	3	5	4	2	4
Asana XL	2-5	3	4	5	4	2	4
Baythroid XL	2-5	3	4	5	4	2	4
Belay	2	—	4	—	3	3	—
Belt	5	5	1	5	5	5	5
Bidrin	1	1	5	4	1	1	4
Blackhawk	5	5	1	5	5	5	5
Brigade	2-5	3	4	3	3	2	4
Carbine	2-3	2-3	5	5	—	—	—
Centric	2	1	5	5	2-3	2-3	2
Curacron	3	3	3	2	3	3	4
Decis	2-5	3	3	5	4	2	4
Denim	4	5	1	3	5	5	5
Diamond	2	5	2	5	2-3	2-3	5
Dimilin	5	5	4	5	5	5	5
Intrepid	5	5	1	5	5	5	5
Intruder	2-3	1-2	5	—	3	3	1-2
Karate 1 EC	2-5	3	4	5	4	2	4
Karate 2.08 Z	2-5	5	4	5	4	2	4
Knack	4	3-4	5	3	4	4	1
Lannate	3	5	3	5	4	4	5
Lorsban	2	2	4	3	3	3	4
Malathion	1	4	5	5	1	1	5
Monitor	2	2	5	5	4	4	2
Mustang Max	2-5	3	3	5	4	2	4
Orthene	1	1-2	3	5	2	2	2
Penncap M	3	4	4	5	1	1	4
Prevathon	5	—	1	—	5	5	—
Prolex	2-5	3	3	5	4	2	4
Radiant	5	1	—	5	5	5	5
Steward	3	5	1	5	3	3	5
Tracer	5	5	1	5	5	5	5
Transform	1	?	5	5	5	4	3
Trimax Pro	2-3	2	5	5	4	4	2
Venom	—	—	5	—	5	5	1
Vydate	3	3	5	5	2	2-3	4
Warrior II Z	2-5	5	4	5	4	2	4

*Ratings range from 1-5: 1 = Very Effective; 5 = Not Effective.

**Pyrethroids have not been effective in controlling plant bugs in most of north Alabama.

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DISEASE CONTROL

Control of Cotton Seedling Disease

Seedling disease is one of the major problems on cotton in Alabama. Losses range from less than 1 percent in some years up to 20 percent in others, depending on such factors as the condition of the soil at planting, seed quality, seed treatment, chemicals, nematode and insect populations, and climatic conditions. These adverse factors favor seedling disease by retarding seed germination and seedling growth and allowing fungal pathogens to overcome the plant's defenses. Vigorous, fast-growing seedlings can usually outgrow damage resulting from invasion by fungi. Planting too early in cold, wet soils is probably the one factor that is most responsible for making seedlings susceptible to seedling diseases.

In Alabama, the fungi most often implicated in seedling disease are *Rhizoctonia solani*, *Pythium* spp., *Fusarium* spp., and *Thielaviopsis basicola*. These fungi, along with several other pathogens of minor importance, usually attack cotton at any time during the first 6 to 8 weeks after planting.

For ease of identification, cotton seedling diseases are placed into the following three categories.

Seed Rot. *Pythium* and *Fusarium* attack cotton seed before or during germination, causing a soft, watery decay. These fungi spread rapidly from seed to seed.

Preemergence Damping-Off. This stage occurs between seed germination and emergence of seedlings from the soil. The newly formed root or stem may become infected, causing the seedlings to die before they emerge from the soil.

Seedling Root Rots and Postemergence Damping-Off. Symptoms occur on the root or hypocotyl after the seedlings have emerged from the soil. Plants may first appear stunted and light green, and as the disease progresses, plants will wilt and die. A close examination of the affected seedlings will reveal varying symptoms depending upon the organisms involved in the disease.

Fusarium and *Thielaviopsis* cause a dry, dark rot that progresses up the root into the stem. *Pythium* is characterized by a light, soft, watery decay of the tap root and is particularly severe in cool, wet weather. *Rhizoctonia* usually attacks the plant at soil level, causing reddish brown lesions (soreshin). It eventually moves into the stem tissue, giving the stem a "wirestem" appearance. In the advanced stage, stems fall over and die, leaving an uneven stand.

Seedling Disease Control Recommendations

The incidence of seedling disease can be reduced by the following practices.

Plant on Well-Prepared Seedbeds and in Well-Drained Soils. Wet soils favor the growth of many soil fungi and retard or slow the growth of cotton seedlings.

Plant in Warm Soil. Plant when the soil temperature at a 4-inch depth remains at least 65°F for three consecutive mornings. AVOID planting when soil temperatures are expected to drop below 50°F at anytime one week following planting. Germinating seed are extremely susceptible to chill injury, which occurs below 50°F, and may be killed outright or badly damaged. Remember, the warmer the soils, the less chance for seedling disease.

Lime Acid Soils. Apply lime as recommended by the Soil Testing Laboratory. Acid soil favors the development of seedling disease by restricting seedling growth and favoring the development of seedling disease-inciting fungi in the soil.

Avoid Chemical or Mechanical Injury. Excessive rates of herbicides, fertilizers, insecticides, or fungicides applied in the drill area can injure seedlings, making them more susceptible to seedling disease. Using high rates of dinitroaniline herbicides or incorporating them too deeply can inhibit root growth and increase seedling disease.

Plant High-Quality Seed. Poor-quality seed usually produces low-vigor seedlings which are more susceptible to attack by fungi that can cause seedling disease. Plant seed with a minimum of 80-percent germination.

Plant Only Treated Seed. Seed treatment will kill most fungal pathogens on the seed coat and protect the seed during germination (see Seed Treatment, below).

Use Soil Fungicides at Planting Time. These fungicides give added protection in areas where there is a history of seedling disease (see Soil Treatment, below).

Chemical Controls

Seed Treatment. Two or more fungicides must be applied to cotton seed in order to control the fungi species in the soil that cause seedling disease. For example, PCNB, Thiram, or Vitavax are active against *Rhizoctonia solani* and *Fusarium* spp. but not against *Pythium* spp., whereas Metalzxy®[®], Anchor®, and Apron XL® are primarily active against *Pythium* spp., Acceleron®, and Dividend® are active against a wide range of soilborne diseases.

Soil Treatment. Soil treatment is not intended to replace seed treatment; it is used as a supplement.

In-the-furrow granules provide additional protection against pathogenic fungi in the soil as seedlings develop. They can be applied with granular applicators, thus eliminating the need for additional spray equipment and water. For the most effective control with granular fungicides, proper granule placement and soil incorporation at the correct rates are necessary. Granular formulations may also contain a systemic insecticide to provide control against many early-season insects.

In-the-furrow sprays provide excellent protection in the zone around seed. For best results, apply fungicide through two flat fan type nozzle tips adjusted parallel to rows.

A minimum spray volume of 5 gallons per acre is required to give adequate coverage in the furrow. Mount the nozzle just behind the seed-drop tube to treat the soil immediately surrounding the seed.

Table 6. In-Furrow Fungicide Treatments for Cotton Seedling Disease Control

Fungicide and Formulation	Rate Per 1000 Row Feet	Comments
<i>Consult product guides and labels before applying fungicides and for plantback restrictions. Not all fungicides and formulations are listed due to space constraints.</i>		
azoxystrobin QUADRIS FLOWABLE	0.4-0.8 fl.oz.	At-plant in-furrow spray for control of <i>Rhizoctonia</i> and <i>Pythium</i> seedling blight. Apply 3 to 7 gallons of water at planting and direct spray into the seed furrow before seed is covered. Use higher rate, particularly on early cotton when conditions favor disease.
azoxystrobin + benzovindiflupyr ELATUS 45W	5-7.3 fl.oz.	For early post emergent protection from <i>Rhizoctonia</i> damping off, apply in a 3- to 7-inch band over the top of the seedlings.
etridiazole TERRAMASTER 4EC	4-8 fl.oz.	Apply over seed in open furrow at planting for control of <i>Pythium</i> seed rot and seedling blight. Listed rate is for 40-inch rows.
fluxapyroxad + pyraclostrobin PRIAXOR	0.1-0.6 fl.oz.	Apply in-furrow or as a directed banded application over the seed furrow for control of <i>Rhizoctonia</i> seed and seedling rot, as well as suppression of <i>Fusarium</i> seed and seedling rot, and <i>Pythium</i> damping off.
mefenoxam RIDOMIL GOLD GR	1.5-3 oz.	Apply at-plant in-furrow for control of <i>Pythium</i> seedling blight. Mount application tubes so the granules are mixed with the soil covering the seeds.
RIDOMIL GOLD SL	0.075-0.15 fl.oz.	Apply at-plant in-furrow for control of <i>Pythium</i> seedling blight. Apply in water or fertilizer at planting. Direct spray over the seed in open furrow before seed are covered.
pentachloronitrobenzene + mefenoxam RIDOMIL GOLD PC GR	8.6-12.3 oz.	Apply at-plant in-furrow to control seed rots and seedling diseases caused by <i>Pythium</i> and <i>Rhizoctonia</i> . Mount application tubes so that granules are mixed with soil covering the seeds. Use higher rate when soil conditions are unfavorable for rapid seed germination and seedling growth.
pyraclostrobin HEADLINE SC	0.1-0.8 fl.oz.	For control of <i>Rhizoctonia</i> and <i>Pythium</i> and seedling diseases. Apply at-plant by directing spray into the furrow before seed is covered. Use minimum of 2.5 gallons spray volume per acre. Refer to label for rates for specific row spacings.

Table 7. Fungicide Treatments for Leaf Spots and Boll Rots

Fungicide and Formulation	Rate Per Acre	Comments
<i>Consult product guides and labels before applying fungicides and for plantback restrictions. Not all fungicides and formulations are listed due to space constraints.</i>		
azoxystrobin QUADRIS FLOWABLE	6-9 fl.oz.	For control of <i>Anthracnose</i> and <i>Ascochyta</i> blight and boll rot, hard lock, and Target spot (<i>Corynespora</i> leaf spot). Apply before pin head square to early bloom or at early stages of disease development and repeat after 14 to 21 days as needed to control disease. Do not make more than two consecutive applications of Quadris flowable. See label for additional information concerning resistance management for strobilurin (QoI or Group 11) fungicides.
flutriafol TOPGUARD	7-14 fl.oz.	Apply at first bloom in a minimum of 10 gallons of spray volume when applied by air or with ground equipment and repeat as needed 7- to 14-days later to control target spot. Make no more than two applications of Topguard per crop.
azoxystrobin + benzovindiflupyr ELATUS 45W	5-7.3 fl.oz.	For target spot control, apply at first sign of disease or when conditions favor disease. Repeat as needed at least 14 days later with a nonionic or COC surfactant. May be applied by air, ground, or chemigation. Use sufficient water to obtain thorough coverage. Make no more than two applications of Elatus per crop.
fluxapyroxad + pyraclostrobin PRIAXOR	4-8 oz	Apply prior to disease development and repeat as needed after 7 to 14 days. Make no more than two consecutive applications of Priaxor before rotating to a non-Group 7 or Group 11 fungicide.
pyraclostrobin HEADLINE 2.09SC	6-12 fl.oz.	For control of leaf spot and boll rot disease caused by <i>Alternaria</i> , <i>Ascochyta</i> (blight), <i>Cercospora</i> , <i>Corynespora</i> , <i>Fusarium</i> (hard lock), <i>Glomerella</i> (anthracnose), <i>Phoma</i> , and <i>Stemphyllum</i> . Begin applications prior to or at early stage of disease development and repeat after 7 to 14 days if conditions favor disease. Make no more than two consecutive applications of Headline 2.09SC. See label for additional information concerning resistance management with QoI fungicides.
pyraclostrobin + metconazole TWINLINE	7-8.5 fl.oz.	For control of leaf spot and boll rot disease caused by <i>Alternaria</i> , <i>Ascochyta</i> (blight), <i>Cercospora</i> , <i>Corynespora</i> , <i>Fusarium</i> (hard lock), <i>Glomerella</i> (anthracnose), <i>Phoma</i> , and <i>Stemphyllum</i> . Apply before disease development and continue applications on a 7- to 14-day schedule as needed to control disease. Do not make more than two consecutive applications of Twinline before alternating to another fungicide with a different mode of action. A total of three Twinline applications may be made per year. See label for additional use restrictions.

NEMATODE CONTROL

Nematodes are microscopic worm-like animals that live in the soil. Most are harmless and feed only on dead organic matter, but a few feed on plant roots. Several of these plant parasitic nematodes attack cotton, causing serious yield reductions.

The cotton root-knot nematode (*Meloidogyne incognita*) and the reniform nematode (*Rotylenchulus reniformis*) are the most widespread and damaging nematodes on cotton.

Damage

Nematodes damage cotton by feeding on the roots and by breaking the cotton's resistance to Fusarium wilt. Nematodes feeding on the plant's roots impair its ability to take up water and nutrients from the soil. The plant becomes stunted and generally unthrifty. As a result of the nematodes' feeding activities, disease-causing bacteria and fungi enter through the wounds.

On cotton, seedling diseases, root rots, as well as Fusarium wilt are increased by nematode activity. Fusarium wilt, a soil-borne disease, can overcome Fusarium wilt-resistant cotton varieties by entering roots through nematode feeding wounds. Once the fungus is inside, it can rapidly plug the vascular system, stop the movement of water and, consequently, cause the plant to wilt and die.

Symptoms

Nematode symptoms can appear early in the season on young plants. Infected seedlings may be severely stunted and may occasionally die. Usually, symptoms do not appear until the middle of June or July as cotton begins to mature.

The first signs of root-knot or reniform nematode damage in newly infested fields appear as stunted cotton in localized spots in the field. These spots may comprise just a few plants or may cover an acre. In most fields with established reniform nematode populations, damage occurs generally throughout the field. As the season progresses, nematode-infested cotton will mature later than healthy cotton. If Fusarium wilt is in the field, cotton plants will turn yellow, wilt, and possibly die.

Roots of a nematode-infested plant are usually stubby and sparse and often rotted. If root-knot nematodes are present, small swellings or galls can be seen on the lateral roots.

A soil sample for nematode analysis should be taken from nematode-suspected fields for positive diagnosis. Take soil samples from around the plant's root zone, place in a plastic bag, and store in a cool place until they can be sent to the Auburn University Nematode Diagnostic Laboratory.

Control

Nematodes can be controlled most effectively by a combination of the following recommended control measures.

Rotate Crops. Crop rotation is a good cultural practice to follow, not only to control cotton diseases and nematodes but also to minimize weed problems and to avoid buildup of certain herbicides in the soil. Plant crops such as peanuts, small grains, millet, sudangrass, sorghum, pasture grasses, and some vetch varieties. The cotton root-knot nematode cannot reproduce on these crops, so its population can be effectively lowered.

Corn is an excellent host for cotton root-knot nematodes and should be avoided as a rotational crop in fields where root-knot is or could be a problem. Planting peanut, some soybean varieties, grasses, or grain sorghum or leaving the land fallow can effectively lower root-knot nematode populations.

In cotton fields where reniform nematodes are a problem, rotating with non-host crops such as grain sorghum, corn, small grains, and peanut will reduce populations.

Plant Resistant Varieties. Root-knot nematodes will predispose cotton to Fusarium wilt, so plant resistant varieties in fields that are known to be infested with root-knot nematodes or with a history of Fusarium wilt. Several commercial cotton varieties have acceptable tolerance to root-knot nematodes and are resistant to Fusarium wilt.

Plow up Cotton Stalks. Immediately after picking cotton, disk and plow the field. This practice reduces nematode populations by exposing them to the drying action of the sun and by depriving them of a food source. If erosion becomes a problem, plant a cover crop of rye. Avoid other legume-type crops because they will maintain the root-knot nematode populations.

Subsoil. Subsoiling under the row has been effective in reducing cotton damage caused by nematodes. It allows cotton roots to penetrate the subsoil more easily, thus compensating for much of the injury caused by nematodes.

Use Nematicides. Nematicides can be an effective way to reduce nematode damage to cotton when they are used with other recommended cultural practices.

Telone, a fumigant, must be injected 14 days prior to planting into well-prepared soils free of undecomposed organic matter and dirt clods. Aeris and Avicta are reported to be effective against low populations of reniform nematodes. Avicta and Aeriis also have activity against early season insects while Telone II is only active against nematodes.

Table 8. Cotton Nematode Control		
Nematodes	Amount of Formulation per Acre (38-Inch Row)	Comments
ROOT-KNOT, RENIFORM		
1,3 dichloropropene TELONE II (Fumigant)	3-6 gal.	Preplant fumigation: Inject with one chisel per row to a final planting depth of at least 14 inches. Seal injection furrow with cultipacker or bedding equipment. Wait 7 days before planting. Rate based on 38-inch row spacing.
abamectin + thiamethoram AVICTA DUO COTTON	See label.	Available only in Avicta Complete Pak with Dynasty CST. Applied only by Delta and Pine Land, Monsanto, and selected retailers.
clothianidin + <i>Bacillus Firmimus</i> I-1582 PONCHO/VOTIVO	2.4 fl.oz.	Delinted cotton seed only. Available on DPL cotton seed.
fluopyram + imidacloprid VELUM TOTAL	14-18 fl.oz.	Apply in-furrow or below the seed at planting. Also will help control thrips, white flies, and aphids.
imidacloprid + thiocarb AERIS (Seed treatment)	25.6 fl.oz./100 lb. seed	Available through Stoneville, FiberMax, and Delta and Pine Land. Used in combination with Gaucho Grande.
oxamyl VYDATE C-LV	17 fl.oz. 8.5-17 fl.oz.	Apply after planting to suppress reniform, root knot, and lance nematodes following the planting of nematicide-treated cotton seed or use of a soil fumigant or contact nematicide. Band or broadcast in the first through seventh true leaf stage. Reapply as needed 14 days after first application of Vydate C-LV. Apply following the application of a preplant or at-plant granular nematicide. Band or broadcast at the second to fifth true leaf stage and repeat 10 to 14 days later. Apply in sufficient water to cover foliage. Rates listed are for broadcast applications, so reduce rates accordingly for banded applications. See label for use restrictions and application guidelines.

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WEED CONTROL

Starting your cotton in a clean, weed-free field will be one of the keys to a successful crop whether growing conventional or no-till. If growing no-till cotton, an early preplant burndown with or without a residual herbicide will be essential to getting your cotton off to a good start. One of the most effective burndown treatments has been glyphosate plus dicamba; however, when glyphosate-resistant horseweed is present, effectiveness of this herbicide combination has greatly reduced in recent years. A combination of glyphosate plus Sharpen has provided the **best consistent** horseweed control. It must, however, be applied 42 days prior to planting.

Including an at-planting burndown with a residual can achieve excellent control. Postemergence applications must be timely, and a tank-mix of glyphosate plus Dual Magnum (Sequence) will improve grass and yellow nutsedge control. Staple can provide postemergence over-the-top (POST) broadleaf weed control, and Envoke can be applied POST after cotton reaches the 5 true leaf stage; however, it does not control Palmer amaranth. Liberty Link cotton is a good option for fields infested with Palmer amaranth. Be sure to include residuals and other modes of action.

Post-directed (PDS) applications are a very important part of cotton weed control. Cotton must be at least 3 inches tall before any PDS may be made, and additional herbicides are available after cotton reaches 5, 8, 12, and 15 inches tall. Hooded sprayers are also an option with any cotton variety (Aim, Gramoxone SL, Liberty 280 SL, Glyphosate). Layby herbicides may be applied in cotton that is greater than 12 inches tall, where bark has formed on the cotton plant (Caparol, Cotoran, Direx, Layby Pro, Suprend, Valor, and Zidua). With layby applications, generally higher applications rates are used.

A weed management system in cotton may include the following:

- Early burndown (no-till)
- At-planting burndown with or without a residual (no-till)
- Postemergence with a residual
- Post-directed herbicide(s) with or without a residual(s)
- Layby herbicide(s)
- Hooded sprayer herbicide(s)
- Preharvest herbicide(s)

Table 9. Recommendation Guide

Herbicide (trade name)	Herbicide (common name)	REI/PHI (hours or days)	Rate/Acre Broadcast		Herbicide Group	Time of Application	Weeds Controlled	Comments
			Formulation	Active Ingredient				
BURNDOWN (NO-TILL/REDUCED TILL)								
Envoke	trifloxysulfuron	12 hr./60 d	0.1 oz.	0.005 lb. a.i.	2	Use as a fall-burndown (after November 15) or a minimum of 90 days before planting.	Many broadleaf weeds including horseweed and henbit.	Add a nonionic surfactant at 0.25% v/v. Do not exceed 0.4 oz. per acre of Envoke from all applications in one season. See label for tank-mix options. Apply malathion-containing insecticides at least 24 hours before or after Envoke. Do not tank-mix with graminicides.
Firstshot SG	thifensulfuron + tribenuron	12 hr./N/A	0.5–0.8 oz.	0.25–0.4 lb. a.i.	2	After weed emergence but 14 days prior to planting.	Postemergence control of broadleaf weeds such as buttercup, chickweed, curly dock, and henbit.	Apply to young, actively growing weeds. Full control will take approximately 13 weeks following application. A nonionic surfactant at 0.25% v/v or a crop oil concentrate at 1% v/v is necessary. See label for tank-mix partners and crop rotation intervals.
various	glyphosate	4 hr./N/A	32–48 fl.oz. (3 lb. ae) 24–35 fl.oz. (4.17 ae) 22–32 fl oz (4.5 lb ae)	0.75–1.13 lb ae	9	Apply prior to planting.	Most annual grasses and broadleaf weeds. Does not adequately control eveningprimrose or horseweed.	Adjuvant recommendations varies by glyphosate brand. See label for tank-mixing partners. Tank-mixes must follow the most-restrictive REI/PHIs. Use lower rate on smaller, easy to kill weeds; increase rate with larger weeds and perennials.
Glyphosate + 2, 4-D	glyphosate + 2, 4-D	48 hr./N/A	See glyphosate recommendations + 1–2 pt. of 4 lb./gal.	0.75–1.13 lb. ae + 0.5–1.0 lb.	9 + 4	Apply 2,4-D before cotton planting. Most brands of 2,4-D may be applied at least 30 days ahead of cotton planting.	Most annual grasses and broadleaf weeds including cutleaf evening primrose.	Higher 2,4-D rates (1.5-2 pt/A) provide better control of glyphosate-resistant horseweed. May not control Carolina geranium.
Glyphosate + Aim	glyphosate + carfentrazone-ethyl	12 hr./7d	See glyphosate recommendations + 0.5–1 fl.oz.	0.75–1.13 lb. ae + 0.008–0.016 lb. a.i.	9 + 14	Apply prior to planting.	Most annual grasses and broadleaf weeds including very small (<1 inch) Palmer amaranth.	Does not provide any residual weed control.
Glyphosate + Clarity	glyphosate + dicamba	24 hr./N/A	See glyphosate recommendations + 8 fl oz	0.75–1.13 lb. ae + 0.25 lb.	9 + 4	Apply prior to planting at least 21 days prior to planting and following 1 inch of rainfall or irrigation.	Annual grasses and broadleaf weeds including glyphosate-resistant horseweed.	Adding a residual herbicide such as Valor, Cotoran, Caparol, or Direx will enhance control of horseweed. See label for specific application instructions and tank-mixing partners. Tank-mixes must follow the most-restrictive REI/PHIs.

Table 9. Recommendation Guide (cont.)

Herbicide (trade name)	Herbicide (common name)	REI/PHI (hours or days)	Rate/Acre Broadcast		Herbicide Group	Time of Application	Weeds Controlled	Comments
			Formulation	Active Ingredient				
Glyphosate + Reflex	fomesafen	24 hr./70 d	See glyphosate recommendations + 1-1.5 pt	0.75-1.13 lb. ae + 0.24-0.38 lb.	9 + 14	Apply as a preplant burndown no later than 14 days prior to planting and 1 inch of rainfall must occur prior to planting.	Control or suppression of broadleaf and sedges.	Apply as a preemergence application to coarse-textured soils only. Apply as a preplant surface application to medium or fine-textured soils up to 21 days prior to planting cotton. At least 0.5 inch of rainfall must occur before planting and plant cotton at least 0.75 inches. See label for tank-mix partners and adjuvant requirements.
Glyphosate + Sharpen	glyphosate + saflufenacil	12 hr./0 d	See glyphosate recommendations + 1 fl.oz.	0.75-1.13 lb. ae + 2.85 lb.	9 + 14	Apply as a preplant burndown no later than 42 days prior to planting and 1 inch of rainfall or irrigation.	Most annual grasses and broadleaf weeds. Excellent glyphosate-resistant horseweed control.	Do not apply to coarse soils classified as sand with less than 1.5% organic matter or cotton injury may occur. Do not apply Sharpen with other Group 14 herbicides as a tank-mix or sequential application within 30 days of planting. See label for recommended adjuvants.
Glyphosate + Valor SX	glyphosate + flumioxazin	12 hr./60 d	See glyphosate recommendations + 1-2 oz.	0.75-1.13 lb. ae + 0.03-0.06 lb.	9 + 14	Conventional: a minimum of 30 days and 1 inch of rainfall must occur prior to planting. No-Till: at 1 oz., a minimum of 14 days and 1 inch of rainfall must occur prior to planting. At 1.5-2 oz. a minimum of 21 days and an inch of rainfall must occur.	Valor will not control existing horseweed. It improves control of wild radish and emerged cutleaf evening primrose.	Do not apply to soils prone to erosion unless adequate crop residue is present to reduce erosion. A minimum of 30 days and 1 inch of rainfall or irrigation must occur between Valor application and cotton planting.
Gramoxone SL/others	paraquat	24 hr./48 d	2-4 pt.	0.5-1.0 lb.	22	Apply prior to planting before crop emerges.	Annual broadleaf weeds and grasses.	Use a nonionic surfactant and apply in 20-40 gallons of spray solution per acre. Use the higher rate for harder-to-kill weeds. Complete coverage is essential for good weed desiccation. See label for specific application instructions and tank-mixing partners. Better control of chickweed, henbit, purple deadnettle, and cutleaf evening primrose than glyphosate.
Liberty 280 SL	glufosinate-sodium	12 hr./70 d	22-29 fl.oz.	0.4-0.78 lb.	10	Apply prior to planting. Weeds should not exceed 3 to 6 inches.	Excellent morningglory, cocklebur, hemp sesbania control. Good control of pigweeds.	Apply in a minimum of 15 gallons per acre in a medium spray droplet. Wait until 1.5 hours after sunrise to begin spraying and stop at least 1 hour before sunset. Control is improved with warm temperatures, bright sunlight, and higher humidity. Don't mix graminicides with Liberty.

Table 9. Recommendation Guide (cont.)

Herbicide (trade name)	Herbicide (common name)	REI/PHI (hours or days)	Rate/Acre Broadcast		Herbicide Group	Time of Application	Weeds Controlled	Comments
			Formulation	Active Ingredient				
PREPLANT INCORPORATED								
Prowl H2O	pendimethalin	24 hr./60 d	1.0–2.0 pts. (coarse) 2.0–3.0 pts. (medium) 3.0–4.0 pt. (fine)	0.475–0.95 lb. (coarse) 0.95–1.43 lb. (medium) 1.43–1.9 lb. (fine)	3	Apply preplant incorporated (PPI) within 60 days of planting and incorporate or preplant within 15 days of planting.	Annual grasses and small-seeded broadleaf weeds.	Incorporate within 7 days of application if rainfall does not occur.
Treflan	trifluralin	12 hr./90 d	1.0 pt. (coarse) 1.5 pt. (medium) 2.0 pt. (fine)	0.5 lb. (coarse) 0.75 lb. (medium) 1.0 lb. (fine)	3	Apply preplant incorporated (PPI) within 90 days of planting and incorporate.	Annual grasses and some small-seeded broadleaf weeds.	Do not apply to wet soils or soils subject to prolonged flooding.
PREEMERGENCE								
Caparol	prometryn	12 hr./30 d	1.5–2.5 pt.	0.75–1.25 lb.	5	Apply from November 1 until 14 days before planting cotton.	Most annual grasses and broadleaf weeds. residual pigweed control.	Use the 1.5 pt./A rate for applications made from January 1 to 30 days before cotton planting. For control of emerged weeds, see label for a suitable adjuvant. If weeds exceed 2 inches in height, mix with a contact herbicide. See label of contact herbicide for rates, adjuvants, etc.
Command 3ME	clomazone	12 hr./65 d	1.33–2.67 pt.	0.5–1.0 lb.	13	Apply at planting	Annual grasses and broadleaf weeds	Do not apply unless either disulfoton or phorate organophosphate insecticide is applied in-furrow with the seed at planting time at a minimum of 0.75 lb. a.i./acre.
Cotoran	fluometuron	24 hr./60 d	2 pt. (coarse) 3 pt. (medium) 4 pt. (fine)	1.0 lb. (coarse) 1.5 lb. (medium) 2.0 lb. (fine)	7	Apply within 24 hours of planting	Most annual grasses and broadleaf weeds.	Caparol, Reflex can be added for improved pigweed control. Staple may also be added to Cotoran for improved control of prickly sida, spotted spurge, and pigweed. Check your label for rates.
Direx, diuron 80 DF Direx, diuron 4L	diuron	12 hr/0 d	1.0–2.0 lb. 0.8–2.2 qt.	1.25–2.5 lb. 0.8–1.6 lb.	7	Apply preplant or preemergence.	Annual grasses and small-seeded broadleaf weeds.	Do not apply to soils with less than 1% organic matter. Do not use where soil-applied organophosphate insecticides are used. See label for tank-mix partners.
Prowl H2O	pendimethalin	24 hr./60 d	1.0–2.0 pt. (coarse) 2.0–3.0 pt. (medium) 3.0–4.0 pt. (fine)	0.475–0.95 lb. (coarse) 0.95–1.43 lb. (medium) 1.43–1.90 lb. (fine)	3	Apply at planting or up to 2 days after planting.	Annual grasses and small-seeded broadleaf weeds.	Rates vary depending on whether using conventional or no-till. See label for rates. Higher rates will be used with no-till systems.

Table 9. Recommendation Guide (cont.)

Herbicide (trade name)	Herbicide (common name)	REI/PHI (hours or days)	Rate/Acre Broadcast		Herbicide Group	Time of Application	Weeds Controlled	Comments
			Formulation	Active Ingredient				
Reflex	fomesafen	24-hr./70 d	1-1.5 pt.	0.25-0.375 lb.	14	Apply preemergence to coarse textured soils only. Other soils cotton may be planted after Reflex application has had 0.5 inches rain or irrigation	Annual broadleaf weeds and partial yellow nutsedge control.	Does not mix well with IPA salt formulations of glyphosate. See label for tank-mix partners.
Staple LX	pyrithiobac	4 hr./60 d	1.3-2.1 fl. oz.	0.0325-0.0525 lb	2	Apply at planting	Annual broadleaf weeds	Do not use on coarse soils such as sands or loamy sands or on soils with less than 0.5% organic matter. See label for tank-mix partners.
Warrant	acetochlor	12 hr/ N/A	1.25-2 qt.	0.94-1.5 lb.	15	Apply within 24 hours of planting.	Annual grasses and small-seeded broadleaf weeds	See label for tank-mix partners. Warrant should be applied in combination with other herbicides for optimum weed control.
Warrant Ultra	acetochlor + fomesafen	24 hrs/70 d	48-60 fl. oz.	1.29-1.62 lb.	15 + 14	Apply as a preplant in medium- and fine-textured soil or a PRE in coarse-textured soil.	Grasses and small-seeded broadleaves	Cotton must be planted at least 0.75 inches deep. Do not apply to emerged cotton. See label for tank-mix partners.
POSTEMERGENCE OVER-THE-TOP								
Assure II	quizalofop-P-ethyl	12 hr./80 d	5-12 fl. oz.	0.034-0.083 lb.	1	Apply to actively growing grasses anytime prior to 80 days before harvest.	Annual and perennial grasses; excellent control of johnsongrass.	Add crop oil concentrate at 1% or a nonionic surfactant at 0.25% v/v. Do not apply more than 18 fluid ounces per season. Do not apply within 24 hours of a postemergence broadleaf herbicide. Do not cultivate within 7 days of application. Controls volunteer Roundup Ready.
Cororan	fluometuron	24 hr./60 d	1.0-2.0 pt.	0.5-1.0 lb.	7	Apply when cotton is 3-6 inches tall.	Annual broadleaf weeds.	Use as a salvage treatment only. Crop injury may occur. Only apply to healthy cotton that is growing under favorable conditions.
Dual Magnum	S-metolachlor	24 hr./100 d	1.0-1.33 pt.	0.95-1.27 lb.	15	Apply when cotton is 3 to 12 inches tall.	Preemergence control of annual grasses and small-seeded broadleaf weeds.	Dual Magnum does not control emerged weeds. Crop injury can occur in environmentally stressed conditions. Do not apply within 100 days of harvest. See label for tank-mix partners.

Table 9. Recommendation Guide

Herbicide (trade name)	Herbicide (common name)	REI/PHI (hours or days)	Rate/Acre Broadcast		Herbicide Group	Time of Application	Weeds Controlled	Comments
			Formulation	Active Ingredient				
Envoke	trifloxysulfuron	12 hr./60 d	0.1–0.15 oz.	0.008–0.0125 lb.	2	Apply when cotton has reached a minimum of 5 true leaves.	Broadleaf weeds including morningglory, sicklepod, pigweed, and nutsedge	Apply with a 80/20 nonionic surfactant blend, NOT a 90/10 blend at a rate of 1 quart per 100 gallons of water. DO NOT use with crop oil concentrate or tank-mix with Pix growth regulator or other pesticides. Never apply preemergence, or cotton injury will occur. Seeabel for tank-mix partners. Do not tank-mix with insecticides containing malathion, profenofos, or emamectin-benzoate or cotton injury may occur.
Fusilade DX	fluazifop	12 hr./90 d	6–12 fl.oz.	0.094–0.188 lb.	1	Apply to actively growing grasses.	Annual and perennial grasses including bermudagrass and rhizome johnsongrass.	Most annual grasses need to be sprayed before 4 inches; Volunteer Roundup Ready and glufosinate-tolerant Corn requires 2 applications at 10 fl. oz each; Add crop oil (1 gal.) or nonionic surfactant (2 pt.) per 100 gal of spray. 2 applications at 10 fl.oz. each; Add crop oil (1 gal.) or nonionic surfactant (2 pt.) per 100 gal. of spray.
Liberty 280 SL	glufosinate-sodium	12 hr./70 d	22–29 fl.oz.	0.4-0.78 lb.	10	Apply from emergence up to early bloom stage. Weeds should not exceed 3 to 6 inches.	Excellent morningglory, cocklebur, hemp sesbania control. Good control of pigweeds.	Apply in a minimum of 15 gallons per acre in a medium spray droplet. Wait until 1.5 hours after sunrise to begin spraying and stop at least 1 hour before sunset. Control is improved with warm temperatures, to begin spraying and stop at least 1 hour before sunset. Control is improved with warm temperatures, bright sunlight, and higher humidity. Don't mix graminicides with Liberty.
Poast Plus	sethoxydim	12 hr./40 d	1.5–2.25 pt.	0.188–0.28 lb.	1	Apply to actively growing grasses.	Annual and perennial grasses	Add crop oil concentrate at 1%. A second application may be made if needed. For best results, apply before grasses exceed 4 inches tall. Controls volunteer Roundup Ready and glufosinate-tolerant corn in cotton. Do not apply within 40 days of harvest. May only be tank-mixed with Buctril and glyphosate. If using Staple, apply Poast Plus 3 days prior to Staple.
SelectMax, Select 2EC	clethodim	24 hr/60 d	9–16 fl.oz. (1 EC) 6–16 fl.oz. (2 EC)	0.068–0.12 lb. 0.094–0.25 lb.	1	Apply postemerge to actively growing annual and perennial grasses.	Annual and perennial grasses	Do not apply within 1 hour of anticipated rainfall. Do not apply more than 32 fl.oz./A in a single application. Do not apply more than 64 fl.oz./A per season. For repeat applications, make a minimum of a 14-day interval. Controls volunteer Roundup Ready and glufosinate-tolerant corn in cotton. Use a Nis at 0.25% v/v or a coc at 1% v/v.

Table 9. Recommendation Guide

Herbicide (trade name)	Herbicide (common name)	REI/PHI (hours or days)	Formulation	Rate/Acre Broadcast		Group	Herbicide	Time of Application	Weeds Controlled	Comments
				Active Ingredient						
Staple LX	pyrithiobac-sodium	4 hr./60 d	2.6–3.8 fl.oz	0.065–0.095 lb.		2	Apply over the top from first visible true leaf through 6 inches in height.	Controls most broadleaf weeds.	Apply with a nonionic surfactant at 0.25% v/v. Do not tank-mix with malathion-containing insecticides as crop injury may occur. To avoid injury, apply malathion-containing insecticides 24 hour before or after Staple LX. Do not tank-mix Staple LX with metolachlor (Dual Magnum) herbicides as a postemergence after Staple LX. Do not exceed 3.8 ounces per acre in a single application or 5.1 ounces per acre per season. Do not apply within 60 days of harvest.	
Aim	carfentrazone-ethyl	12 hr./7 d	0.75–1.6 fl.oz.	0.013–0.025 lb. a.i.		14	Apply when cotton is at least 12 inches tall with sufficient broadleaf weeds including morningglories and pigweed.	Controls most broadleaf weeds	Coverage is essential for good control. See label for tank-mix partners. Use a crop oil concentrate at 1% v/v or 1 gallon per 100 gallons of spray. Do not apply more than 3.2 ounces of Aim 2EC total per season by layby or postdirected applications.	
Caparol (or with MSMA)	prometryn	12 hr./30 d	2.4–3.2 pt.	1.2–1.5 lb.		5	Apply when cotton is at least 12 inches tall with sufficient bark.	Annual grasses and broadleaf weeds	Rate is dependent on soil texture. See label for specific rate and tank-mix partners. Add a nonionic surfactant (0.25% v/v) if weeds are present. Do not apply MSMA after first bloom.	
Dirun (or with MSMA)	dirun	12 hr./0 d	1.6–2.4 pt.	0.8–1.2 lb.		7	Apply when cotton is at least 12 inches tall and cotton laps the row middles.	Late emerging annual grasses and small-seeded broadleaf weeds	If weeds are present, add a nonionic surfactant (0.25% v/v). See label for tank-mix partners. Do not apply MSMA after first bloom.	
Layby Pro	linuron + dirun	24 hr./76 d	1.6–2.4 pt.	0.4–0.6 + 0.4–0.6 lb.		7+7	Apply after cotton is 15 inches tall and weeds no more than 4 inches tall.	Annual grasses and broadleaf weeds	If weeds are present, add a nonionic surfactant (0.25% v/v) or a crop oil concentrate (1% v/v). See label for tank-mix partners. Use rate based on soil type: 1.6 pt./A on coarse soils, 2 pt./A on medium soils, and 2.4 pt./A on fine soils. Do not use on sand or loamy sand or on soils containing less than 1% organic matter unless otherwise directed.	
Reflex	fomesafen	24 hr./70 d	1.0–1.5 pt.	0.25–0.375 lb.		14	Make a post-directed application to the base of the cotton plant with at least 4 inches of bark, avoiding contact with the foliage.	Controls or suppresses broadleaf, sedges, and grass weeds	Do not apply with liquid nitrogen. Do not apply within 70 days of cotton harvest. Do not apply more than 1.5 pints per acre per season.	

Post-Directed and Layby

Table 9. Recommendation Guide

Herbicide (trade name)	Herbicide (common name)	REI/PHI (hours or days)	Rate/Acre Broadcast		Herbicide Group	Time of Application	Weeds Controlled	Comments
			Formulation	Active Ingredient				
Valor	flumioxazin	12 hr./60 d	1–2 oz.	0.5–1.0 lb.	15	Apply with a shielded sprayer when cotton has reached a minimum of 6 inches in height. Apply as a layby application when cotton has reached a minimum of 16 inches in height. Must be directed to the lower 2 inches of the cotton stem to avoid injury.	Provides control of broadleaf weeds.	Severe crop injury may result if applied to green or unbarked stem. Do not exceed 4 ounces of Valor during a growing season. Add a nonionic surfactant at 0.25% v/v. Do not use a crop oil concentrate, methylated seed oil, organo-silicant surfactant, or products containing these as severe crop injury may occur.
Zidua	pyraxosulfone	12 hr./0 d	Coarse: Do NOT Use Medium: 0.75–1.5 oz., Fine: 1.5–2.1 oz.	0.055–0.154 lb.	15	Apply as a layby application from 5 leaf to beginning bloom stage.	Residual control of select broadleaf and annual grasses..	See label for tank-mix partners. Do not use on a coarse textured soil type. There is no preharvest interval between Zidua application and cotton harvest.
HOODED SPRAYER								
Various	glyphosate	4 hr./N/A	32–48 fl.oz. (3 lb. ae) 24–35 fl.oz. (4.17 ae) 22–32 fl.oz. (4.5 lb. ae)	0.75–1.13 lb. ae	9	Apply in cotton at least 6 inches tall using hooded sprayers only.	Most annual grasses and broadleaf weeds. Does not adequately control evening primrose or horseweed	Adjuvant recommendations vary by glyphosate brand. See label for tank-mixing partners. Tank-mixes must follow the most-restrictive REI/PHIs. Use lower rate on smaller, easy-to-kill weeds; increase rate with larger weeds and perennials. Avoid crop contact. Operate hoods as close to soil surface as possible.
Gramoxone SL	paraquat	24 hr./48 d	1.25–2.5 pt.	0.31–0.62 lb.	22	Apply to 6 inch cotton using hooded sprayers only.	Annual broadleaf weeds and grasses less than 6 inches tall.	Use a nonionic surfactant at 0.25% v/v or a crop oil concentrate at 1% v/v. Use the higher rate for harder-to-kill weeds. Complete coverage is essential for good weed desiccation. See label for specific application instructions and tank-mixing partners. Operate hoods as close to the soil surface as possible. Avoid crop contact with spray solution. Other formulations are NOT labeled for hooded sprayer applications. STATE LABEL ONLY.

Table 9. Recommendation Guide

Herbicide (trade name)	Herbicide (common name)	REI/PHI (hours or days)	Rate/Acre Broadcast		Herbicide Group	Time of Application	Weeds Controlled	Comments
			Formulation	Active Ingredient				
Liberty 280 SL	glufosinate-sodium	12 hr./70 d	22–29 fl.oz.	0.4–0.78 lb.	10	Apply from emergence through early bloom using a hooded sprayer.	Excellent morningglory, cocklebur, hemp sesbania control. Good control of pigweeds.	Thorough spray coverage is essential for optimum performance. Use only hooded sprayer equipment if not using varieties tolerant Liberty. Make up to 3 applications per season. Do not harvest cotton within 70 days of last Liberty application. Ground application requires a minimum of 15 gallons of water/acre. Avoid contact with plant foliage.
Valor	flumioxazin	12 hr./60 d	1–2 oz.	0.5–1.0 lb.	14	Apply with a hooded sprayer after cotton has reached 6 inches tall.	Provides control of broadleaf weeds.	Severe crop injury may result if applied to green or unbarked stem. Do not exceed 4 ounces of Valor during a growing season. Add a nonionic surfactant at 0.25% v/v. See label for tank-mix partners. Use only hooded sprayer equipment. Operate hoods as close to the soil surface as possible.

¹ Will not control ALS-resistant ryegrass

² Weeds must not be larger than 2 inches at time of application.

Table 10. Weed Response to Cotton Herbicides

Herbicides	FirstShot SG	Glyphosate	Glyphosate + 2, 4-D	Glyphosate + Aim	Glyphosate + Clarity	Glyphosate + Reflex	Glyphosate + Valor	Glyphosate + Sharpen	Gramoxone SL/Others	Liberty 280 SL
Application Timing										
Site of Action Group	2	9	9 + 4	9 + 14	9 + 4	9+14	9+14	9+14	22	10
WEEDS										
annual bluegrass	N	E	E	E	E	E	E	E	G-E	F
bermudagrass	N	F	F	F	F	F	F	F	P	N
crabgrass, large	N	E	E	E	E	E	E	E	F	F
crowfootgrass	N	F-G	F-G	F-G	F-G	F-G	F-G	F-G	P	G
foxtail	N	F-G	F-G	F-G	F-G	F-G	G	F-G	F	F-G
goosegrass	N	E	E	E	G	E	E	G	F-G	P
johnsongrass (seedling)	N	G-E	G-E	G-E	G	G-E	G-E	F-G	P	G
little barley	N	E	E	E	E	E	E	E	G	F-G
ryegrass, Italian	N	G	G	G	G	G	G	F	F	F
signalgrass, broadleaf	N	F-G	F-G	F-G	F-G	F-G	F-G	F-G	P	G
Texas panicum	N	E	G-E	E	E	E	E	G	F-G	G
purple nutsedge		F	F	F-G	F	F	G	F	P-F	P
yellow nutsedge		P-F	P-F	P-F	P-F	P-F	F	P-F	P-F	P
buttercup	E	G-E	G-E	G-E	E	F	F	E	E	E
Carolina geranium	G-E	P-F	F	F-G	G	G	G	P	G-E	G
chickweed	G-E	E	E	E	E	E	E	G	E	E
cudweed		G	G	G-E	E	E	E		F-G	
curly dock	E	F	F	F	G-E	F	F	E	N-P	F
cutleaf eveningprimrose	G-E	P	G-E	F	G	F	E	F	F	F-G
henbit	F-G	F	F-G	F-G	G	G	E	G	G	P-F
horseweed	F	G	E	E	G	P	N	G	P-F	G-E
lambquarters, common		F-G	E	E	E				F-G	E
morningglories sp.	F-G	F	E	E	E	G	E	G	F-G	E
morningglory, smallflower	G	G	E	E	E	F	G	G	P	E
Palmer amaranth	P-F	E	E	E	E	E	P	E	F-G	F-G
Pennsylvania smartweed		F-G	G	E	E	F-G	E	G-E	P-F	G
prickly sida	P	F	G	E	E	G		F-G	P-F	P
purslane, common		F	G-E	E	E				G	F-G
ragweed, common		G	E	E	E		E	E	G	E
shepherdspurse	E	G	G	G	G		G-E	E	G	G
sicklepod	P	G-E	E	E	E	F-G	G	G	G	E
swinecress		F-G	G	F-G	F-G		F	F	P-F	

N = No control P = < 70% control F = 70-80% control G = 80-90% control E = 90% control

¹ Will not control ALS-resistant ryegrass.

² Weeds must not be larger than 2 inches at time of application.

Table 11. Weed Response to Cotton Herbicides

Herbicides	Glyphosate	Glyphosate + 2,4-D	Glyphosate + Clarity	Glyphosate + Aim	Glyphosate + Diuron	Glyphosate + Harmony Extra	Glyphosate + Valor
Application Timing	BURNDOWN						
Site of Action Group	9	9+4	9 + 4	9+14	9+7	9+2	9+14

Weeds

GRASSES/SEDGES

annual bluegrass	E	E	E	E	E	E	E
bermudagrass	F	F	F	F	F	F	F
crabgrass, large	E	E	E	E	G	E	E
crowfootgrass	F-G	F-G	F-G				
fall panicum							
foxtail	F-G	F-G					G
goosegrass	E	E	G	E	G	E	E
johnsongrass (seedling)	G-E	G-E	G	G-E	F-G	G-E	G-E
little barley		E	E	E	E	E	E
ryegrass, Italian	G	G	G	G	F	G	G
signalgrass, broadleaf							
Texas panicum	E	G-E	E	E	G	E	E
volunteer corn (not RR vol corn)	E	E	E	E	E	E	E
purple nutsedge	F	F	F	F-G	F-G	F-G	G
yellow nutsedge	P-F	P-F	P-F	P-F	F	P-F	F

N = No control

P = < 70% control

F = 70–80% control

G = 80–90% control

E = 90% control

¹ Will not control ALS-resistant ryegrass² Weeds must not be larger than 2 inches at time of application.

Table 11. Weed Response to Cotton Herbicides (cont.)

Herbicides	Glyphosate	Glyphosate + 2,4-D	Glyphosate + Clarity	Glyphosate + Aim	Glyphosate + Diuron	Glyphosate + Harmony Extra	Glyphosate + Valor
Application Timing	BURNDOWN						
Site of Action Group	9	9 + 4	9 + 4	9+14	9+7	9+2	9+14
Weeds							
BROADLEAF WEEDS							
beggarweed, Florida	E	E	E	E	E	E	E
bristly starbur	E	E	E	E	E	E	E
black nightshade							
buttercup	G-E	G-E	E	G-E	G-E	G-E	F
Carolina geranium	P-F	F	G	F-G	G	G-E	G
chickweed	E	E	E	E	E	E	E
cocklebur	E	E	E	E	E	E	
coffee senna	E	E	E	E	E	E	
crotalaria, showy							
cudweed	G	G	E	G-E	E	E	
curly dock	F	F	G-E	F	P-F	E	F
cutleaf eveningprimrose	P	G-E	G	F	F-G	F	E
eclipta	G-E			G-E	G-E		
hemp sesbania	P-F	E		G-E	F-G		
henbit	F	F-G	G	F-G	G	E	E
horsenettle	P-F	F-G	F-G		F	P-F	
horseweed	G	E	G	E	G-E	G-E	N
groundcherries							
jimsonweed							
lambsquarters, common	F-G	E	E	E	G-E		
morningglories sp.	F	E	E	E	G	F	E
morningglory, smallflower	G	E	E	E	G-E	G	
Palmer amaranth	E	E	E	E	E	E	P
Palmer amaranth (glyphosate-resistant)	N	F	F	F	G	P	
Pennsylvania smartweed	F-G	G	E	E	G	E	E
prickly sida	F	G	E	E	F-G	F-G	
purslane, common	F	G-E	E	E	G	F	
ragweed, common	G	E	E	E	G		E
ragweed, giant							
redweed	G		G-E	G-E	G		
shepherdspurse	G		G	G			
sicklepod	G-E	E	E	E	E	G-E	
speedwell	E	E	E	E	E	E	
spurred anoda	G				G		
swinecress	F-G	G	F-G	F-G	G	G-E	
tropic croton	G-E	G-E	G-E	G-E	G-E		
velvetleaf	G				G		

N = No control
P = < 70% control
F = 70–80% control
G = 80–90% control
E = 90% control

Table 11. Weed Response to Cotton Herbicides (cont.)

Herbicides	Glyphosate + Sharpen	Gramoxone	Gramoxone + Clarity	Reflex	Treflan	Prowl	Command
Application Timing	BURNDOWN			PRE	PPI	PPI/PRE	PRE
Site of Action Group	9+14	22	22+4	14	3	3	
Weeds							
GRASSES/SEDGES							
annual bluegrass	E	G-E	E				
bermudagrass	F	P	F	N	N	N	P-F
crabgrass, large	G	F	E	P	E	E	E
crowfootgrasses	F-G	P			E	G	G
fall panicum				N	E	E	G-E
foxtail	F-G	F		N	E	E	E
goosegrass	G	F-G	E	P	E	E	E
johnsongrass (seedling)	F-G	P	G	N	P	P	G
little barley	E	G	E				
ryegrass, Italian	F	F	G				
signalgrass, broadleaf		P		N	G	G	E
Texas panicum	G	F-G	E		G	F	F
volunteer corn (not RR vol corn)	E	F	E				
purple nutsedge	F	P-F	F-G		N	N	N
yellow nutsedge	P-F	P-F	P-F	P	N	N	N

N = No control
 P = < 70% control
 F = 70–80% control
 G = 80–90% control
 E = 90% control

¹ Will not control ALS-resistant ryegrass
² Weeds must not be larger than 2 inches at time of application.

Table 11. Weed Response to Cotton Herbicides (cont.)

Herbicides	Glyphosate + Sharpen	Gramoxone	Gramoxone + Clarity	Reflex	Treflan	Prowl	Command
Application Timing	BURNDOWN			PRE	PPI	PPI/PRE	PRE
Site of Action Group	9+14	22	22+4	14	3	3	3
Weeds							
BROADLEAF WEEDS							
beggarweed, Florida		E	E	P	P	P	F-G
bristly starbur		E	E	G-E	N	N	P
black nightshade							
buttercup	E	E	E				
Carolina geranium	P	G-E	G				
chickweed	G	E	E				
cocklebur		G-E	E	G	N	N	F
coffee senna		F	E	N	N	N	P
crotalaria, showy					N	N	
cudweed		F-G	E				
curly dock	E	N-P	G-E				
cutleaf eveningprimrose	F	F					
eclipta		F		G-E	P	P	
hemp sesbania		F		P	N	N	F
henbit	G	G	G				
horsenettle		P-F			N	N	N
horseweed	G	P-F	E		N	N	N
groundcherries							
jimsonweed				N	N	N	G
lambquarters, common		F-G	E	E	G	F-G	G
morningglories sp.	G	F-G	E	P-F	P	P	P-F
morningglory, smallflower		P	E	G-E	P	P	P
Palmer amaranth	E	F-G	E	E	F-G	P-F	N-P
Palmer amaranth (glyphosate-resistant)	E	F-G	F	E	E	F	N-P
Pennsylvania smartweed	G-E	P-F	E	F	N	N	E
prickly sida		P-F	E	N	N	N	E
purslane, common		G	E	G	E	G	G-E
ragweed, common	E	G	E	G	N	N	G
ragweed, giant							
redweed		F	G-E		N	N	G-E
shepherdspurse		G	G				
sicklepod		G	E	P	P	P	P
speedwell		G	E				
spurred anoda		F-G			N	N	G
swinecress	F	P-F	F-G				
tropic croton		F	G-E	F-G	N	N	E
velvetleaf		P		P	P	P	G

N = No control P = < 70% control F = 70–80% control G 80–90% control E = 90% control

¹ Will not control ALS-resistant ryegrass² Weeds must not be larger than 2 inches at time of application.

Table 11. Weed Response to Cotton Herbicides (cont.)

Herbicides	Cotoran	Diuron	Warrant	Dual II Magnum	Staple LX	Envoke	Liberty
Application Timing	PRE				POST		
Site of Action Group	7	7	15	15	2	2	10
Weeds							
GRASSES/SEDGES							
annual bluegrass	N	N	N	N	N	N	N
bermudagrass	F-G	F-G	E	G-E	P	P	G
crabgrass, large	F-G	F-G	E	G-E		P	G
crowfootgrass	F	P	G	G-E	P-F	P	G
fall panicum	F-G		E	G-E	P	P	G
foxtail	F	F	E	G-E	P-F	P	P
goosegrass	P	P	F	G-E	N	N	G
johnsongrass (seedling)					N	P	G
little barley					N	P	G
ryegrass, Italian	P	P	F-G	G-E	N	P	G
signalgrass, broadleaf	P	P	P-F	P-F	N	P	G
Texas panicum					N	P	G
volunteer corn (not RR vol corn)	N	N	P	P	F	P	P
purple nutsedge	N	N	P	G	P-F	P	P
yellow nutsedge	N	N	P	G	P-F	P	P

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P = < 70% control

F = 70-80% control

G = 80-90% control

E = 90% control

¹ Will not control ALS-resistant ryegrass² Weeds must not be larger than 2 inches at time of application.

Table 11. Weed Response to Cotton Herbicides (cont.)

Herbicides	Cotoran	Diuron	Warrant	Dual II Magnum	Staple LX	Envoke	Liberty
Application Timing	PRE				POST		
Site of Action Group	7	7	15	15	2	2	10
Weeds							
BROADLEAF WEEDS							
beggarweed, Florida	G-E	G	P-F	P-F	G	F-G	G
bristly starbur	G-E	F-G	P	P	G	G-E	G
black nightshade							
buttercup							
Carolina geranium							
chickweed							
cocklebur	F-G	F	P	P	N-P	E	G
coffee senna	F-G	F	P	P	G		G
crotalaria, showy	G	G	P	P			
cudweed							
curly dock							
cutleaf eveningprimrose							
eclipta	G						G
hemp sesbania	P	P	P	P	P		
henbit							
horsenettle			N	N			
horseweed			N	N			
groundcherries							
jimsonweed	G	G			F-G	N	E
lambsquarters, common	G-E	G-E	F	F	G		E
morningglories sp.	G-E	F	P	P	F-G	E	E
morningglory, smallflower	G-E	G-E	P	P	E	P-F	E
Palmer amaranth	F	G	G	G	G-E	P-F	F-G
Palmer amaranth (glyphosate-resistant)		G	G	G	G-E	P-F	F-G
Pennsylvania smartweed	G	G			G		G
prickly sida	E	F	F	F	G	N	F
purslane, common	E	E	G	G	G		F-G
ragweed, common	E	G	P	P	N-P		
ragweed, giant							
redweed	E	G-E			G-E		
shepherdspurse							
sicklepod	G	F	P		P	E	E
speedwell							
spurred anoda	P			N	G	P-F	
swinecress							
tropic croton	F-G	F-G	P	P	F		G
velvetleaf	P			N	E		F

N = No control P = < 70% control F = 70–80% control G 80–90% control E = 90% control

¹ Will not control ALS-resistant ryegrass

² Weeds must not be larger than 2 inches at time of application.

Table 11. Weed Response to Cotton Herbicides (cont.)

Herbicides	Poast Plus	Select Max	Assure	Fusilade	Liberty	Glyphosate + Direx	Glyphosate + Aim
Application Timing	POST					EPD	
Site of Action Group	1	1	1	1	10	17	14+9
Weeds							
GRASSES/SEDGES							
annual bluegrass	F	G	G	G	N	F	F
bermudagrass	G-E	G	G	G	G	G-E	E
crabgrass, large	F-G	G-E	G	F	G	G-E	E
crowfootgrasses	E	E	G-E	G-E	G	G-E	E
fall panicum	E	E	E	E	G	G-E	E
foxtail	E	E	G	G	P	E	E
goosegrass	G	E	E	G-E	G	G-E	E
johnsongrass (seedling)		E			G	E	
little barley		E			G	G	
ryegrass, Italian	G-E	E		G-E	G	E	E
signalgrass, broadleaf	E	E	G	G	G	G-E	E
Texas panicum	E	E			G	E	E
volunteer corn (not RR vol corn)	N	N	N	N	P	G	G
purple nutsedge	N	N	N	N	P	F-G	F-G
yellow nutsedge	N	N	N	N	P	F-G	F-G

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F = 70–80% control

G = 80–90% control

E = 90% control

¹ Will not control ALS-resistant ryegrass² Weeds must not be larger than 2 inches at time of application.

Table 11. Weed Response to Cotton Herbicides (cont.)

Herbicides	Poast Plus	Select Max	Assure	Fusilade	Liberty	Glyphosate + Direx	Glyphosate + Aim
Application Timing	POST					EPD	
Site of Action Group	1	1	1	1	10	17	14+9
Weeds							
BROADLEAF WEEDS							
beggarweed, Florida	N	N	N	N	G	E	E
bristly starbur	N	N	N	F	G	G-E	G-E
black nightshade	N	N	N	N			
buttercup	N	N	N	N			
Carolina geranium	N	N	N	N			
chickweed	N	N	N	N			
cocklebur	N	N	N	N	G	E	E
coffee senna	N	N	N	N	G	G	E
crotalaria, showy	N	N	N	N		G	G
cudweed	N	N	N	N			
curly dock	N	N	N	N			
cutleaf eveningprimrose	N	N	N	N			
eclipta	N	N	N	N	G	E	E
hemp sesbania	N	N	N	N			G-E
henbit	N	N	N	N			
horsenettle	N	N	N	N			
horseweed	N	N	N	N			
groundcherries	N	N	N	N			
jimsonweed	N	N	N	N	E	E	E
lambsquarters, common	N	N	N	N	E	G-E	G-E
morningglories sp.	N	N	N	N	E	G-E	E
morningglory, smallflower	N	N	N	N	E	E	E
Palmer amaranth	N	N	N	N	F-G	F-G	E
Palmer amaranth (glyphosate-resistant)	N	N	N	N	F-G	F-G	P-F
Pennsylvania smartweed	N	N	N	N	G	G	G-E
prickly sida	N	N	N	N	F	G	F-G
purslane, common	N	N	N	N	F-G	G-E	G
ragweed, common	N	N	N	N		E	E
ragweed, giant	N	N	N	N			
redweed	N	N	N	N		G-E	G-E
shepherdspurse	N	N	N	N			
sicklepod	N	N	N	N	E	E	E
speedwell	N	N	N	N			
spurred anoda	N	N	N	N			
swinecress	N	N	N	N			
tropic croton	N	N	N	N	G	E	E
velvetleaf	N	N	N	N	F		

N = No control P = < 70% control F = 70–80% control G 80–90% control E = 90% control

¹ Will not control ALS-resistant ryegrass

² Weeds must not be larger than 2 inches at time of application.

Table 11. Weed Response to Cotton Herbicides (cont.)		
Herbicides	Glyphosate + Valor	Glyphosate + Zidua
Application Timing	LPD	LAYBY
Site of Action Group	14+9	15+9
Weeds		
GRASSES/SEDGES		
annual bluegrass	F	F
bermudagrass	E	E
crabgrass, large	E	E
crowfootgrass	E	E
fall panicum	E	E
foxtail	E	E
goosegrass	G-E	E
johnsongrass (seedling)		
little barley		
ryegrass, Italian	E	E
signalgrass, broadleaf	E	E
Texas panicum	E	E
volunteer corn (not RR vol corn)	F	P
purple nutsedge	F	F
yellow nutsedge	N	N

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 P = < 70% control
 F = 70–80% control
 G = 80–90% control
 E = 90% control

¹ Will not control ALS-resistant ryegrass
² Weeds must not be larger than 2 inches at time of application.

Table 11. Weed Response to Cotton Herbicides (cont.)		
Herbicides	Glyphosate + Valor	Glyphosate + Zidua
Application Timing	LPD	LAYBY
Site of Action Group	14+9	15+9
Weeds		
BROADLEAF WEEDS		
beggarweed, Florida	E	E
bristly starbur	E	P-F
black nightshade		
buttercup		
Carolina geranium		
chickweed		
cocklebur	E	E
coffee senna	E	E
crotalaria, showy		G
cudweed		
curly dock		
cutleaf eveningprimrose		
eclipta	E	E
hemp sesbania		P-F
henbit		
horsenettle		
horseweed		
groundcherries		
jimsonweed	E	E
lambsquarters, common	G-E	G
morningglories sp.	E	F-G
morningglory, smallflower	E	G
Palmer amaranth	E	E
Palmer amaranth (glyphosate-resistant)	P-F	P
Pennsylvania smartweed	G	G
prickly sida	G-E	F-G
purslane, common	G-E	F-G
ragweed, common	E	E
ragweed, giant		
redweed		G-E
shepherdspurse		
sicklepod	E	E
speedwell		
spurred anoda		
swinecress		
tropic croton	E	E
velvetleaf		

COTTON DEFOLIATION GUIDE

The defoliation of cotton, under favorable circumstances, is a very desirable production practice. Defoliation can result in higher grades of cotton. It can reduce damage from boll rot by exposing greater portions of the plants to sunlight and air. Also, defoliation can facilitate the harvesting schedule. It tends to hasten the start of the picking season and allows picking to start earlier on mornings when the dew is heavy.

Is Defoliation Profitable?

Over several years and under favorable circumstances, defoliation is profitable. That is, the added returns from defoliation are greater than the added costs. However, results can vary considerably from year to year and from farm to farm, and even from field to field. As a consequence, the extra profits earned from defoliation are a reward for alert cotton producers who vary their use of the practice depending on the circumstance. This superior management involves combining close observation with a thorough knowledge of plant growth characteristics and the attributes of various defoliant materials.

A defoliant application will likely be profitable when:

- Plants are tall.
- Fruit set is heavy.
- Foliage is dense and succulent.
- Plants have cut-out but are not completely inactive.
- Secondary growth is not excessive.

A defoliant application will likely not be as profitable when:

- Plants are short.
- Leaves are sparse.
- Leaves are inactive due to drought, lack of plant food, complete maturity, etc.
- Boll set is light.
- Natural leaf drop is high.
- Plants are actively growing with no sign of cut-out.

Between these two extremes, the economic basis for defoliation is not so clear-cut. The advantages relate chiefly to creating a better environment for the opening bolls and facilitating the harvesting schedule as well as the mechanics of picker operation.

Timing of Application

The best time to defoliate varies with the weather, the condition of the crop, and the principal benefits expected. Often, something must be sacrificed to realize this benefit. Defoliating early to take advantage of higher temperatures and to permit earlier harvesting may result in sacrificing part of the top crop. Delaying defoliation of large, high-yielding plants until late-set bolls are fully mature may mean that lower temperatures will prevent good leaf drop and may result in excessive field deterioration of fiber and seed in the bolls that opened early.

In general, defoliation should be timed to permit the most efficient picking schedule with machines. If the application is delayed until 60 percent of the total crop to be harvested is open, 75 to 90 percent of the crop can likely be harvested within two weeks after the application, except when weather conditions are very favorable.

A defoliant should not be applied to the entire acreage at one time. The defoliation schedule should be coordinated with the harvest in such a way that harvest can follow defoliation within about two weeks. Defoliating too far ahead of picking can result in second growth problems, excessive field loss, and quality deterioration.

Materials

Aim, ET, Resource. These products provide good defoliation of mature cotton leaves but have minimal activity on juvenile growth. They may be mixed with ethephon and/or thidiazuron to speed boll opening and/or suppress regrowth. Adding crop oil concentrate at 1 to 2 pints per acre is needed for optimum activity.

CottonQuik, Finish. These “activated” ethephon products contain proprietary additives that increase the speed of boll opening and in some cases defoliation. Other harvest aides such as thidiazuron, Def, Harvade, Aim, ET, or Resource must often be added to increase overall defoliation.

Sodium Chlorate. Sodium chlorate is generally not used as a defoliant on spindle-picked cotton. Leaf sticking may occur with high application rates, and at normal rates it is usually not as effective as other defoliant. It is not a strong inhibitor of terminal regrowth and is not very effective on young immature leaves. **DO NOT** mix sodium chlorate with surfactants, oils, insecticides, or other defoliant.

Def 6. This phosphate-type material has been a standard defoliant for several years in Alabama. Although this material does not strongly inhibit regrowth, it is effective on young immature leaves. A rain-free period of 2 hours is sufficient for phosphate-type defoliant. The use of surfactants and/or crop oil has enhanced the performance of this material under very adverse conditions.

Thidiazuron (Dropp, etc.). Thidiazuron provides defoliation essentially equal to the phosphate-type defoliant. However, thidiazuron is a strong inhibitor of terminal regrowth. Thidiazuron activity is relatively sensitive to cool weather. Tank mixing thidiazuron with DEF or ethephon (Prep, etc.) will enhance the activity of thidiazuron under cool conditions. Thidiazuron requires a 24-hour rain-free period. Make sure to follow the label instructions for tank cleanup when using thidiazuron. Failure to follow label tank-cleaning instructions may cause premature defoliation of cotton when the sprayer is used the following year.

Ethephon. Ethephon (Prep, etc.) has been shown to accelerate the opening of cotton bolls. Increasing the rate of boll opening has allowed harvest operations to begin several days earlier, increased the percentage of the crop harvested during the first picking, and eliminated the need for a second harvest in many fields. However, some quality reduction may occur if a large percentage of the total harvest is immature bolls, which will be opened and harvested. The crop should be well matured prior to the use of this material to avoid reductions in fiber quality.

Although ethephon is not labeled as a defoliant, it does have some defoliant activity. It has provided satisfactory defoliation at the higher rate of application (2 pounds active ingredient per acre) under optimum conditions on well-matured cotton. The addition of ethephon at lower rates with other defoliants has been reported to increase the degree of defoliation under adverse conditions. Ethephon is compatible with Def, Harvade, thidiazuron, Aim, ET, and Resource but should **NOT** be mixed with sodium chlorate.

Desiccants. Desiccants (sodium chlorate, paraquat) are generally not used as a harvest aid for cotton harvested with spindle-type pickers. If desiccation is necessary because of regrowth or weeds, it is best to apply a defoliant, wait until leaf drop occurs, and then apply the desiccant. Desiccants kill the entire plant and burn immature bolls. Therefore, 90 percent of the crop should be open before applying a desiccant.

Coverage

Adequate spray coverage is essential. Good defoliation requires that the chemical be sprayed on each leaf. Where cotton is tall and foliage is dense, failure to distribute the material over the entire plant is a frequent cause of poor results. Too often the application is concentrated on the upper leaves which may be “burned” too drastically and fail to drop while the lower foliage remains green and unaffected.

For plants up to 5 feet tall which are not densely over-lapped between the rows, satisfactory spray coverage can be obtained with 5 to 8 gallons of total spray per acre applied by airplane and 15 to 20 gallons by ground machine. It is not satisfactory to fly 3 to 4 gallons per acre twice or to overlap the swaths in order to apply 6 to 8 gallons. In these cases, the spray is concentrated on the upper leaves as described above.

With ground equipment, coverage of entire plants can be accomplished using three nozzles per row with one over-the-top and one on each side. This is particularly advantageous for cotton that has rank growth. With aerial applications to rank cotton, two applications about 1 week apart may be required to get spray on all the leaves.

Surfactants

Surfactants are used to obtain more thorough wetting and adsorption. Read the container label for surfactant-use requirements.

Evaluating Cotton for Maturity

Determining when to defoliate and terminate a crop is often difficult. Cotton requires approximately 40 to 50 days for an early-season white bloom to develop into a mature boll. That interval will increase to as many as 60 days later in the season. The cutoff dates for white blooms to develop into mature bolls are generally predicted to be August 15 for North Alabama and September 1 for South Alabama. These dates may be earlier or later, depending on the temperature, rainfall, and length of the fall season.

Several methods can be used to predict the number of mature bolls that will probably be harvested. One involves simply counting down four to five nodes from the top of the plant. All bolls below that point should mature in time for harvest. Another method, called Nodes Above Cracked Boll, involves locating the uppermost cracked boll (already cracked when found) on the first fruiting position. The bolls located four to five nodes above this point are generally considered mature, and defoliation at that time would not decrease yield or quality.

Traditionally, producers have used a method that involves cutting the bolls with a sharp knife. If the boll cannot be cut without stringing fiber and if the seed coats have begun to darken, the boll is considered mature.

COTTON GROWTH REGULATORS AND HARVEST AID PRODUCTS

Growth Regulation

Plant growth regulators (PGRs) have long been used for controlling cotton height and vegetative production to facilitate insecticide application, reduce boll rot, and improve picker efficiency. The products currently marketed for controlling excessive vegetative growth in actively grown, non-stressed cotton contain the following: mepiquat chloride, mepiquat pentaborate, or cyclanilide plus mepiquat chloride. Research conducted over many years and/or locations across the Cotton Belt has indicated that these products will consistently control cotton plant height and often result in increased earliness when compared to untreated cotton. PGRs will likely provide the greatest growth-regulating benefits in fields where excessive growth traditionally occurs; fields where excessive vegetative production can occur due to irrigation, high fertilization rates, or poor fruit set; and fields planted in varieties known to have excessive growth habits. Treatment strategies may change depending on the sensitivity of the variety to PGRs. In many cases PGRs for cotton can be tank-mixed with insecticides, miticides, and/or foliar fertilizer according to specific product label directions and precautions.

Boll Opening

It may be desirable to accelerate the opening of mature cotton bolls in order to harvest earlier or for a once-over harvest operation. Ethephon has been shown to accelerate the opening of bolls and to enhance defoliation. Immature bolls will also be affected and, depending on the stage of maturity, the fiber may be immature, quality of seed may be lowered,

and yield may be reduced. Application should not be made until sufficient mature, unopened bolls have developed to produce the desired yield.

Cool, damp conditions occurring within 48 hours before or after treatment may severely inhibit the effectiveness of ethephon.

Defoliants and Boll-Opening Products

Several chemicals are labeled for use as defoliants (see table, below). They will defoliate cotton but will not kill the stalk under normal use. Some regrowth will occur with all of these products. For more information on cotton defoliation, see Circular ANR-715, "Cotton Defoliation."

Desiccants

A desiccant primarily dries plant tissue. These chemicals usually act so rapidly that leaves are killed and stick to the stalk and defoliation does not occur. Desiccants are generally recommended in areas where cotton is harvested by strippers. In Alabama, they should be used only as a last resort to eliminate second growth.

Additives

Additives are materials that are included in a tank mix with defoliants or boll openers to enhance the mixture's performance. Additives are often used to increase the speed of activity. They are also used when weather conditions are less than ideal. Before using an additive with harvest aides, carefully consider the crop condition and environmental conditions. Lush plants and hot (greater than 90°F) temperatures may be conducive to leaf sticking if additives are used.

Table 12. Rain-safe Period and Carrier Volume¹

PRODUCT	—————Rain-safe Period—————		—Minimum Water Carrier Volume—	
	without surfactant ²	with surfactant	aerial	ground
mepiquat chloride (Pix)	8 hours	4 hours	2 gpa	2 gpa
mepiquat pentaborate	2 hours	1 hour	2 gpa	10 gpa
cyclanilide + mepiquat chloride	4-8 hours	2 hours	2 gpa	10 gpa

¹ Specifications in this table are according to manufacturer's label directions.

² Rain-safe period may vary according to the product used, rain-fall duration, and the inclusion of a high-quality EPA-exempt surfactant.

Table 13. Plant Growth Regulators		
Trade Name	Common Name	Application Instructions
PIX and various trade names and formulations	mepiquat chloride (MC)	Apply Pix (8 to 16 fluid ounces) when cotton is approximately 20 to 30 inches tall and is not more than 7 days beyond the early bloom stage (five to six blooms per 25 row feet) or when poorly fruited cotton is 24 inches tall. Subsequent applications can begin 2 to 3 weeks after the first one. MC products can also be applied in low-rate multiple treatments when cotton is at the match-head square stage with additional treatments made at 7- to 14-day intervals if re-growth occurs. Low rate multiple application rates may increase according to the vegetative vigor of the field. Do not apply more than 48 fluid ounces of standard Pix or its active ingredient equivalent (0.132 pound mepiquat chloride) per acre per season. Late-season applications can be made up to 30 days prior to harvest. Since there are many trade names and formulations of MC available, read and follow use directions for the specific product.
PENTIA (8-24 fl.oz.)	mepiquat pentaborate (0.026-0.154 lb.)	Make initial application after cotton has reached the pinhead square stage and is actively growing and the second application after 2 weeks on vigorously growing cotton that has greater than five NAWF. Subsequent applications can be made as needed. Pentia can also be applied late in the bloom cycle on cotton likely to experience additional vegetative growth or re-growth up to 30 days prior to harvest. Do not exceed 48 fluid ounces of Pentia per acre per season.
STANCE (2-4 fl.oz.)	cyclanilide + mepiquat chloride	Begin applications at match-head square when 50 percent of the cotton plants have one or more match-head squares or later. Sequential applications should begin 7 to 14 days later or when re-growth occurs with a minimum of 7 days between applications. Do not apply within 30 days of harvest. Rate is dependent upon field examination and vegetative vigor. Do not exceed 22 fluid ounces of Stance per acre per year.

Table 14. Boll Opening Products		
Trade Name (Product/A)	Common Name (Rate a.i./A)	Application Instructions
BOLL'D* ETHEPHON PREP SUPER BOLL (1.33-2.67 pt.)	ethephon (1-2 lb.)	Apply in 5 to 50 gallons of water per acre when 40 to 60 percent of the bolls are open and when there are sufficient mature unopened bolls to produce the desired yield. Ethephon can be used 4 to 7 days prior to application of defoliant as a preconditioning agent, tank mixed with defoliant, or applied after defoliation. DO NOT harvest cotton sooner than 7 days after ethephon application. DO NOT mix ethephon with sodium chlorate products because toxic chlorine gas fumes will be produced.
* The addition of 5.33 fluid ounces of ethephon to Dropp or Folex is registered for use in Alabama. These mixtures have provided accelerated defoliation in some cases over the defoliant used alone, especially under less than ideal conditions.		

Table 15. Defoliant		
Trade Name (Product per Acre)	Common Name (Rate a.i. per Acre)	Application Instructions
SODIUM CHLORATE (several brands) Read label for rates.	sodium chlorate with fire suppressant (3-3.25 lb.)	Apply to mature cotton plants after the youngest bolls expected to make cotton are at least 30 days old. DO NOT apply later than 7 days before harvest. With ground equipment, use 10 to 20 gallons of spray solution per acre; by air, use 5 to 10 gallons per acre.

Table 15. Defoliant (cont.)		
Trade Name (Product per Acre)	Common Name (Rate a.i. per Acre)	Application Instructions
AIM 2EC (1-1.6 fl.oz.) + Crop Oil Concentrate (1 pt.)	carfentrazone (0.01-0.025 lb.) + crop oil concentrate	Apply when 60- to 70-percent of the bolls are open or according to Cooperative Extension System recommendations. Aim may be applied as a tank mix with other cotton harvest aids or as a sequential treatment. When applied alone, Aim provides cotton defoliation and desiccation of annual morningglory vines.
BLIZZARD EC (0.6 fl.oz.) + Crop Oil Concentrate (1 pt.)	fluthiacet (0.004 lb.) + crop oil concentrate	Apply when 60 percent or more of the bolls are open AND there are no more than four nodes between the highest first position cracked boll and the highest first position harvestable boll. May be mixed with other harvest aide products.
FIRSTPICK or COTTONQUIK (2-3.5 qt.)	ethephon plus tetraoxosulfate (4.8-8.4 lb.)	CottonQuik is a combination product designed to provide defoliation and open bolls. Dropp may be added to the tank mix to increase regrowth control.
DEF 6 (1-2 pt.)	phosphoro-trithioate (0.75-1.5 lb.)	Apply Def when 50 percent or more of the bolls are open and 7 to 10 days prior to anticipated picking. Use the low rate when the crop is mature and the weather is warm. When plants are still green and actively growing, when the temperature is cool, or when the weather is dry, use higher rates or a tank mix with another defoliant. Spray-mix of 5 to 25 gallons per acre should be applied.
DROPP SC or Generic Forms (3-6 fl.oz.)	thidiazuron (0.1-0.2 lb.)	Apply Dropp to plants ONLY when 60 to 70 percent of the bolls are open. Apply in 10 to 25 gallons of water per acre by ground equipment and 2 to 10 gallons per acre by air. Use higher rates during periods of low temperatures. Apply at least 5 days prior to picking. May be tank mixed with Def or Prep. Thidiazuron rates as low as 0.05 pound per acre (0.1 pound Dropp 50 WP or 1.5 fluid ounces Free Fall SC) may be used in tank mixes. Spray tanks should be cleaned immediately after using Dropp. To make cleanup easier, a non-ionic surfactant or compatibility agent is recommended when using tank mixes of Dropp plus Def. See label for more information.
ET 0.2E (1.5-2 oz.) + Crop Oil Concentrate (1 pt.)	pyraflufen (0.0015-0.003 lb.) + crop oil concentrate	Apply when 50 to 70 percent of bolls are open or according to label recommendations. ET provides cotton defoliation and desiccation of annual morningglory vines when used alone.
FINISH 6 PRO (1.3-2 pt.)	ethephon + cyclanilide (1-1.5 lb.)	Finish is a combination product designed to provide defoliation, boll opening, and regrowth control in one product. May be mixed with Def, Dropp, or Harvade.
GINSTAR 1.5E (0.4-1 pt.)	thidiazuron + diuron	Ginstar provides defoliation and regrowth control in cooler weather than Dropp. Adjuvants (crop oil concentrates, non-ionic surfactants) are not required with Ginstar. May be mixed with Prep (ethephon) to provide boll opening.
RESOURCE (4-8 fl.oz.)	flumiclorac (0.027-0.054 lb.)	Apply with 1 to 2 pints crop oil concentrate per acre to cotton at least 60 percent open. Resource can be tank mixed with other harvest aides to increase boll opening or suppress regrowth. A sequential application may be made 7 days after the initial application at up to 6 fluid ounces per acre.
ROUNDUP or TOUCHDOWN or GLYPHOSATE (generic)	glyphosate (1-2 lb.)	For preharvest use to control weeds and to provide regrowth control on non-Roundup Ready cotton. Apply at least 7 days prior to harvest. May be applied when cotton is 20 percent open with no fruiting gaps. Roundup will not defoliate cotton; therefore, a defoliant must be used following a Roundup application. Or, a tank mix with defoliant can be applied at the proper timing for defoliant use.

Table 16. Desiccants		
Trade Name (Product per Acre)	Common Name (Rate a.i. per Acre)	Application Instructions
GRAMOXONE LS (1-2 pt.) or FIRESTORM (0.67-1.33 pt.) + Non-ionic Surfactant (1 pt./100 gal. spray mix)	paraquat (0.25-0.5 lb.) + non-ionic surfactant	Apply as a desiccant when 80 percent or more of the bolls are open and the remaining bolls to be harvested are mature. DO NOT apply within 3 days before harvest. Low rates of paraquat may be used to speed boll opening when used with ethephon. Consult specific paraquat label for rate. Paraquat is a RESTRICTED USE pesticide.
SODIUM CHLORATE (several brands)	sodium chlorate (4 lb.)	Apply when cotton is fully mature and 70 percent or more of the bolls are open. DO NOT mix with other harvest aids. Picking should begin no later than 7 days after treatment.

Table 17. Additives		
Trade Name (Product per Acre)	Common Name (Rate a.i. per Acre)	Application Instructions
AMS 99% Powder (2 lb.)	ammonium sulfate (2 lb.)	Research has shown a small quantity of ammonium sulfate added to the spray mixture can increase the amount of defoliant which penetrates the cotton leaf.
PREP (other trade names) (5-6 fl.oz.)	ethephon (0.25 lb.)	The addition of 5 to 6 fluid ounces of ethephon per acre to defoliant has increased leaf drop in some cases. This rate will not open bolls.
ADJUVANTS	crop oil concentrates non-ionic surfactants penetrants wetting agents spreader-stickers organo silicones	Adjuvants form a broad group of materials sold under a variety of trade names to be used with post-applied chemicals. Read the harvest aid label to determine if any adjuvant should or can be used.

WEED MAPS

Importance of Weed Maps

Maps showing locations of weed infestations in cotton fields are extremely helpful in planning and conducting weed control programs. Knowing the location of perennial weeds such as bermudagrass in fields helps in winter tillage programs and spot treatment with herbicides. The identification and location of weeds such as prickly sida (teaweed), spurred anoda, and velvetleaf should be extremely helpful in herbicide selection and rates needed.

Time of Year.

Weed maps should be made near the end of the growing season, with the ideal time being just before picking. Producers who employ scouts to check for insects could let the scouts

make weed maps of the fields the last time they scout the cotton. It is important to be as accurate as possible so that weed maps will reflect the weed problems in the field.

How to Make a Weed Map

In an average field, make a minimum of one count per 10 acres at random in the field. If one weed dominates in an area of the field, note on the field diagram the area of high population. Step off 500 feet. Count and record the number of different weeds for two crop rows and one middle. Count all weeds no matter how small. As you are moving through the field, note and diagram weeds such as johnsongrass, bermudagrass, and nutsedge on the field outline. In skip row cotton, count the skip and the rows on each side.

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FOR MORE INFORMATION on pesticides, pesticide safety, or submitting samples for analysis, see the following publications in the IPM series:

IPM 1293, "Safety." Safety contact information; worker protection standards; the safe use, handling, and storage of pesticides

IPM 1294, "Submitting Samples." Procedures for submitting samples for diagnosis, analysis, and identification

IPM 1295, "General Pesticide Information." Federal and state restricted use pesticide lists; pesticides and water quality

IPM 1317, "Appendix." Pesticide guidelines for agronomic crops, including preharvest intervals; rain-free requirements; grazing restrictions; crop rotation guidelines; and the names, classifications, and toxicities of pesticides.

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For more information, contact your county Extension office. Visit www.aces.edu/counties or look in your telephone directory under your county's name to find contact information.

Use pesticides **only** according to the directions on the label. Follow all directions, precautions, and restrictions that are listed. Do not use pesticides on plants that are not listed on the label

The pesticide rates in this publication are recommended **only** if they are registered with the Environmental Protection Agency or the Alabama Department of Agriculture and Industries. If a registration is changed or canceled, the rate listed here is no longer recommended. Before you apply **any** pesticide, check with your county Extension agent for the latest information.

Trade names are used **only** to give specific information. The Alabama Cooperative Extension System does not endorse or guarantee any product and does not recommend one product instead of another that might be similar.

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