Crop Profile for Cotton in North Carolina

Prepared: February 1999
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General Production Information

- North Carolina ranked sixth nationally in the production of cotton in 2003, representing 5.7 percent of U. S. production.
- In 2003, 770,000 acres of cotton were harvested in North Carolina.
- In 2003, 1,037,000 bales (480-pound bales) of cotton were produced in North Carolina for a value of $322,051,000.
- North Carolina is the leading textile-manufacturing state in the nation. Most of the cotton produced in the state is consumed by mills in North Carolina or neighboring states.

Production Regions

Most of the cotton produced in North Carolina is grown in the Coastal Plain region in the eastern portion of the state (Figure 1). About 3 percent of the acres are located in the southern Piedmont. Production in the Piedmont has increased dramatically recently.

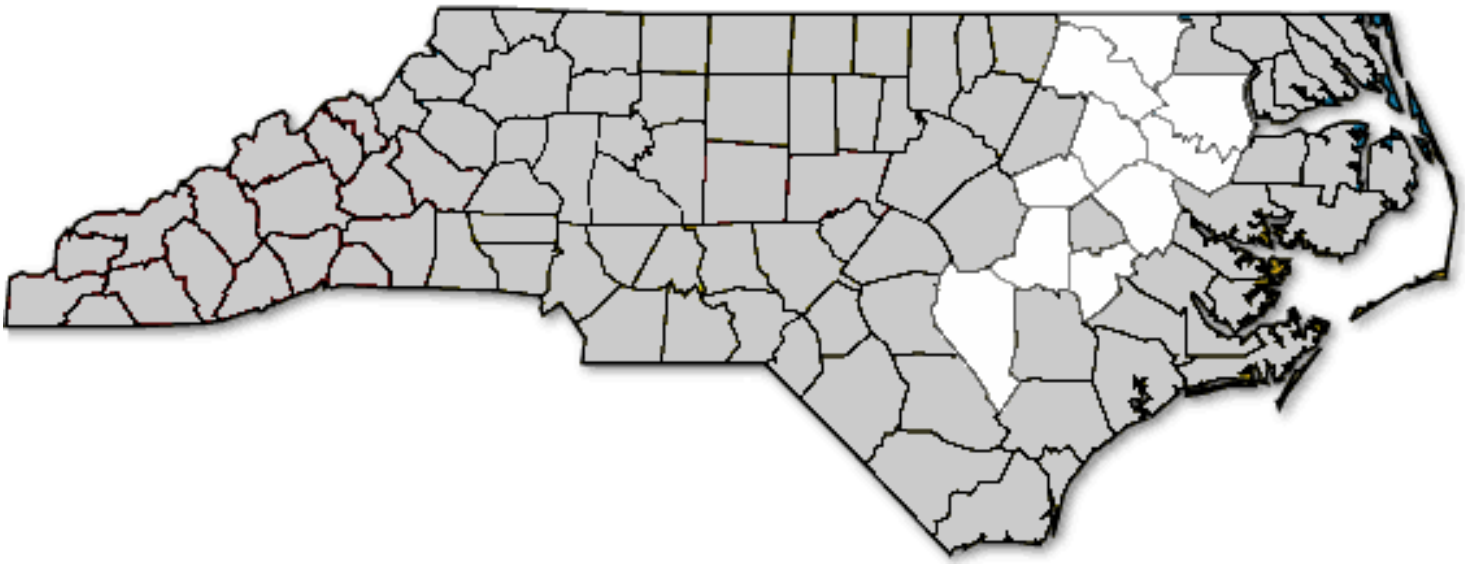

Figure 1. Leading cotton-producing counties in North Carolina, including Northampton, Halifax, Edgecombe, Martin, Bertie, Lenoir, Sampson, Pitt, Wilson and Wayne counties.

Cultural Practices

A wide variety of cultural practices are used across the state. The majority of cotton is located on the sandy loam soils of the Coastal Plain, and these require subsoiling to break naturally occurring hardpans. However, about 20 percent of the cotton produced in the coastal plain is grown on heavier soils that do not require subsoiling. No-till systems are gaining in popularity in these locales, as the soils have higher levels of organic matter and are often the most productive. Traditionally, these soils have been heavily tilled, utilizing two disking operations followed by subsoiling/bedding. Strip-till is increasing dramatically in this area as a method of controlling sand blasting. The heavier clay soils of the Piedmont do not require subsoiling, and most of this cotton is produced in no-till systems.

Planting begins in mid-April and usually is finished by the end of May, depending on the year. Only about 5 percent of the acreage in North Carolina is irrigated, much of that being supplemental and not sufficient to provide optimum water rates for the crop.

Weed control in cotton is critical. As a perennial, cotton is a very poor competitor with weeds. Also, uncontrolled weeds reduce quality and can reduce the value of the lint by 7 to 14 percent.

Insect pressure can reduce cotton yields dramatically in some years. Although North Carolina producers do not have to spray for insects nearly as often as those in many other cotton-producing states, heavy July bollworm flights demand that growers be timely with insecticide applications when they are needed.

Essentially, all of the cotton in the state is defoliated to allow for harvesting without fiber-quality loss.

Cotton harvested without defoliation is very likely to be of low quality because green leaves can stain the lint. Defoliation also allows the harvested material to be low enough in moisture to not heat and degrade in modules, a key consideration because most cotton in North Carolina is stored in modules before ginning. Defoliation further causes a harsh environment for aphids, reducing the need for chemical treatments in opening cotton.

Worker Activities

(The following information was taken from the March 2002 Mississippi Cotton Crop Profile and adapted for North Carolina cotton production.)

Insect Scouting: Scouting for insects and weeds and monitoring plant development are the primary activities requiring pedestrian workers to enter cotton fields during the growing season. Scouting is performed by professional crop consultants and summer scouts (usually high school or college aged individuals) sometimes employed by these consultants and sometimes self-employed, as well as by producers and industry field men. Full time cotton scouts often work in excess of 40 hours per week, and much of this time is spent walking through cotton fields, counting insects and assessing damage and collecting information on plant development. Cotton is scouted an average of twice weekly from emergence through the beginning of boll opening. Full time cotton scouts are in direct contact with plants for a large portion of each workday.

Irrigation: Approximately 5% of the cotton in North Carolina is irrigated via either furrow or overhead. With furrow irrigation (approximately 1/20th of the 5% that is irrigated), the irrigation pipe must be placed in fields for the season after all tillage operations are completed and removed before harvest. This requires workers to enter fields at least twice during the growing season to place and remove pipe. Workers may also be required to enter fields while the pipe is in place to make repairs and to manage the irrigation procedure. Workers performing such irrigation procedures may be in direct contact with plants; however, this occurs during a limited portion of the season.

Hand Weeding: Hand weeding is uncommon in North Carolina cotton (an estimated one-tenth of one percent of the acreage may be walked over by workers a single time).

Tillage, Spraying, and Harvest: Individuals performing cultivation, spraying and/or during harvesting are operating motorized equipment, usually from an enclosed cab. Occasionally, it is necessary for equipment operators to dismount in the field to perform minor repairs, such as adjusting cultivators or unclogging spray nozzles. Workers are in direct contact with plants during the time that they are dismounted, but this represents only a small portion of the workday.

Insect and Mite Pests

Thrips (various species)

Because thrips have the potential to cause significant yield losses and maturity delays, this pest group must be controlled annually. Treatment options include treated seed, at-planting granular insecticides, foliar insecticide application(s), or some combination. Thrips damage cotton seedlings by puncturing and rasping the outer cells of young leaves and buds. Then they consume plant juices. Damage frequently results in ragged-looking plants with crinkled or "possum-eared" leaves. This damage can stunt growth, resulting in fruiting at higher positions, maturity delays, and reduced yields. Damage from thrips can also be significant when plants fail to grow because of cool or dry weather. Dry weather may inhibit the uptake of at-planting insecticides, making the seedlings more susceptible. Also, the premature drying of alternate thrips hosts (for example, various crops and weeds) during dry or drought periods may force large numbers of flying adult thrips to abandon these plants in search of younger, greener hosts, such as cotton seedlings.

Chemical control

An at-planting, systemic insecticide or seed treatment is recommended in cotton planted with conventional row spacing. Even when a soil-applied systemic insecticide is used, thrips may still occur in damaging numbers. When a systemic insecticide fails to control thrips, a foliar spray may be warranted. However, in some cases, a spray may give rise to other problems. Aphid populations may increase, or second generation June tobacco budworms on conventional cotton may become established after the spraying because of the removal of beneficial insects. In most cases, the use of an at-planting, systemic insecticide is successful and is recommended over a foliar-spray-only approach because it

is less disruptive to the beneficial insects, far more persistent, and sometimes produces higher yields. However, a foliar-spray-only approach may be a viable option in ultra-narrow-row cotton due to the greater expense of an at-planting insecticide.

Of the several at-planting, systemic insecticides used to manage thrips in North Carolina, Temik 15G accounts for 99% or more of the market share, or approximately 80% of North Carolina's cotton acreage. Seed treatments used for thrips management account for the approximately 20% of the remaining at-planting acreage. Seed treatments include imidacloprid (Gaucho Grande) and thiamethoxam (Cruiser). Foliar insecticides applied to manage thrips include acephate (Orthene, dicrotophos (Bidrin), and dimethoate, and methamidophos (Monitor). Approximately 60 to 70% of the state's cotton acreage is treated with a foliar insecticide following Temik 15G or one of the seed treatments.

Cultural control

The importance of early planting for agronomic reasons (i.e., the short growing season) and in minimizing the impact of late-season insects overshadows other cultural practices that would help in lowering thrips damage. Some varietal differences in susceptibility to thrips have been noted, but these differences have generally not been significant or consistent.

Cotton Aphids *(Aphis gossypii)*

Cotton aphids are an occasional headache in a number of North Carolina cotton fields. Due to resistance development, treatment with organophosphates is often ineffective. The pyrethroid insecticide bifenthrin (Capture) also has succumbed to aphid resistance. Several new insecticides that provide good aphid control are now available, but they are costly. Additionally, because all of the new insecticides are of the chloronicotinoid class, aphid resistance to this new, effective class of insecticides is a major concern.

Fortunately, high levels of aphid mummifying parasites and fungi that, in most cases, usually hold or reduce aphids to low, subeconomic numbers often characterize our region. The combination of predators, parasites, and fungi, along with ineffective insecticides, usually justifies our general recommendation not to treat cotton aphids, especially in early to mid season, except under dry, stressed conditions, very high aphid levels, and little evidence of mummies or the fungus. In opening cotton, aphid-caused sooty mold or sticky cotton (from the heavy presence of honeydew) may become a problem. After the defoliant has been applied, however, cotton aphids are typically only at very low levels.

Chemical control

Insecticides recommended for cotton aphid management include the chloronicotinoids acetamiprid (Assail), imidacloprid (Trimax) and thiamethoxam (Centric). Imidacloprid + bifenthrin (Leverage) may be used to manage cotton aphids and bollworms occurring together.

Cultural control

Because cotton aphids are often more problematic in later-planted, rank cotton fields, early planting and growth regulation limit aphid population buildups. Early maturity can also minimize the number of pyrethroid insecticide applications required for July and August bollworms; these treatments often tend to flair cotton aphid populations.

Spider Mites *(Tetranychus urticae)*

Spider mite damage, rare in North Carolina as an economic problem in most years but sometimes more common on cotton in the northeastern peanut-production counties, can occur almost any time during the season and is usually more prevalent during dry conditions and on sandy soils. Mite damage appears as a slight yellow specking of the leaves, which later changes to a purplish or bronze color. Mite damage also can be recognized by the presence of fine webbing on the underside of the affected leaves. This webbing often traps blown sand grains. In severe infestations, the damage can cause widespread leaf yellowing and defoliation, typically beginning with the lower leaves.

Visual spot checks for mites can be made while scouting for other pests. Initial mite infestations often occur at field borders adjacent to drying corn, weeds, or mowed ditch banks or roadways. Even with obvious yellowing and defoliation, the presence of an active mite population in the field should be confirmed before

treating. In treating for mites, two expensive applications with excellent coverage are sometimes required for effective control. A fungus that preys on mites is often present, particularly under rainy or humid conditions, and may greatly reduce mite numbers while the damage symptoms are still present. Insecticides should not be applied if rain is likely.

Chemical control

Insecticides used for spider mite management include bifenthrin (Capture, Discipline), dicofol (Kelthane), fenpropathrin (Danitrol), propargite (Comite), methidathion (Supracide), and recently labeled (2005) spiromesifen (Oberon). In a typical year, approximately 1 to 2% of North Carolina's cotton acreage is treated for spider mites.

Cultural control

Because spider mites occur as a result of factors largely outside the control of producers (dry weather and mowing of highway rights of way), little in the way of cultural practices can be effectively practiced in non-irrigated cotton. Growers can affect mite populations somewhat by avoiding mowing field borders in cases where mites are present.

Plant Bugs *(Lygus lineolaris)*

Prior to bloom, plant bugs, or *Lygus*, damage cotton by feeding in tender terminals and, more commonly, directly on small squares with their needle-like mouthparts, causing the squares to abort. In pre-blooming cotton, plant bugs have required treatment on approximately 6 percent of the cotton acreage in North Carolina, averaged over the past eight years.

When blooming begins, plant bugs continue to feed on smaller squares and also on larger squares, which causes "dirty blooms" (white blooms with darkened pollen anthers and sometimes with small circular deformities on the petals). Additionally, plant bug feeding on small bolls up to approximately 2 weeks old may cause stinkbug-like external boll spotting and internal boll damage, such as callous growth (warts), deformed or rotted fruit, or small boll abortion. This boll damage is often identical to that caused by stink bugs. Plant bug damage to bolls is more common in untreated or minimally treated cotton, such as Bollgard cotton. However, plant bug damage can occasionally occur in blooming cotton before the major bollworm moth flight.

Early season monitoring of plant bug populations is recommended. Also, cotton growers should be mindful of field edges along ditch banks, adjacent host plants such as weedy flowering fields, or where Irish potatoes or a substantial acreage of corn is present. These areas are often a likely source of migrating adult plant bugs.

Chemical control

Insecticides used for plant bug management include acetamiprid (Assail), chlorpyrifos (Lorsban), dicrotophos (Bidrin), imidacloprid (Trimax), methomyl (Lannate), methyl parathion, oxamyl (Vydate), profenophos (Curacron) and thiamethoxam (Centric).

Cultural control

Early planting, adequate plant spacing (three or fewer plants per foot), and holding down excessive plant growth have been shown to decrease plant susceptibility to plant bug damage.

Stink Bugs *(Acrosternum hilare, Euschistus servus,* and others)

In situations of low insecticide use, often the case with Bollgard, BG II, and Widestrike cotton, the green stink bug (*Acrosternum hilare*) and the brown stink bug (*Euschistus servus*) have become more abundant and damaging. Stink bugs often invade cotton fields in early to mid July and may reach damaging levels from this time through late August and sometimes into September. They damage cotton by puncturing the carpal walls of bolls with their "beaks" and feed primarily on the soft, developing seeds. Heavy feeding often completely destroys small bolls, causing them to abort. These small, dead, dry, brown bolls are then either shed or remain on the plant. When stink bugs feed on slightly larger to medium-sized bolls (up to about 3 to 3.5 weeks), they may introduce boll-rot pathogens, resulting in partially or entirely destroyed locks, hard-lock, and a lower grade of harvested cotton.

Externally, boll damage is characterized by small, round, shallow, purplish depressions, usually in the 1/32- to 1/16-inch range. These spots tend to be larger than the tiny spots usually seen on maturing bolls. Internally, the damaged bolls will often have a yellowish to tan to brown stain in the seed areas, often, but not always, under the external feeding spots. Other damage symptoms include small wart-like growths and/or dark "pin prick" spots on the inside of the boll wall. Internal boll damage may be present without obvious external evidence.

Stink bug damage is more prevalent in fields where bollworm treatments have been minimal (that is, none or one), although significant stink bug damage may occasionally occur prior to applications for bollworms. Where the bollworm population is high enough that the field has been treated twice or more (as is often the case with conventional cotton), stink bug numbers will usually, but not always, be reduced enough to limit damage to low levels. Because stink bug and plant bug damage symptoms are often indistinguishable, damaged boll levels may sometimes be the result of feeding by both kinds of bugs.

Chemical control

Insecticides used for stink bug management include acephate (Orthene), dicrotophos (Bidrin), methyl parathion (Penncap-M), oxamyl (Vydate) and pyrethroid insecticides. Pyrethroids are less effective against brown stink bugs than green stink bugs.

Cultural control

Cultural practices that promote early maturity, providing stink bugs older, damage-resistant bolls, are the primary defense against this pest. Such practices include early planting, use of early varieties, avoidance of poorly drained soils, judicious use of nitrogen, and appropriate use of plant growth regulators to limit plant height.

Bollworms and Tobacco Budworms (*Helicoverpa zea* and *Heliothis virescens*)

Although technically beginning at first bloom in late June to early July, the start of the major mid July to early August bollworm (corn earworm) moth flight usually signals the onset of our most critical insect control period. The bollworm-tobacco budworm complex, typically composed of mostly bollworms, is the primary target for foliar insecticides in conventional cotton. However, European corn borers (ECB) and fall armyworms (FAW) also can inflict significant boll damage in some years, and stink bugs can be moderate to serious pests in low bollworm treatment situations, as is often the case in Bollgard, Bollgard II, or Widestrike cotton.

Because of the potential for severe boll damage from one or more of the above pests and because cotton damaged at this time of year usually compensates little for boll damage, insect damage to bolls must be minimized during all or part of late July through mid-to-late August in North Carolina.

The first two generations of bollworms occur primarily on field corn. Third generation

(sometimes referred to as the second field, or F_2 generation) moths usually emerge in large numbers from mid July to early August when corn is drying, and they fly to the more attractive, blooming cotton.

Systematic, regular weekly scouting of non-*Bt* cotton for the bollworm, and the tobacco budworm, should begin in early to mid July. Weekly scouting is adequate until egg laying or light-trap catches increase, although light traps are ineffective in monitoring budworm moths. Budworms, whose population levels may be assessed more effectively by pheromone traps, typically make up a small component of the bollworm/budworm complex at the time of the major moth flights.

Bollgard cotton

Bollgard and Bollgard II cotton (varieties that have been genetically altered to express the caterpillar toxin of *Bacillus thuringiensis)* were planted on approximately 81 percent of the state's cotton acreage in 2004, up 8 percent from the prior year. Bollgard cotton was treated an average of 1.24 times, up slightly from the 1.1 applications in 2003. Mean boll damage to Bollgard cotton from bollworms was approximately one-sixth of that found in conventional cotton (1.24 versus 7.2 percent). Stink bug (including plant bug) damage to Bollgard and conventional cotton bolls was 15.3 and 6.9 percent, respectively, much higher than the average boll damage of the previous 8 years of Bollgard availability – 3.1 and 1.2% boll damage from bug species for Bollgard and for conventional cotton, respectively. Overall boll damage to Bollgard cotton was slightly higher than on conventional cotton, 16.9 versus 15.0 percent, respectively, in 2004.

Widestrike cotton

Limited quantities of Widestrike cotton varieties will be introduced for the 2005 growing season. Widestrike is a two-gene product like Bollgard II, and in replicated tests this new product appears to be intermediate between Bollgard and Bollgard IIin its effectiveness against bollworms, North Carolina's major caterpillar pest of cotton. Like Bollgard II and unlike Bollgard, Widestrike also shows a wide range of activity against other caterpillar pests, such as fall and beet armyworms and loopers.

Chemical control

Insecticides used for the management of bollworms and tobacco budworms are bifenthrin (Capture, Discipline), cyfluthrin (Baythroid), cypermethrin (Ammo), deltamethrin (Decis), esfenvalerate (Asana XL), *gamma*-cyhalothrin (Prolex), *lambda*-cyhalothrin (Karate), tralomethrin (Scout X-Tra), zetamethrin (Fury, Mustang Max), spinosad (Tracer), indoxacarb (Steward), methomyl (Lannate), profenophos (Curacron) and thiodicarb (Larvin).

Cultural control

As with stink bugs, cultural practices that promote early maturity, providing these larvae older, damage-resistant bolls, are the primary defense against this damage. Such practices would include early planting, use of early varieties, avoidance of poorly drained soils, judicious use of nitrogen, and the appropriate use of plant-height-limiting plant growth regulators.

Budworm and bollworm resistance to pyrethroid insecticides

Unlike several Mid South and western cotton-growing states whose growers must sometimes treat portions of 3 or 4 tobacco budworm generations per year in conventional cotton, in the past seven years our growers have treated only 1 to 8 percent of their cotton acreage for the June to early July budworm generation, primarily in southern North Carolina. However, more than 95 percent of our cotton crop is treated for the major late July to early August bollworm generation and sometimes part of a late August to early September generation. Adult vial testing for bollworm resistance to pyrethroid insecticides and a decline in pyrethroid performance against bollworms have revealed the beginning of resistance to pyrethroids in scattered North Carolina bollworm populations. Fortunately, the bollworms have remained susceptible to pyrethroids for the most part, and widespread use of Bt cotton varieties has likely removed some of this selection pressure.

European Corn Borers *(Ostrinia nubilalis)*

Larvae of the European corn borer damage cotton by feeding on medium and large bolls of conventional cotton from early August through mid September. This species causes very little damage to Bollgard, Bollgard II, or Widestrike cotton. In rank or late-maturing cotton, boll damage can be significant. An earlier tunneling type of damage may occur within stems and leaf petioles, usually in mid July through late

August. Although this damage looks serious, with wilting and eventual death of the tissue above the feeding site, it causes no known economic loss.

European corn borers are primarily controlled via pyrethroid insecticide applications targeted for bollworms. Very few insecticide applications are targeted for European corn borers alone.

Fall Armyworms *(Spodoptera frugiperda)*

The presence of fall armyworms and their damage are recorded as part of bollworm scouting. Additional samples are usually unnecessary. However, if fall armyworms are found, noting and recording egg masses on the undersides of leaves in the upper third of plants and checking flowers for all armyworms are helpful. Because fall armyworms migrate into North Carolina from farther south, their numbers vary greatly from year to year and normally reach higher levels in the southern and southeastern counties. Fall armyworms have been an occasional complicating factor in the bollworm fight in a number of cotton fields in the southeastern counties for most of the past nine years, sometimes requiring the addition of a non-pyrethroid insecticide, such as thiodicarb (Larvin), profenophos (Curacron), or chlorpyrifos (Lorsban), to achieve effective control of small fall armyworms. Spinosad (Tracer) and indoxacarb (Steward) insecticides also show fall armyworm activity, but they have received only limited testing on this pest in North Carolina through 2004. Control of medium-sized to large fall armyworms is at best mediocre with all labeled insecticides. Bollgard II and Widestrike cotton lines appear to offer excellent resistance to fall armyworms.

Fall armyworms prefer blooms and bolls of all sizes. These caterpillars can be extremely damaging if present in moderate to large numbers, and they can become established late in the season, though rarely after September 1. They can feed on mature bolls normally resistant to bollworm penetration. Because the insecticides that control bollworms do not always control fall armyworms effectively, it is very important that they be identified correctly. Also, because fall armyworms are difficult to control with insecticides, treatments are best applied at an early boll bract feeding stage. Be on the alert if scouts find egg masses, particularly if the small, post-hatching larvae are dispersing from the egg masses. Fall armyworms have a more difficult time becoming established under a bollworm spray regime with certain pyrethroid insecticides.

As is the case with bollworms and European corn borers, all cultural practices that hasten cotton crop maturity also minimize fall armyworm damage via less susceptible fruit.

Beet Armyworms *(Spodoptera exigua)*

Beet armyworms are rarely cotton pests in North Carolina, although as recently as 2002 beet armyworms were present in most cotton fields, mostly at subeconomic levels. When beet armyworms occur initially, their population levels are usually low, and feeding is typically confined to leaves. When beet armyworms are present in higher numbers and the larvae attain some growth, they often begin to feed on squares and blooms and into small developing bolls. At times defoliation can be substantial. Early stage larvae tend to feed in groups on leaves and are often associated with webbing. These hatching egg masses with their

initial feeding are called “hits.” Initial spotting of a potential beet armyworm infestation is best accomplished by the finding and examining of brownish areas on the undersides of leaves, particularly at row ends or in plant skips in the field.

Spinosad (Tracer) and indoxacarb (Steward) usually provide acceptable to good control of beet armyworms at high rates, while methoxyfenozide (Intrepid) most often offers good to excellent activity. No other presently labeled bollworm insecticides in North Carolina will control beet armyworms; however, Bollgard II and Widestrike cotton lines provide excellent beet armyworm resistance.

Cabbage and Soybean Loopers *(Trichoplusia ni and T. includens)*

Cabbage and soybean loopers rarely damage cotton in North Carolina because they prefer foliage, are prone to virus attack (less so with the soybean looper), and occur sporadically. Observing foliage during routine late season scouting for other pests in most cases suffices for looper monitoring. However, with more cotton being grown in the far eastern counties, migratory, insecticide-resistant soybean loopers may occasionally be a problem and could warrant closer attention in conventional and in single gene Bollgard varieties.

Soybean loopers, however, are very difficult to control with insecticides. Indoxacarb (Steward) and spinosad (Tracer) insecticides appear to offer good control of soybean loopers, unlike our other labeled materials. Because foliage feeding typically begins at the bottom of the cotton plant and proceeds upward and out, foliage feeding may be beneficial in pre-harvest cotton that has begun to open. The brownish larval frass can be plentiful and temporarily stain opening cotton; however, this is not thought to be an economic problem.

Bollgard II and Widestrike cotton lines provide excellent resistance to loopers.

Boll Weevils (*Anthonomus grandis*)

The boll weevil was formally eradicated from North Carolina in 1987. To insure that the boll weevil is not reintroduced to the state, the North Carolina Department of Agriculture and Consumer Services administers a trapping program in association with the Southeastern Boll Weevil Eradication Foundation, Inc. All cotton fields in the state are trapped with a minimum of two traps.

Table 1. Insecticide use estimates for upland cotton in North Carolina, 2004. Source: October, 2004 Survey of North Carolina Independent Crop Consultants, selected county extension agents, and selected cotton producers. J. S. Bacheler.

Insecticide Active Ingredient	Area Applied[1] (Percent)	Number of Applications	Rate per Application (lbs./ acre)	Rate per Crop Year (lbs./ acre)	Total Applied[2] (1,000 lbs.)
Acephate	61	1.2	0.25	0.30	134
Aldicarb	79	1.0	0.67	0.67	386
Cyfluthrin	26	1.5	0.035	0.053	10
Cypermethrin	40	1.5	0.07	0.09	26
Dicrotophos	50	1.3	0.37	0.50	474
lambda-Cyhalothrin	28	1.5	0.03	0.03	6
Imidacloprid, Thiamethoxam	30	1.0	0.025 [3]	0.025	5.5
zeta-Cypermethrin	6	1.2	0.03	0.03	1.3

[1] Planted acres in 2004 for North Carolina were 730,000.
[2] Other insecticides used represented less than 1,000 pounds active/acre in 2004.
[3] Rate influenced by amount of seed and row spacing; these products also used in a foliar spray formulation for cotton aphids.

Current Insecticide and Miticide Recommendations for Cotton

Current North Carolina Cooperative Extension Service recommendations for insecticide and miticide use on cotton (including information on formulations, application rates, and precautions/limitations) are provided in the following table from the *North Carolina Agricultural Chemicals Manual*:

Table 5-5: Insect Control on Cotton
http://ipm.ncsu.edu/agchem/chptr5/505.pdf

Diseases

Organisms that cause cotton diseases, such as fungi, nematodes, and bacteria, grow on and within plant tissues. They often result in stunting of the plants, poor color, reduced vigor and yields, and sometimes death. Seeds and seedlings attacked by these pathogens often die, while older plants usually survive but perform poorly. Diseases also can result from an inhospitable environment, such as a field with too much or too little water or fertilizer, or from air pollutants, temperatures unfavorable for plant growth, or chemical injury, such as herbicide carryover.

Seed and Seedling Diseases

Seedling diseases cause an estimated average annual yield loss of 5 percent and are usually the major disease problems in cotton production in North Carolina. Several soil-borne fungi are responsible; however, cultural and environmental factors that delay seed germination and seedling growth make the problem more severe.

Environmental factors and seedling disease control

Seedling disease occurs more frequently under cool, wet conditions and seems to be more prevalent on sandy, low-organic-matter soils. Environmental factors are very important in influencing the development of seedling diseases. Other factors, such as planting too deeply, poor seedbed conditions, compacted soil, nematode or insect infestations, and misapplication of soil-applied herbicides such as dinitroanalines, may increase the problem. Seedling diseases tend to be more severe in reduced tillage situations and when beds are absent. Planting on beds elevates the seed, allowing for more rapid emergence, especially after heavy rains. Plants are more prone to attack by pathogens when stressed by insects or other causes. As a result, contagious diseases are often associated with insect infestations and poor growing conditions. Damage from thrips in particular can delay seedling development and enhance damping-off diseases caused by various fungi.

Fungi causing seedling diseases

Several species of fungi can cause seedling disease, but the primary agents are *Pythium* spp., *Rhizoctonia solani*, *Phoma exigua* (*Ascochyta*), and *Fusarium* spp. These disease-causing organisms can attack the seed before or at germination. They also can attack the young seedling before or after emergence. Seedling diseases do not usually kill the entire seedling population, but rather result in uneven, slow-growing stands with skips in the rows. In some years, replanting is necessary. Poor stand establishment causes problems with the management of other pests and may reduce yields.

***Pythium* spp.:** Several species of fungi in the genus *Pythium* can cause seedling disease in cotton as well as several other crops. *Pythium* spp. are generally classified as water molds, producing spores that move actively in soil water. In general, *Pythium* is commonly the culprit if the soil has remained saturated for several days or is poorly drained. Mefenoxam (Ridomil Gold) or etridiazole (ETMT, Terrazol) is necessary to control *Pythium* spp. seedling disease.

Rhizoctonia solani: This fungus typically causes sore shin and is more common on sandy, well-drained soils. Plants injured by sand blasting are particularly susceptible to this pathogen. Fungicides containing PCNB (Terrachlor), iprodione (Rovral) or azoxystrobin (Quadris) are generally effective against *Rhizoctonia solani*.

***Phoma exigua* (*Ascochyta gossypii*):** This fungus can cause postemergence damping-off. This disease is characterized by premature dying of cotyledons, which turn brown and shrivel; and it has been observed when night temperatures fall into the 50s and are accompanied by foggy or misty conditions. Fungicide effectiveness against *P. exigua* has not been evaluated.

***Fusarium* spp.:** Various species of the fungal genus *Fusarium* are typically found on diseased cotton seedlings. Seed-applied fungicides are generally effective in managing it.

Chemical control

A control program for seed and seedling diseases is based on preventive rather than remedial treatments. The program uses fungicides along with cultural practices to make conditions more favorable for the young cotton and less favorable for the disease-causing organisms. Poor-quality seed with low germination potential should be avoided.

All cotton seed offered for sale in North Carolina are treated with fungicides. Seed treatments are categorized as protectants and systemics. Protectant fungicides, such as captan or thiram, provide surface protection from disease organisms carried on the seed and from organisms found in nearby soil that cause seed rot. Systemic fungicides, such as carboxin (Vitavax) or mefenoxam (Ridomil Gold), are absorbed through the seed coat of the germinating seed and are taken up by the young seedling. Systemic fungicides provide temporary protection from certain types of preemergence and postemergence damping-off. Newer seed treatments are being developed at a rapid pace and for the most part reduce the amount of active ingredient required to achieve disease control and in most instances eliminate the need for older chemicals, which have been reviewed (such as captan and thiram). For example, Mefenoxam (Apron XL) is the active isomer of the product ridomil (metalaxyl) and the use of this material reduces the amount of chemical placed on seed by about one-third. Dynasty seed treatment is a combination of azoxystrobin, mefenoxam, and fludioxonyl, which provides broad spectrum control of a number of pathogens. Other seed treatments may still use metalaxyl (Apron) to control oomycetes but this must be used at higher rates. The only alternative to treatment with Apron type alternatives is currently etriadazole, although azoxystrobin may provide some protection against these types of fungi.

In most years, seed treatment fungicides are sufficient for controlling seedling disease, unless the quality of the seed is low or weather conditions are unfavorable for germination. If additional fungicide is desired, it is best to use an in-furrow treatment. Hopper-box seed treatments are also available, but coverage and effectiveness are much better with in-furrow sprays or granules.

An in-furrow fungicide is suggested for fields with a history of seedling disease problems, when planting early, or when cool, wet weather is expected shortly after planting. In-furrow treatments also are helpful if the seed quality is questionable. Fungicides, however, are not a substitute for high-quality seeds and good planting conditions. In-furrow fungicides will not be profitable in most years; however, if conditions are less than optimal, they can result in better and more uniform stands. In-furrow fungicides include azoxystrobin (Quadris), PCNB (Terraclor), iprodione (Rovral), etridiazole (Terramaster), mefenoxam (Ridomil Gold), PCNB + etridiazole (Terraclor Super X), mefenoxam + PCNB (Ridomil Gold PC) and azoxystrobin + mefenoxam (Quadris Ridomil Gold).

Cultural control

Crop rotation, good seed quality, optimum soil temperature, and destruction and incorporation of cotton residue are beneficial in suppressing most diseases. Seed treatments and in-furrow fungicides may become

more important in no-till cotton production systems.

Other Cotton Diseases

Boll rot

Boll rot is generally a problem when excessive insect damage or excessively wet conditions exist. Boll rot typically starts with small brown lesions that expand until the entire boll becomes blackened and dry. Growers can control insect damage and lower humidity in the canopy (by preventing rank growth) to reduce boll rot problems.

Leaf spots

Cotton leaves often get small, brown, circular lesions that enlarge to approximately ½ inch. Old lesions sometimes develop gray centers, which may fall out. Leaf-spot diseases are typically of minor importance, and specific controls are not recommended. These lesions often are not a disease at all but rather symptoms of phytotoxicity caused by a variety of crop protection chemicals. Leaf spots may be minimized by using the proper amounts of fertilizer and adequate drainage and by minimizing rank vine growth, which can promote excessively high humidity in the crop canopy.

Cotton stem canker

Numerous fields in the northeastern portion of the state and in Virginia were affected by cotton stem canker in 1999. This was caused by the fungus *Phoma exigua* (often referred to as *Ascochyta*). This fungus typically causes a leaf spot in North Carolina during wet years. Unseasonably cool weather in June was largely responsible for the outbreak of this disease. All varieties of cotton were apparently susceptible. Rotation and cultural practices did not have an impact on the severity of the disease. No fungicides are currently labeled for foliar application on cotton in the southeastern United States. Hot, dry weather prevented further development of the disease, although stands in many fields were reduced and cotton maturity was delayed in some instances.

Table 2. Fungicide use on upland cotton in North Carolina in 2003. Source: Agricultural Chemical Usage: 2003 Field Crops Summary. May 2004. U. S. Department of Agriculture, National Agricultural Statistics Service.

Fungicide Active Ingredient	Area Applied[1] (Percent)	Number of Applications	Rate per Application (lbs./ acre)	Rate per Crop Year (lbs./ acre)	Total Applied (1,000 lbs.)
Etridiazole	3	1.0	0.13	0.13	3
Mefenoxam	4	1.0	0.13	0.13	4
PCNB	7	1.0	0.55	0.58	33

[1] Planted acres in 2003 for North Carolina were 810,000 acres.

Current Fungicide Recommendations for Cotton

Current North Carolina Cooperative Extension Service recommendations for fungicide use on cotton (including information on formulations, application rates, and precautions/limitations) are provided in the following table from the *North Carolina Agricultural Chemicals Manual*:

Table 6-5: Cotton Seedling Disease Control
http://ipm.ncsu.edu/agchem/chptr6/602b.pdf

Nematodes

Nematodes are microscopic worms that feed on or in plant roots, robbing them of nutrients and causing injury. Nematodes occur in damaging levels in approximately 5 percent of the cotton fields of the state. But problems are more common and severe in the southeastern counties, where as many as 50 percent of the fields may be infested with damaging levels of nematodes. This high level of infestation is probably due to intensive cotton production (short or no rotation) and the lack of resistant varieties. The plant-parasitic nematodes that damage cotton include root-knot nematodes, stubby-root nematodes, sting nematodes, lance nematodes (common and Columbia) and reniform nematodes.

Nematode problems are most common in coarse-textured soils, although the reniform nematode is often a problem on heavier land. Damage caused by nematodes limits water and nutrient uptake and makes the root system more susceptible to other diseases. Symptoms can include increased seedling disease (root-knot and reniform nematodes), stunting, lower yield, poor stands, loss of green color, root galling (root-knot), stunted roots (sting and Columbia lance nematodes), and various nutrient deficiency symptoms. In some cases, there can be yield reduction without visible symptoms above ground. For example, reniform nematodes may cause 5 to 15 percent suppression in cotton lint yield in apparently healthy cotton fields. Yield losses caused by nematodes often result from abortion or dropping of bolls because of nematode-induced nutrient or water stress.

The kinds and numbers of nematodes in fields can be determined through a soil sample. Soil samples collected in the fall (September through November), when nematode numbers are highest, provide the best information, although samples can be collected anytime.

Chemical control

Nematicides have proven effective in increasing cotton yield when plant-parasitic nematodes exceed the damage threshold. Labeled nematicides at this time include 1,3-dichloropropene (Telone II), aldicarb

(Temik), fenamiphos (Nemacur), oxamyl (Vydate), and metam sodium (Vapam). If Temik is not used with Telone II, another material is recommended for thrips control. A new product (AVICTA, abamectin is a nematicide derived from the soil actinomycete *Actinomyces ivermitilis* has been shown to be effective in preventing cotton yield loss in the presence of damaging levels of plant-parasitic nematodes and will be available to producers in 2006. This is classified as a reduced risk pesticide by EPA and will be applied as a seed treatment at the rate of 0.15 mg/seed or about 9 grams of active ingredient per acre compared to approximately 400 grams of active ingredient per acre for aldicarb. It will however, only be available with selected treatments against fungi and early season insects.

Cultural control

Cotton nematode control is accomplished through crop rotation, resistance, and nematicides. Resistant varieties are available only for root-knot nematodes. Some varieties have shown extreme susceptibility to Columbia lance nematode and should be avoided in heavily infested fields. Long-season cotton varieties generally perform better than short-season ones when Columbia lance nematode is present.

Nematode control is best accomplished by preventing the buildup of harmful numbers of these parasites through rotation to crops that do not support their reproduction. Subsoiling can help reduce losses due to Columbia lance and other nematodes in areas where a hardpan is common. Destroying cotton roots after harvest will help reduce nematode survival in general since cotton is basically a perennial plant and some reproduction may occur after cotton harvest if soil temperatures remain warm. Some weeds also serve as hosts for nematodes and should be controlled in cotton and rotational crops.

Cover crops such as rye or wheat may aid in suppression of reniform and Columbia lance nematodes. Rye and wheat, however, are fair hosts for root-knot, Columbia lance, sting, and stubby-root nematodes. Cover crops should be planted as late in the fall as possible and either killed or tilled under in the spring before soil temperatures increase above 55° F to prevent nematode reproduction.

Applications of poultry litter have been shown to suppress both Columbia lance and root-knot nematodes in North Carolina. Generally, 4 to 6 tons per acre of poultry litter have proved effective in suppressing nematodes and enhancing cotton yield. Rates of litter should be applied according to an analysis of the nutrient levels of the litter and the crop requirements. Poultry litter must be incorporated to be effective in suppression of nematodes. However, in some cases the amount of poultry litter required to adequately suppress nematodes may exceed environmental guidelines for application of this waste.

Current Nematicide Recommendations for Cotton

Current North Carolina Cooperative Extension Service recommendations for nematicide use on cotton (including information on formulations, application rates, and precautions/limitations) are provided in the following table from the *North Carolina Agricultural Chemicals Manual*:

Table 6-6: Nematode Control on Cotton

http://ipm.ncsu.edu/agchem/chptr6/602b.pdf

Weeds

Effective weed management is one of many critical components of successful cotton production. Cotton requires better weed control than either corn or soybeans. Because cotton does not compete well with weeds, especially early in the season, a given number of weeds will reduce cotton yield more than corn or soybean yield. Weeds also may interfere more with harvesting of cotton, and they can reduce lint quality because of trash or possibly stain.

Summer annual and perennial grasses and nutsedges infesting cotton in North Carolina include bermudagrass, broadleaf signalgrass, crabgrass, crowfootgrass, fall panicum, Setaria species (giant foxtail, yellow foxtail), goosegrass, johnsongrass (seedling and rhizome), sandbur, Texas panicum, purple nutsedge and yellow nutsedge. Spreading dayflower and doveweed are becoming more common. The most common summer annual broadleaf species include *Amaranthus* species (redroot pigweed, smooth pigweed, Palmer amaranth), common lambsquarters, *Ipomoea* species (tall morningglory, pitted morningglory, entireleaf morningglory, ivyleaf morningglory, red morningglory), common cocklebur, common ragweed, prickly sida, sicklepod, tropic croton, and *Polygonum* species (Pennsylvania smartweed, ladysthumb smartweed). Less common summer annual broadleaf species include volunteer cowpea, Florida pusley, Eclipta, cutleaf groundcherry, eastern black nightshade, spurred anoda, and velvetleaf. Winter annual weeds encountered in conservation tillage systems include common chickweed, mouseear chickweed, henbit, Italian ryegrass, annual bluegrass, cudweed species, cutleaf eveningprimrose, curly dock, varius *Ranunculus* species, red sorrel, swinecress, wild mustard, and wild radish.

The first step in a weed management program is to identify the problem, which is accomplished by growers through weed mapping and in-season monitoring of weeds in their cotton fields. Both of these activities are dependent on proper weed identification.

Cultural control

Crop rotation aids in the management of nematodes and diseases. Additionally, it can be a significant component of a weed management program. Crop rotation allows the use of different herbicides on the same field in different years. By rotating cotton with other crops and selecting a herbicide program for the rotational crop that effectively controls the weeds that are difficult to control in cotton, one can reduce or prevent the buildup of problem weeds and help keep the overall weed population at lower levels. Crop rotation and properly planned herbicide rotation also prevent evolution of herbicide-resistant biotypes of weeds.

Cultivation has traditionally been a significant component of cotton weed management programs. In addition to controlling weeds, cultivation may improve early season cotton growth in tight or crusted soils. On most soils, however, cultivation is of no value beyond weed control. As better weed management

technology has become available, the need for cultivation has decreased. Most growers have successfully eliminated cultivation, and many have converted to no-till systems. Eliminating cultivation reduces equipment and labor demands and the subsequent weed flushes, moisture loss, and root damage associated with the practice.

Chemical control

Transgenic Cotton

Very little non-transgenic cotton is now being grown in North Carolina. **Roundup Ready** cotton is any variety of transgenic cotton containing the gene that imparts resistance to the herbicide glyphosate. Roundup Ready varieties were grown on 95 percent of North Carolina's acreage in 2004.

Most brands of glyphosate can be applied overtop of Roundup Ready cotton any time from cotton emergence until the fourth true-leaf stage of the crop (or fifth true leaf no larger than a quarter coin). The label-suggested rate for annual weeds is 0.56 to 0.75 pound acid equivalent per acre, depending on weed size. Registered brands of glyphosate can be applied twice overtop of Roundup Ready cotton as long as the two applications are at least 10 days apart, two nodes of new growth have occurred between the applications, and the second application is made before the cotton exceeds the four-leaf stage.

Labels of glyphosate brands registered for application to Roundup Ready cotton prohibit over-the-top application on cotton larger than the four-leaf stage except in salvage situations. Glyphosate applied overtop cotton larger than the four-leaf stage can and often does cause significant fruit abortion.

If application is desired on cotton larger than four leaves, glyphosate can be directed until layby. Two directed applications can be made per season. The maximum rate per application is 0.75 pound acid equivalent per acre. Glyphosate labels caution users to be especially careful to minimize contact with the cotton plant when directing on cotton larger than the four-leaf stage.

Liberty Link refers to transgenic cotton resistant to the herbicide glufosinate, which is sold under the trade name Ignite. Data on performance of Liberty Link varieties are still limited.

Crop tolerance of Ignite is excellent. The herbicide can be applied overtop of Liberty Link cotton from emergence until the early bloom stage without concern over injury or fruit shed. On cotton larger than about 10 inches, a semi-directed application may be preferred in order to obtain better coverage on weeds under the cotton canopy.

Preplant Incorporated Herbicides

Annual grasses and small-seeded broadleaf weeds: pendimethalin (Prowl, Prowl H_2O), trifluralin (Treflan)

Annual grasses and most broadleaf weeds: trifluralin (Treflan) + fluometuron (Cotoran)

Preemergence Herbicides

Annual broadleaf weeds: fluometuron (Cotoran), pyrithiobac sodium (Staple)

Annual grasses and pigweed: pendimethalin (Prowl, Prowl H_2O)

Annual grasses and broadleaf weeds: pendimethalin (Prowl, Prowl H_2O) + fluometuron (Cotoran)

Postemergence Herbicides – Overtop Application

Any Cotton Variety:

Annual grasses: quizalofop-p-ethyl (Assure II), fluazifop p-butyl (Fusilade DX), sethoxydim (Poast, Poast Plus), clethodim (Select)

Annual broadleaf weeds: trifloxysulfuron (Evoke), pyrithiobac sodium (Staple), pyrithiobac sodium (Staple) + MSMA (several brands)

Liberty Link Varieties:

Annual broadleaf weeds and most grasses: glufosinate-ammonium (Ignite), glufosinate-ammonium (Ignite) + S-metolachlor (Dual Magnum), glufosinate-ammonium (Ignite) + pyrithiobac sodium (Staple)

Roundup Ready Varieties:

Annual and perennial grasses, annual broadleaf weeds, nutsedge, and suppression of perennial broadleaf weeds: glyphosate (numerous brands), glyphosate (numerous brands) + S-metolachlor (Dual Magnum), glyphosate + S-metolachlor (Sequence), glyphosate (numerous brands) + pyrithiobac (Staple)

Postemergence Herbicides – Directed Application

Any Cotton Variety:

Annual broadleaf weeds, small annual grasses and nutsedge: DMSA, MSMS, prometryn (Caparol) + MSMA, prometryn (Caparol) + MSMA + S-metolachlor (Dual Magnum), lactofen (Cobra) + MSMA, lactofen (Cobra) + diuron (Direx) + MSMA, fluometuron (Cotoran) + MSMA, fluometuron (Cotoran) + MSMA + S-metolachlor (Dual Magnum), diuron (Direx) + MSMA, trifloxysulfuron (Evoke) + MSMA, linuron (Layby Pro, Linex) + MSMA, trifloxysulfuron + prometryn (Suprend) + MSMA, flumioxazin (Valor) + MSMA

Liberty Link Varieties:

Annual grass and broadleaf weeds: glufosinate-ammonium (Ignite)

Roundup Ready Varieties:

Annual grass and broadleaf weeds, nutsedge, and suppression of perennial weeds: glyphosate (numerous brands), glyphosate (numerous brands) + carfentrazone (Aim), glyphosate (numerous brands) + prometryn (Caparol), glyphosate (numerous brands) + diuron (Direx), glyphosate (numerous brands) + S-metolachlor (Dual Magnum), glyphosate (numerous brands) + trifloxysulfuron (Evoke), glyphosate (numerous brands) + dimethipin (Harvade), glyphosate (numerous brands) + trifloxysulfuron + prometryn (Suprend), glyphosate (numerous brands) + flumioxazin (Valor), glyphosate + S-metolachlor (Sequence)

Postemergence Herbicide – Applied with Hooded Sprayer

Annual grasses and broadleaf weeds, and suppression of nutsedge: glyphosate (numerous brands), paraquat (Gramoxone Max)

Postemergence – Applied with Wiper Applicator

Weeds taller than crop: glyphosate (numerous brands)

Burndown in No-Till or Strip-Till Cotton

Cover crops (or heavy stands of winter weeds) should be killed at least 2 to 3 weeks before planting. This will avoid soil moisture depletion by the cover crop or weeds and allow time to apply additional burndown herbicide, if needed, to kill streaks that may have been missed during the original application. A small grain cover crop should be killed after the tillering stage but before enough residue is produced to interfere with the planting operation. If greater residue is desired, one can kill a strip over the row early and allow the cover crop in the row middles to continue to grow. Recommended burndown herbicides and application rates for small grain cover crops are outlined in Table 8-2D (http://ipm.ncsu.edu/agchem/chptr8/803.pdf) of the *North Carolina Agricultural Chemicals Manual*.

If no-tilling or strip-tilling into natural cover (i.e., winter weeds), the need for an early burndown treatment will depend on the weed species present and the size of the weeds. An early burndown is normally advantageous, especially if ryegrass, cutleaf eveningprimrose, wild mustard, wild radish, curly dock, or glyphosate resistant horseweed is present. For recommendations on the burndown of natural cover, see Table 8-2D (http://ipm.ncsu.edu/agchem/chptr8/803.pdf) of the *North Carolina Agricultural Chemicals Manual*.

Cutleaf eveningprimrose has been one of the most common and most difficult weeds to kill in strip-till or no-till fields. The most effective and economical option for cutleaf eveningprimrose is application of 2,4-D alone or mixed with glyphosate at least 30 days before planting. The ideal time to apply 2,4-D is early March. The suggested rate of application of 2,4-D to control cutleaf eveningprimrose is ½ pint per acre (use 1 pint per acre for other weeds, such as wild radish). Growers are strongly encouraged to incorporate this

treatment into their no-till or strip-till management programs. Cutleaf eveningprimrose is very difficult to control in emerged cotton. For growers who do not want to put 2,4-D in their sprays, a combination of glyphosate plus Valor is an option. Extensive research has shown little to no benefit from application of Aim, Goal, Harmony Extra, Harmony GT, or Resource to cutleaf eveningprimrose. Before using Valor, review the label for tank-cleaning procedures recommended after each day of use.

Early control of cutleaf eveningprimrose and other weeds is recommended. However, after cutleaf eveningprimrose has begun blooming, good control can be obtained with a combination of Gramoxone plus Direx. This combination also is effective on most other winter weed. In preliminary research, Ignite has also been effective on cutleaf eveningprimrose under warm conditions. In addition to the burndown herbicide applied 2 to 3 weeks or more before planting, one normally needs to apply glyphosate or Gramoxone at planting to kill any weeds emerging after the earlier burndown application.

Table 3. Herbicide use on upland cotton in North Carolina in 2003. Source: Agricultural Chemical Usage: 2003 Field Crops Summary. May 2004. U. S. Department of Agriculture, National Agricultural Statistics Service.

Herbicide Active Ingredient	Area Applied[1] (Percent)	Number of Applications	Rate per Application (lbs./ acre)	Rate per Crop Year (lbs./ acre)	Total Applied (1,000 lbs.)
2,4-D	5	1.0	0.43	0.43	17
Carfentrazone-ethyl	13	1.0	0.03	0.03	3
Fluometuron	16	1.0	0.97	0.98	128
Glyphosate	90	2.4	0.70	1.72	1,252
MSMA	19	1.0	1.39	1.47	222
Pendimethalin	25	1.0	0.68	0.68	135
Prometryn	28	1.0	0.80	0.88	196
Pyrithiobac-sodium	6	1.1	0.03	0.04	2
S-Metolachlor	7	1.0	0.95	0.95	51

[1] Planted acres in 2003 for North Carolina were 810,000 acres.

Current Herbicide Recommendations for Cotton

Current North Carolina Cooperative Extension Service recommendations for herbicide use on cotton (including information on formulations, application rates, and precautions/limitations) are provided in the following tables from the *North Carolina Agricultural Chemicals Manual*:

Table 8-2A: Chemical Weed Control in Cotton
http://ipm.ncsu.edu/agchem/chptr8/803.pdf

Table 8-2B: Weed Response to Preplant, Preemergence, and Postemergence Overtop Herbicides in Cotton
http://ipm.ncsu.edu/agchem/chptr8/803.pdf

Table 8-2C: Weed Response to Postemergence Directed Herbicides in Cotton
http://ipm.ncsu.edu/agchem/chptr8/803.pdf

Table 8-2D: Weed Response to Burndown Herbicides for Conservation Tillage Cotton
http://ipm.ncsu.edu/agchem/chptr8/803.pdf

Plant Growth Regulators, Defoliants and Desiccants

Plant Growth Regulators

Growth regulators are used to control cotton plant height. Mepiquat chloride, the active ingredient in Mepiquat, is now available under other trade names. Mepiquat pentaborate is the active ingredient in a new growth regulator named Pentia. These growth regulators are both anti-gibberellens that control plant height and can increase earliness. Research conducted in North Carolina, as well as in other areas of the cotton belt, has demonstrated that Mepiquat treatment can hasten maturity, reduce plant height, facilitate insect management, decrease boll rot, and increase yield.

Boll-opening materials are often used in combination with defoliation materials to increase the percentage of the crop harvested during first picking or possibly to eliminate the need for a second picking. Boll maturity is very important when using a boll-opening material. Lint micronaire and strength can be adversely affected if immature bolls are opened. In certain years cotton micronaire is improved by mixing higher micronaire cotton from the bottom of the cotton plant with lower micronaire cotton from the top. Picking capacity, the number of unopened bolls, and the cost of second picking determine whether boll opening is economical. Ethephon (Prep, Boll-D, Ethephon) stimulates boll opening by increasing ethylene synthesis that normally occurs at boll opening.

Defoliants

Defoliation is the application of chemicals to encourage or force cotton leaves to drop from the plant in order to harvest the crop in a timely manner. Benefits of defoliation include: 1) elimination of the main source of stain and trash, resulting in better grades; 2) faster and more efficient picker operation; 3) quicker drying of dew, allowing picking to begin earlier in the day; 4) straightening of lodged plants for more efficient picking; 5) retardation of boll rot; and 5) potential stimulation of boll opening, which can increase earliness, yield, and profit. Defoliants used on cotton in North Carolina include carfentrazone (Aim), ethephon + cyclanilide (Finish), glyphosate (Roundup), thidiazuron (Dropp, Free Fall), thidiazuron +

diuron (Ginstar), 1-aminoethanide dihydrogen tetraoxosulfate and ethephon (CottonQuik), cacodylic acid (Quick Pick), tribufos (Def, Folex), and dimethipin (Harvade).

Desiccants

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

Table 4. Plant growth regulator and defoliant use on upland cotton in North Carolina in 2003. Source: Agricultural Chemical Usage: 2003 Field Crops Summary. May 2004. U. S. Department of Agriculture, National Agricultural Statistics Service.

Active Ingredient	Area Applied[1] (Percent)	Number of Applications	Rate per Application (lbs./ acre)	Rate per Crop Year (lbs./ acre)	Total Applied (1,000 lbs.)
Bacillus cereus[2]	37	1.5			
Cyclanilide	25	1.0	0.15	0.15	31
Ethephon	78	1.0	1.15	1.16	734
Mepiquat chloride	62	1.5	0.07	0.12	58
Monocarbamate dihyd.	35	1.0	3.32	3.35	945
Paraquat	4	1.2	0.32	0.40	14
Pyraflufen ethyl	6	1.0	0.003	0.003	[3]
Thidiazuron	9	1.0	0.05	0.05	4
Tribufos	37	1.0	0.66	0.66	198

[1] Planted acres in 2003 for North Carolina were 810,000 acres.
[2] Rates and total applied are not available because amounts of active ingredient are not comparable between products.
[3] Total applied is less than 500 pounds.

Current Plant Growth Regulator and Defoliant Recommendations for Cotton

Current North Carolina Cooperative Extension Service recommendations for plant growth regulator and defoliant use on cotton (including information on formulations, application rates, and precautions/ limitations) are provided in the following tables from the *North Carolina Agricultural Chemicals Manual*:

Table 9-1: Growth Regulators for Cotton
http://ipm.ncsu.edu/agchem/chptr9/901.pdf

Table 9-2: Guidelines for Use of Defoliants on Cotton
http://ipm.ncsu.edu/agchem/chptr9/901.pdf

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2. Morgan, E. R. 2002. Crop Profile for Cotton in Mississippi. http://www.ipmcenters.org/cropprofiles/docs/MScotton.html
3. Sherrell, E. M. (ed.). 2004. North Carolina Agricultural Statistics 2004. Publication No. 204. North Carolina Department of Agriculture & Consumer Services, Raleigh.
4. U. S. Department of Agriculture, National Agricultural Statistics Service. 2004. Agricultural Chemical Usage: 2003 Field Crops Summary. May 2004.

On-Line Resources

2005 Cotton Information
http://ipm.ncsu.edu/Production_Guides/Cotton/contents.htm

Cotton Disease Information Notes
http://www.ces.ncsu.edu/depts/pp/notes/Cotton/cotton_contents.html

Cotton Insect Corner
http://ipm.ncsu.edu/cotton/InsectCorner/

Cotton Insect Scouting Guide
http://ipm.ncsu.edu/cotton/insects/scout_insects.html

Insect Pests of Cotton, from Insects and Related Pests of Field Crops
http://ipm.ncsu.edu/AG271/cotton/cotton.html

A Scout's Guide to Basic Cotton Terminology
http://ipm.ncsu.edu/cotton/glossary/glossary.html

Pesticides and Wildlife – Cotton

http://ipm.ncsu.edu/wildlife/cotton_wildlife.html

The Cotton Pickin' Web
http://pestdata.ncsu.edu/cottonpickin/

Boll Weevil Program, North Carolina Department of Agriculture and Consumer Services
http://www.ncagr.com/plantind/plant/entomol/BW.htm

Cotton, Field Crop of North Carolina
http://www.ncagr.com/markets/commodit/horticul/cotton/index.htm

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