41. Dutch Elm Disease

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Dutch elm disease is a systemic vascular wilt disease caused by the fungus *Ceratocystis ulmi*. Its presence was first confirmed in North America in Ohio in 1930. By the 1980's it had been found in all parts of the United States except the desert Southwest, and in eastern and central Canada.

Hosts and Distribution

C. ulmi is exclusively a parasite of trees in the elm family (Ulmaceae). Among 28 species of elms tested, the response ranged from highly resistant to highly susceptible. Among other genera in the elm family, including species of *Celtis* and *Zelkova*, only *Z. carpinifolia* was susceptible; all others were highly resistant or immune. Elm species native to the Great Plains include American (white) elm, rock elm, slippery (red) elm, winged elm, and cedar elm. The first four are susceptible to the Dutch elm disease fungus and are killed outright; the cedar elm, native to the southern Plains, is susceptible although some resistant individuals may occur.

Figure 41-1. Yellowing of foliage is an early symptom of Dutch elm disease in American elm.

Figure 41-2. Infected American elm in a windbreak. In late symptom development, all foliage on the tree wilts and the tree dies.

Of several exotic elms that have been planted on the Plains, the most common is Siberian elm, which has been widely used in shelterbelts, on farmsteads, and in urban plantings. The Siberian elm, as it occurs on the Great Plains, is best considered moderately tolerant to Dutch elm disease. Among other Asiatic elms, *Ulmus japonica*, *U. laciniata*, and *U. villosa* contain a high proportion of resistant trees. The Chinese or evergreen elm, *U. parvifolia*, is highly resistant or immune to Dutch elm disease. Several European elm species and hybrids are moderately resistant, but they are not climatically adapted to the Great Plains and are seldom planted here. There are several active tree breeding programs in the United States, Canada, and Europe, attempting to produce elm hybrids or selections that are resistant to Dutch elm disease. Several trees from these programs are already being tested and more can be expected in future years.

Symptoms and Signs

In a susceptible species such as American elm, the first symptoms of Dutch elm disease are yellowing of foliage (fig. 41–1), followed by wilting and browning. Usually a single branch is affected first; the symptoms then spread to adjacent branches. Later, one whole part of the tree may be symptomatic, and the entire tree finally wilts and dies (fig. 41–2). This progression of symptoms may develop in a single season in highly susceptible individuals, but often takes several years.

The fungus is strictly a vascular parasite, invading the xylem vessels of the host tree. It can persist in wood for several years after the tree dies. When bark on infected branches is peeled back, brown streaks in the wood indicate the presence of a vascular infection (fig. 41–3). Other wilt-causing fungi may also cause streaking of the wood, so this symptom is not entirely diagnostic for Dutch elm disease. Positive diagnosis requires a laboratory test in which chips of wood (not bark) from streaked branches are placed in a moist chamber for 7–10 days. Under these conditions, the coremia—fruiting structures of the *Pesotum* (formerly *Graphium*) stage of *C. ulmi*—will be produced on the chips (fig. 41–4). These coremia appear as dark stalks 2–5 mm high, supporting a pale globose ball of slime containing the spores.

Disease Cycle

Like most members of the genus *Ceratocystis, C. ulmi* is uniquely adapted for, and entirely dependent on, vectored transmission from tree to tree. There are two vectors for the Dutch elm disease fungus in North America, the native elm bark beetle, *Hylurgopinus rufipes*, and the lesser European elm bark beetle, *Scolytus multistriatus*. Both of these beetles feed and breed under the bark of living or recently dead elm trees or logs. As they fly from infected trees, they carry the spores of the Dutch elm disease fungus and introduce it to healthy trees as they feed. Both species of elm bark beetles are effective vectors.

The cycle of infection by the causal fungus is tied to the life cycle of the vectors. The beetles breed in recently dead elm wood or weakened living trees. If the fungus is present in such breeding sites, emerging beetles will carry spores of *C. ulmi* to healthy elms and introduce the fungus in feeding sites on young twigs. The beetles can fly up to 1/4 mile in search of feeding or breeding sites, but they may be blown many miles by winds.

Damage

The American elm (*U. americana*) was native along river valleys throughout the Great Plains. Because it had many desirable qualities, was easily handled, and grew rapidly, early settlers planted American elm in their cities and towns, on farmsteads, and later in windbreaks. Most of these plantings, as well as large areas of native elms, have now been lost to Dutch elm disease over much of the Great Plains. Only in the very northern and southern parts of the Great Plains do elms remain in substantial numbers. The cost to cities and towns just for removing dead elms was tremendous, and continues to be so where elms remain. The cost of losing an excellent species for farmstead windbreaks cannot be calculated, and the effect of removing one of the dominant species from the riparian forest is probably significant but completely unknown.

Control

To date there is no cure for Dutch elm disease, and the term control is a misrepresentation of what can be done; the term "Dutch elm disease management" most accurately represents the state of the pathologists' art. In urban areas, an effective sanitation program can reduce the rate of tree loss due to Dutch elm disease to a level the community can live with, allowing for gradual replacement of the trees. In rural communities, windbreaks, and native woodlands, little can be done to forestall the loss of the elm.

Individual high-value trees may be protected by injection of chemical fungicides at 1- to 3-year intervals. These materials can provide reasonable protection, but they are expensive and the repeated wounding from injections may eventually damage the tree seriously. The success of these treatments for therapy of infected trees is much more limited. They may be worth trying on very high value trees but have little prospect for general use.

Some elm species have high levels of resistance to infection by *C. ulmi*. Selections or hybrids from these resistant parents have been released to the trade, but some may lack the climatic adaptability needed for good growth and longevity under Great Plains conditions. Large scale use should be deferred until wider testing has been done.

Selected References

Gibbs, John N. Intercontinental epidemiology of Dutch elm disease. Annual Review of Phytopathology. 16: 287–307; 1978.

Kondo, E. S.; Hiratsuka, Y.; Denyer, W. B. G. Proceedings of the Dutch elm disease workshop and symposium. Winnipeg: Manitoba Department Natural Resources; 1982. 517 p.

Sinclair, W. A.; Campana, R. J., eds. Dutch elm disease: Perspectives after 60 years. Ithaca, New York: Cornell University Agricultural Experiment Station. Search (Agriculture) 8(5): 1–52; 1978.

Figure 41-3. Brown streaking in the wood indicates presence of *Ceratocystis ulmi* in host vascular tissue.

Figure 41-4. Pesotum (Graphium) stage of *C. ulmi* produced on wood chips plated on an agar medium.