CROP PROTECTION: SEEDLING DISEASES AND NEMATODES

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Abstract

Seedling diseases which result in poor emergence, post-emergence damping-off and damaged roots are found in every state where cotton is grown. Some of these fungi cause more disease under wet conditions, others cause more disease under cool temperatures. These diseases are managed by altering the soil environment, seed and in-furrow fungicides, and variety tolerance. Cost-effective management can be obtained by rating fields for: seedling disease history; soil temperatue near planting time; rainfall forcast for the week after planting; tillage practices; crop rotation; and nematodes. Use of the best combination of management practices should be based on potential for seedling disease. Nematode problems are more consistent year to year than seedling disease, because damage is primarily related to the density of the nematode at planting. Management includes resistant cultivars, crop rotation, and use of nematicides. Management options should be chosen based on sampling soil for nematode species and density.

Introduction

Cotton production costs are affected by seedling diseases every year. Seedling diseases can cause: cotton seed to rot in the ground; post-emergence damping-off; and root rots which result in unthrifty plants that are easily killed or grow very slowly. Once cotton roots and stems become woody, they are no longer as vulnerable to seedling diseases. Young cotton plants are vulnerable and must be protected. The fungi that often cause damping-off or reduced emergence are *Rhizoctonia solani* and *Pythium* spp. The fungi that primarily damage roots are *Thielaviopsis basicola* and *Fusarium* spp. They each have different environmental conditions upon which they thrive. *Pythium* spp. require wet soils to cause problems, while *T. basicola* require cool soil temperatures (<70F) to cause problems. *Rhizoctonia* probably has the widest range of environmental conditions upon which it can cause disease. Cool, wet conditions results in worse seedling disease, while warm, dry weather results in minimal seedling disease. However, the specific combination of pathogens in a field will dictate which weather conditions lead to seedling disease.

Where do these different fungi occur? They can occur in any state where cotton is grown, and all these fungi can be found in the same field or only one may be found. States where *R. solani*, *Pythium* spp., and *Fusarium* spp. are of primary importance include the southeast and midsouth regions (Wrona et al., 1996a). In the southwest and western regions, *T. basicola* (causal agent of black root rot) along with *Pythium* spp. and *R. solani* are considered most important (Wrona, et al., 1996a).

Management of seedling diseases can seem like buying a lottery ticket. You could buy just one ticket and win, or you could buy lots and lots of tickets and not win, i.e. lose the field to disease. How much money and management should a producer invest? To increase the odds of winning, it is important to look at how much risk there is for seedling disease in each field. As mentioned previously, the weather has something to do with the chance of having seedling disease. Looking at soil temperatures and predicted rainfall is one way to manage risk. Try to avoid planting when the predicted weather is cool and wet. If black root rot is a problem, try to avoid planting in cool weather. Other factors that a producer can monitor is field history, rotation crops, tillage practices, and nematode problems.

All of these factors can be used to predict severity of seedling diseases. Field history not only can provide an indication of how frequently fields are replanted because of seedling diseases, but whether problems are due to poor emergence, root problems after emergence, or a combination of both. In west Texas, soil from several hundred fields has been examined to develop methods for providing producers with information on which fungi are present and how much risk is involved when cotton is planted under cool, wet conditions. Cotton seed are treated with a fungicide specific to each fungal problem and then emergence and root necrosis of cotton are monitored in soil samples from fields in a growth chamber set to 68F. For example, if seed treated with a product specific for *Pythium* has good emergence, but seed treated with a product for *R. solani* does not, then that field may benefit most from protection against *Pythium*. In follow up visits to several fields which were tagged as being high risk by our laboratory tests, the seedling disease potential was confirmed.

Rotation to crops other than cotton can reduce seedling diseases when cotton is next planted. However, it is not an exact science, since the host ranges of these seedling disease fungi can be slightly different for every different location. In general, rotation with a grain crop will result in a reduction of seedling disease (Leach and Garber, 1970; Linsey, 1974). A fallow soil will not necessarily result in less seedling disease when cotton is grown again, particularly in a dry climate. It also follows that cotton grown after cotton, especially in soils with a history for seedling disease, results in higher potential for seedling disease.

Conventional tillage is becoming less and less practiced. There are many benefits for using reduced tillage practices. Unfortunatly, a negative factor is that the potential for

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:12-13 (1997)
National Cotton Council, Memphis TN

seedling disease is increased (Chambers, 1995). This is particularly true for *R. solani*. The consequences of tillage practices on seedling disease for other fungi are less consistent. Therefore, for fields with a history of emergence problems or sore-shin type symptoms, minimum or non-tillage systems means a higher potential for seedling disease.

Root-knot (*Meloidogyne incognita*) and reniform (*Rotylenchulus reniformis*) nematodes have been shown to increase the severity of seedling disease (Starr and Page, 1990). Management of nematodes can lead to less seedling disease.

Control of seedling diseases involves manipulation of the environment in which cotton is planted; chemical and/or biological products applied on or near the cotton seed; and tolerant varieties. Manipulation of the environment can include planting later when soil temperatures are more favorable for cotton growth and providing beds with good drainage. Any practice which increases the soil temperature or reduces the chance of standing water can be beneficial to getting the plant up and growing vigorously through its time of vulnerability.

Chemical and/or biological products are routinuely applied to cotton seed. It is important to start with high quality seed. All the chemical protection in the world can do little if the seed does not germinate vigorously. It is important to have seed that germinates well under cool conditions and not just under warm conditions. A cool-warm vigor test has been developed which can alert producers to seed that won't perform well in cool soils. A broad-spectrum fungicide is often applied for protection against many different fungi which can rot seed. Additional materials can be applied which are active against *Pythium*, or *Rhizoctonia* or *Thielaviopsis* and *Rhizoctonia*. It is important to realize that each product will control only one or two of these fungi. That is why multiple fungicides are stacked on seed. Additional protection can be obtained from in-furrow fungicides. These products may be specific for either *Pythium* or *Rhizoctonia*. Sometimes combinations of products are sold which give activity aginst both fungi. There is not a lot of evidence that in-furrow fungicides provide protection against *T. basicola* or *Fusarium* spp. So be aware of which fungi are causing problems and use products specific for your problem. Hopper box treatments may be used when seed treatments are inadequate, but are not a substitute for in-furrow treatments, when disease pressure is severe. If the risk of *R. solani* or *Pythium* related seedling disease is high, then the best chemical control are seed treatments plus in-furrow fungicides.

Few varieties are tolerant to seedling diseases. Recently, Acala Maxxa was released in California with a high level of tolerance to *Pythium ultimum* (Wrona, et al., 1996a). Early root vigor can differ slightly between cultivars, but true resistance to these seedling disease pathogens has not been identified.

A producer can make risk assessment calculations for each field. If a field has little history of seedling disease, and the weather is warm and dry, then minimal management is necessary. As the risk factors build, then so must the cost of control. However, cost of replanting a field is much higher than control costs, and even more important the delay in maturity due to replanting can be critical. Be aware that primary risk factors are field history, temperature, and soil moisture. Secondary risk factors are tillage, crop rotation, and nematodes. Match management to risk.

Nematode problems in cotton are due primarily to the root-knot, reniform, and lance (*Hoplolaimus*) nematodes. In the southeast, all three of these nematodes can cause damage (Wrona, et al., 1996b). In the mid-south, reniform nematode is probably responsible for the most damage, though root-knot nematode is also a problem (Wrona, et al., 1996b). In the southwest, root-knot nematode is the most severe problem, though reniform can be devestating in some areas (Wrona, et al., 1996b). In the west, only root-knot nematode is known to cause damage, and reniform nematode has not been found west of Texas (Wrona, et al., 1996b).

Yield losses caused by nematodes are related to how high nematode populations are at planting. Composite soil samples taken in the fall and assayed for plant-parasitic nematodes can indicate problem fields for the subsequent year. Nematode management can be divided into three areas: crop rotation, nematicides, and resistant varieties. Often the most expensive tool is crop rotation away from cotton. The choice of alternate crops like grains, peanut, or nematode (root-knot or reniform) resistant soybeans can greatly reduce root-knot and reniform nematode populations (Kirkpatrick and Sasser, 1984; Thames and Heald, 1974). Lance nematodes have such broad host ranges that it is difficult to use crop rotation.

Nematicides are used to reduce the spring population of nematodes. If cotton has a well established root system early in the season, then later increases by nematodes are not very damaging. In fact, use of nematicides often leads to high populations of nematodes at harvest, because the plant does have a large root system. Smaller, less thrifty roots will often result in smaller numbers of nematodes in the fall. Nematicides that are nonfumigants (Temik, Vydate, Furadan) are also insecticides at lower rates. It is important to use higher rates when controlling nematodes than when controlling insects. Within the range of rates of nematode control, nematode density (determined from soil samples) can be used to determine more specific rates. A high rate of nematicide may be twice what a low nematicide rate is. There is potential that variable application of nematicides (i.e. precision agriculture) can reduce production costs and/or increase yields.

Root-knot nematode resistance was found years ago in primitive cotton (Shepherd, 1983), but getting that resistance, which is polygenic, into high yielding cotton cultivars has been difficult. However, several varieties now exist with at least partial resistance to root-knot nematode (examples are Stoneville 887 and Acala NemX). There is a fierce effort being made to find reniform nematode resistance, but no resistant varieties exist yet. There is minimal or no current effort to find resistance to the lance nematode and previous efforts were unsuccessful (Mueller and Sullivan, 1988). Transgenic cotton resistant to root-knot and reniform nematodes is not yet available, but there is high potential in this area.

Crop rotation has always been very important in control of nematodes. However, use of this tool has declined in recent years and reliance on nematicides and resistance has increased. In the next five years, the new farm program may permit a resurgence of crop rotation with grains, but nematicides will still be heavily used. Precision application of nematicides may become a profitable tool in the future. For root-knot nematode, resistant varieties will continue to be heavily utilized, and within ten years, it is hoped that reniform nematode resistant varieties will also be available.

Summary

Plant resistance and variable application of nematicides are the way of the future with nematodes. Management requires knowledge of nematode species and population densities. Soil samples are the most efficient way to determine these factors. This can be contrasted with seedling diseases, where management primarily involves fungicides, with little to no resistant varieties. Management of seedling diseases requires knowledge of field history, soil temperature, rainfall, tillage practices, crop rotation, and nematode problems.

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