Corn Stewart's Disease

Stewart's disease of corn, or Stewart's wilt, caused by the bacterium *Pantoea stewartii,* formerly called *Erwinia stewartii,* was first reported in New York in 1897. The disease also has been called bacterial wilt or bacterial leaf blight. The disease is common in North America but is economically important only during periodic outbreaks. Stewart's disease is generally more destructive on sweet corn than on popcorn or dent corn, but some hybrids and inbred lines of popcorn and field corn are very susceptible. The disease tends to be more common in the southern part of the Corn Belt and in the eastern United States. This disease is somewhat unique because its spread depends almost completely on an insect vector, the corn flea beetle.

Stewart's disease was the most significant bacterial disease of corn in the United States during the first half of the 20th century. It was economically a very important disease, but its importance declined with the introduction of more resistant hybrids and the northern movement of the sweet corn industry. In the latter half of the century, there have been occasional severe outbreaks, especially in sweet corn. During the 1990s, Stewart's disease increased again in economic importance due to recurring favorable weather conditions and the existence of restrictions in many nations against the import of seed grown where the pathogen is present. Currently, the impact of Stewart's disease is in three areas: yield loss in sweet corn due to leaf blighting and sometimes plant death; moderate yield loss in dent corn in some years due to leaf blighting; and the impact on the corn seed industry in terms of testing costs and loss of export markets.

Symptoms

There are two phases for the symptoms of Stewart's disease—the wilt phase and the leaf blight phase. In either case the symptoms initially appear as leaf lesions originating from flea beetle feeding scars (Fig. 1).

Lesions begin as pale-green to yellow, sometimes water-soaked streaks extend along the leaf veins.

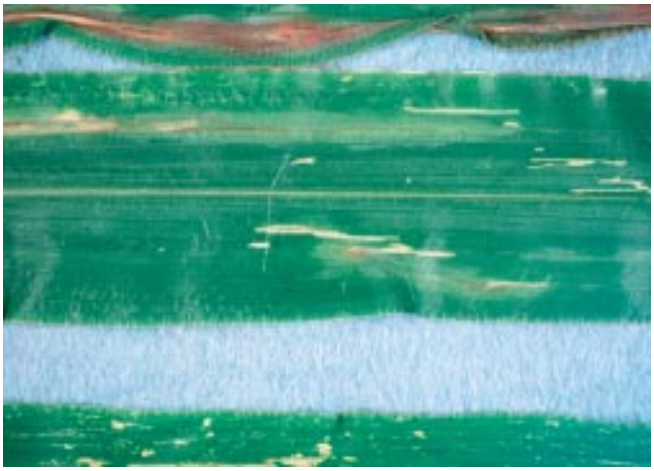

Figure 1. Corn flea beetle feeding scars and early symptoms of Stewart's disease (Photo by G. P. Munkvold)

The wilt phase generally occurs in seedlings but can occur in older plants of very susceptible sweet corn. Inbreds and sweet corn hybrids are most likely to be affected, but occasionally the wilt phase impacts dent corn hybrids. The wilt phase is associated with systemic (whole-plant) infection, but plants can have systemic infection without displaying the wilt symptoms. As the bacterium spreads rapidly within the plant, entire leaves wither and die, and the plants are stunted, or the entire plant may wilt and die (Fig. 2). The plants may produce dwarfed, bleached tassels that eventually shrivel and die. Plants showing wilt symptoms often display leaf blight symptoms also. As the bacterium spreads into the stalk tissue, it causes a browning and necrosis of the vascular bundles. Yellow masses of bacteria may ooze from the vascular bundles of systemically infected stalks (Fig. 3) when the stalks are cut and squeezed. This can be followed by a general browning and water-soaking of the stalk tissue. Sometimes open cavities will form in this tissue (Fig. 4). Stalk rot fungi may invade the weakened plants, resulting in further damage later in the season.

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Figure 2. Sweet corn hybrids collapsing from wilt phase of Stewart's disease (right); resistant hybrid (left) (Photo by J. K. Pataky, University of Illinois)

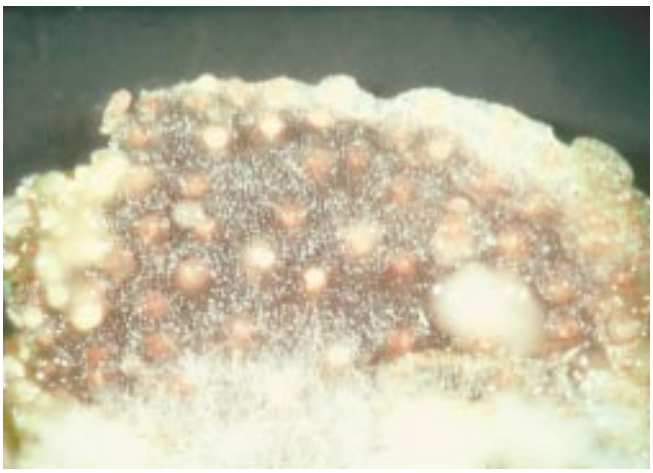

Figure 3. *Pantoea stewartii* oozing from a cut stalk. (Photo by C. C. Block)

Figure 4. Cavity in corn tissue of severely affected seedling. (Photo by P. H. Flynn)

The leaf blight phase can occur any time during the season but is more common after pollination. When seedling leaves are blighted, they often wither and die, but the plant continues to produce new leaves. On adult plants, leaf blighting is more obvious because no new leaf tissue is produced. Leaf lesions begin as described earlier. As the lesions expand, their margins become irregular or wavy (Fig. 5). Lesions may extend the entire length of the leaf. They range in width from 1/16 to 1/2 inch. As the disease progresses, these leaf streaks die and turn brown (Fig. 6). Entire leaves may be blighted as lesions coalesce (Fig. 7). Secondary fungi often grow on the dead tissue. In severe cases, yield can be reduced and the diseased plants become more susceptible to stalk and root rots.

Figure 5. Yellow streak with wavy margin typical of Stewart's disease. (Photo by G. P. Munkvold)

Figure 6. Extensive Stewart's disease lesions (Photo by G. P. Munkvold)

Disease Spread and Development

The bacteria survive low winter temperatures in the digestive tract of dormant, adult corn flea beetles, *Chaetocnema pulicaria* (Fig. 8). Although the pathogen may survive in other flea beetle species, they are not believed to contribute significantly to infection of corn. The corn flea beetle is the primary mode in which the bacteria are able to overwinter, and the primary vector for disease spread. The beetles spend the winter in the soil of grassy areas near agricultural fields. As the adult beetles emerge and feed in spring and early summer, bacteria are deposited in feeding wounds and enter the veins of corn leaves. Beetles feeding on infected tissue acquire the bacterium and further spread the disease throughout the season. An infested beetle carries the bacterium for the rest of its life. Other insects can acquire, carry, and transmit *P. stewartii* to corn plants. The beetle stages of rootworms and several flea beetle species can be vectors of the pathogen, but their impact is minimal compared to the corn flea beetle.

In addition to overwintering beetles, some corn flea beetles may be blown into the Corn Belt states from further south. They will feed on grasses and small grain crops if corn is not available, and then move to corn soon after it emerges. Corn plants adjacent to grassy areas and winter wheat crops often are affected more severely by Stewart's disease.

Figure 7. Leaf almost entirely blighted by Stewart's disease (Photo by G. P. Munkvold)

The bacterium that causes Stewart's disease can be detected in seeds from severely diseased, systemically infected plants. Transmission of the bacterium from seed to young seedlings has been demonstrated, but it is extremely rare. Studies assessing the risk for seed transmission have concluded that the risk is almost nonexistent under commercial conditions. Only severely affected plants produce infected seed. Most of this seed is of poor quality and would be removed during routine seed conditioning. Even among infected seeds, the frequency of seed transmission is extremely low (0.02 percent or less).

Nutrition also influences the severity of Stewart's disease. High levels of ammonium nitrogen and phosphorus tend to increase susceptibility, while high levels of calcium and potassium tend to decrease susceptibility. High temperatures also enhance development of the disease.

Temperature and Flea Beetle Survival

Warm winter temperatures favor the survival of flea beetle vectors and increase the risk of Stewart's disease. A generally accepted method to assess the risk of disease is to add the mean monthly temperatures for December, January, and February. If the sum of the mean temperatures is 90° F or greater, the beetles survive in high numbers and the disease risk is high;

Figure 8. Corn flea beetle and feeding scars (Photo by M. Rice)

if the sum is between 85° and 90°, the risk is moderate to high; 80° to 85°, moderate to low; and a sum less than 80° represents a low risk. Recent observations suggest this system may be too conservative (the predicted risk is too low) for predicting Stewart's disease in Iowa seed production fields. Heavy snow cover acting as insulation favors the survival of the beetles, and other undefined factors probably influence beetle survival and disease development.

Control of Stewart's Disease

In sweet corn, planting resistant hybrids is the most effective means of control. Most dent corn hybrids have adequate partial resistance, but when flea beetle populations are very high, damage still occurs. There are no cultural practices that are known to reduce the disease. Foliar insecticides, soil insecticides, or systemic seed treatment insecticides can reduce disease incidence early in the season. Late-season control is not practical because soil or seed-treatment insecticides do not have a long enough duration of activity, and the cost of extending foliar sprays throughout the season is prohibitive. Insecticide use can be economical in sweet corn and seed corn production but less so in commercial hybrid corn production. Established economic thresholds for flea beetle control with a foliar insecticide are as follows: in commercial hybrid corn prior to stage V5, 50 percent of plants with severe feeding injury and five or more beetles per plant; in seed corn on susceptible inbreds, 10 percent of the plants with severe feeding injury and two or more beetles per plant. Several insecticides are registered. The thresholds originally were based on insect feeding damage alone; therefore, somewhat lower thresholds may be appropriate for genotypes very susceptible to Stewart's disease.

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