Controlling Corn Diseases in Conservation Tillage

Conservation tillage systems use crop residues on the soil surface to retard soil erosion, insulate the soil, and conserve soil moisture. This residue consists of leaves, leaf sheaths, ear husks, and stalks of corn that decompose very slowly on the soil surface. The relationship of surface residue to corn diseases can be divided into two categories: (1) a source of inoculum of disease-causing organisms, and (2) environment modification for the disease-organisms and the corn plant.

Residue as an Inoculum Source

Many diseases of above-ground plant parts are caused by pathogens that depend on host residues for survival between crops and as a base for inoculum production the next season. The residue also provides nutrients for pathogen growth and spore production. In the case of continuous corn, the pathogen is already in the proximity of the host, thereby accentuating disease potential (figure 1).

Many leaf and stem pathogens normally do not survive in residue buried in soil for more than a few months, except when temperatures are low or the soil is very dry. When residue is buried in soil, it is continually moist and there is a reduction of inoculum potential that results from the antagonistic activities of saprophytic soil microorganisms colonizing the decaying residue, a form of biological control. The antagonistic microorganisms destroy or suppress the pathogens and decompose the residue, thereby depriving the pathogens of protection and a nutrient source (figure 2).

Foliar Diseases Affected by Residue

Following in alphabetical order by common name are some foliar diseases whose incidence and severity depend upon residues on the soil surface as a source of inoculum.

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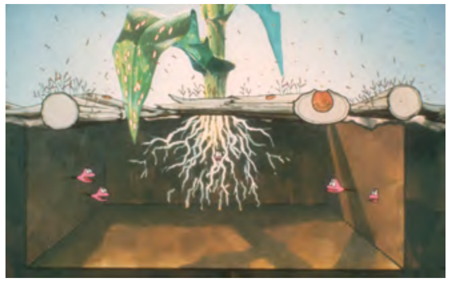

Figure 1: Fungi sporulating on residue in which they have overwintered are causing leaf spots on corn. Fungi are microscopic. They are shown here larger than life.

Figure 2: Soil microorganisms destroying residue and disease-causing fungi that have been buried in soil. Microoganisms are shown here larger than life.

Anthracnose

Anthracnose, caused by the fungus *Colletotrichum graminicola*, has a variety of symptoms including root rot, seedling blight, top dieback, and ear and kernel infections. The most conspicuous symptoms are leaf blight, top dieback, and stalk rot.

Certain dent corn and sweet corn hybrids and inbred lines are very susceptible and can be severely damaged when grown under minimum tillage with a corn-corn rotation. Severity of leaf blight is directly associated with surface residue which is the source of inoculum. Consequently, anthracnose has been observed in a higher incidence in no-till compared with conventional tilled fields. The causal fungus has been observed to survive in infested corn stalks above the soil surface with infective conidia (spores) produced on these stalks after 10 months in the field. *C. graminicola* is gradually eliminated from tissues as soil saprophytes colonize the residue. The disease may increase and spread late in the season and produce extensive stalk rot with few leaf lesions.

Figure 3: Symptoms of anthracnose on corn leaf.

Figure 4: Symptoms of anthracnose top dieback.

Figure 5: Symptoms of anthracnose on corn stalk.

Leaf symptoms are brown, spindle-shaped lesions with yellow to reddish-brown or purple borders (figure 3). **Top dieback symptoms** (figure 4) are death of the top of the plant. If the leaf sheath is peeled back, black blotches can be seen on the stalk. **Stalk rot symptoms** are large dark brown to shiny black areas on the outside of the lower internodes (figure 5). Pith tissue becomes disintegrated and infected plants may lodge. Frequently, the stalk

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above the ear will die four to six weeks after pollination but the rest of the stalk may remain green. Some control is achieved through use of resistant hybrids, crop rotation, and balanced soil fertility.

Eyespot

Eyespot disease, caused by the fungus *Kabatiella zeae*, is a major problem associated with conservation tillage of corn in Iowa. The fungus overwinters primarily in undisturbed stalk and husk debris; therefore, the amount of disease is directly related to the amount of infested corn residue on the surface and the severity of the disease the previous year. Disease is also more severe in continuous corn.

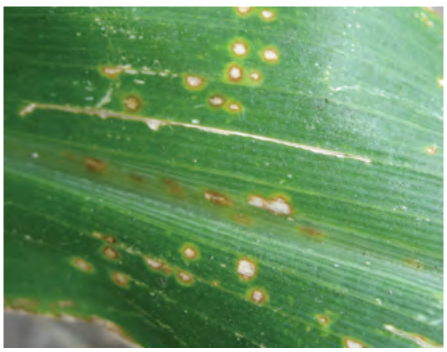

Figure 6: Symptoms of eyespot.

Symptoms are small (about 1⁄16 to 1⁄8 inch in diameter), circular tan spots surrounded by a brown or purple ring with a narrow yellow halo (figure 6). The spots increase abundantly on the lower leaves until mid-August when the disease increases very rapidly on the upper leaves of some hybrids. Spots occur on the husks, leaf sheaths, and stalks.

Seedlings and young plants will exhibit symptoms 10 to 12 days after a prolonged rainy period in the spring. Hybrids vary greatly in susceptibility and some fairly resistant dent and popcorn hybrids are available.

Spores of *K. zeae* can be carried by air currents to infect plants in fields, usually late in the season. A farmer should look for symptoms of this disease in early September and if observed, two choices for the next year include planting a resistant variety of corn or rotating to another crop for one or two years.

Goss's wilt

This disease is caused by the bacterium *Corynebacterium nebraskense* and is becoming relatively widespread in the western Corn Belt.

The causal bacterium overwinters in infected residue on the soil surface. It serves as the primary source of inoculum although the bacterium also can be seed borne and seed transmitted. Transmission to seedlings occurs at very low rates and thus is not considered a major source of inoculum.

Symptoms are gray-green lesions with irregular margins that enlarge and become brown. Droplets of bacterial exudate may occur on the surface of diseased tissue, appearing as a crystalline substance that glistens in sunlight and looks like dark "freckles" when dry (figure 7). Control may be obtained with resistant hybrids, crop rotation, and use of seed from disease-free areas.

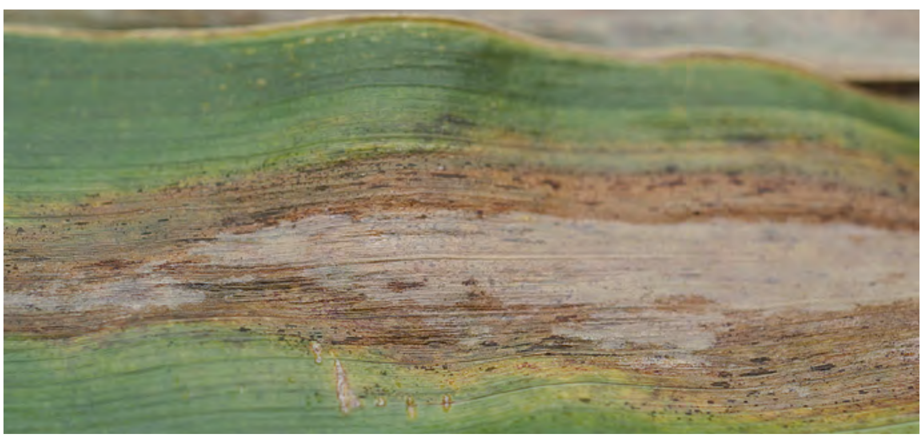

Figure 7: Symptoms of Goss's wilt.

Gray leaf spot

This disease is caused by the fungus *Cercospora zeae-maydis*. Before 1971, it was considered an obscure disease. Its intensive development in the southern U.S. early in the growing season had been associated with the widespread practice of no tillage.

Gray leaf spot is now prevalent in Iowa. Besides reduced tillage, prolonged high relative humidity and leaf wetness daily for extended periods are conducive for disease development.

Symptoms are long, narrow, rectangular dark brown lesions on the leaf that are delineated by leaf veins (figure 8). Severe stalk rot and lodging may also occur, but these are caused by secondary organisms. Control is resistant hybrids.

Figure 8: Symptoms of gray leaf spot.

Northern corn leaf blight

Outbreaks of northern corn leaf blight, caused by the fungus *Helminthosporium turcicum*, have been associated with mild, moist weather and cultural practices of continuous corn and conservation tillage. The fungus overwinters primarily as conidia on corn residue. Some conidia can survive in soil alone. Most inoculum is probably of local origin with the initial lesions resulting from virulent conidia on corn residue and in soil coming in contact with young plants. Therefore, susceptible hybrids can be more seriously diseased under

Figure 9: Symptoms of northern corn leaf blight.

Figure 10: Seedling blight. The mesocotyl is rotted by soil fungi.

conservation tillage conditions than with conventional practices. Symptoms are long (up to 6 inches) elliptical leaf lesions that are gray-green to tan (figure 9). Sporulation can be seen on the lower side of the leaf as a black fuzz during the morning while dew is still on the plant.

Two types of resistance are available, monogenic and polygenic. The lesions on monogenic resistant plants will remain gray-green to yellowish with little tan coloration; few spores are produced. This lack of sporulation retards the development of new lesions. Lesions on plants without monogenic resistance have distinct borders between the tan lesion tissue and the green lesion tissue.

New races of the pathogen are present that overcome some sources of the monogenic resistance. Polygenic resistance is manifested through fewer and smaller lesions somewhat resembling a susceptible reaction. However, polygenic resistance is stable and effective against all known races of the pathogen.

Diseases Affected by Environment

Residue may create a soil environment that is favorable for disease early in the growing season and unfavorable for plant growth. Organisms that attack the roots, the root-crown and lower stalk area, and seedlings are soil-borne and well equipped for life in the soil. Burial of residue containing these pathogens usually does not seriously reduce their inoculum potential. Such pathogens have protective mechanisms to retain possession of host residue against other saprophytic soil colonizers or form structures that enable them to survive outside of the tissue. Therefore, the relationship of these microorganisms to conservation tillage is by surface reducing affecting the environment. This affects disease directly by affecting pathogens or indirectly through host susceptibility.

Seedling blight and stunting

Crop residue on the soil surface affects soil temperature and moisture. Early in the growing season, residue insulates soil from solar radiation, thereby retarding the warming of the soil which remains cooler than plowed soil and creates a favorable environment for disease. The lower soil temperature delays germination, emergence, and early growth of corn. However, several fungi are able to grow well in cool, wet soils and attack the roots of plants.

There is evidence that corn residue can emit water-soluble toxins that percolate into the root zone with rain water and can be taken up by the seedlings. These cause stunting of root growth, top growth, and yellowing of the leaves. This is most apparent with no till corn.

Above-ground symptoms of seedling infection are yellow, wilting and death of leaves, and stunting of the top growth. The young roots will be rotted. The mesocotyl (first internode above the seed) also can be rotted, which impedes movement of water and nutrients from the seed and primary roots to the shoot (figure 10). Seed rots and pre-emergence damping off can be a problem when cool soil or saturated soil conditions persist for extended periods of time. Prolonging the time that the young plant is dependent on the seed for food will provide more time for the soil-borne pathogens to attack the seed and seedling in the hostile soil environment.

Treatment of the seed with a fungicide is probably the best control of seed rots. Conservation tillage systems that move the residue aside and leave a narrow band of freshly-tilled soil, like till planting, are probably the better systems for avoiding seedling problems in the spring.

Stalk rot

Later in the growing season, conservation tillage may provide an environment that is unfavorable for stalk rot. Stalk rot ordinarily is caused by several different genera of soil fungi. It is considered a stress disease because it is accentuated when plants are stressed during grain filling by drought, hail damage, corn borer injury, extended cloudiness, and leaf diseases. It probably begins as a root rot and crown rot when roots do not receive enough sugar to maintain vigorous life (figure 11). Roots receive sugar as it is made by photosynthesis. However, the amount of sugar produced is determined by several factors including water and minerals available to the plant. Therefore, the stresses leading to stalk rot are environmental factors that reduce sugar making processes, particularly water availability.

More moisture is usually available under conservation tillage than conventional

Figure 11: Plant on left is affected by stalk rot; healthy plant is on right.

tillage systems throughout the growing season. The significance of the additional moisture under no-till its ultimate effect on stalk rot.

Lack of moisture later in the growing season is more likely to occur under conventional tillage and put stress on corn that predispose plants to stalkrot organisms.

Symptoms of stalk rot are sudden death of plants with leaves turning gray-green and drying up (figure 12). This resembles frost injury.

How to Control Diseases

Control measures for diseases of corn grown under conservation tillage do not differ radically from conventional tillage. Following are some general control measures that will aid in the control of corn diseases under conservation tillage conditions.

Be observant

A farmer must pay more attention to fields throughout the growing season. Observation of diseases will allow a corn grower to make more intelligent management decisions for the next year. Different diseases may require different control measures; a farmer has to know which disease is causing the injury, how widespread and how severe it is. Leaf diseases that appear one year and will likely carry over to the next year and will require management decisions for the next year's crop.

Figure 12: Corn plants prematurely killed by stalk rot.

Resistant hybrids

Planting resistant hybrids is still the most economical way to control plant diseases. However, hybrids developed for conventional tillage may not be adequate for reduced tillage systems.

Crop rotation

Crop rotation has been one of the most ignored but better disease control practices. This could be the most important practical control measure currently available. Many corn disease problems in conservation tillage will occur in a continuous corn rotation. Most corn pathogens can attack only corn and are starved out when corn or its residues are absent. The rotation period required for disease control depends on the rate of crop residue decay.

Certain diseases may occur on more than one crop; therefore it is important to identify the disease problem. Additionally, some pathogens produce airborne spores that can be blown long distances. Fields adjacent to conservation tillage fields may be affected.

Other factors

Certain herbicides or insecticides may predispose plants to disease or they may directly affect the pathogen. Weeds and volunteer plants may serve as hosts for viruses and insect vectors of plant disease. Conservation tillage has changed the spectrum of problem weeds and this could affect disease incidence. Several insects that affect corn are increased under conservation tillage and these insects can predispose plants to plant diseases, especially stalk rots and root rots. Other variables that may become more important are planting date, plant density, row spacing, method or timing of irrigation, and kind and amount of fertilizer.

Conservation tillage and similar cultural systems must continue to expand to conserve soil. Leaving plant residue on the soil surface is a practical way to control soil erosion.

Foreseen and unforeseen problems come with each new cultural practice. Disease problems will occur and there probably will be losses before control measures become adequate. Nevertheless, it does not appear that disease problems are insurmountable.

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