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CONTROLLING CORN DISEASES
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Root and Stalk Rots

The root and stalk rots of corn commonly observed in Iowa are incited by fungus pathogens. In some instances the pathogen can cause both root and stalk rot and some pathogens are associated with only one or the other.

The root rots can be separated into those that attack all portions of the root system and those that affect primarily the fine feeder roots. Symptoms are generally non-descriptive and isolations must be made to confirm the identity of the pathogen. The most common pathogen isolated from all roots is Helminthosporium pedicellatum. The frequency of isolation can vary with genotype. Fusarium spp. as a group, usually cause the most damage, but one or more of five or six species may be involved. The fusaria commonly spread into the crown of the plant (the five or six compacted nodes that comprise the lower portion of the plant and give rise to the rings of adventitious roots) and then spread into the stalk tissues. Pythium graminicola is a specialty fungus that attacks the root tips, especially the fine feeder roots, and progressively rots the roots from the tips to the main branches. The damage caused by P. graminicola is not apparent until one wonders what happened to the feeder roots. This fungus is favored by wet soils, compacted soils, heavy soils, and no-till conservation tillage. In some very wet years it can be isolated frequently from the crowns of plants that died quickly and prematurely.

Root rots occur 99% of the time with severely rotted stalks. This association does not infer that the root rot fungi spread through the crown tissues into the stalks. Conditions that trigger stalk rot development also favor root rot development. The development of root rot will predispose the plants to stalk rot and vice versa. Therefore the apparent association of root rot and crown rot with stalk rot is not spurious, but the stresses on the plant due to one disease will lower the resistance to the other rots. The rots of the roots, crown, and stalk can develop from many independent infections and the progress of any one infection has an effect, through plant vigor and resistance, on the potential severity of the other infections.

The kernels developing on a corn ear are the primary sink for the photosynthates (sugars) produced in the green leaves and translocated through the plant. Photosynthates in the stalk accumulate in the kernels and under stress conditions where the leaves cannot provide adequate photosynthates for both the stalk and ear, the carbohydrate level of the stalk and roots becomes limiting and resistance decreases. Then, incipient, latent, and arrested infections by pathogens
develop further. Stresses imposed on the plant after tasseling are the stresses that generally result in increases in the frequency of stalk rot. These may be drought, insect feeding, hail, high plant population, fertility, leaf diseases, root diseases, prolonged cloudiness, or any other malady that interferes with photosynthesis and plant vigor.

The control of root, crown, and stalk rots is achieved through resistance and cultural practices. Breeding for resistance has been both intentional and incidental. Some companies inoculate them with specific stalk rot pathogens and select genotypes based on root strength and root mass. Some select for performance of genotypes, which includes stalk quality under stress environments. Some select for the trait of "stay green" stalks and a dry ear. The performance of hybrid corn varieties (stalk lodging, root lodging, yield, and dropped ears) may be obtained from results of the Iowa Corn Yield Tests, available through the Iowa State University Cooperative Extension Service. Local variety demonstration plots planted by the companies may be useful in selecting the better hybrids. Stalk rot can also be a problem when unadapted hybrids are used, especially using hybrids adapted for Minnesota and North Dakota in Iowa. The use of conservation tillage has generally had a positive effect on the control of stalk rots. No-till could lead to Pythium root rot problems, especially with heavier soils. Soil compaction could lead to Pythium root rot. Increased stalk rot is a probability when plant populations are increased above populations recommended for the hybrid in the area, when fertility is inadequate or unbalanced (especially with higher than normal N, or inadequate N and/or K), green leaf area is decreased by diseases and insect feeding, stalks are damaged by corn borer tunneling, and moisture becomes limiting. The farmer has control over some of these factors.

**Leaf Diseases**

A prevalent disease every year is common rust, caused by the fungus *Puccinia sorghi*. This obligately parasitic fungus supposedly does not survive the winters in Iowa and the spores of the organism must be blown in from the Southern states where it parasitizes living corn plants during the winter. Lesions are observed in Iowa by early June and frequently by mid-June. Cool wet weather during the summer is ideal for development of rust. Normally common rust development is inhibited greatly by the hot summer temperatures and the disease does not increase greatly until the cooler nights of late August and September. Sweet corns and some inbred lines of dent corn are very susceptible to rust. Most dent hybrids are somewhat resistant to rust, especially until mid-August, and this usually suppresses disease development greatly. Southern rust, which is caused by *Puccinia polysora*, is normally prevalent in Iowa about one out of every four years. Southern rust is associated with hot, humid weather with nightly dews. There is essentially no resistance to Southern rust in corn belt hybrids, but the lateness of the epidemics and cooler weather late in the growing season tend to prevent serious epidemics.

The corn flea beetle is the overwintering source and primary vector of the bacterium *Erwinia stewartii*, which is the causal agent for Stewarts wilt of corn. The bacteria survive the winter in the body of the insect and are transmitted to the plants by the same insect. Survival of
the corn flea beetle will occur when the average temperatures for December, January, and February total 90 degrees or more, which usually means that the flea beetle (and bacterium) do not survive most Iowa winters and the "flea beetle survival line" is usually about mid Missouri. Occasionally there is survival in Southern Iowa, but usually the flea beetles must migrate north with Southerly winds. The bacteria may be systemic in the vascular system of many corn varieties, yet the leaf lesions are the most obvious symptoms of the disease. The disease is often misdiagnosed as Northern leaf blight. Stewart’s wilt is primarily a problem for seed producers because it is on the quarantine list for most countries buying US produced corn seed.

Northern leaf blight, Northern leaf spot, gray leaf spot and eyespot and anthracnose are the more common foliar diseases where the pathogen overwinters in the debris from the prior corn crop. These diseases are more severe with conservation tillage and continuous corn cropping because the debris on the soil surface is a ready source of inoculum. Northern leaf blight, which is characterized by elongated, lens shaped lesions about 2 to 6 inches long, is observed every year over the entire state. Some years, like 1990, it reaches epidemic proportions. This disease is caused by the fungus *Exserohilum (Helminthosporium) turcicum*, which exists as several races. The more common races are races 1 and 3, which are effectively controlled by the single Ht1 gene, and race 2, which defeats the Ht1 gene. Because race 2 of *E. turcicum* became widely distributed throughout the corn belt during the last 10 years, most of the newer hybrids are being released without the Ht1 gene. The races that dominated in 1990 were 1 and 3, because some fields among the severely diseased would be green and any Northern leaf blight lesions were of the small, chlorotic, non-sporulating resistant type ascribed to Ht1. The seed companies confirmed that these hybrids carried the Ht1 gene. Ten years ago most of the hybrids had the Ht1 gene and after race 2 developed, it became the predominant race. Seed companies stopped incorporating Ht1 into their newer hybrids, because the gene had limited effectiveness.

Northern leaf spot appears every year and can be a severe problem in a few hybrids and in many of the seed production fields, especially in Eastern Iowa. The fungal pathogen, *Bipolaris zeicola* (=*Helminthosporium carbonum*), exists as 3 or 4 races. In 1989, 1990, and again in 1991, Northern leaf spot was a problem in some seed production fields north of Interstate 80 from Eastern Iowa, through Wisconsin, Illinois, Indiana, and Michigan according to several seed company representatives. The disease apparently is most severe on materials of B73 heritage, moderately severe on Mo17 types, and lightest on Oh43 derivatives. This host selectivity is one of several reasons to support designating this apparently new pathogen as race 4 of *B. zeicola*. This new pathogen is one that must be followed closely because of the large number of hybrids that are derived from B73 and Mo17 types and because it has become a serious problem for seed producers.

The remaining three leaf diseases of any importance in Iowa are gray leaf spot (*Cercospora zeae-maydis*), eyespot (*Kabatiella zeae*), and anthracnose (*Colletotrichum graminicola*). All are fungal pathogens. Gray leaf spot was prevalent throughout Iowa in 1991, and was the most common disease in seed production fields. There is little resistance to gray leaf
spot in corn belt hybrids. Eyespot prevalence has diminished in recent years because of resistance in most current hybrids. Because of the wet weather in 1991, which delayed planting greatly, the shorter season hybrids used by many farmers were fairly susceptible. Low inoculum potential prevented serious eyespot epidemics, however. Anthracnose can be found every year, but the leaf blight phase is rarely an important disease. Anthracnose as a stalk rot pathogen is very important in Iowa. The shiny black discoloration of the surface of the affected stalks is very diagnostic.

Leaf Disease Control

The principles of disease control are avoidance, exclusion, eradication, resistance, protection, and therapy. These principles are implemented through various practices and management techniques. Some of these are appropriate for controlling leaf diseases of corn and some have little application.

Avoidance

Selection of fields for corn production that have low levels of inoculum is important for avoidance of the pathogen. Corn fields that had high levels of foliar diseases in 1991 may best be avoided for corn production in 1991, except if the main problem in 1991 was rust. The rust pathogen will not survive in the plant debris, therefore the plant debris will not be a source for rust inoculum in 1992. Crop rotation is a good practice to employ with the other pathogens, because the inoculum from the prior season is avoided. This is especially true with large fields. The use of strip intercropping is not a satisfactory rotation scheme, because the debris from the prior corn crop is adjacent to the next years crop repeatedly throughout the field. Strip intercropping is an inadequate rotation scheme for control of leaf pathogens that survive in plant debris. A long cold winter will kill the corn flea beetle, thereby eliminating the Stewarts wilt bacterium, and the farmers will avoid this disease early in the growing season in 1992.

Exclusion

Seed certification and seed treatments are procedures to exclude seed borne and seed transmitted pathogens from the fields. The Stewarts wilt bacterium and Bipolaris zeicola are the only leaf pathogens that are seed transmitted to the next crop. Growers are at the mercy of the seed producers, because seed health certification is not required with corn seed produced for domestic use. Nearly all seed is treated with a fungicide and this will control the surface borne fungal pathogens.

Eradication

The eradication of fungal leaf pathogens is practiced by management techniques that destroy the overwintering inoculum of the pathogen. This can be achieved by several procedures.
The debris from the prior crop that carries the pathogen can be buried by plowing, removed from the field by cutting the corn for silage or fodder, or employing crop rotation practices which allow for other microorganisms to digest and rot the debris and kill the pathogens before corn is replanted into the field. Theoretically tillage practices performed soon after harvest of corn would expose the pathogens in the leaves and stalks to the soil microflora longer than tillage practices done in the spring and should hasten the demise of the pathogens.

**Resistance**

Resistance is a primary means for control of many leaf pathogens. Corn hybrids and inbreds differ in their responses to all of the leaf pathogens mentioned above. Because there are numerous hybrids available to every grower, the growers must rely on the seed producers and seed sales representatives to inform them of the relative disease resistance of the hybrids for sale. The Ht1 gene for resistance to race 1 of the Northern leaf blight pathogen has not been incorporated into most of the inbreds used to produce the newer hybrid introductions. Although races 1 and 3 have been the dominant races of *F. turcicum* in Iowa in recent years, race 2 of the pathogen exists in Iowa and could return to be the dominant race if extensive use of Ht1 resistance were to recur. Most seed companies are breeding for broad based resistances to all of the diseases. Farmers should notice the disease severity in the hybrids in the demonstration plots that the seed companies plant in the neighborhood, but compare only among the varieties in that planting. The inoculum potential, disease pressure, and management will likely be different at each planting site, therefore it is unwise to compare disease severities between sites. Comparisons should not be made between an early maturing hybrid and a late hybrid. An early hybrid may avoid a late season epidemic and thereby look more resistant than a later hybrid. Resistance to leaf diseases is often lost as the plant nears senescence; thus an early hybrid may look very susceptible at the same time that a later hybrid appears green and less diseased, when in fact both varieties are equal in resistance.

**Protection**

Protection from fungal leaf pathogens is commonly achieved by using foliar fungicides. Tenn-Cop 5E (Reg. TM of Boliden Intertrade Inc.), which is the copper salts of fatty and rosin acids, is the only fungicide registered for use on field corn; there are no feeding restrictions. Bravo (Reg. TM of ISK Biotech Corp.), which has the common name chlorothalonil, is registered for use on seed corn, but the residue cannot be fed to livestock. In 1991, seed corn producers in some states (not Iowa) were granted limited FIFRA Section 18 specific exemptions to apply propaconazole [Tilt (Reg. TM of Ciba-Geigy Corp.)] to seed corn. The efficacy and current status of the three materials will be discussed in the conference workshop.

The effectiveness of fungicide applications is influenced by characteristics of the fungicide formulation, the life cycle of the pathogen causing the disease, and the weather. Both of the registered compounds are non-systemic fungicides and act only as external protectants on the leaf
surface. They must be applied before the fungus penetrates into the leaf and the fungicide must possess the tenacity to remain on the leaf surface and be effective against future inoculations by spores of the fungus. The fungicide is subject to erosion by elements of the weather, therefore the fungicide may need to be reapplied at seven to 14 day intervals. Leaf tissues emerging from the plant whorl after application will not be protected. The fungus spore, after being deposited on the leaf surface, must germinate and penetrate the leaf surface. Germination and penetration may require from six hours to five or more days, depending on the pathogen invading. After penetration into the leaf, the fungus parasitizes the leaf and this activity may go unnoticed for three to 20 or more days until a visible lesion appears. This period between penetration and lesion development is known as a latent infection or the latent period of infection and is fairly constant for a pathogen. The latent period of infection for Northern leaf spot is three to five days, for rust, and eyespot is about ten days. Northern leaf blight is about 14 days, and gray leaf spot is 14-24 days. The fungicides will have no effect during the latent period of infection, therefore the application of a fungicide may initially appear ineffective, because the latent infections will continue to develop lesions and the fungicide will be effective only in the prevention of new penetrations and infections. Fungicides must be applied early in the epidemic to have a significant effect on disease development; once the leaves have some noticeable disease, there will be numerous latent infections and the fungicide application may be essentially useless. The effect of timing of fungicide applications will be discussed in the workshop. The cost of fungicides and applications would probably preclude the use of fungicides on field corn, but can be cost effective for seed corn and sweet corn production.

**Therapy**

There are no curative treatments for leaf diseases of corn.