COTTON DISEASE AND NEMATODE CONTROL
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by
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Table of Contents

Seedling Disease Symptoms .................................................................................................................. 1
Cotton Seedling Disease Loss Estimate, Table 1 ............................................................................... 2
Seedling Disease Control .................................................................................................................. 3
Cotton Seedling Disease Point System, Table 2 .............................................................................. 4-5
Verticillium Wilt .............................................................................................................................. 6
Boll Rots ........................................................................................................................................... 7
Nematodes .......................................................................................................................................... 7
Major Cotton Disease Identification and Control Chart ................................................................. 8
General Cotton Disease Control Guide ............................................................................................ 9
Diagnosis and Management of Foliar Diseases of Cotton .............................................................. 10-13
COTTON DISEASES

Cotton is a major crop in parts of the African Tropics, Australia, China, Egypt, India, Mexico, Pakistan, Soviet Union, the Sudan, United States, and warmer regions of Central and South America. Diseases have always been a problem wherever cotton is grown. Toward the end of the 19th century, concern was voiced about the increasing toll taken by diseases each year in the U.S. In 1887, studies were undertaken to determine the loss to Phymatotrichum root rot in the black lands of Texas. In 1899, Atkinson reported in detail the serious damage caused in Alabama by Fusarium wilt, anthracnose, bacterial blight and nematodes. These pioneering works have been followed by a century of research and education on cotton diseases. In 1936 in Jackson, Mississippi, a small group of cotton pathologists organized the Cotton Disease Council, which has met annually except during World War II. This group shares information concerning the control of cotton diseases and studies ways to estimate disease losses. It has developed general guidelines for assessing yield reduction in cotton-growing states.

SEEDLING DISEASES

Seedling diseases can cause great losses to cotton producers in Tennessee. They comprise the number one disease problem. The estimated loss is an average of 7.53 percent annually based on a range of 3.0 to 22 percent since 1995. The average seedling disease loss for the U. S. Cottonbelt is only 3.0% annually for the same period. During cool, wet planting seasons, such as 1993, 1997, 2002, and 2003, seedling diseases can become severe. Loss estimates do not include the cost of replanting or losses due to lateness of replanted cotton. Table 1 gives the average loss from the major diseases over the past 15-year period.

CAUSE

A number of organisms are associated with cotton seedling diseases. The organisms include both seed- and soil-borne fungi and bacteria. The soil-borne fungi, Rhizoctonia solani and Pythium spp., are the most important causes of seedling diseases in Tennessee. Rhizoctonia solani is the fungus most commonly associated with seedling diseases due to wide temperature range for infection (64 - 91° F); however, Pythium spp. may become more prevalent even with its narrower range (61 - 68° F). Thielaviopsis basicola has been found to cause seedling diseases, but it is still uncertain how prevalent it is.

SYMPTOMS

The various phases of seedling diseases include seed-rot, root-rot, preemergence damping-off, and postemergence damping-off. The term "seed-rot" is used to describe the decay of seed before germination.

Root-rot (or black-root) may occur any time after germination of the seed but may not become conspicuous or cause severe damage until after the emergence of the seedling. Preemergence damping-off refers to the disease condition in which the seedling is killed between germination and emergence from the soil. The death of seedlings resulting shortly after their emergence from the soil is termed postemergence damping-off. The latter is referred to as "sore shin" when only stem girdling occurs. Rhizoctonia is usually the cause of sore shin.

1
### Table 1. Cotton Disease Loss Estimate for Tennessee 2000-2015

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SEEDLING DISEASES (<em>Rhizoctonia solani</em>, <em>Pythium</em> spp., <em>Fusarium</em> spp., etc.)</td>
<td>4.0</td>
<td>8.5</td>
<td>20.0</td>
<td>22.0</td>
<td>8.0</td>
<td>4.0</td>
<td>3.5</td>
<td>3.0</td>
<td>3.5</td>
<td>4.0</td>
<td>3.5</td>
<td>6.0</td>
<td>10.0</td>
<td>6.0</td>
<td>5.0</td>
</tr>
<tr>
<td>BOLL ROTS</td>
<td>3.0</td>
<td>5.0</td>
<td>5.0</td>
<td>2.0</td>
<td>5.0</td>
<td>4.5</td>
<td>2.0</td>
<td>0.5</td>
<td>1.0</td>
<td>5.0</td>
<td>0.5</td>
<td>0.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>VERTICILLIUM WILT (<em>Verticillium dahliae</em>)</td>
<td>0.25</td>
<td>0.1</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>0.20</td>
<td>0.1</td>
<td>0.01</td>
<td>0.1</td>
<td>0.0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>FUSARIUM WILT (<em>F. oxysporum f. sp. vasinfectum</em>)</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>BACTERIAL BLIGHT (<em>Xanthomonas malvacearum</em>)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ASCHOCHYTA BLIGHT (<em>Ascochyta gossypii</em>)</td>
<td>0.20</td>
<td>2.0</td>
<td>2.0</td>
<td>0.2</td>
<td>1.0</td>
<td>0.50</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>NEMATODES (Reniform)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.5</td>
<td>2.1</td>
<td>2.1</td>
<td>2.2</td>
<td>2.3</td>
<td>2.01</td>
<td>2.51</td>
<td>2.01</td>
<td>2.01</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>2.8</td>
</tr>
<tr>
<td>LEAF SPOTS (<em>Alternaria, Cercospora, Phomopsis, etc.</em>)</td>
<td>0.5</td>
<td>0.5</td>
<td>0.3</td>
<td>1.0</td>
<td>1.0</td>
<td>0.3</td>
<td>1.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.1</td>
<td>0.5</td>
<td>0.5</td>
<td>0.75</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td><strong>Total Percent Loss to Disease</strong></td>
<td>9.06</td>
<td>17.11</td>
<td>28.91</td>
<td>27.55</td>
<td>17.6</td>
<td>11.7</td>
<td>10.4</td>
<td>6.52</td>
<td>8.02</td>
<td>12.01</td>
<td>6.61</td>
<td>11.01</td>
<td>15.01</td>
<td>12.26</td>
<td>10.96</td>
</tr>
</tbody>
</table>

**COMMENTS:** Loss estimates were taken from research and extension demonstrations and general observations taken across the state by Melvin A. Newman and Heather Kelly, Extension and Research Plant Pathologists.
SEEDLING DISEASE CONTROL

**Seed treatments:** Fungicide seed treatments give control of seed-rot and some control of preemergence damping-off. However, seed treatments may only give slight control of postemergence damping-off and root-rot. Seed treatment is quite effective in controlling seed-borne diseases.

**Soil treatments:** Postemergence damping-off and root-rot can be controlled to some extent by soil treatment. Three methods of applying soil fungicides are recommended in Tennessee. These methods are the **hopper-box method**, the **in-furrow spray method**, and the **in-furrow granule method**. These methods should be used in addition to the recommended seed treatments. IN FIELDS WHERE SOIL-INCORPORATED, PREPLANT HERBICIDES OR GRANULAR, SYSTEMIC INSECTICIDES ARE USED, BE SURE TO USE A SOIL FUNGICIDE. Producers are advised to use the seedling disease point system on Table 2 to determine if in-furrow fungicide application is necessary.

**Hopper-Box Method:** Mix recommended fungicides thoroughly with reginned or acid delinted seed just before planting. Mixing may be done in a container, such as a tub, or by alternating layers of seed and fungicide as they are placed in the hopper. **Application of the fungicide in the hopper-box may change the seeding rate, and recalibration of the planter may be required.** Because of handling and mixing the hopper-box materials, clogging of the planter and abrasive action of the chemical may occur. This method is not as desirable as the in-furrow methods. Although less expensive, it is also less effective, but when used properly, gives better results than seed treatments alone, especially under lower disease pressure.

**In-Furrow Spray Method:** This method consists of applying a soil fungicide into the seed furrow and to the covering soil during the planting operation. Application is best accomplished with two spray nozzles mounted on the planter. A cone-pattern nozzle is suggested for applying the material into the furrow behind the planter shoe. This nozzle should be placed far enough behind the shoe to prevent wetting and clogging of the seed spout. The second nozzle should be placed so as to direct the spray into the covering soil in front of the press wheel. The recommended height for the front nozzle with a TX6 tip is 1½ inches above the original soil surface and 2 to 3 inches above the soil for the back nozzle with a TX3 tip. Where space is limited and two nozzles cannot be used, substitute one nozzle with a TX8 or TX10 tip in-furrow. Use 3-5 gallons of water per acre.

**In-Furrow Granule Method:** Granular fungicides or fungicide-insecticide combinations have given good control of seedling disease. They can be applied with applicators used for other granular chemicals and eliminate the need for additional spray equipment and water with the spray method. Effective control with granules depends on proper placement in the furrow between the seed spout and the covering device.

When using a single delivery tube, attach a flared baffle to the end at approximately a 45- to 90-degree angle to the row to obtain a two- to three-inch wide band. Granules then fall into the furrow from the seed drop to the covering device.

**Cultural Practices:** Certain cultural practices can help considerably in controlling seedling disease (see Table 2). Turning under crop residues as early as possible is suggested. Also, crop rotation with soybeans, corn, or grass crops will help prevent the buildup of certain pathogenic organisms to cotton seedlings. A well-prepared seedbed greatly enhances the chances of a good stand. Planting on beds has been shown to be of considerable value in some seasons by providing better drainage and warmer soil temperatures. Use certified seed or high quality seed with a germination of 80% or higher and plant only when soil temperatures reach 65-70°F and are expected to remain that high or higher for an extended period of time.
### Table 2

**COTTON SEEDLING DISEASE POINT SYSTEM**  
FOR IN-FURROW FUNGICIDES & SEED TREATMENTS  
by Melvin A. Newman, Professor  
The University of Tennessee Extension

<table>
<thead>
<tr>
<th></th>
<th>Points</th>
<th>Producer's Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soil Temperature:</strong> 3-Day Average at 4 Inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Less than 65 F</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>B. 65 – 72 F</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>C. Higher than 72 F</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Five-Day Forecast:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Colder and wetter</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>B. Colder</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>C. Wetter</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>D. Warmer</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Seed Quality: Cold Germination Value</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Less than 49%</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>B. 50-69 %</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>C. Higher than 70%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Field History:</strong> Based on Seedling Disease in Previous Years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Severe</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>B. Moderate</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>C. Low</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Tillage:</strong> Based on Field Preparation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. No-till</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>B. Minimal tillage</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>C. Conventional</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Row Preparation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Firm beds present</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B. Beds not firm</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>C. Bed absent</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td><strong>Seeding Rate:</strong> Number of Seeds Per Row Ft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Low: 3 and lower</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>B. Moderate: 5-6</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>C. High: 7 and higher</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>In-furrow Insecticide/Nematicide Applied: Temik, Di-Syston, Thimet, etc.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Yes</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>B. No</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Total:** If Point Total **Exceeds 150**, an In-Furrow Fungicide Application is Suggested. If less than 150 a seed treatment or hopper-box overcoat treatment should provide enough protection under light to moderate disease conditions. However, this point system does not guarantee an economical return.
The point system (See Table 2) was tested in by scientists, consultants, and growers in most areas of the Cotton Belt. One version of the system is not likely to fit all beltwide conditions. The seedling disease complex can vary greatly from field to field, and from year to year, depending upon several cultural and environmental conditions in Tennessee.

The use of soil fungicides should be determined by the **presence and intensity** of the following factors:

- **Soil Temperature.** Low soil temperatures create conditions that will slow seed germination and seedling emergence, thus extending the vulnerable period for infection. Many soil-borne pathogens are active at lower temperatures.

- **Five-Day Forecast.** Environmental conditions during the first week of planting are important to consider. A critical factor to evaluate is the combination of low soil temperatures and high soil moisture. Any condition that slows germination and growth of the seedling favors the seedling disease complex.

- **Seed Quality.** Poor quality seeds germinate and emerge more slowly than good quality seeds under similar conditions. Slow germination and emergence extends the period seeds are vulnerable to infection.

- **Field History.** The history of each field should be evaluated to determine if it has had a stand-establishment problem, which may have been caused by factors including: soil type, drainage, soil pH, and levels of organic matter.

- **Tillage.** A no-till, or stale, seed bed has a tendency to be slightly cooler and wetter than a conventional seed bed. This combination may be conducive to a carryover of disease inoculum on the past year's crop debris.

- **Seeding Rate.** Recommended seeding rates have gradually declined in most parts of the Cotton Belt. This increases the importance of getting a high percentage of seeds to germinate, emerge, and become established.

- **Insecticide/Nematicide Use.** Experience shows that the use of a soil fungicide can be a “safening” factor when certain soil-applied insecticides/nematicides are used.

- **Soil Moisture.** When soils are saturated with moisture for prolonged periods, seeds and seedlings are adversely affected. These conditions are ideal for the growth of several soil pathogens.

- **Planting Date.** A field planted prior to normal planting dates for its area will have conditions that **favor greater seedling disease pressure.**
VERTICILLIUM WILT

Verticillium wilt is one of the diseases affecting cotton in Tennessee. It is the most damaging of the two wilts that occur on cotton. This disease is present in the cotton-growing area and is most severe during cool, wet growing seasons.

Verticillium wilt is caused by the soil-borne fungus, *Verticillium dahliae*. This fungus can survive in the soil for many years, even in the absence of cotton.

Cotton seedlings infected with *Verticillium* usually turn yellow, dry out, and die. Plants which become infected later in the season are stunted and exhibit a yellow condition along the leaf margins and between the major veins. This yellowing imparts a mottled appearance to the plant. Severely affected plants will shed their leaves. Sprouts or new shoots may develop near the base of infected plants.

Positive diagnosis of Verticillium wilt in the field can be difficult because of its close similarity to Fusarium wilt. Both wilt diseases cause a brown discoloration of the interior of the stem. The discoloration associated with Verticillium wilt is usually more evenly distributed across the stem than that associated with Fusarium wilt. The browning of the stem tissues is also usually less intense where the wilt is caused by *Verticillium*.

The most tolerant varieties available should be planted in fields that are infested with *Verticillium*. Crop rotations will help reduce losses to Verticillium wilt, but they must be four- to six-year rotations. Any practice, such as bedding, which permits rapid warming of the soil will also help reduce losses.
BOLL ROTS

Boll rots have caused heavy losses to cotton producers during wet growing seasons. Damage from boll rots is most severe in fields where rank growth occurs. Rain and high humidity during late summer and fall are optimum conditions for boll-rot development.

A number of fungi and bacteria have been associated with boll rots. Some of these organisms invade the cotton bolls directly, whereas others enter through insect wounds or as secondary invaders. Boll rots cause losses by reducing yields, damaging the cotton fibers, and infecting seed. Infected seed will result in seedling blights the following season. Boll rots usually first appear as water-soaked spots. Later, as the infection spreads, the bolls turn black and may be covered with a moldy fungus growth. Badly infected bolls may drop from the plant.

To prevent boll rots, cotton growers should avoid excessive applications of nitrogen that promote rank growth of cotton. It has been found that skip-row cotton provides better air circulation, resulting in less boll rot. Defoliation will also help reduce boll rots. Bottom defoliation followed by complete defoliation about two weeks later has given good control of boll rots. A good insect control program will prevent injuries, which serve as infection sites for boll-rotting organisms.

Plant growth regulators such as Pix can also be used where rank growth usually occurs and boll rot is likely to be a problem. Pix should not be used on cotton under stress, especially drought stress.

Certain foliar fungicides (Quadris and Headline) are cleared for use in controlling boll rots and leaf spot. To date, research has not shown any yield benefit with foliar fungicide on cotton.

NEMATODES

For several years reniform nematodes (Rotylenchulus reniformis) have been a severe problem in cotton production in several states south of Tennessee. Reniform nematodes were first found in Madison and Crockett counties 1997-8. This nematode is spread very easily on farm equipment and has now spread to a total of 16 counties. They include: Bedford, Crockett, Fayette, Gibson, Hardeman, Haywood, Lauderdale, Madison, Shelby, Lake, Obion, Dyer, Carroll, McNairy, Tipton, and Lincoln counties. Producers should sample their cotton land for this nematode in the fall after harvest. High levels of reniform have been found as deep as 36 inches in the soil, making control difficult.

No current cotton varieties are resistant to the reniform nematode. If the reniform nematode is present, producers should rotate with a non-host crop such as corn or grain sorghum. The winter grain crops such as wheat, rye, oats and barley also are non-hosts; however, legume winter cover crops such as vetch and clover are hosts, as is soybean.

Reniform nematodes can infect and reproduce on cocklebur, cowpea, crotalaria, sow thistle, jimson weed, Florida beggar weed, and Florida pusley. While Temik was recommended in the past to help manage reniform nematodes this product is no longer on the market. Other options available include nematode seed treatments (active ingredients include Abamectin, Thiodicarb, or Bacillus firmus) and/or use two applications of Vydate 14 days apart starting at 2 leaf or pinhead growth stages.
## Major Cotton Disease Identification & Control Chart

<table>
<thead>
<tr>
<th>Disease</th>
<th>Cause</th>
<th>Symptoms</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Seedling Diseases</strong></td>
<td>Rhizoctonia, Pythium, Thielaviopsis spp., and several other fungi and bacteria</td>
<td>Seed-rot, root-rot, preemergence and post emergence damping-off.</td>
<td>Fungicide seed treatments help control seed rots and some preemergence damping-off. However, an additional soil treatment of fungicide may be used to control root-rots and most damping-off. In addition, producers must follow all other recommended cotton production practices for decreasing seedling diseases. Some of these practices include use of correct planting equipment and date of planting, good seed bed preparation, correct use of herbicides and insecticides, and use of high germinating seed.</td>
</tr>
<tr>
<td><strong>Fusarium Wilt</strong></td>
<td>Fusarium oxysporum F. vasinfectum</td>
<td>Plants become stunted, yellowed, followed by defoliation. Yellowing first occurs around leaf edges and advances inward. Cross sections of infected stems usually reveal a brown discoloration that is more intense in outer layers of tissue. Infected plants fruit earlier and produce smaller bolls.</td>
<td>(Use Point System) Reduce nematode population. Crop rotations. Use resistant varieties.</td>
</tr>
<tr>
<td><strong>Boll Rots</strong></td>
<td>Several fungi and bacteria</td>
<td>Boll rots usually first appear as water-soaked spots. Later, as infection spreads, bolls turn black and may be covered with a moldy fungus growth. Badly infected bolls may drop from plant.</td>
<td>Avoid excessive rates of nitrogen. Practice skip-row planting. Timely defoliation will reduce boll rots. Reduce insects that injure bolls. Growth regulators can be effective.</td>
</tr>
<tr>
<td><strong>Verticillium Wilt</strong></td>
<td>Verticillium dahliae</td>
<td>Seedlings may become infected and turn yellow, dry out and die. Plants that become infected later in the season are stunted and exhibit a yellow condition along leaf margins and between the major veins. Severely affected plants will shed their leaves. A brown discoloration of the interior of the stem can usually be found later in the season. This discoloration is distributed evenly across the inside of the stem.</td>
<td>Plant resistant varieties when Verticillium Wilt is severe. A variety that matures very early may in some years escape injury from Verticillium Wilt.</td>
</tr>
<tr>
<td><strong>Reniform Nematode</strong></td>
<td>Rotylenchulus reniformis</td>
<td>Above ground: Infested plants are usually slightly stunted. Plants under stress may be severely stunted and show potassium deficiencies. Under ideal growing conditions, plants may not show any detectable symptoms. Reniform nematodes may cause increased incidence and severity of seedling disease.</td>
<td>Yield losses can range from 10-50 percent, depending on stress and nematode population. Crop rotation with corn or grain sorghum will help reduce the population of reniform. The longer the rotation, the better the result; but the population may rebound when cotton is planted back. Soil samples for reniform nematodes should be taken each year. Nematicides can be profitable under high stress conditions.</td>
</tr>
<tr>
<td><strong>Leaf Spots and Blights</strong></td>
<td>See section 'Diagnosis and Management of Foliar Diseases'</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
GENERAL COTTON DISEASE CONTROL GUIDE

1. PLANT high quality seed with at least 80% germination and a high cold test germination.

2. TREAT seed with a fungicide to avoid early losses.

3. PLANT in warm soil (65-70°F). Research shows that this is very important.

4. USE in-furrow fungicides and/or seed treatments.

5. ROTATE cotton with other crops to avoid the build-up of disease organisms.

6. PLANT disease-resistant varieties with high seedling vigor.

7. USE cultural practices such as planting on a bed and balanced fertility to help prevent disease.

8. SAMPLE soil for nematodes.

9. TO PROVIDE PROTECTION from nematode damage, use seed treatment with nematicide component. If nematode counts are high, additional applications of Vydate insecticide should be applied at 2-leaf or pinhead growth stage.

10. USE the point system on page 6 to help with decision making for seedling disease control.
Name: Ascochyta Blight (Wet Weather Blight)
Caused by: Ascochyta gossypii (Phoma exigua)
Foliar Symptoms: Ascochyta Blight forms lesions on cotyledons, leaves, stems, and bolls. Lesions on the cotyledons and leaves approach 2 mm (<0.1 in) in diameter, are white to light brown and circular in shape. Elongated cankers on the stem are reddish-purple to black or ash gray in color. Small, black fruiting structures are likely to be embedded in symptomatic tissue.
Management: Use fungicide treated seed, avoid planting in cool wet weather, and incorporate cotton residue to encourage decomposition, which helps in fields with a history of Ascochyta Blight.
Diagnostic Note: Margins of necrotic regions on leaves and cotyledons will have dark borders. Spots may have a target-like appearance. However, Ascochyta Blight typically occurs early in the season and small black fruiting structures are observed in the lesions.
Range and Yield Loss: Ascochyta Blight has been reported in most major cotton producing regions. Yield loss is rarely reported, but is possible under conditions such as prolonged cloudy weather with cooler temperatures and rainfall.

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Name: Bacterial Blight (Angular Leaf Spot, Black Arm)
Caused by: Xanthomonas citri pv malvacearum
Foliar Symptoms: Symptoms of Bacterial Blight start as tiny water-soaked spots, and progress into characteristically angular shapes due to leaf veins limiting bacterial movement. Lesions appear on the upper side of the leaf, turn black as they expand, and defoliation may occur. Systemic infections follow the main veins as black streaks; symptoms on the bolls are characteristically sunken, water-soaked lesions.
Management: Resistant cultivars are the most economical option to minimize yield loss. Incorporation of infected residue into the soil will help with decomposition of infected debris and reduce inoculum in the soil.
Diagnostic Note: Lesions are typically dark brown (darker than many other pathogens) and can be “shot-hole” in appearance when necrotic tissue falls away. Observe the underside of the leaf for water-soaking around the lesions.
Range and Yield Loss: Bacterial Blight is a major disease of cotton. Since acid delinting of cottonseed in the U.S., Bacterial Blight has been rare, except in OK and TX; however, there is a recent resurgence in additional states. Yield loss can be severe, up to 20%, depending on variety and pathogen race.
**Target Spot**

**Name:** Target Spot  
**Caused by:** *Corynespora cassiicola*  
**Foliar Symptoms:** Characteristic symptoms of Target Spot include brown lesions, sometimes approaching 2 cm (~1 inch) in diameter, exhibiting a series of concentric rings. Unlike Stemphylium and Alternaria Leaf Spot, the spots are typically not bordered by a dark band. Leaf spots and premature defoliation are generally confined to the interior canopy (unlike that found in Stemphylium and Alternaria diseases.)  
**Management:** Management of Target Spot with fungicides is made difficult by the dense canopy which obstructs placement of fungicides in the interior of the canopy. Greatest success in managing Target Spot has been achieved by applying fungicides during the 1st and 3rd weeks of bloom.  
**Diagnostic Note:** Target Spot can be quickly differentiated from Stemphylium Leaf Spot by location in the canopy. Also, defoliation from Target Spot typically begins at the bottom of the plant and progresses upwards. Lesions may occur on the upper canopy, but defoliation of the upper 20% has not been observed.  
**Range and Yield Loss:** Target Spot has become progressively more widespread in the Southeast and Mid-South regions of the Cotton Belt, but is most severe in Florida, Alabama and Georgia. In severe cases, yield losses exceeding 200 lbs lint/A have been documented.

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**Cercospora Leaf Spot**

**Name:** Cercospora Leaf Spot  
**Caused by:** *Cercospora gossypina,*  
*Mycosphaerella gossypina*  
**Foliar Symptoms:** Reddish lesions will occur during the early stages. As the disease progresses, the lesions enlarge and turn white to light brown in the center. The lesions are circular and vary in size. Concentric zones are often present with a red color at the margins.  
**Management:** Maintaining plant vigor by having proper fertility and preventing drought stress through irrigation helps delay primary infections and reduce the severity of disease outbreaks.  
**Diagnostic Note:** In the field it is often difficult to differentiate Cercospora Leaf Spot from other foliar diseases. The spots appear concentric, like those of Target Spot, and the general distribution of spots on the plant may be the same as Stemphylium Leaf Spot and Alternaria Leaf Spot. Correct diagnosis often requires viewing the long, thin whip-like, septate spores. Caution should be taken as *C. cassiicola* spores can appear similar to Target Spot, but typically are broader and may have a basal scar.  
**Range and Yield Loss:** Cercospora Leaf Spot occurs in all cotton producing areas within the U.S. When Cercospora Leaf Spot occurs while plants are under stress, or in a disease complex with Alternaria or Stemphylium Leaf Spot, premature defoliation, reduced yield, and lower fiber quality have been documented.
**Name:** Alternaria Leaf Spot  
**Caused by:** *A. macrospora, A. alternata*  
**Foliar Symptoms:** Alternaria Leaf Spot forms lesions on senescing leaves that are brown with purple margins. As they expand they typically exhibit concentric zonation and the necrotic tissue will overlap with other lesions. As the disease progresses the lesions will become gray and dry with some of the necrotic tissue falling out giving it a “shot-hole” appearance.  
**Management:** Reducing plant stress and insuring proper soil fertility, especially with potassium, can reduce disease severity.  
**Diagnostic Note:** Symptoms of Alternaria Leaf Spot and Stemphylium Leaf Spot are similar; however Alternaria Leaf Spot is more commonly observed in Texas and the Mid-South and Stemphylium Leaf Spot in the Southeast. Lesions with concentric rings may appear similar to Target Spot; however spots from Alternaria Leaf Spot will be throughout the canopy and are also associated with reddening and yellowing leaves.  
**Range and Yield Loss:** Alternaria is one of the most common cotton diseases and is associated with late season cotton development. (Note: Alternaria Leaf Spot and Stemphylium Leaf Spot are similar in that both are most severe when cotton plants have insufficient potassium, either from inadequate fertilization or during periods of drought.) Yield loss is not considered a problem with Alternaria Leaf Spot if symptoms and defoliation occur late in the season.

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**Name:** Stemphylium Leaf Spot  
**Caused by:** *Stemphylium solani*  
**Foliar Symptoms:** Stemphylium Leaf Spot lesions are 2 cm in diameter (~1 inch), circular in shape and brown in color with concentric zones. As they mature the lesions will have a whitish center that may crack and fall out producing a “shot-hole” appearance. The lesions normally form on the upper leaves in the canopy and start at the leaf margin and move inward. Fields where Stemphylium Leaf Spot is severe also typically demonstrate symptoms of nutrient deficiency.  
**Management:** Managing vigorous crop growth by irrigating to avoid drought stress, proper fertilization, and reducing pest pressure will help reduce the incidence of disease outbreaks. Fungicides are available but are not normally economical for the control of Stemphylium Leaf Spot.  
**Diagnostic Note:** Stemphylium Leaf Spot can be differentiated from Target Spot by position on the plant (Stemphylium typically is found at the top of the plant first, Target Spot is within the canopy). Also, leaves affected by Stemphylium Leaf Spot often show nutrient deficiencies (yellow and red) while leaves affected by Target Spot often appear green, unless approaching senescence.  
**Range and Yield Loss:** Stemphylium Leaf Spot has been found in all the cotton producing areas of the U.S. Since this disease is normally associated with other plant stress factors (drought, nutrient deficiencies, nematode and insect pressure) yield loss can be severe from the stress complex.
Name: Areolate Mildew  
Caused by: Ramularia gossypii  
Foliar Symptoms: Small lesions appear on leaves in the lower canopy late in the growing season. The lesions, 3-4 mm (~0.15 in) wide and restricted by a major leaf vein, are slightly chlorotic on the upper leaf surface with a white mildew growth on the lower surface. Lesions may become necrotic and resemble bacterial blight. In severe cases, premature defoliation will occur.

Management: Use of resistant varieties is the best control strategy for Areolate Mildew. Incorporating crop residue and crop rotation will help reduce inoculum for next season. Fungicides (e.g. azoxystrobin and pyraclostrobin) were effective in managing this disease in Georgia.

Diagnostic Note: No other cotton disease commonly found will have the white, powdery growth on the underside of the leaf.

Range and Yield Loss: Areolate Mildew is found in most countries where cotton is produced, but not commonly observed in the U.S. In Georgia, the disease is typically restricted to the extreme southeastern counties. This disease normally appears late in the season and usually causes little yield loss.

Key to differentiating spots in the cotton fields:

1A. Borders of spots often defined by leaf veins, creating angular or geometric appearance: Go to 2  
1B. Border of spots not defined by leaf veins and approximately circular in shape: Go to 3

2A. Typically observed late in season; often a white sporulation is found on the underside of spots: Areolate Mildew.  
2B. Spots dark in color, may appear early in the season and often have a "water soaked" appearance: Bacterial Blight/Angular Leaf Spot.

3A. Spots affect foliage throughout the plant, especially on upper leaves. Spots typically associated with plants affected by nutrient deficiencies or stress: Stemphylium, Alternaria or Cercospora Leaf Spots. Submit to disease diagnostic clinic for further diagnosis.  
3B. Spots often with concentric rings and not associated with symptoms of nutrient deficiencies or stress: Go to 4

4A. Spots found typically on young plants and with dark, pepper grain-like sunken structures: Ascochyta Leaf Spot.  
4B. Spots with concentric rings on older plants: Go to 5

5A. Spots with concentric rings, typically found on leaves within the canopy of foliage: Target Spot.  
5B. Spots with concentric rings possibly surrounded by a yellow halo: Identification requires additional diagnosis and a sample should be submitted to a plant disease diagnostic lab for confirmation.