COTTON DISEASE AND NEMATODE MANAGEMENT

The importance of diseases and nematodes in cotton production is easy to overlook since the cotton plant is less severely affected by disease than are other crops and symptoms caused by nematodes can be easily mis-diagnosed. However, it is estimated that in recent seasons diseases and nematodes have cost cotton growers in Georgia over $190 million annually. This figure includes the cost of control for the grower (mainly nematicides and fungicides for seedling disease) and losses to boll rot, nematodes, seedling diseases, and Fusarium wilt.

Many growers may not even recognize the price that they are currently paying to reduce disease. For example, the cost of basic fungicide seed treatments is included with the price of their seed, and growers may plant at an increased seeding rate, in part to off set potential losses from a poor stand due to seedling disease.

With the exception of losses to nematodes and seedling disease, the use of pesticides has not been economically justified to control most diseases of cotton in Georgia. (Note: This may change with the introduction of newer fungicides for control of foliar diseases.) However, a grower can effectively reduce the impact of diseases and nematodes on his crop by making sound management decisions. These include the use of crop rotation, choice of planting date, fertility and plant growth management, and choice of cotton variety. Although difficult for some growers, good crop rotation with crops that are non-host for major cotton pathogens remains one of the most effective means of reducing losses in cotton.

Seedling Diseases

Seedling diseases are widespread but typically not a major problem in Georgia cotton in most years. However, economic loss to seedling diseases can be significant at specific locations, especially when weather conditions are cool and wet at planting time and the grower is not able practice good crop rotation. Seedling diseases are caused by fungi that either survive on the seed or that live in the soil and infect seeds or developing seedlings. By far, the most common cause of seedling disease in Georgia is the fungus *Rhizoctonia solani*; however *Pythium* spp. and *Fusarium* spp. May also damage young plants. Generally as the young plant matures it becomes less susceptible to infection by these pathogens.

Seedling diseases are differentiated by the stage of development of the seed and young plant when symptoms occur.

1. **Seed rot** is the first disease in this sequence and is easily identified by the presence of decayed seed; however the problem is often detected only after the grower notices “skips” in the stand. Seed rot may be caused a number of different fungi that can exist either in the soil or on the seed itself.
2. The second disease in this sequence is **pre-emergence damping-off** where a fungal pathogen attacks the young seedling after germination but before it cracks the soil surface. Like seed rot, pre-emergence damping-off results in skips in the stand.
3. **Post-emergence damping-off** occurs once the seedling has emerged from the soil. It is identified by the presence of a brown lesion at, or just below, the soil line that will eventually expand and girdle the young, succulent stem. Once the stem is completely girdled, the young plant will quickly wither and die. In the case of “hill-dropped” cotton, it is a common that if one seedling in a hill is diseased, all of the seedlings will be

affected. Post-emergence damping-off is often referred to as "soreshin" in Georgia and is caused by the fungus *Rhizoctonia solani*. It is perhaps the most common seedling disease of cotton in the state and the one with which growers are most familiar. Although seedling disease caused by *Pythium* spp. is less common, it still occurs and is characterized primarily by a water-soaked root rot, either before or after emergence. As will be discussed later, it is important to identify the pathogen(s) that is/are responsible for seedling disease in a field as *Rhizoctonia solani* and *Pythium* spp. may not be controlled by a single fungicide.

Management of Seedling Diseases

Control of seedling diseases of cotton begins with the use of a fungicide seed treatment. All commercial seed sold in Georgia is pre-treated with at least two fungicides. **Growers should never plant cotton seed that has not been treated with a fungicide**. Some seed treatments, such as thiram and captan, are protectant fungicides that protect the seed from fungi borne on the seed or in the soil associated with the seed. Other treatments such as Vitavax (carboxin), baytan, metalaxyl (Allegiance), and mefenoxam (Ridomil Gold) have systemic activity and when absorbed in the seedling, offer some protection immediately following germination.

Growers can greatly minimize the effect of seedling diseases by avoiding conditions in which seeds/seedlings are at risk to damage from fungal pathogens. Cool, wet weather at planting and low soil temperatures produce an environment that not only slows germination and emergence, but may also favor fungal growth and infection. *Pythium* can be especially troublesome in saturated soils; *Rhizoctonia solani* is less dependent on soil moisture or temperature. **NOTE: Growers should avoid planting cotton seed when rain and colder soil temperatures are likely, even if seedling disease is not an issue.**

Rapid germination and vigorous growth by the seedling are factors which help to insure the survival of the young plants. Slower growth early in the season gives the fungal pathogens more time to infect the vulnerable seed and seedling. The sooner the seedling develops hard, "woody" tissue, the less likely it is to be penetrated and rotted by fungi. Good management practices to reduce the chance of disease include the following:

1. Plant in warm soils where the temperature at a 4-inch depth is above 65˚ F and where the 5-day forecast doesn't call for cooler or cooler/wetter weather. **NOTE:** Cotton growers should **NOT** plant cotton if at all possible when conditions are cool and wet or if the forecast calls for such conditions soon after planting, even if they plan to use additional fungicide treatments!
2. Plant seed on a raised bed since soil temperatures in the bed are generally slightly warmer than surrounding soil and drainage is likely to be better. Cotton planted in conservation tillage is not grown on raised beds, thus potentially increasing the threat from seedling disease.
3. Avoid planting seed too deeply. Seed that is planted too deeply results in longer periods before the young seedling cracks the soil surface, increasing the likelihood of seedling disease.
4. Correct soil pH with lime (pathogenic fungi are more tolerant to acidic soils than are cotton seedlings; pH should be in the range of 6.0 to 6.5).

5. Fertilize according to a soil test so as to promote rapid seedling growth; however care should be taken to avoid "burning" the seedling with excessive rates of at-plant fertilizers.
6. Avoid chemical injury through the use of excessive amounts or improper application of insecticides, fungicides, or pre-plant herbicides.
7. Plant only high quality seed as indicated by the percent germination in the standard seed and cool germination tests. Preferably, cool germination test results should be above 70%, though 60-69% is still adequate.

Additional fungicides, applied to the seed, mixed with the seed in the hopper box, or applied in the open furrow at planting, can significantly reduce the amount of seedling disease, increase stands, and potentially improve final yields. However, significant outbreaks of seedling diseases are a sporadic problem. Because we cannot reliably predict which years will have greater amounts of seedling disease, growers can become justifiably frustrated when trying to determine the economic benefit of the additional fungicide.

As significant yield losses to seedling disease are sporadic in Georgia, the Cooperative Extension does not recommend an additional fungicide treatment for each and every cotton field. Numerous field trials have been conducted by researchers at The University of Georgia assessing the benefits of seed treatments, hopper box treatments, and in-furrow fungicides. It has been very difficult to document significant yield benefits from these products despite increases in stand that may occur.

When a grower is assessing the need for additional protection from seedling diseases, he should note the following. Any field with a history of cotton seedling diseases should be considered a prime candidate for the use of these additional fungicides, especially when a poor history is combined with any combination of the following: cool, wet weather at planting, poor seed quality, conservation tillage (which tends to keep the soil cooler and perhaps moister than conventional tillage), a low seeding rate, or the use of an in-furrow insecticide or nematicide. The risk for losses to seedling disease increases in fields where multiple factors, as described above, apply.

If a grower chooses to use a fungicide in addition to that already on the seed, he has the choice of additional seed treatments, a hopper box treatment, a granular in-furrow fungicide, or a liquid in-furrow fungicide.

1. Additional **seed treatments** are typically applied by the seed distributor or by a local distributor and may help to reduce the severity of seedling disease. In much of the research data collected from trials at The University of Georgia, the use of seed treatments in addition to those already sold with the seed did not improve yields. However, given that some growers are lowering their seeding rates per acre in order to save on costs at planting, treating seed with an additional fungicide treatment may provide added protection to insure a successful stand.
2. **Hopper box treatments** are perhaps the easiest for the grower to use as the fungicide, either a powder or liquid formulation, is mixed with the seed before planting. Hopper box treatments can be thought of as additional seed treatments and are most effective if mixed thoroughly with the seed. Hopper box treatments frequently do not form a

uniform coating acid-delinted seed. Unlike in-furrow formulations however, hopper box treatments are not well distributed in the soil that surrounds the seed and thus may not offer the same level of protection as an in-furrow fungicide.

3. **In-furrow fungicides** theoretically offer the grower protection that is beyond that of hopper box or additional seed treatments. There are basically of two types of in-furrow fungicides: granular and liquid formulations. Both formulations are applied to the open furrow as the seed is planted. Because of this, both the seed and the soil within the furrow are treated which helps to protect the seedling as it begins to grow. Growers, especially those who apply at-plant herbicides, may find it easier to use granular formulations for a couple of reasons. First, their equipment may not be set up to apply more than one liquid formulation (i.e. they only have a single tank). Second, many planters already have a split hopper where an insecticide/nematicide can be put in one half and the fungicide can be placed in the other. Calibration of granular fungicides is fairly simple but must be checked periodically to make sure that the correct amount of product is being applied. Although potentially more challenging to apply, liquid formulations may offer the greatest protection against seedling disease because of the coverage in the open furrow. Whether a grower applies a liquid formulation with a single nozzle or with a dual nozzle set up, he should insure that not only the seed, but the soil beneath and around the seed are also treated. The University of Georgia Extension Bulletin 1143, "Cotton Diseases and Their Control," provides more detail on control practices.

Final note on seedling diseases: It is important to understand that fungicides which are effective on *Rhizoctonia solani* may not be effective on *Pythium* spp., and vice versa. For example, PCNB is active against *Rhizoctonia* but not *Pythium*. Metalaxyl, mefenoxam, and etridiazole are active on *Pythium* spp. but not *Rhizoctonia*. Appendix II includes detailed information on chemical treatments for seedling diseases.

Fusarium Wilt

Fusarium wilt is a fungal disease that typically becomes evident in mid-season, though it can occur at any point in the growing season. Fusarium wilt is not currently a wide-spread problem in Georgia; however there are fields throughout the state where losses can be significant. For some reason, Fusarium wilt seems to be more common around Berrien County than elsewhere.

In cotton, Fusarium wilt is usually found in association with infections by the southern root-knot nematode, which has a synergistic effect on this disease. Although root-knot nematodes are most often associated with Fusarium wilt, other parasitic nematodes such as Columbia lance, reniform, and sting nematodes also injure cotton roots and increase the severity of the disease. As populations of parasitic nematodes increase throughout the state from inadequate crop rotation, it is possible that Fusarium wilt will become a more serious problem. Recommended control measures for this disease are to plant Fusarium wilt resistant cotton varieties (none is currently available) and to control root-knot and other nematode infestations.

The most visible symptom of Fusarium wilt is the presence of wilted and dying cotton plants in a field. Some plants may be stunted and the leaves may yellow between the veins (also

know as interveinal chlorosis). Root-knot nematodes alone can cause wilting, but the synergistic effect with the Fusarium fungus is usually required to kill plants, unless the soil is extremely dry for prolonged periods. Fusarium-infected plants wilt even if soil moisture is adequate because of damage to the vascular system that carries water throughout the plant.

A preliminary diagnosis of Fusarium wilt can be made fairly easily in the field by slicing through the plant stem at a shallow angle to expose the vascular tissue. Fusarium wilt will cause a noticeable browning of the vascular tissue. This discoloration is the result of damage to the vascular tissue which prevents adequate flow of water and nutrients. If you **carefully dig** up the root system of wilting plants, you will also usually see significant galling caused by root-knot nematodes. To verify the diagnosis, submit a sample through your county agent to the UGA Plant Disease Clinic. You should also submit a soil sample for nematode assay to the UGA Extension Nematology Laboratory.

Plants affected by Fusarium wilt tend to be clustered in the field rather than randomly spaced. In fact, areas of the field where Fusarium wilt occurs will probably be consistent from year to year. This is because the fungal pathogen and the associated parasitic nematodes tend to be unevenly distributed in the field.

Additional information on Fusarium wilt in cotton can be found in University of Georgia Extension Bulletin 1143, "Cotton Diseases and Their Control." and "Cotton Nematodes and Fusarium Wilt," Leaflet L 82, 1996.

Nematodes

An estimated 60 to 70 percent of Georgia's cotton fields are infested with at least one species of potentially damaging nematodes. In a recent statewide survey of cotton fields (nearly 1800 samples were submitted by agents from randomly selected fields in 2002) approximately 69 percent of the fields were infested with root-knot nematodes, 2.8 percent with Columbia lance nematodes, 4.6 percent with reniform nematodes, and 0.6 percent with sting nematodes. While the southern root-knot nematode is responsible for the greatest amount of damage to cotton in the state, the Columbia lance and reniform nematodes also cause tremendous damage in more restricted areas, e.g. in the heavier soils along our the fall-line between the Piedmont and the Coastal Plain. Every cotton grower in the state of Georgia either has a problem with nematodes now or is at risk for such a problem should they lose the ability to practice effective crop rotation.

If damage to cotton from parasitic nematodes is such an important problem in Georgia, one may question why more attention is not devoted to this pest. There are three basic reasons. First, many growers do not recognize the symptoms of nematode damage as they can appear similar to drought stress, poor soil fertility, and injury from herbicides. Second, nematodes are microscopic worms that are not easily viewed by the growers. Third, many growers feel that they cannot afford to treat with nematicides because of the perceived cost associated with such treatments. Nothing could be further from the truth.

Symptoms of Nematode Damage

Symptoms of damage from nematodes in a field are variable and are dependent on the species of parasitic nematode infecting the plants. Damage from reniform nematodes may be evident

in the seedling stage where severely infected plants wilt and die. Stunting throughout the season is the most readily recognized symptom of severe infection by root-knot, reniform, and Columbia lance nematodes. In some cases, stunting may approach 50%, and infected plants are likely to show drought stress earlier than healthy plants. However, plants infected with low levels of reniform nematode may actually grow taller and larger than healthy plants as nutrition is going to vegetative growth rather than filling bolls. Although foliar symptoms are not the direct result of infection by parasitic nematodes, infected plants often show nutrient deficiencies, e.g. nitrogen and potassium, in the leaves. The leaves may be slightly yellowed, and in more advanced cases, interveinal chlorosis and leaf scorch may occur.

It is often useful to examine the root systems of plants suspected to be infected with parasitic nematodes to further diagnose the problem. It is important to carefully dig and remove the roots from the soil to preserve the finer secondary roots; roots infected with root knot nematodes often develop swellings and galls that are most evident on the finer secondary roots. The galls can be fairly small, but are visible if the roots are examined carefully. The tap roots from plants infected with the Columbia lance nematode are often severely stunted because of feeding at the growing tip by the nematodes. Secondary roots are also often severely stunted. Root systems from plants infected with reniform nematodes may appear normal because this parasite does not produce galls or severely stunted taproots. However, small clumps of dirt particles (containing egg masses) may be visible on the roots with the aid of a magnifying glass.

Crop Rotation

Crop rotation is a critical tool for nematode management in Georgia's cotton and should be used where economically feasible. Alternating cotton crops with non-host crops will help to reduce the size of the nematode populations in a field. Although this reduction may not be sufficient to eliminate the need of a nematicide in all fields, it will allow the grower to receive better effectiveness and larger yields from lower rates of nematicides.

Common rotation crops to help manage nematodes damaging to cotton include the following: peanut and certain forage crops for southern root-knot nematode; peanut, and certain forage and vegetable crops for Columbia lance nematode; peanut, corn, and certain forage and vegetable crops for reniform nematode. Corn is a host crop for several important species of root-knot nematode, but recent research documents that the root-knot species found in soil samples from corn fields will almost always be the southern root-knot nematode regardless of previous crop. Therefore, when planting cotton following corn, it should be assumed that any root-knot nematodes found in a soil sample from corn will also be damaging to the subsequent cotton crop. Additional information can be found in UGA Extension Bulletin 904 "Plant Susceptibility to Major Nematodes in Georgia."

Growers who practice conservation tillage often have questions regarding cover crops and nematode management. Common cover crops such as wheat, oats and rye are somewhat susceptible to the southern root-knot nematode. However, because nematodes are inactive during the winter months when soil temperatures are cold and because wheat, oats and rye are fairly poor hosts for the southern root-knot nematode, these cover crops can be planted without increasing the nematode problem in the next cotton crop.

Leguminous cover crops, such as clovers and vetches, are also popular in conservation tillage, especially with the current cost of nitrogen. However, growers who have problems with southern root-knot nematodes in a field should exercise caution in planting vetches or clovers as cover crops because they are very good hosts. Though cold soil temperatures in the winter will reduce the build-up of nematodes on clover and vetch, the nematodes will become active once the soil begins to warm up in the spring. Growers who wish to plant vetches or clovers in a field where southern root-knot nematodes are present should seek to find a resistant variety, if one exists.

Nematodes and Stress

Nematodes are considered "stress" pathogens because of the sub-lethal damage that they typically cause to the root system. In addition to crop rotation, one very effective way to reduce the effects of nematodes in a field is to reduce the stress on the cotton crop. Fertility, pH, hardpan and water problems exacerbate plant injury due to nematodes and should be corrected. Irrigation can reduce, but not eliminate, yield losses caused by nematodes. Growers should wash soil from equipment that is being moved from infested to non-infested fields in an attempt to minimize the spread of the parasitic nematodes. There are no commercially available varieties with acceptable levels of resistance to root-knot, reniform, or Columbia lance nematodes. However, ST 5599 BR, a variety not widely adapted to Georgia conditions, is reported to have some tolerance to the southern root-knot nematode. Tolerance is defined as the ability to produce acceptable cotton yields even in the presence of damaging populations of the root-knot nematodes. Research continues at The University of Georgia to evaluate the performance of this variety in fields with elevated root-knot nematode populations.

Resistant Varieties

In the future, it may be possible for growers to select a cotton variety with resistance to parasitic nematodes for use in an appropriate field. Resistance varieties are probably the best long term solution to nematode problems, but the only current variety with documented tolerance to southern root-knot nematodes is ST 5599 BR. Unfortunately, this variety has performed inconsistently in Georgia and has some susceptibility to Bronze Wilt.

Nematicides

Nematicides are an important component in the management of nematodes on cotton. Despite their effectiveness, nematicides cannot completely compensate for poor crop rotation. Recommendations to use a nematicide are usually based on the results of a nematode assay from a soil sample collected near harvest of the previous year's cotton crop. Nematicides, e.g. AVICTA Complete Pak, AERIS Seed-Applied System, Temik 15G applied at "nematode rates", and Telone II, can provide cost-effective control of nematodes when yield losses are expected to exceed approximately 10 percent or when results from a soil sample exceed a predetermined economic threshold. The choice of one of these products over another is influenced by factors such as the potential severity of losses to nematodes in a field versus the level of control offered by the product, application capabilities of the grower, and cost. Although growers may be concerned about the initial cost of using a nematicide in a field with damaging populations of parasitic nematodes, the resulting increase in yield will often provide a very good return on the investment. Nematode threshold levels and nematicide options also are given in Appendices III and IV. Additional information can be

found in UGA Extension Bulletin 1149 "Cotton Nematode Management," UGA Extension Circular 834 "Guide for Interpreting Nematode Assay Results," and UGA Extension Bulletin 1160 "Controlling Nematodes with Soil Fumigants."

Seed Treatments and Nematodes

Until recently, cotton growers in Georgia typically considered using Temik 15G, Telone II, and perhaps Vydate C-LV for managing nematodes. In 2008, growers will be able to use three seed treatments that have been promoted for the management of nematodes on cotton. These seed treatments are a) AVICTA Complete Pak from Syngenta, b) AERIS Seed-Applied System from Bayer CropScience and c) N-Hibit, from Plant Health Care, Inc.

It is very important that growers understand that N-Hibit is a different type of product than AVICTA Complete Pak and AERIS Seed-Applied System. The nematicidal activities of AVICTA Complete Pak and AERIS Seed-Applied System have been assessed in a number of field trials and may reduce damage from parasitic nematodes and increase yields. To date, N-Hibit has been shown in a study at the University of Arkansas to reduce the egg production of root-knot nematodes on cotton roots in the laboratory. The benefit of this finding in the commercial field is unclear. However, in field trials conducted by the University of Georgia, the use of N-Hibit seed treatment coupled with an in-furrow application of Temik 15G (5 lb/A) has not improved yields over the use of 5 lb/A Temik alone.

AERIS Seed-Applied System is a new product from Bayer CropScience and includes a mixture of the active ingredient thiodicarb for nematode management and Gaucho (imidacloprid) for thrips control. An additional fungicide for control of seedling diseases is not automatically included with AERIS Seed-Applied System (as it is in AVICTA Complete Pak). However, an additional fungicide seed treatment (Trilex) may be added to AERIS if the grower feels such is needed. By keeping the addition of the fungicide optional for the grower, Bayer CropScience is able to keep the cost of the key components- a nematicide and a thrips management insecticide, at a lower price.

The University of Georgia has less research data on AERIS Seed-Applied System than on AVICTA Complete Pak. In data collected in 2006 and in 2007, the results obtained for AERIS Seed-Applied System + Trilex have been similar in most situations to AVICTA Complete Pak. Growers who use AERIS Seed-Applied System in 2008 should only use it fields where there is low to moderate pressure from nematodes. AERIS Seed-Applied System will not provide sufficient control in fields with more damaging populations of plant-parasitic nematodes.

AVICTA Complete Pak is composed of Avicta (abamectin) for management of nematodes, Cruiser (thiomethoxam), for early season thrips management, and Dynasty CST for additional protection from seedling disease. Growers who wish to use AVICTA Complete Pack can either pre-order the product with their seed or have it treated at special facilities after acquiring the seed. AVICTA Complete Pack is to be marketed as comparable in efficacy to 5.0 lb/A of Temik 15G. That is, Syngenta is confident that AVICTA Complete Pack will provide control of nematodes similar to that of Temik 15G at 5.0 lb/A.

Evaluations of AVICTA and AVICTA Complete Pak began in field trials at The University of Georgia in 2003. AVICTA Complete Pack does have efficacy against nematodes on cotton and that it can perform well in some situations. In evaluations by the University of Georgia, there have been a number of trials where yields from AVICTA Complete Pak and Temik at 5.0 lb/A have been equivalent, and other trials where one product out yielded the other. The main concern for AVICTA Complete Pak has been its variability in performance.

After reviewing the data that has been collected for the nematicidal activity of AVICTA Complete Pak and AERIS Seed-Applied System by the University of Georgia, it is evident that these seed treatments are a popular and valuable tool for growers. However, Temik 15G (5 lb/A) has efficacy at higher/more damaging populations of nematodes than do the seed treatment nematicides. This is based upon ratings of early season galling on the cotton roots and on final yields. Based upon the ease with which AVICTA Complete Pak is used in the field, fewer growers are asking is, "Is AVICTA Complete Pak (or AERIS Seed-Applied System) AS GOOD as Temik 15G (5 lb/A)?" and more are asking "Is AVICTA Complete Pak GOOD ENOUGH for my field?".

Below are UGA recommendations for use of AVICTA Complete Pack or AERIS Seed-Applied System.

1. Growers who want to try AVICTA Complete Pack or AERIS Seed-Applied System in 2008 should insure that the nematode levels in their field are low to moderate, e.g. less than twice the economic threshold value. Neither AERIS Seed-Applied System nor AVICTA Complete Pack will offer the same protection that Telone II or Temik 15G (applied both at planting and at side-dress) offer. From data collected in 2006, use of AVICTA Complete Pak or AERIS at planting **followed by** a timely sidedress application of Temik 15G (5 lb/A) looks to be a promising treatment in fields where nematode pressure is more severe, but is NOT as effective as applications of Telone II.
2. Growers who use AVICTA Complete Pack or AERIS Seed-Applied System in 2008 are encouraged to conduct their own field tests; perhaps by treating a portion of their field with the seed treatment(s) and a portion of their field with Temik 15G at 5.0 lb/A.

More on Temik 15G and Telone II

Before using nematicides such as Temik and Telone, growers need to remember that they are Restricted Use Pesticides and misuse can be hazardous. Always consider your personal safety and the safety of those around you as the greatest priority. To obtain the greatest benefits from a nematicide, growers must consider the following:

1. Growers should insure that they are using a product and a rate that is appropriate for the severity of nematodes in a field.
2. Application equipment must be properly calibrated to deliver precise rates of product. Lower than labeled rates may provide insufficient control while excessive rates are an unnecessary expense and may injure cotton. Calibration should be checked periodically throughout planting time to make sure that flow rate has not changed. Assistance with calibration is often available through the county agent and industry representatives.

3. Equipment used to deliver nematicides must be properly maintained and checked for leaks and plugged lines. For use of Temik, hopper boxes should be cleaned and inspected before adding the product. Drop tubes should not be cracked or damaged. Rotors should be clean and not too worn. If Temik is to be left in a hopper box overnight, the hopper box should be covered and the tubes plugged to protect from moisture. Flow meters and tubing may need to be cleaned with a substance such as diesel fuel after using Telone. For more detailed information, contact Temik and Telone representatives.
4. The effectiveness of Temik is influenced by soil moisture levels at the time of planting (for activation of the product and movement in the soil). Telone II is a fumigant and therefore not dependent on water for movement through the soil; however its effectiveness is still affected by both soil moisture (for proper soil sealing) and soil temperature (greater than 40 degrees F) at the time of application. Growers should make sure that conditions are adequate for maximum effectiveness of the products.
5. Growers who choose to side-dress with Temik 15G should be very conscientious of proper timing of the application. The purpose of the side-dress application is to improve nematode control by extending the protective window for the young cotton. Typically, the side-dress application is made somewhere between the 2nd and 8th true-leaf stages and prior to pin-head square. If the application is not applied in a timely manner, the grower will likely damage the roots of the young cotton as the product is knifed into the soil. This damage can result in reduced yields.
6. For many growers, the exposure and aeration period for use of Telone II is 7 to 14 days between application and planting. However, Telone II is labeled in Georgia for an at-plant application, i.e. the grower can apply Telone II and plant the cotton seed in a single trip across the field. While an at-plant application of Telone II can be accomplished successfully, it does increase the risk to seeds and seedlings under certain environmental conditions for phytotoxicity, reduction in germination, and seedling injury. Before a grower chooses to apply Telone at-plant without waiting the standard time period, he should insure that heavy rains and cooler soil temperatures are not forecast soon after planting. He may also wish to consult the county agent and/or Telone dealer for further guidance.

Use of Vydate C-LV (oxamyl)

Vydate C-LV is an insecticide/nematicide that is applied as a foliar spray to cotton typically at 17.0 fl oz/A between the 5th and 8th true-leaf stage of cotton development. This application is a supplemental treatment for earlier applications of Telone II or Temik 15G, or use of AVICTA Complete Pak or AERIS Seed-Applied System. Use of Vydate C-LV is quite popular with cotton growers in the mid-south (e.g. Mississippi), but much less so in Georgia. For whatever reason, Vydate C-LV has rarely shown a yield benefit in our trials; however it is certainly an option for growers who seed additional protection from nematodes after cotton seedlings emerge.

Examples of Use of Nematicides based on Soil Samples

Extension Specialists and County Agents are often asked to recommend treatments for a cotton crop based upon the results from a soil sample collected in the fall of the previous season. This can be very difficult to do. For example, high populations of nematodes may cause tremendous damage in one field, but only minor damage in a field with ideal growing

conditions. Conversely, low populations of nematodes may not cause any damage in one field, but cause serious damage in another field suffering from drought or fertility stress.

There are no hard-and-fast rules on recommendations for use of nematicide; however options based upon results from recent field trials are presented below. In general, where any parasitic nematodes are found in a cotton field, Temik 15G (3.5 lb/A) is preferential over either Cruiser or Gaucho seed treatments as there tends to be some yield benefit, even though 3.5 lb/A provides minimal control of nematodes. As the size of the nematode populations increases a grower may consider the use of AERIS Seed-Applied System or AVICTA Complete Pak, or increase the rate of Temik 15G from 3.5 lb/A to 5-6 lb/A to 7 lb/A (note caution below). Also, side-dress applications with Temik or foliar applications of Vydate C-LV can be effective as well. In particularly troublesome fields, and where populations of nematodes are high, use of Telone II provides the most consistent management of the nematodes. Specific examples are presented below.

1. **No nematodes** are identified in a soil sample collected in the fall: Grower should use Temik (3.5 lb/A), or Cruiser or Gaucho Grande seed treatments for the management of thrips.
2. **Low levels of parasitic nematodes (well below threshold values) are identified in a soil sample collected during the fall:** Grower should consider using Temik at 3.5 lb/A. Results from research trials consistently demonstrate that Temik 15G, even at a "thrips" rate of 3.5 lb/A, provides some benefit in a field infested with low levels of nematodes above Cruiser or Gaucho Grande. In fields where nematode damage has been observed in the past, despite apparently low levels of plant parasitic nematodes, growers may consider use of higher rates of Temik 15G, AVICTA Complete Pak, or AERIS Seed-Applied System.
3. **Levels of parasitic nematodes in a fall sample approach, match, or are slightly above threshold values for parasitic nematodes:** Grower should consider, as a minimum, the use of Temik 15G at 5 lb/A, AVICTA Complete Pack or AERIS Seed-Applied System.
4. **Levels of parasitic nematodes exceed threshold values (e.g. 2X threshold values) in the fall and damage has been observed:** Although growers may still obtain sufficient control with AVICTA Complete Pack, AERIS Seed Applied System or Temik 15G, 5.0 lb/A, they may also consider the 5 lb/A at-plant rate of Temik 15G (or perhaps use of AVICTA Complete Pak) and then later side-dress with either Vydate CLV (17 fl oz/A 2nd to 6th true leaf stage), or another application of Temik 15 G at 5 lb/A prior to pinhead square. Side-dress applications of Temik will provide more consistent results than with Vydate, especially in heavily infested fields. If the grower chooses not to side-dress, he may consider an at-plant application of Temik 15G at 7 lb/A. **However, this rate (7 lb/A) has been observed to reduce yields below those achieved with 5 lb/A in some trials; hence it should be used with caution.**
5. **Levels of parasitic nematodes in the fall soil samples are well above the economic threshold, or combinations of nematodes each reach threshold values:** In such situations, the grower should consider using either the 5 lb/A + 5 lb/A side-dress Temik option or using Telone II at 3 gal/A (pre-plant) + a product for thrips control. In the case where the problem in the field is associated specifically with the Columbia

lance nematode, use of Telone II may be the better option as this nematode can be difficult to manage.

6. **Levels of parasitic nematodes in the fall samples are much greater than the economic threshold values and damage from nematodes has been significant in the past:** Grower may still achieve satisfactory results with a 5 lb/A + 5 lb/A side-dress Temik option; however at such elevated nematode populations (and beyond) use of Telone II is often the most effective and consistent treatment.

Boll Rot

Boll rots are caused by a complex of fungal and bacterial pathogens. Boll rot is unavoidable if cotton is subjected to prolonged periods of wetness and humidity late in the growing season. In Georgia, this can happen if a tropical storm or hurricane causes excessive rainfall, especially over a several-day period. In such situations, there is little a farmer can do to minimize losses to boll rots.

Actions that reduce humidity in the cotton canopy can help reduce the likelihood of a significant boll rot problem in the absence of inclement weather. Such practices include proper nitrogen fertilization to avoid rank vegetative growth, lower plant populations (plants/acre), timely defoliation and harvest, and the use of mepiquat chloride, a plant growth regulator which limits vegetative growth. These practices increase airflow through the canopy and reduce humidity around the lower bolls which makes the microclimate less conducive for boll rots. Adjusting planting dates so that bolls approach maturity later in the summer, when conditions are typically drier, can help. Neither fungicides nor bottom defoliation have proven effective for boll rot control. Plants with fewer bolls may have increased vegetative growth, which can increase humidity in the plant canopy thereby increasing boll rot problems. For additional information, refer to UGA Extension Leaflet 143, "Cotton Boll Rot."

Good insect control can reduce boll rot. Injury from insect feeding can increase boll rot by creating wounds where rot-inducing organisms can enter bolls and by causing plants to set fewer bolls. Also, proper insect control can promote better plant utilization of nitrogen, thus reducing excessive vegetative growth.

Fusarium Hardlock of Cotton

Every grower in the state is aware that his field will contain bolls with lint that does not "fluff", a condition that has been referred to as "tight-lock" and "hard-lock". Such bolls are usually not harvested with a spindle-type picker. Reasons for the failure of the boll to fluff properly include boll rots, insect damage (especially from stink bugs), environmental conditions at boll opening (e.g. very high humidity), immature bolls, and perhaps other factors. Researchers in Florida have been evaluating this problem in considerable depth over the past several years and have concluded that the fungus *Fusarium verticillioides* is a causal agent of at least some of the hardlock of cotton in that state. They have differentiated this condition as "Fusarium hardlock" and theorize that the infection by the fungus occurs through the flower at bloom, rather than directly through the boll as in traditional boll rot. They have also reported that multiple applications of specific fungicides have been helpful in the management of Fusarium hardlock. Research results from across the Southeast in 2003, 2004, and 2005 have not adequately demonstrated the benefits of fungicide applications to

manage Fusarium hardlock. At this point, researchers in Georgia are uncertain of the benefit of fungicide applications to manage hardlock, the timing and frequency of such applications, or the rate of such. No fungicides are currently labeled for the management of "Fusarium hardlock" in Georgia. For the 2006 season there is no recommendation for the use of a fungicide to manage Fusarium hardlock.

Foliar Diseases

Although cotton is susceptible to a number of diseases that affect the leaves, foliar diseases are not usually a problem in Georgia and tend to show up most often on aged and senescent tissue. Cotton foliage is often marred by various leaf spots caused by fungi such as *Cercospora*, *Alternaria*, and *Ascochyta*; yet no control measures are generally needed. Ascochyta wet weather blight was very common in 2003 due to the ample rainfall. However, the disease was typically gone early in the season and no treatment was necessary.

Late season outbreaks of Ascochyta blight in 2005 and 2006, especially in southwestern Georgia, caused great concern for a number of growers, agents, and crop consultants. Spots from this disease developed extensively on the petioles, foliage, and bolls of affected cotton plants. Fortunately, most of this damage seemed to be superficial and did not cause serious losses; however, Headline (pyraclostrobin) is now labeled for control of this disease.

Over several seasons, growers and agents have noted a disease resembling powdery mildew in the field. This disease is likely to be "areolate mildew" and is caused by the fungus *Ramularia*. Yield losses are generally not attributed to this disease. In 2007, foliar applications of Headline (6.0 fl oz/A) provided outstanding control of this disease.

Perhaps the most troubling foliage concern for growers is known as Stemphylium leaf spot because of the lesions produced by the fungal pathogen. Interestingly, although the fungus *Stemphylium* spp. is the cause of the disease, it is the occurrence of late-season potassium (K) deficiency that predisposes the foliage to infection by the pathogen. Potassium adds strength to the cells in the plant leaf; it is the deficiency of K that makes the leaves susceptible to infection by *Stemphylium*. What begins as well formed leaf spots can in severe cases lead to complete defoliation soon after the fourth week of bloom. The use of fungicides will not correct the problem. To prevent Stemphylium leaf spot, growers should insure that adequate K is available in the soil through careful soil testing and proper fertilization.

Management of foliar disease: Headline (pyraclostrobin) is now labeled for use on cotton to manage foliar diseases. Although additional studies are needed to document the yield advantage from use of this product, results from 2007 **clearly** demonstrate its efficacy on Aereolate mildew and Ascochyta blight.

Seed Rot

This malady was first detected in Hampton County, South Carolina, in July 1999. To quote a report from South Carolina, "Seed rot was observed in apparently healthy fields which had high yield potentials 3 to 4 weeks after initiation of flowering. Bolls containing seed rot exhibited no outward symptoms of seed rot or any other problem. Symptoms were most visible when bolls were cut transversely. Affected seeds were poorly developed and often hollow, while less affected seeds were pinkish in color and partially hollow...Bolls in which

seed rot occurred did not mature normally and were often hard- or tight-locked, i.e. unharvestable by mechanical picker." (From: "Preliminary investigations on cotton seed rot in South Carolina", Clemson University Station Bulletin 675, September 2000). The definite cause of this problem has not been determined by researchers in South Carolina and their efforts on this issue continue. Although symptoms similar to "seed rot" have been reported by agents in Georgia, our state does not seem to have the severity of the problem as South Carolina. Growers who detect this problem in their fields should report it to their local county agent.

Bronze Wilt

Bronze wilt is a plant malady that affected thousands of acres of Georgia's cotton in 1998 but has been quite limited in subsequent crops. Bronze wilt has thus far been limited to varieties that have TAMCOT SP-37 in their pedigree. These include Stoneville 132 and 373, the Paymaster 1200 series, and a few transgenic lines in which a Paymaster 1200 parent was used as the donor of Bollgard and Roundup Ready genes.

Bronze wilt is related to restricted water transport in the plant and manifests itself with numerous symptoms. These include reddish bronze discoloration in the upper canopy, elevated leaf temperatures, extreme reddening of plant stems, and/or loss of fruit and foliage. In young plants, initial pale coloration can progress to total plant death. Bronze wilt is more easily diagnosed in younger plants that begin to redden and wilt than in mature plants with heavy fruit loads. Older plants with heavy boll loads are more susceptible to stresses that produce nearly identical symptoms that are unrelated to bronze wilt. Conditions that may be confused with bronze wilt include premature cutout, normal plant maturation and senescence, nutrient depletion, Fusarium and Verticillium wilts, and environmental stresses.

Bronze wilt is triggered in part by an interaction between the genetics of the cotton variety and hot weather. Since bronze wilt is not a true disease, the isolation of a pathogen is not involved in the diagnosis of this condition. Therefore, diagnosis of bronze wilt is often made after ruling out other possible causes of plant decline. **Bronze wilt is successfully controlled by avoidance**; that is by NOT planting varieties with the genetic background known to have potential for the problem. Also, bronze wilt has been found to be less severe when susceptible varieties are planted earlier in the season rather than later.