9. DISEASE MANAGEMENT IN COTTON

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In 2023, cotton diseases led to an approximate yield loss of 13% in North Carolina. Diseases are more severe in inhospitable environments, such as fields with too much or too little water or fertilizer; air pollutants; unfavorable temperatures; insect infestations; or chemical injury from pesticide applications or carryover. Management of diseases in cotton should focus on prevention through cultural practices that promote good soil conditions and inoculum suppression.

SEED AND SEEDLING DISEASES

Seedling diseases are among the major diseases in North Carolina, causing an estimated average annual yield loss of 2.5%. Seedling diseases are caused by several soilborne fungi; however, cultural and environmental factors that delay seed germination and seedling growth lead to more severe disease.

Fungi Causing Seedling Diseases

The most prevalent of these in North Carolina are *Fusarium* spp, *Phoma exigua (Ascochyta)*, *Pythium* spp., and *Rhizoctonia solani*. Among these, *Pythium* spp. and *R. solani* are the most common fungi associated with seedling diseases. These fungican infect seeds before or at germination, and seedlings before or after emergence. Multiple fungi can be found infecting the same seeds and seedlings.

Symptoms of seedling diseases include seed decay, necrosis of the new root or hypocotyl, decay of the seedling before emergence, and partial or complete girdling of emerged seedling stems. Seed and seedling diseases are characterized by soft, watery rots. Damaged seedlings that emerge are pale, stunted, slower growing, and may die within a few days. Examination of infected seedlings may reveal dark lesions on the stem and root. The taproot is often destroyed, and only shallow-growing lateral roots remain to support the plant. The "sore shin" phase of seedling disease is characterized by reddish-brown, sunken lesions at or below ground level. These lesions enlarge, girdle the stem, and cause it to shrivel. Seedling diseases do not usually kill the entire seedling population, but may 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.

The most common fungi associated with seedling diseases in North Carolina are *Pythium* spp. and *Rhizoctonia solani*. Often both fungi can be found on the same seedling. The fungi may cause seed decay, seedling root rot, or both. *Pythium* spp. and *Fusarium* spp. usually attack the seed

and below-ground parts of young seedlings, while *R. solani* usually causes sore shin. *Rhizoctonia solani* and *P. exigua* may attack seedlings from the time they emerge until they are about 6 inches tall. After this stage, the stem becomes woody, and subsequent infection rarely occurs unless the stem is injured.

***Fusarium* spp.** Various species of the fungal genus *Fusarium* are typically found on diseased cotton seedlings. *Fusarium* spp. usually attack the seed and below-ground parts of young seedlings. Seed-applied fungicides are generally effective in managing it.

Phoma exigua (Ascochyta gossypii). This fungus can cause post-emergence damping-off up until cotton plants are 6 inches tall. This disease is characterized by premature dying of cotyledons, which turn brown and shrivel. *P. exigua* is often observed when night temperatures fall between 50°F to 60°F and are accompanied by foggy or misty conditions (see also Plant Pathology Cotton Information Note No. 2). Fungicide effectiveness against *P. exigua* has not been evaluated.

Pythium spp. Several species in the genus *Pythium* can cause seedling disease in cotton as well as several other crops. Like *Fusarium*, *Pythium* spp. usually attack the seed and below-ground parts of young seedlings *Pythium* spp. are 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. Fungicides such as mefenoxam (Ridomil Gold) or etridiazole (ETMT, Terrazol) are usually effective in reducing *Pythium* spp. seedling disease.

Rhizoctonia solani. This fungus typically causes sore shin and is more common on sandy, well-drained soils. Like Phoma, Rhizoctonia may attack seedlings from the time they emerge until they are about 6 inches tall. Plants injured by sand blasting are particularly susceptible to this pathogen. Fungicides such as PCNB (Terrachlor), iprodione (Rovral), azoxystrobin (Quadris), or pyraclostrobin (Headline) are generally effective against *Rhizoctonia solani*.

Boll Rot. Boll rot is generally the most prevalent problem in North Carolina cotton, and occurs 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. Chapter 11, "Managing Insects on Cotton," and chapter 2, "The Cotton Plant," explain how to reduce insect damage and lower humidity in the canopy by preventing rank growth to reduce boll rot problems.

Foliar Diseases: Leaf Spots. Leaf-spot diseases are typically of minor importance, appearing when plants are under nutritional stress or periods of high moisture. Leaf spots may be minimized by using the proper amounts of fertilizer and adequate drainage, and by reducing rank vine growth, which can promote excessively high humidity in the crop canopy. Several pathogens cause leaf spots on cotton, including Ascochyta blight (*Phoma exigua*), Alternaria leaf spot (*Alternaria* spp.), Cercospora leaf spot (*Cercospora* spp.), Stemphylium leaf spot (*Stemphylium solani*), and Target spot (*Corynespora cassiicola*). Cotton leaves often develop small, brown, circular lesions that enlarge to approximately 1/2 inch. Old lesions can develop gray centers

which may fall out. Sometimes lesions are not a disease, but rather phytotoxicity symptoms caused by a variety of crop protection chemicals. Differentiating between causal agents of leaf spots is difficult, and often requires the aid of the North Carolina State University Plant Disease and Insect Clinic. Leaf-spot diseases are typically of minor importance, appearing when plants are under nutritional stress or periods of high moisture.

Emerging Foliar Diseases. Since 2018, damages from areolate mildew (also known as false mildew) caused by *Ramularia gossypii* have been observed in North Carolina. Since 2012, target spot caused by *Corynespora cassicola* has also become more common in North Carolina cotton fields. In the last few years, both diseases have led to increasing yield losses in the state. Frequent scouting and disease reporting is important to monitor foliar disease development in the field.

Bacterial Blight. Bacterial blight, also known as angular leaf spot, is caused by the bacterium *Xanthomonas compestris* pv. *malvacearum*. Bacterial blight initially appears as angular leaf spots with a red or brown border, and spots may spread along the major leaf veins. Premature defoliation may occur and bolls may become infected, causing a boll rot that results in discolored lint and rotted seed. This disease is promoted by high amounts of rainfall and humidity in conjunction with warm temperatures. There are no corrective measures to reduce disease after a field is infested. Planting high-quality, acid-delinted seed, planting bacterial-blight-resistant varieties (where available), proper plant spacing to reduce humidity in the canopy, applications of plant growth regulators to prevent rank growth, and destruction of crop debris after harvest will reduce incidence of bacterial blight under conducive environmental conditions for disease development.

Cotton Stem Canker. Cotton stem canker is caused by the fungus *Phoma exigua* (often referred to as *Ascochyta*). This disease typically develops in cool, wet weather. Management options for this disease are limited; rotation has little impact on this disease due to the wide host-range, including other field crops and weed species present in North Carolina. Fungicides currently labeled for foliar application on cotton in the Southeast may not provide adequate control of this disease.

SEEDLING AND FOLIAR DISEASE MANAGEMENT

A control program for cotton diseases is based on preventive rather than remedial treatments. A combination of cultural practices and chemical controls is required for cotton disease management to make conditions more favorable for young cotton and less favorable for disease-causing organisms. Poor-quality seed with low germination potential should be avoided. Cotton plants are less susceptible to seed and seedling disease when they are about 6 inches tall. After this stage, the stem becomes woody, and subsequent infection rarely occurs unless the stem is injured. For additional information on seedling diseases, see content.ces.ncsu.edu/cotton-seedling-diseases. Even after disease management strategies are practiced, foliar diseases may occur during the blooming period when environmental conditions are favorable for disease. Foliar fungicides may be used in these cases; for available treatments, see the *North Carolina Agricultural Chemical Manual* (content.ces.ncsu.edu/north-carolina-agricultural-chemicals-manual).

Crop Debris Destruction and Tillage. Despite soil property benefits, the recent trend to low- or no-till cotton has resulted in an increased frequency and severity of seedling diseases. The inoculum of pathogens from previous crops overwinters in crop debris, and reduced tillage preserves the debris adjacent to emerging seedlings whereby pathogens have little distance to infest susceptible tissues. The lack of a raised bed, inadequate seed bed preparation, and additional crop residue associated with reduced tillage, all contribute to delays in emergence and stand establishment. Early cutting and shredding of stalks aid in the control of several cotton diseases by reducing the amount of inoculum that carries over from year to year. The use of an in-furrow fungicide or seed treatment should be considered in reduced-tillage situations.

Rotation. Rotating cotton with other non-host crops helps prevent buildup of several seedling and leaf spot cotton diseases. The longer a rotation, the more effective it is at reducing disease; however, even a rotation of at least 2 years is more beneficial than continuous cropping.

Plant Health Promotion. It is important to prepare a good seedbed to control seedling diseases. Raised beds give some control of seedling disease, especially in cotton planted early, by improving soil drainage. Avoid planting when soil temperatures are below 65°F. Below this temperature, germination is slow, and the seed and seedlings are more vulnerable to infection. Proper fertilization and liming promote early growth, which gets the seedling to a resistant stage sooner. Avoid improper use of herbicides, as this may lead to injury that will expose seedling to fungal infections.

Seed Treatment. All cotton seeds offered for sale in North Carolina are base-treated with fungicides and insecticides. Systemic fungicides provide temporary protection from certain types of preemergence and postemergence damping-off. 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.

Several seed treatments are available for cotton nematode control. These products often work best on low populations of soil nematodes, and determining the level of nematode pressure in a given field is important for selecting the proper seed treatment. Chemicals available include Avicta Complete Cotton from Syngenta, which also has the insecticide Cruiser for thrips control and additional fungicide treatments on the seed, and Aeris with Poncho, Votivo, or Trilex Advanced, which has an option to add Gaucho Grande for thrips control and additional fungicides if desired by the producer. Avicta complete pack has abamectin (a nematicide), and Aeris has thiodicarb (Larvin), which acts as a nematicide. Acceleron is another brand offered by Bayer that can provide some control of diseases, thrips, and nematodes, depending on the version requested. A plethora of chemistries are also offered through downstream seed-treaters.

In-furrow Fungicides. Seedling diseases are more likely to occur when planting and environmental conditions are favorable for disease. Seedling diseases tend to be more severe under cool, wet conditions, in reduced-tillage situations, compacted soil, and when beds are absent. Assess the risk of disease development based on the factors occurring in a field and consider an in-furrow treatment when the threshold (200 points) is exceeded (Table 9-1A).

Table 9-1A. Point System for Determining the Need for In-Furrow Fungicides*

Factor	When Does It Matter	Points*
Soil temperature	Less than 65°F	75
5-day forecast	Colder and wetter	50
Seed quality	Cold germination less than 59°F	75
Field history	Severe disease	100
Tillage	Minimum tillage	50
Row preparation	Beds absent	75
Seeding rate	Less than 3 to 4 per ft of row	100
Poorly drained soil	Consistently saturated	50
TOTAL		—

If the total exceeds 200, consider using an in-furrow fungicide.
* This point system is only a guide as to the probability of cotton seed benefitting from an application of an in-furrow fungicide.

Foliar Fungicides. Foliar fungicides may be beneficial for controlling foliar diseases such as target spot or areolate mildew (Table 9-1B) when disease management strategies are not fully practiced, disease pressure is high, and environmental conditions are favorable for disease (excessive warm, wet conditions). Start scouting for foliar diseases in the first week of bloom by checking the lower canopy of at least 10 cotton plants in 10 different locations in a field. If symptoms are not seen, scout again within 2 weeks. If excessive foliar disease symptoms are observed and extensive wet conditions are predicted, a foliar fungicide may be used. If not scouting, a fungicide spray may be optimal during the third week of bloom. For fields that are beyond the sixth week of bloom—full cutout with fairly mature bolls and within about four weeks from defoliation—a fungicide application may not be warranted.

Fungicides must be used carefully to protect against human injury and harm to the environment. When possible, use different modes of action (FRAC) when repeated applications of pesticides are necessary for controlling disease. Follow label-use directions, and obey all federal, state, and local pesticide laws and regulations.

Table 9-1B. Condensed List of Foliar Fungicides for Target Spot and Areolate Mildew

FRAC	Fungicide	Active Ingredient	Rate
11	Quadris	Azoxystrobin	7 fl oz/a
11	Headlinea	Pyraclostrobin	6 fl oz/a
3	Topguard	Flutriafol	14 fl oz/a
3	Proline	Prothioconazole	5 fl oz/a
7,11	Priaxor	Fluxypyroxad & Pyraclostrobin	4 fl oz/a
Row preparation	Beds absent		75
Seeding rate	Less than 3 to 4 per ft of row		100
Poorly drained soil	Consistently saturated		50

For more information, contact your local Cooperative Extension agent.

Table 9-3. Variety Resistances for Common Diseases of Cotton

Variety	Root-Knot Nematode	Fusarium Wilt	Verticillium Wilt	Bacterial Blight
ST 5020GLTP	MR [1]	MR	MR	R
ST 49494GLT	MR	MR	MR	S
ST 5115GLT	MR	MR	MR	R
ST 4946GLB2	R	R	MR	S
ST 6448GLB2	MR	MR	MR	R
NG 4601 B2XF	MR	MR	MR	S
NG 3406 B2XF	R	R	MR	S
NG 3522 B2XF	N/A	N/A	MR	S
NG 1511 B2RF	R	R	MR	S
AM UA48	R	R	R	R
DP 1725 B2XF	N/A	R	S	S
DP 1747NR B2XF	R	MR	N/A	S
DP 1646 B2XF	N/A	MR	MR	MR
DP 1558NR B2RF	R	S	R	S
DP 1522 B2XF	N/A	MR	MR	S
DP 1252 B2RF	N/A	S	MR	S
DP 1050 B2RF	N/A	MR	MR	S
3109 B2XF	N/A	N/A	MR	N/A
3445 B2XF	N/A	N/A	HT	HT
3544 B2XF	N/A	N/A	HT	HT
3635 B2XF	N/A	HT	N/A	N/A
3226 B2XF	N/A	N/A	LT	S
PHY 220 W3FE	N/A	N/A	HT	N/A
PHY 427 WRF	R	N/A	N/A	N/A
PHY 490 W3FE	N/A	N/A	N/A	R
PHY 575 WRF	N/A	N/A	N/A	R
PHY 805 RF	N/A	MT	N/A	N/A
PHY 811 RF	N/A	HT	N/A	N/A
PHY 841 RF	N/A	HT	N/A	N/A

[1] Resistance level of a variety to a given disease denoted by R = resistant, MR = moderately resistant, S = susceptible, HT = high tolerance, MT = moderate tolerance, LT = low tolerance, or N/A = resistance information not available.