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COTTON DISEASE AND NEMATODE CONTROL 2011

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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 over 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 are presently causing 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; however, during cool, wet seasons ***Pythium*** spp**.** may become more prevalent. ***Thielaviopsis basicola*** is being found to cause seedling diseases more frequently each year.

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.

Table 1. Cotton Disease Loss Estimate for Tennessee 1996-2011

Disease	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	**2010**
SEEDLING DISEASES (*Rhizoctonia solani, Pythium* spp., *Fusarium* spp., etc.)	5.0	9.5	7.0	5.0	4.0	8.5	20.0	22.0	8.0	4.0	3.5	3.0	3.5	4.0	**3.5**
BOLL ROTS	4.0	3.0	3.0	2.0	3.0	5.0	5.0	2.0	5.0	4.5	2.0	0.5	1.0	5.0	**0.5**
VERTICILLIUM WILT (*Verticillium dahliae)*	1.5	1.0	1.5	0.75	0.25	0.1	0.1	0.25	0.5	.20	0.1	.01	.01	0	**0**
FUSARIUM WILT (*F. oxysporium* f. sp. *vasinfectum)*	0.01	0.01	0.01	0.01	0.01	.01	.01	0	0	0	0	0	0	0	**0**
BACTERIAL BLIGHT (*Xanthomonas malvacearum)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
ASCHOCHYTA BLIGHT (*Ascochyta gossypi)*	0	0.02	0.02	0.01	.20	2.0	2.0	0.2	1.0	.50	1.0	0.5	0.5	0.5	**0.5**
NEMATODES (Reniform)	0.2	0.2	0.4	0.80	1.0	1.0	1.5	2.1	2.1	2.2	2.3	2.01	2.51	2.01	**2.01**
LEAF SPOTS (*Alternaria, Cercospora, Phomopsis,* etc.)	1.0	0.5	0.5	0.25	0.5	0.5	0.3	1.0	1.0	0.3	1.5	0.5	0.5	0.5	**0.1**
Total Percent Loss to Disease	11.7	14.23	12.43	8.82	9.06	17.11	28.91	27.55	17.6	11.7	10.4	6.52	8.02	12.01	**6.61**

COMMENTS: Loss estimates were taken from research and extension demonstrations and general observations taken across the state by Melvin A. Newman, Extension Plant Pathology.

SEEDLING DISEASE CONTROL

Seed treatments: Fungicide seed treatments give control of seed-rot and some control of preemergence damping-off. However, seed treatments give little, if any, 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 (see Table 2). 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 3 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 3). 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 organisms pathogenic 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 Seedling Disease Fungicide Treatments for Cotton

Fungicide	***Formulation***	***[2]Rate/Acre*** (Use higher rates where severe disease is expected)
In-Furrow Granular Fungicides		
Terraclor Super X	18.8G	6 - 10 lb
Ridomil PC 11G	11G	7 - 10 lb
Ridomil Gold PC	10.5G	7 - 10 lb
In-furrow Fungicide + Insecticide Combinations		
Terraclor Super X-Di-Syston	6.5G-1.63G-6.5G	12 - 15 lb
[1]Terraclor Super X + Di-Syston EC	17.5-4.3-17.5	4 - 5.5 pt (40 inch row spacing) (5-6 3/4 fl oz/1000 row ft)

Commercial Seed Treatment [4]		
Vortex + Baytan + Allegiance FL (formerly Apron)	ipconazole + triadimenol + metalaxyl	0.08 fl oz + 0.5 fl oz + 0.75 fl oz
Systhane 40WP + Maxim 4FS + Apron XL LS	myclobutanil + fludioxonil + mefenoxam	1.25 oz + 0.08 fl oz + 0.32 fl oz
Dynasty CST	azoxystrobin + fludioxonil + mefenoxam	0.03 mg ai/seed
Seed Shield	azoxystrobin + fludioxonil + mefenoxam	4 oz/cwt
Avicta Complete Cotton[3]	Dynasty CST + thiamethoxam + abamectin	0.03 mg ai/seed 0.34 mg ai/seed 0.15 mg ai/seed
Trilex Advanced	trifloxystrobin + metalaxyl + triadimenol	1.6 fl oz/cwt

Continued and footnotes on next page . . .

Table 2 . . . Continued

In-Furrow Sprays	Formulation	Rate/Acre
Reason 500 SC	44.4%	6.3 oz
Uniform	3.72 EC	4.4 - 6.6 fl oz
Terraclor Super X	2.5 EC	3 - 6 pt
Quadris	2.08F	5.5 - 8.25 oz
Headline	2.09F	4.1 - 11 oz

Hopper-box dusts, slurries and seed treatments (these may not be as effective as in-furrow methods under severe disease conditions). See point system on page 5.		
Trilex Advanced	25.64%	1.6 fl oz/cwt
Delta Coat AD (HB slurry)	3.5% - 30%	11.75 oz/cwt
Prevail (HB dust)	15%-15%-3.12%	8-16 oz/cwt

NOTES: In-furrow spray treatments are recommended in 3-5 gallons of water per acre. In-furrow granules can be applied in-furrow with Temik 15G or Di-Syston with a split-box method. See pesticide labels for other use instructions and precautionary statement.

[1] In-furrow liquid application: Apply the specified dosage to the soil around the seed and to the covering soil as it fills the furrow. Do not apply directly to the seed. The soil around the seed and the covering soil should be thoroughly mixed with the product. Use the higher rates when weather conditions are expected to be unfavorable for rapid germination and in fields having a history of disease problems or in no-till situations.

[2] Dosage rate at 38" row spacing.

[3] Avicta Complete Cotton contains Dynasty + an insecticide + a nematicide. This treatment should be consider when nematode assays show that reniform or root-knot are present.

[4] Please refer to label for specific restrictions and application instruction.

and follow the most current label on the product – *The Label is the Law*. For further assistance, contact the local Extension Service office.

Table 3

COTTON SEEDLING DISEASE POINT SYSTEM

FOR IN-FURROW FUNGICIDES & SEED TREATMENTS

by Melvin A. Newman, Professor
The University of Tennessee Extension

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

LEAF SPOTS AND BLIGHTS

Several leaf spot and blight diseases occur on cotton and under favorable conditions can cause considerable damage. The most important of these diseases are Ascochyta blight (wet weather blight), bacterial blight (blackarm and angular leaf spot), Cercospora leaf spot, and Alternaria leaf spot. These diseases cause various types of leaf-spot and blight symptoms. The following measures will help control these minor disease problems: (1) use a recommended fungicidal seed treatment, (2) destroy crop residue by chopping and plowing it under when not under no-till conditions, (3) use suitable rotations as prescribed for other diseases, (4) plant resistant varieties when they are available, and (5) keep the potassium at a high level, according to soil tests.

Where leaf spots and boll rots occur frequently, two fungicides have been cleared for that use. They are Quadris and Headline which are both strobilurin type fungicides and will help control foliar diseases. If diseases are severe enough these fungicides may help increase yield. So far, research plots have not shown significant increases in yield.

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 11 counties. They include: Bedford, Crockett, Dyer, Fayette, Gibson, Hardeman, Haywood, Lincoln, Madison, Obion, and Shelby 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.

Reniform nematodes can infect and reproduce on cocklebur, cowpea, crotalaria, sow thistle, jimson weed, Florida beggar weed, and Florida pusley. Temik 15G at 5 lb./acre applied in-furrow at planting will reduce the reniform nematode population for the early part of the season. An additional side-dress application of Temik 15G at 5 lbs/A can be made for better control at the pinhead stage, or use two applications of Vydate 14 days apart starting at pinhead.

A seed treatment (called “Avicta Complete Cotton”) has been shown to be effective in increasing yields where reniform nematodes are present on certain varieties. If nematode counts

are extremely high (above 5000/pt. of soil in the fall sampling) additional applications of either Vydate or Temik could be used at pin head for extended protection.

MAJOR COTTON DISEASE IDENTIFICATION & CONTROL CHART

DISEASE	CAUSE	SYMPTOMS	CONTROL
SEEDLING DISEASES (seed-rot, root-rot, and damping off)	Rhizoctonia, Pythium, Thielaviopsis spp., and several other fungi and bacteria	Seed-rot, root-rot, preemergence and post emergence damping-off.	Fungicide seed treatments help control seed rots and some preemergence damping-off. However, an additional soil treatment of fungicide must 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. (Use Point System)
FUSARIUM WILT	Fusarium oxysporum F. vasinfectum	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.	Reduce nematode population. Crop rotations. Use resistant varieties.
BOLL ROTS	Several fungi and bacteria	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.	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.
LEAF SPOTS	Ascochyta, Cercospora, Alternaria, spp. and some bacteria	Various types of leaf spots and blights. Many spots occur on leaves toward maturity, but these are not usually damaging to the plant at this stage of growth.	Use fungicide seed treatments. Destroy crop residues. Use crop rotations and plant resistant varieties when available (esp. when Bacterial Blight is severe). Keep potash levels at least medium to high.
VERTICILLIUM WILT	Verticillium dahliae	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.	Plant resistant varieties when Verticillium Wilt is severe. A variety that matures very early may in some years escape injury from Verticillium Wilt.
RENIFORM NEMATODE	Rotylenchulus reniformis	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.	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.

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 either Temik in-furrow or a seed treatment with "Avicta Complete Cotton". If nematode counts are high, additional applications of Vydate insecticide should be applied at pinhead or side-dressed with Temik.

10. USE the point system on page 6 to help with decision making for seedling disease control.