Gray Leaf Spot on Corn

David H. Nielsen

Background

- Grew up in southwest Nebraska
- Worked on friend's family farms
- Gained an interest in agriculture through high school FFA

Education/ Career

- Associates of Applied Science, Nebraska College of Technical Agriculture, 2000
- Bachelors of Science in Agricultural Science, University of Nebraska-Lincoln, 2004
- Moved to Ames in 2004 so my wife could pursue her Ph.D. in Microbiology at Iowa State
- Taught high school agricultural education and physical science for 4 years at Woodward Academy in Woodward, IA from 2004-2008
- Currently employed as a Research Associate with Syngenta Seeds in Nevada, IA working with replicated soybean yield trials

Interest in Program

- Wanted to continue education but not in high school education
- I was teaching full time and was looking for and online option
- Interested in more Applied Sciences
- Discovered program surfing the internet while on deployment to Mosul, Iraq in 2005

Gray Leaf Spot on Corn

Course Index

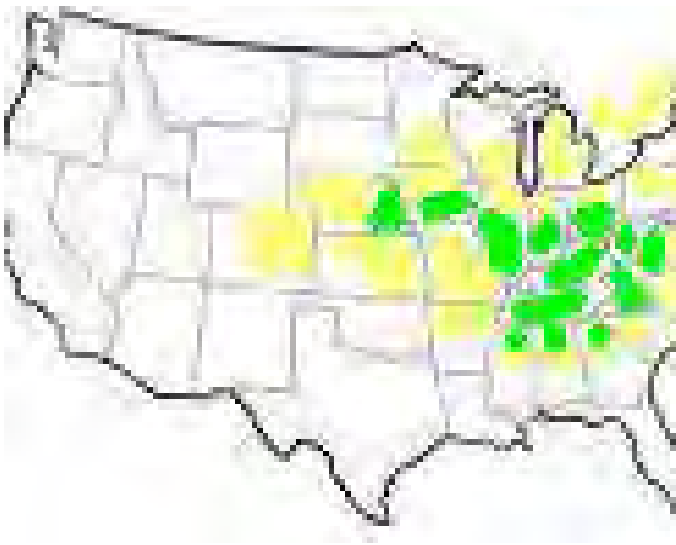
Introduction

Brief History

Gray leaf spot (GLS) is a foliar disease of corn (*Zea mays* L.). Gray leaf spot was first observed in corn in 1925 in Illinois and then more extensively in eastern seaboard states, such as the Carolinas and Virginia, in the 1940's.

This pathogen was not seen as an economic threat until the mid 1970's when no-till and other conservation tillage practices were becoming more prevalent. Potential climate issues, such as increased cloudiness and annual rainfall levels, may also be a contributing factors to the increase in prevalence and severity of disease.

More recently, biofuel production has increased the number of acres that are in continuous corn production. This factor coupled with limited preventative tactics has likely lead to GLS becoming more prevalent in the U.S.



Current U.S, and Canada areas affected
Green areas are more severe
Yellow is light to moderate
White no reports of disease

Introduction

Economic impacts

Currently, gray leaf spot is present in most of the Southeastern United States and across the Midwest, stretching as far west as Colorado. Over 37 million acres of corn are affected by this pathogen, and gray leaf spot has become a major economic concern for producers in affected areas.

The potential financial impact for a producer depends on disease severity and how early in the grain-fill period leaves become infected. In most cases there is only a dramatic yield loss if leaves above the ear leaf show signs of infection 2-4 weeks prior to pollination. Due to shading in between rows, leaves higher on the stalk become the primary surface areas for light absorption and photosynthetic carbohydrate production. Loss of this leaf tissue can lead to delayed or loss of kernel development, which in turn affects overall yield potential.

Levels of yield loss can be measured by determining the percentage of leaves infected by early dent stage. Yield loss can be as extreme as 85 percent when all leaves above the ear leaf are lost.

GLS late season affects resulting in sev reduction in photosynthetic leaf area.

Predicted Yield Loss

The earlier the damage advances to the ear leaf, the greater the yield loss will be. Levels of leaf loss later in the plant's development leads to more limited yield loss.

Percent ear leaf area affected by GLS at early dent	Approximate yield loss expected
5% or less	0 – 2%
6 – 25%	2 – 10%
25 – 75%	5 – 20%
75% - dead leaf	15 – 50%

From: Lipps, P. 1999. Predicted yield loss due to gray leaf spot. AG answers, August 17, 1999. (Data from Kentucky, Indiana, and Ohio.) http://www.agriculture.purdue.edu/AgAnswers/story.asp?storyID=2029

Introduction

There are many options available for minimizing the impact of gray leaf spot, however several of the options can be costly. Some options should be decided on prior to planting, such as tillage options and choosing resistant hybrids, where as other options can be considered in season, like fungicide application at proper timing for maximized control.

Early gray leaf spot leaf damage.

Objectives:

- To describe the gray leaf spot disease cycle on corn
- To identify environment conditions that favor GLS development
- To determine plant economic thresholds based on infection level and environmental conditions
- To discuss management practices available to reduce yield losses due to gray leaf spot

Life Cycle

Environmental Conditions for Development

Like all fungal pathogens the gray leaf spot fungus requires specific field conditions and environmental factors to survive and propagate.

Favorable field conditions are:

- Continuous corn production
- Susceptible hybrid selection
- No-till or conservation tillage practices
- History of the disease in field

Pop-up information in the NOTES section

Favorable environmental factors (usually needed about 60 days after planting) are:

- High humidity and warmer temperatures
- Moderate wind for spore dispersal
- Light rain for days or heavy fog conditions
- Twelve hours of “free” moisture on lower leaves prior to inoculation

Life Cycle

The life cycle of GLS on corn has steps from planting to harvest.

Mid-April	June	July	September-October
Planting		Pollination	Harvest

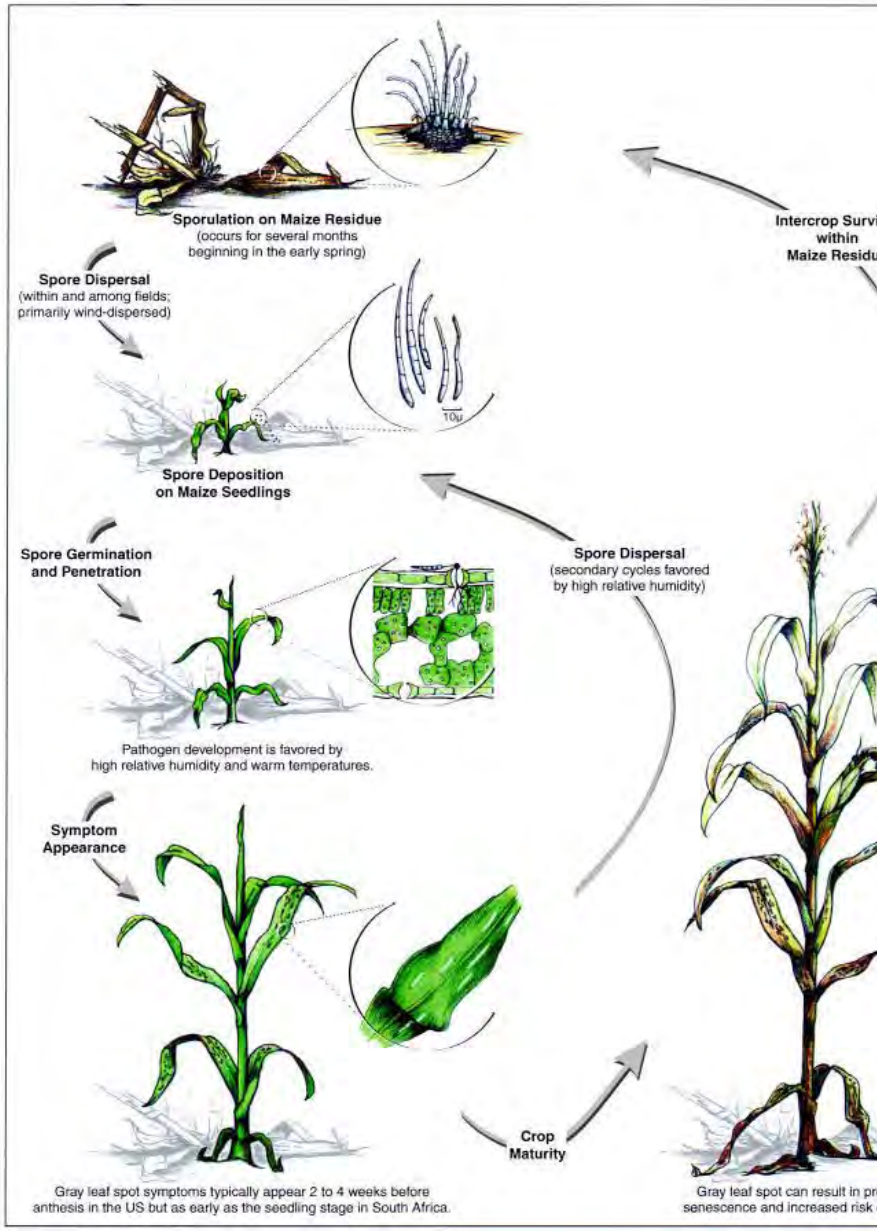
Click on the month to see what is going on in the gray leaf spot life cycle.

Disease Cycle

I would again like to insert a picture cycle with some animation showing the stages of the disease cycle in relation to its life cycle

Primary steps would include:

- Sporulation
- Spore dispersal and methods
- Spore deposition
- Spore germination and leaf penetration
- Symptom appearance
- Secondary inoculum
- Crop Maturity
- Over-wintering on crop residue



Disease cycle of gray leaf spot in corn from Plant Disease 83:884-895.

Life-cycle

Life and Disease Cycle Activity

This slide would be devoted to having a matching section where a cycle is shown and the student would drag and drop the step. The next stage would be just a visual or text description of the event and the student needs to drag and drop or fill in the blank for each one. This would need a couple of slides.

Signs and Symptoms

Early Signs and Symptoms

Early Signs

Under normal scouting conditions there are no early signs of fungal presence on the corn leaf. However, under magnification fungal structures are visible.

Early Symptoms

Some of the early symptoms (plant responses to infection) consist of:

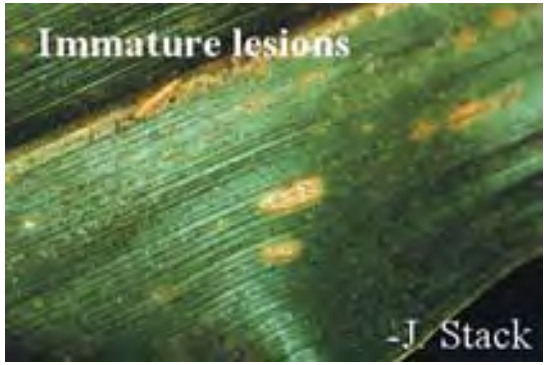
- Appearance of small lesions (0.4 - 0.8 inch long) on the leaf surface
- Lesions are initially tan or brown in color and may have a yellow ring around the lesion that can disappear as the disease progress
- Lesions are irregular or rectangular in shape
- Initial lesions of other corn foliar diseases (Anthracnose, eyespot, and common rust) look very similar

Early GLS lesions on a corn leaf. Courtesy of Gary Munk

Pictures for GLS comparison

Common rust - initial symptoms are chlorotic flecks on the leaf surface.

Eyespot - initial symptoms are small circ (1/16 in diameter) lesions that are tan wit watery ring. Symptoms usually start on l leaves similar to GLS.



Anthracnose - initial symptoms are small watery lesions that are brown with yellow to reddish borders. Symptoms occur on lowest leaves of the plant.

Signs and Symptoms

Mature Signs and Symptoms

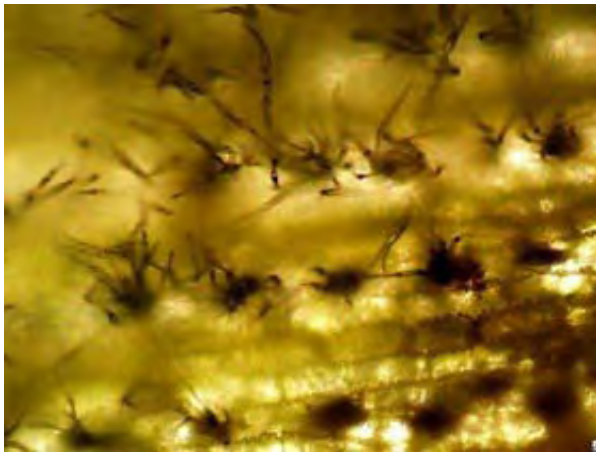
Mature signs and symptoms of gray leaf spot appear around corn pollination.

Mature Signs

- Conidia can be seen on surface with magnification
- Visible signs are dark conidiophores arranged in rows since they grow out of stomatal openings within the lesions
- Larger lesions produce more spores with conidia producing as many as 5,000 spores per millimeter of leaf surface affected

Mature Symptoms

- Lesions are long and can be 0.4-2.8 inches in length
- Lesions are limited by veins on leaves which gives the lesions their rectangular, long/narrow appearance
- Color of the lesions are initially tan and become gray with age
- As the disease progress, gray leaf spot is easier to differentiate from other diseases (Anthracnose, eyespot, and common rust) .



Fungal conidia and dark condiophores on the leaf surface emerging from corn stomata.

Mature GLS lesions on corn leaf. Courtesy of Gary Munkvold.

Late Pictures for GLS Comparison

Eyespot - late season lesions are very s
round and necrotic. They have a dark b
or purple ring that is often water-soaked
greasy in appearance. They can cover
sections of the leaf yet retain individual s
rather than combining to make a larger
rectangular or irregular shape on the lea

Anthracnose - late season lesions are irregular in shape and are dark brown rather than gray or tan. These can cover large sections of the leaf and are prevalent from three weeks after tasseling.

Common rust - late season signs are streaks of pustules on the leaf surface. These are a reddish brown and are round and raised from the surface.

Management

Assessing Risk Factors

There are several factors that can predispose a field to gray leaf spot disease development. Some of the more common factors are listed below:

Click on each topic for additional information.

- Resistant hybrid selection
- Continuous corn
- Late planting date
- Conservation or no-till management
- Field history
- Early disease activity (before tasseling)
- Irrigation
- Favorable weather for inoculation

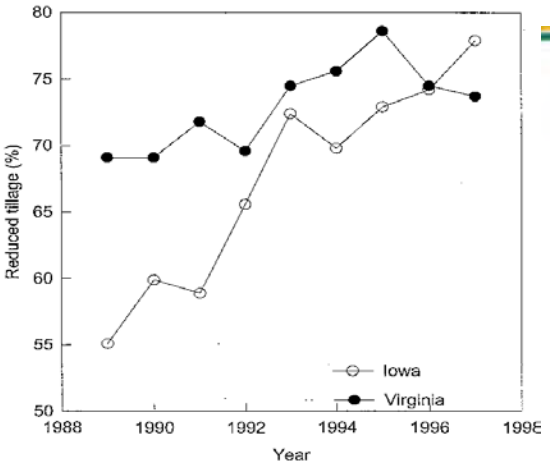
Irrigation can increase the risk of GLS.

Management

Tillage

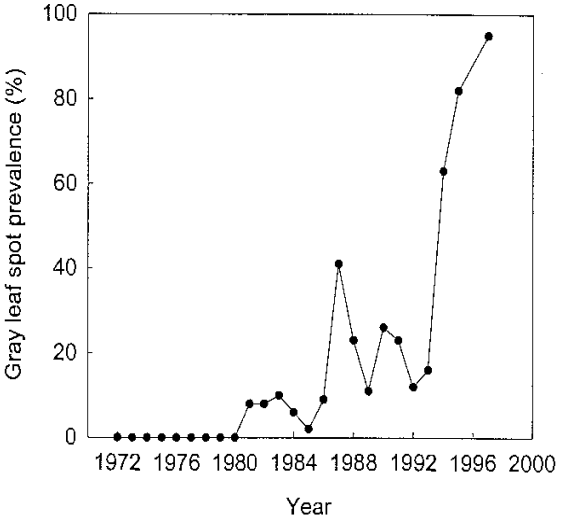
Tillage is a useful tool in controlling gray leaf spot. Conidia survive on corn residue that remains in the field following harvest. Tillage in the fall or spring (before April) will incorporate mycelium and conidia into the soil disrupting the fungal life cycle. This physical barrier prevents spore movement on to plants in the spring, thus preventing inoculation of new corn seedlings. If fungal propagules are not on the surface, then they must compete with soil saprophytes for nutrients. *C. zea-maydis* is a poor competitor against soil saprophytes and normally cannot assimilate enough nutrients and die.

Reduced tillage can lead to an increase in GLS incidence in a given field. This is due to the levels of crop residue left on the surface. The attached graphs show the effects in Iowa and Virginia on GLS levels in relation to the percentage of acres under reduced tillage during the 1990's.



Percentage of maize fields in reduced tillage in Virginia and Iowa 1989 to 1997 from Plant Dis. 83:884-895.

Click on Graph to enlarg



Increase in prevalence of gray leaf spot in maize in Iowa from 1972 to 1997. Gray leaf spot was not detected in surveys prior to 1981 from Plant Dis. 83:884-895.

Management

Hybrid Selection

Hybrid selection should be the cornerstone for GLS management. When selecting a hybrid for your operation or a customer, consider the following:

1. **Tolerance to GLS**: Currently, there are no corn hybrids resistant to this pathogen, yet many are tolerant. Consult company seed literature to find hybrids suitable to your area that have GLS tolerance.

2. **Maturity and planting date**: Depending on where you live knowing what hybrids are available with appropriate maturities is a must. Having a hybrid that grows vigorously helps the plant fight off potential disease agents. Along with this you must know what is available for maturities if a replant is needed due to poor weather conditions early in the season.

Hybrid selection can have a dramatic effect on

Management

Fungicides

Fungicides can be a preventative or curative tactic employed to control gray leaf spot:

- **Preventative fungicides** – protect the plant from becoming infected. These cannot control a fungus that already is living in the plant tissue.
- **Curative fungicides** – are applied to eliminate an existing pathogen. However, if there is too much fungal biomass, the fungicide may not be effective.

Fungicides are also classified as how they move within the plant:

- **Contact fungicides** are considered protectants that cover the leaf surface and prevent the infection or development of fungi on plant surfaces.
- **Mesostemic fungicides** – chemical moves into or is absorbed into immediately surrounding tissue. If fungal biomass is present in this surrounding tissue, the fungicide may stop fungal growth depending on the mode of action of the fungicide. Fungicide moves into leaf tissues, but does not move into the vascular system.
- **Systemic fungicides -** move throughout the plant internally, not localized.
  - **True systemic –** is translocated in the phloem tubes and can move both up and down in a plant. This helps provide better coverage than a distal fungicide.
  - **Distal systemic –** fungicide moves distally from the point of contact and needs greater application rates to ensure protection.

Click here to see a video demonstrating the above points.

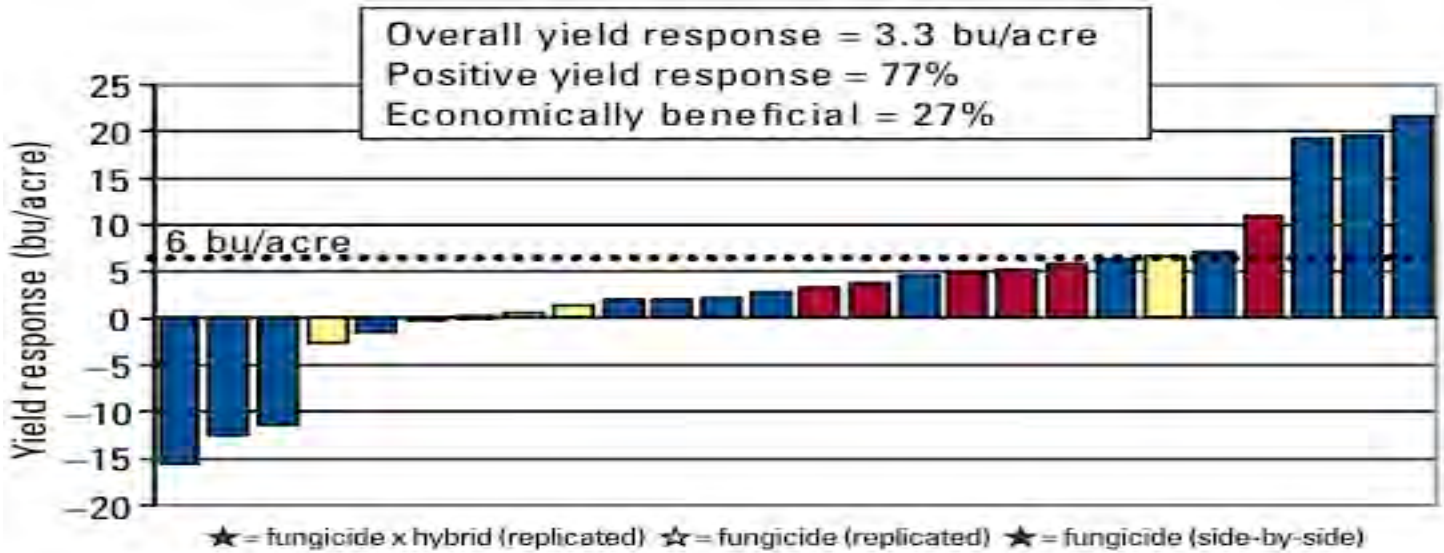
Management

Fungicides

When deciding whether to apply fungicide or not, there are several factors to consider:

- What is the cost per acre of fungicide + application?
- What is the value per bushel for corn?
- How many bushels of increased production are needed to break even financially?

The example below shows that in most cases test plots did not meet the minimum threshold of six bu/a (cost of fungicide and application) in increased yield. In most circumstances there is a chanc that the fungicide application may not be worth the time or money. Hybrid selection, type of application, and environmental conditions need to be considered before applying. It is important to realize that every growing season will be different based on both management decisions and curr economic climate. Click the graph to enlarge.

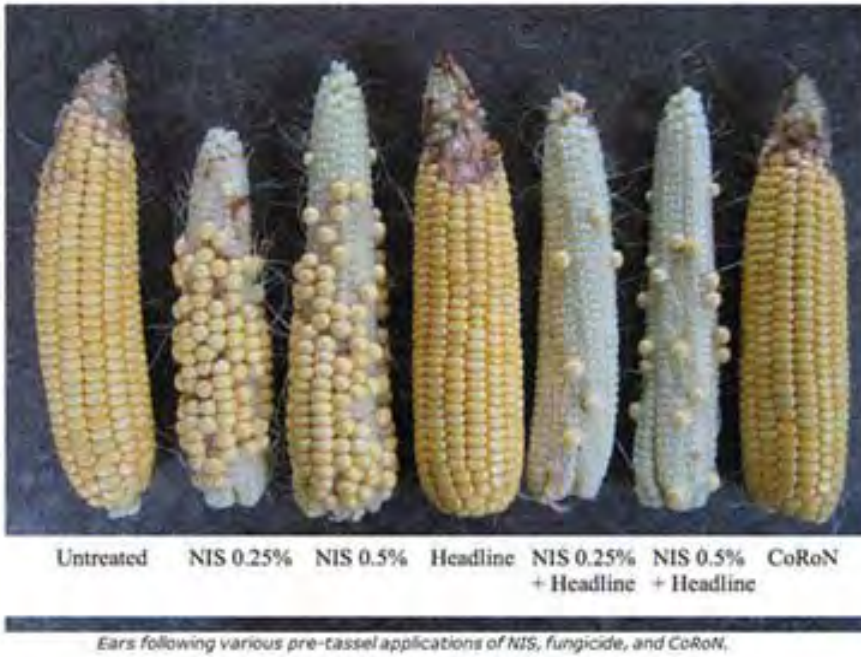


Management

Non-ionic Surfactants

Non-ionic surfactants (NIS) are used in fungicide applications to help with decreasing a fungicides surface tension and allowing for greater droplet contact with a leaf. There has been some research correlating surfactant use and application time to corn ear injury. The most common observed conditions are stunting and limited kernel formation, which can lead to a reduction of up to 70 percent kernel loss with certain spray combinations.

This injury is mostly associated with fungicide applications in conjunction with a NIS applied two weeks prior to tasseling. This has been associated with potentially severe yield loss. Use of NIS products above recommended rates increased the level of ear damage.



Corn injury at varying levels of NIS surfactant used with fungicide trea

Fungicide Products and Rates

			Adjuvant	Adjuvant	Coverage (gpa)	Coverage (gpa)
Fungicide	**Application Rate (fl oz/acre)**	**Application Timing**	**Ground**	**Air**	**Ground**	**Air**
Headline®	6-12	Prior to disease development	NIS @ 1 pt/100 gal	COC @ 1 pt/acre	20	2-5
Quadris®	6-15.5	Prior to disease development	NIS @ 1 pt/100 gal	N/A	Sufficient water volume for adequate coverage	5
Quilt®	7-14	At onset of disease to brown silk	NIS @ 1 pt/100 gal	COC @ 1 pt/acre	Sufficient water volume for adequate coverage	2-5

Common GLS Fungicides (Courtesy, Robertson, 2007)

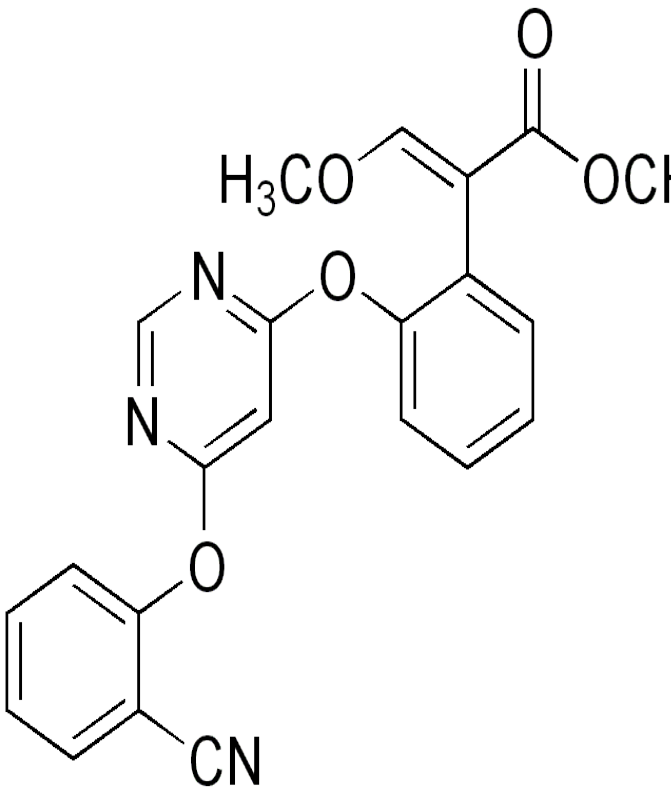
Fungicides

Strobilurin

Strobilurins control fungus by preventing energy production within fungal mitochondria by disrupting electron transfer at the Quinol outer binding site of bc1 cytochrome complex. Thus, the fungus is unable to develop mycelium and grow, which in turn prevents germination and therefore infection.

Strobilurin is considered a protectant. Most of the active ingredient is bound in the waxy cuticle so it will affect fungus present on the leaf surface more readily.

Strobilurins have limited mobility in plants, which can lead to additional applications if the required level of control is not met.



Azoxystrobin: a common Strobilurin active ingredie

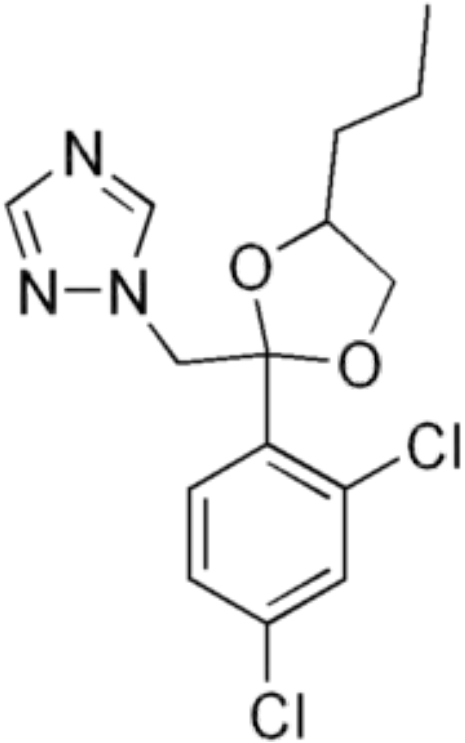
Fungicides

Triazole

Triazoles affect a specific enzyme, C14-demethalyase, that is required to produce sterols in the fungus. Sterols are necessary for cell membrane structure and function. This affect inherently limits a fungus from developing normally when contacted by triazole fungicide.

Triazole application is recommended as a protectant that also has applications against early stages of infection. Triazoles are quickly absorbed into the leaf tissue and xylem of the leaf tissue.

Appropriate applications are required to ensure that all leaf surfaces are covered to increase fungicide effectiveness.



Propiconazole a common Triazole active ingredient

Summary

Gray leaf spot (GLS) is becoming a disease of greater importance in the United States. It is affecting more acres of corn each year and this has prompted many to look at how to best manage this disease.

Scouting plays a important role in managing this disease. It is important to scout a couple of weeks before tasseling to see if the disease is present. One should look for small, tan lesions, about ¼ inch on lower to middle leaves, and scout again every two weeks to monitor injury levels.

If gray leaf spot is present in your field, it is important to determine disease levels to make an appropriate management plan to combat this threat.

Most early season symptoms cannot be seen unless you get i field and examine the plants more closely.

Summary

Management plans need to account for both environmental and economic concerns when deciding what is best for an operation. There can be cultural options, such as tillage plans, hybrid selection, or planting date, or curative options, such as fungicide applications. Each has potential benefits and risks.

A producer needs to pay attention to current grain markets, labor costs, chemical product and application costs, or more importantly, disease pressure within the crop. Each factor should be considered before implementing any plan.

A proper GLS management plan can lead to a better harves

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