Goss's Wilt of Corn

Goss's wilt (*Clavibacter michiganensis* subsp. *nebraskensis*) is a bacterial disease usually associated with corn fields in Nebraska and Colorado. In 2010, damage from this disease was notable not only in those states, but also in states to the north and east, including the Dakotas, Minnesota, Iowa, Wisconsin, Illinois and Indiana. The disease has even extended into some Manitoba, Canada corn production areas.

Plant pathogists have reported increased Goss's wilt and corn damage in many midwestern and northwestern states over the last few years. Higher levels of corn residue from corn-after-corn production and reduced tillage are likely contributing factors in the spread of the Goss's wilt.

However, the prevalence of hail events and storms has a large impact on the severity of infection and yield loss in a given growing season. When plants sustain abrasion injuries from hail or wind, Goss's wilt bacteria can infect the leaves through the damaged plant tissues.

Disease Development

Goss's wilt overwinters in infected corn residue, and that of other host plants, including green foxtail, barnyardgrass and shattercane. From this infected residue, Goss's wilt bacteria enter corn plants through wounds caused by hail, heavy rain, wind or mechanical damage, and may even enter the leaves through the stomates. Rain splash is the usual means of transfer from residue to growing corn plants, but Goss's wilt can also survive in irrigation water during the growing season. Plants may be infected at any stage of development.

Wet weather and high relative humidity tend to encourage development of Goss's wilt. This is because leaf wetness is required for infection to occur, and the bacteria also spread most readily in humid weather. Goss's wilt tends to be more severe in fields with high levels of corn residue.

Disease Symptoms

Early leaf symptoms are oblong or elongated lesions of water-soaked, grayish-green tissue that progress to long dead streaks with wavy, irregular margins (Figure 1a). These streaks extend along the leaf veins, which suggests a bacterial infection. One of the most characteristic symptoms of Goss's wilt is leaf "freckles" that develop within the streaks (Figure 1a and 1b). In addition, a sticky exudate forms in the streaks, which dries to form a glistening residue, or varnish, within the lesion (Figure 1c). As lesions enlarge and coalesce, they form large areas of necrotic tissue on the leaves and eventually, entire leaves may wilt and dry up (Figure 1).

Plants may also be infected systemically by Goss's wilt, especially in the seedling stage. These plants have discolored vascular tissue, with a slimy bacterial exudate in the stalk. Plants are commonly stunted and wilt and die as if drought stressed.

Goss's wilt symptoms can be confused with those of another bacterial disease, Stewart's wilt. Laboratory tests can easily distinguish them, but careful field examination can separate the diseases as well. In general, development of Goss's wilt is most common after a hailstorm or sandblasting, whereas Stewart's wilt epidemics occur when populations of flea beetles are high.

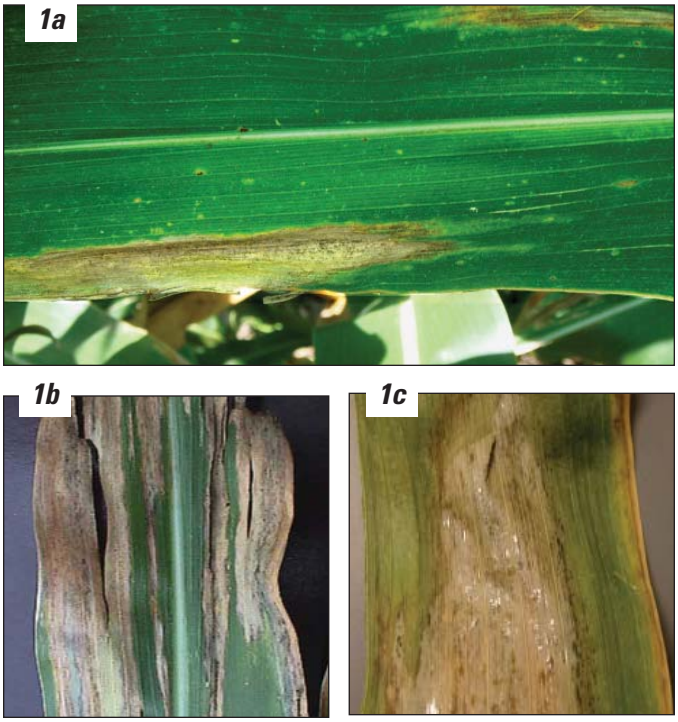

Figure 1. Goss's wilt symptoms on corn leaves.

Therefore, Stewart's wilt is accompanied by obvious flea beetle feeding scars on leaves. Table 1 lists other distinctions between these two diseases.

Table 1. Comparison of important features of two bacterial wilts of corn: Stewart's wilt and Goss's wilt.

Symptoms	Stewart's Wilt	Goss's Wilt
Infection of corn	Flea beetle	Hail storm
Long irregular lesions	Yes	Yes
Leaf freckle symptoms	No	Yes
Varnish-like exudate	No	Yes
Crown cavity symptoms	Yes	No
Vascular discoloration	Yellow	Orange

**Adapted from University of Nebraska*

Bacterial soft rot can often occur in the same field with Goss's wilt, and can sometimes be confused with systemic Goss's infection. Bacterial soft rot can be caused by a number of bacterial species, but is most often associated with *Erwinia chrysanthemi pv. zea*. Other *Erwinia* and *Pseudomonas* species have also been identified as soft rot causal agents. These bacteria survive in plant residue and infect through physical wounds in the corn plant. Rain splash due to strong thunderstorms and sprinkler irrigation are associated with severe levels of infestation.

Yield Loss

Goss's wilt limits yield by reducing green leaf area and causing premature death in corn plants (Figure 2). Timing of the infection has a critical role in the disease's influence on grain yield. Early infections lead to the greatest yield reductions, whereas late infections may have little yield influence. Yield reductions of 50 percent have been documented when susceptible

hybrids were infected early in the growing season. Other agronomic issues such as stalk lodging may result from fields that have prematurely died from Goss's wilt. This can result in further reductions in yield (harvest losses) and quality.


Figure 2. Goss's wilt lesions may expand to eventually encompass entire corn leaf.

Disease Management

No rescue measures are available to control Goss's wilt, so preventing or avoiding infection are crucial. Where the disease is already present in a field, growers can minimize damage by reducing corn residue and using resistant hybrids.

Prevention/Avoidance

Goss's wilt may be transmitted from field to field by equipment and weather that move infected residue. Harvest and tillage equipment, balers, and wind can all transfer infected residue and soil to previously uninfested fields. To help avoid spreading the pathogen in this way, harvest and till infected fields last and clean equipment of crop residue.

Reducing Corn Residue

Crop rotation and tillage, when practical, can be used to reduce the amount of corn residue remaining on the soil surface to infect the new crop. Crop rotation to a non-host crop such as soybeans, dry beans or alfalfa allows for an additional year of corn residue decomposition between corn crops. Deep tillage is especially effective at incorporating and burying infected residue. However, these practices only reduce but do not prevent disease occurrence. Goss's wilt has occurred on fields that are first-year corn and in fields that were plowed.

Resistant Hybrids

Because useful levels of resistance to Goss's wilt have been identified in certain parent lines and hybrids, hybrid resistance is becoming the primary method for disease management of Goss's wilt.

Pioneer researchers screen hybrids for resistance to Goss's wilt at sites with reliable annual disease pressure. In addition to screening under natural infestations, researchers also hand-inoculate inbreds and hybrids with Goss's wilt bacteria and evaluate for disease symptoms. With the recent outbreaks of Goss's wilt, new samples of Goss's wilt bacterium have been collected and incorporated into the screening program to address potential strain shifts. Hybrids are rated against known susceptible and resistant hybrids using Pioneer's 1 to 9 rating system (1=susceptible, 9=resistant).

On-farm strip trials provide an additional resource for data collection if the disease occurs. The primary maturity range for Goss's screening is from 90 CRM to 110 CRM. However, due to the recent increase in Goss's incidence in Manitoba, Kansas and the Texas Panhandle, Goss's screenings have been expanded. Pioneer now offers a wide genetic range of hybrids with very good to excellent resistance within a hybrid maturity range of 75 to 118 days.

Pioneer will continue using all available plant breeding technologies to improve hybrids for Goss's wilt resistance. This includes screening parent lines and hybrids in areas with severe natural infection, as well as use of molecular markers to identify more resistant types prior to field screening. These steps are designed to accelerate hybrid improvement for resistance to Goss's wilt bacterial disease.

Notes

Positioning Pioneer® brand Hybrids in Goss's Wilt Areas (S = Suitable to grow hybrid with this rating)					
Field Situation	Previous Crop	Goss's Wilt History	Goss's Wilt Rating		
			5	6	7+
Corn Following Crop Other Than Corn	Rotational Crop	No	S	S	S
Corn Following Crop Other Than Corn	Rotational Crop	2 yrs. previous	S	S	S
Corn Following Corn	Corn-Unknown Goss's Wilt Resistance	No	S	S	S
Clean Tillage - Very Little Residue	Corn	Previous year		S	S
Minimum Tillage - Existing Surface Residue	Corn	Previous year			S
Corn Following Corn	Corn Unknown Score	Previous year			S
Corn Following Corn	Pioneer hybrid with a Goss's Wilt score of 5 or lower	Previous year			S
Corn Following Corn	Pioneer hybrid with a Goss's Wilt score of 7 or higher	Previous year		S	S
Corn Following Corn	Corn	2 yrs. previous, previous year			S
Corn Following Corn	Susceptible Competitor Hybrid	Previous year			S
Corn Following Corn	Corn	Unknown			S

ADDITIONAL CONSIDERATIONS

Irrigation Type – Overhead irrigation vs. gravity irrigation. Overhead irrigation simulates a rain event and rain splash with every irrigation, consequently, increasing the possibility for Goss's Wilt.

Soil Type – Sandy soils are prone to blowing sand and sand blasting; potentially increasing the likelihood of early-season infection.

Cultural Practices – Cultural practices that cause injury to the plant may increase the risk of Goss's Wilt infection.

Hybrid Rotation – This is a recommended practice that prevents placing susceptible genetics on the same field year after year.

Border Fields – If bordering fields have a history of Goss's Wilt, then consideration should be given to planting hybrids with at least a "6" score.

Hybrid Suitability Ratings and position statements are based upon analysis of hybrid agronomic characteristics and field observations of Pioneer agronomists and research scientists. Suitability ratings are not based upon research in these environments. Since not all combinations of environmental factors can be observed and rated, hybrid response to these environments can be variable. Characteristics such as disease tolerance, relative maturity, early growth and plant height can make a hybrid well suited in one region and poorly suited in another region. Please use these ratings as suggestions only. Pioneer makes no warranty regarding the environmental suitability of hybrids as stated in this guide.

DISEASE PRECAUTION: Grower should balance hybrid yield potential, hybrid maturity and cultural practice selection against their anticipated risk of a specific disease and need for resistance. In high disease risk conditions, consider planting hybrids with at least moderate resistance ratings of 4 or higher to help reduce risk. When susceptible hybrids with disease ratings of 1 to 3 are planted in conditions of high disease pressure, the grower assumes a higher level of risk. If conditions are severe, even hybrids rated as resistant can be adversely affected. Independent of yield reduction, diseases can predispose plants to secondary diseases such as stalk rots. This requires individual field and hybrid monitoring for stalk stability and timely harvest when warranted.

IMPORTANT: Ratings based on comparison with other Pioneer hybrids, not competitive hybrids. Ratings are assigned from research and data over a wide range of both climate and soil types, based on average performance across area of adaptation under normal conditions. Extreme conditions may adversely affect performance. Contact your local Pioneer sales professional for specific product information in your area.

DISEASE & PEST RATINGS: 8-9 Highly Resistant; 6-7 Resistant; 4-5 Moderately Resistant; 1-3 Susceptible.; Blank=Insufficient Data. Scores based upon period-of-years testing. Refer to www.pioneer.com/growingpoint or FIS for the latest and complete listing of traits and scores for each Pioneer corn hybrid.