Additional Pest Surveyed: Hickory Decline

Year 2011
State: Iowa

Forest Pest
Common Name: Hickory Decline
Scientific Name: *Fusarium solani* and *Ceratocystis smalleyi*

Hosts: Bitternut Hickory and Occasionally Shagbark Hickory

Setting: Rural Forests and Urban

Counties: Statewide

Survey Methods: Ground, General Observation, and Culturing

Acres Affected: Statewide

Narrative: **Submitted by:** Jennifer Juzwik, Northern Research Station, USDA Forest Service, St. Paul, MN, and Ji-Hyun Park, formerly with Dept. of Plant Pathology, University of Minnesota, St. Paul.

A five year investigation of the cause of rapid crown decline and mortality of bitternut hickory was concluded in September 2011. Results of a series of related studies found that multiple cankers and xylem (the water conducting tissue) dysfunction caused by *Ceratocystis smalleyi* are correlated with rapid crown decline typical of a limited vascular wilt disease. Because reproductive attacks by the hickory bark beetle (*Scolytus quadrispinosus*) also are correlated with canker and xylem lesion occurrence, the synergistic interaction of the beetle and the fungus in combination with host stress (e.g. drought) is important in disease development. This disease has been referred to as hickory decline or hickory dieback in the past several decades; however, the researchers propose hickory wilt as a more appropriate name based on their recent findings. A brief synopsis of the key results supporting these conclusions is presented in this report.

Hundreds to over one thousand Hbb attacks were found on the main stem of three bitternut hickory with active crown decline (40, 55 and 80% decline rating) that had been felled and debarked. The extent of beetle colonization ranged from aborted to fully successful (i.e. full gallery system). Between 26 and 585 bark cankers and xylem lesions also were found on the main stems of the same trees. *C. smalleyi* is frequently isolated from such damaged tissues. A high percentage (92 to 94) of these cankers and lesions were associated with Hbb attacks. Female Hbbs captured while creating entry tunnels during initial attacks were found to commonly carry viable propagules of *C. smalleyi* on their bodies. These results indicate that fungus spores dislodge from the beetles during tunneling, germinate, and infect the wounded bark and sapwood tissue, resulting in bark cankers and xylem lesions.

Bark cankers up to 25 inches long were produced on hickory stems within 12 months of inoculation with a water suspension of the *C. smalleyi* spores. Long, narrow reddish-brown discoloration of sapwood was always associated with each fungus- inoculated point. In cross-section, corresponding discoloration in the sapwood was observed in a wedge-shaped pattern. The fungus was commonly observed in multiple elements of the xylem tissue, including vessel, parenchyma cells and fibers. Tyloses (balloon-like structures) were abundant in early-wood vessels of the fungus-inoculated trees. Multiple, contiguous tyloses were found to plug many more vessels in fungus-inoculated trees compared to the fewer ones formed in response to water-inoculation. Gelatinous materials produced in response to fungal infection were also found to plug late-wood vessels. Thus, over-expressed tree response to infection induces physical plugging of the water-transport system of infected bitternut hickory.

The resulting impact of numerous bark cankers and xylem lesions on sap flow rate was experimentally tested in non-Hbb attacked, but fungus inoculated, bitternut hickory in two natural stands. Sap flow rates were measured in both *C. smalleyi*-inoculated and water-inoculated trees 13 months after treatment. Fifty inoculations were made between 6 and 13 feet above ground on the main stem of each poletimber-sized study tree. Significantly lower sap flow rates during mid-day were found for fungus-inoculated trees compared to the water-inoculated and non-inoculated controls. Statistical analyses found significant interactions between average maximum sap flow rate and abundance of tyloses in the outer two annual rings of study trees in both experimental sites. Significantly fewer tyloses were found in the water-inoculated trees than the fungus-inoculated ones. Correlation analysis also detected significant interactions between maximum sap flow rate and proportion of cankered bark area of the study trees. Thus, reduced sap flow rates in bitternut hickory with numerous stem infections apparently result from fungus-induced and fungus-produced obstructions in the xylem vessels. Furthermore, multiple cankers and xylem lesions and resulting tree response can logically explain the symptom of rapid crown decline with wilting foliage observed in affected bitternut hickory. This disease situation is similar to that of infections of oaks in Japan by the fungus *Raffaelea quercivora* following attacks by an ambrosia beetle species in a disease known as Japanese oak wilt. Thus, hickory wilt is a logical name for this particular disease of hickory based on its similarities to the Japanese oak wilt.

In summary, the results from the above series of studies document the deleterious effects of multiple cankers and xylem dysfunction caused by *C. smalleyi* on the health of bitternut hickory. The synergistic interaction of Hbb and *C. smalleyi* results in numerous bark cankers and debilitating xylem lesions of affected trees that the researchers hypothesize leads to rapid crown decline and tree death, especially following predisposing events such as drought that lead to build-up of the beetle population.

http://na.fs.fed.us/spfo/pubs/pest_al/hickory/hickory.htm

Figure 28. The pictures below shows the hickory bark beetle attack and associated cankers. (Image: Dr. Jennifer Juzwick, USFS).